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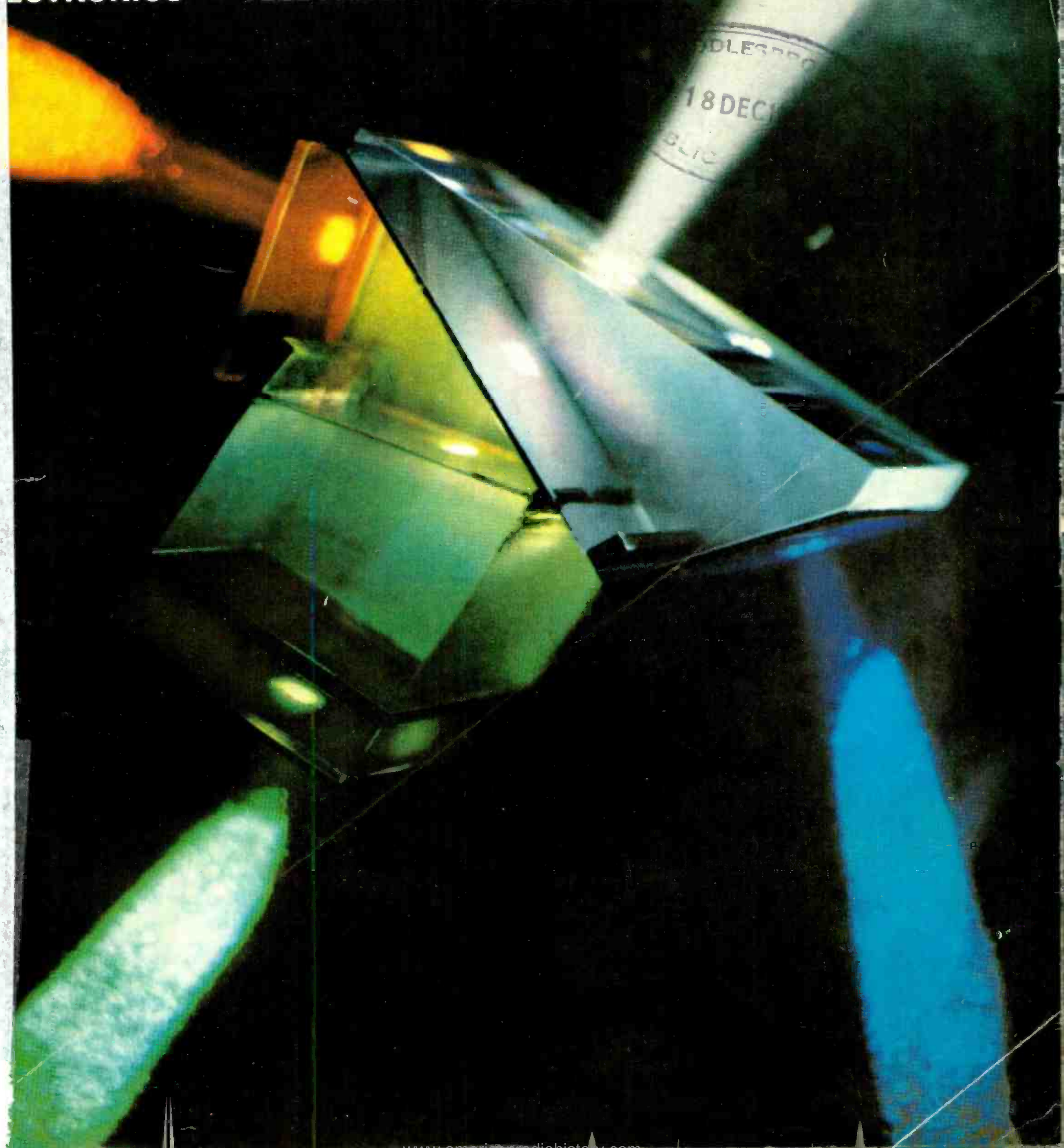

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A Genuine Reject?

WHILE the article by T. D. Towers in this issue on transistor type numbers should assist readers in identifying a particular device and tracking down the manufacturers, one is tempted to ask how much faith can be placed in a type number? Large users of semiconductors buy direct from the manufacturers and can have every confidence in the devices they receive. The situation is rather different, however, for the home constructor who requires only a couple of AC107s. It has become apparent that unscrupulous dealers are stamping reject transistors with well-known type numbers and selling them as genuine items. Type numbers have also been altered when a particular device is in short supply; an example of this would be to remove the D from OC81D. Restamped devices often do not resemble the transistors they replace, electrically or mechanically or both. It is a well-known fact that many transistors will operate, to the detriment of the circuit, under conditions for which they were not intended, thereby facilitating the deception. The deceit is not limited to individual sales of semiconductors; complete equipments and sometimes kits are being marketed that use reject semiconductors, although no mention is made of this in the literature.

The home constructor would blame his own workmanship, lack of knowledge or the circuit he was making when it failed to operate satisfactorily rather than suspect that the semiconductors were not what they claimed to be. We do not deprecate the use of reject transistors; we only object when they masquerade as "on spec" devices.

How can the home constructor recognize these devices? The deception is not easily detected although the print used on restamped devices is usually large and untidy or the new markings are sometimes placed on a plastic sleeve slipped over the transistor. Genuine transistors nearly always carry the manufacturer's name or emblem and usually also a batch number—re-marks have neither of these. Another point to watch for is the case and lead-out configuration; sometimes the re-marks are not even in the correct encapsulation. Because the range using the old European coding "OC" is probably the most common and best known as far as the home constructor is concerned it is these devices that appear to be most often misrepresented.

Our advice is, deal only with a reputable supplier, return any devices that are not what they are claimed to be and beware of the isolated term "guaranteed." Guaranteed for what?

By Numbers

ANOTHER aspect of numbering is raised by a correspondent whose letter is published in this issue. He pleads for a common identification or part-numbering system for components. Instead of each user of a component giving his own part-number to it—depending upon the particular piece of equipment in which it is to be used—there should be, the writer suggests, a British Standard part number that all could use. If this were done it would certainly simplify the specification of components but it would, of course, mean that every variant of the physical and electrical specification of a particular resistor, capacitor, or what have you, would have to bear a different number. Only those most closely concerned with the supply of components will fully appreciate the difficulties experienced in the present jungle, but is the correspondent's suggestion practicable? Perhaps the introduction of i.cs provides a golden opportunity for starting such a scheme.

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Radio Signals from the Heart of Matter

An old circuit—the superregenerative receiver—put to a new use in analysis of materials by nuclear quadrupole resonance spectrometry

By D. A. TONG, B.Sc., Ph.D.

Only too often research into atomic scale phenomena involves large and costly electronic apparatus. Presented here is a technique that can provide useful information about the actual electron distribution within a molecule but which only costs a few pounds to set up. The article should provide enough information to enable the interested electronics experimenter or student to experience for himself the thrill of picking up radio signals from the very heart of matter, the atomic nucleus.

THE superregenerative receiver[1] was widely used by radio amateurs in the early days of v.h.f. because it combines very high sensitivity with great simplicity. Later on as v.h.f. techniques advanced, its disadvantages, i.e., poor selectivity, poor frequency stability and radiation of interference, resulted in its virtual elimination as a serious rival to the superheterodyne receiver for communications work. Since the early 1950s, however, the superregenerative detector has embarked on a new career in a totally different field, that of the branch of nuclear magnetic resonance (n.m.r.) spectrometry known as nuclear quadrupole resonance (n.q.r.)[2] spectrometry. Later in this article we will describe simple circuitry with which it is possible to detect n.q.r. in suitable solids, but first it will be useful to discuss briefly the physical basis of the phenomenon itself.

THEORY OF N.Q.R.

A spinning atomic nucleus has a magnetic moment which is colinear with the axis of spin, and therefore can be regarded as a minute spinning bar magnet. Because of its submicroscopic size, however, the motion of such a magnet in a magnetic field can only be described adequately by means of quantum mechanics, and, in fact, differs somewhat from that of a spinning magnet of ordinary size.

When an ordinary bar magnet is placed in a magnetic field, it tends to take up a position of minimum potential energy; that is, with its magnetic moment aligned along the field direction as shown in Fig. 1(a). Any small displacement from this position makes the magnet oscillate as shown in (b), until its potential energy has been dissipated by friction, when it again comes to rest. If, instead of being stationary, the magnet is continually spinning about an axis coincident with its magnetic moment (c), it still tends to align along the field (shown by H_0), except that any displacement now results in a precession about the field direction (d), instead of a vibration. The behaviour is entirely analagous to that of a spinning gyroscope in the earth's gravitational field, and the angular frequency of the precession is proportional to both the magnetic moment, M, and the applied field strength, H_0. Fig. 1 (e) is a vector diagram representation of the precession.

When, on the other hand, one considers the motion of a spinning magnet of nuclear dimensions in a magnetic field, one finds that, unlike the classical magnet, it can never align itself completely along the field, to do so would be to violate the Heisenberg Uncertainty Principle. In fact, the angle that the spin axis makes with the field is restricted to one of a limited number of "allowed" values and the spin axis therefore precesses continually about the field direction.

In practice one is not concerned with the nucleus of a single atom but usually with specimens containing extremely large numbers of atoms. Under such conditions the individual nuclear magnetic moment of one atom cannot be observed and one can only detect the resultant of all the microscopic moments. Not surprisingly, perhaps, this resultant, or "macroscopic", magnetic moment behaves in many ways as if it belonged to a spinning bar magnet as shown in Fig. 1. In particular, it tends to align itself completely along the direction of an applied magnetic field. Then, if the spin-system is suddenly disturbed by suitably applying energy to the sample, the macroscopic moment temporarily begins to precess around the field direction at some particular angle and at a frequency, the "Larmor" frequency, which depends on the nuclear magnetic moment and the applied field strength.

The method usually adopted for transferring energy to the sample is to introduce a second magnetic field at right-angles to the first, but one which is oscillating at a radio

Dr. David Tong, who is 26, graduated in chemistry at Leeds University and received his Ph.D. for research into chemical applications of N.Q.R. He has been a research fellow at the University of Warwick and has recently joined the staff in the Department of Chemistry, University of Glasgow. Dr. Tong has developed an improved superregenerative N.Q.R. spectrometer which is to be produced by Decca Radar Ltd. to which he is a consultant.

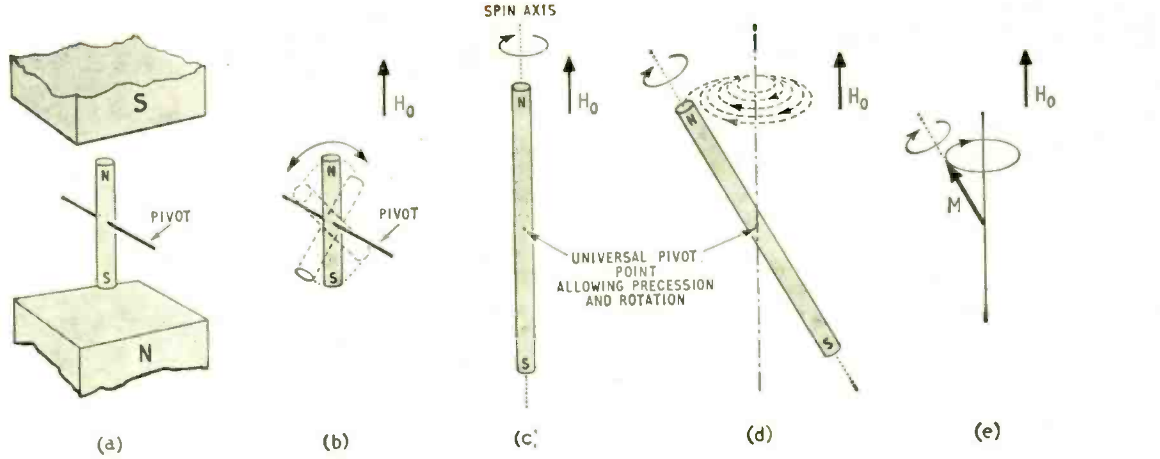


Fig. 1. (a) Equilibrium position of a bar magnet in a uniform magnetic field. (b) shows the oscillations of the bar magnet about the equilibrium position resulting from a small displacement therefrom. Assuming the bar magnet is spinning about its long axis, (c) shows it in its equilibrium position in the uniform magnetic field. (d) shows the precession about H_0 which results from displacing the spinning magnet from its equilibrium position. In a real system the precession dies away as shown as the potential energy of the displaced magnet is dissipated. Finally (e) shows in vector form the precessing magnet in the absence of frictional forces; M represents the magnetic moment of the magnet.

frequency. Such a field is equivalent to two separate fields rotating in opposite directions, and if the rotation frequency is much different from the Larmor frequency, neither has any appreciable effect on the spin system. In contrast, when the two frequencies are identical the effect is considerable, because, no matter how the macroscopic moment precesses, the resultant of the steady field, H_0, and the component of the oscillating field which rotates in the same direction as the precession, H_1, will always act so as to pull it away from the H_0 direction. The system is then said to be in resonance, and energy is absorbed from the rotating field. This effect is shown in Fig. 2. In the case of the hydrogen nucleus, for example, the Larmor frequency is 42.577 MHz in a field of 1.0 tesla (10,000 gauss), and is therefore well within the radio-frequency range. All other nuclei have lower frequencies than this.

So far we have only discussed the phenomenon of n.m.r., but it is now only a small step to extend the discussion to explain n.q.r. (Fig. 3). Atomic nuclei with the property of spin fall into two groups according to whether the distribution of their positive charge is spherical or non-spherical. Nuclei in the latter category, in addition to having a magnetic moment also possess an electric quadrupole moment. Such a moment is equivalent to two electric dipoles placed back-to-back, and if a quadrupolar nucleus is present in a non-uniform electric field, it experiences a torque and will tend to align itself with its quadrupole moment (which is co-linear with the axis of spin and the magnetic moment) along the direction of maximum electric field gradient (e.f.g.). Moreover, as the nucleus is spinning, precession at certain " allowed " angles will again occur, but in this case it will be about the e.f.g. direction.

Notice, however, that such precession still involves a precessing magnetic moment and the resultant of a large number of such moments can still couple with a rotating magnetic field. In short, in n.q.r. the interaction energy, and hence the resonance frequency, is determined by an electrostatic field gradient acting on the nuclear quadrupole moment, whereas in n.m.r. the important interaction is that of the nuclear magnetic moment with an external magnetic field. Both effects can be detected by interaction between the macroscopic magnetic moment and a rotating magnetic field.

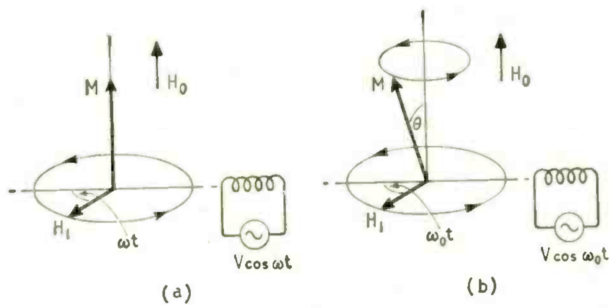


Fig. 2. Interaction of the macroscopic nuclear magnetic moment M with a steady magnetic field H_0 and a rotating magnetic field H_1. (a) When the frequency of rotation ω is different from the Larmor frequency ω_0, M remains aligned along H_0 and is unaffected by H_1. (b) When H_1 rotates at W_0, M experiences a force which pulls it away from the H_0 direction, about which it precesses.

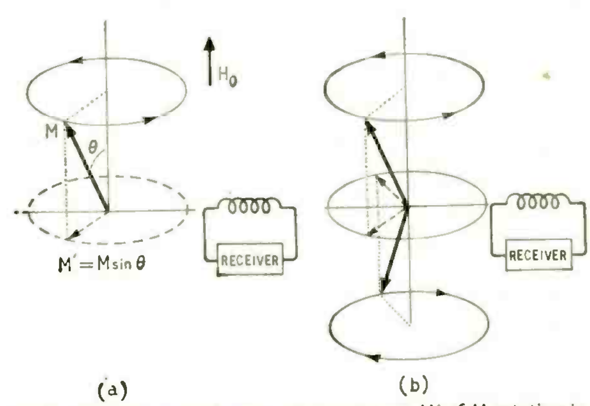


Fig. 3. (a) In the case of n.m.r., the component M′ of M rotating in a plane perpendicular to the steady field direction induces an alternating voltage in the sample coil. (b) The case of n.q.r. in powdered samples is similar, except that H_0 is not present and M, which is now the resultant of a large number of macroscopic moments each precessing about a different direction, is accompanied by an equal and opposite moment rotating in the opposite direction.

The main difference between the two techniques in practice is that a large external magnetic field must be applied to the sample to detect n.m.r., and by varying the field strength the resonance frequency can be brought into a suitable range. The e.f.g. necessary for n.q.r., on the other hand, is already present in most crystalline solids and the resonance frequencies are fixed. The e.f.g. arises from the detailed electron distribution within chemical bonds, and since the n.q.r. frequency depends directly on the e.f.g. important information about these distributions can be obtained. Typical n.q.r. frequencies range from as low as 5 MHz right up to several thousand, depending on the properties of the particular nucleus and the type of compound.

THE SUPERREGENERATIVE DETECTOR

Having looked at the magnetic resonance phenomenon, we can now return to what is probably more familiar ground and see where the superregenerative receiver enters the picture. We have mentioned that to excite a resonance it is necessary to place the sample of material in a coil which is supplied with r.f. current. This can be done very conveniently by making the coil part of the tank circuit of an oscillator. The system can then be easily tuned over the necessary wide frequency range. If the level of oscillation is arranged to be critically dependent on the tank circuit Q, as in the so-called marginal oscillator, the sudden absorption of energy by the sample as the oscillator passes through the resonance frequency causes a drop in r.f. level and provides a means of detecting the resonance. Such oscillators, many of them very simple, are widely used for studying n.m.r. For n.q.r., however, considerably greater values of H_1 are required, and this is where the superregenerative oscillator (s.r.o.) comes into its own, for even when a superregenerative receiver is adjusted for maximum sensitivity, the average r.f. level may be several volts. In fact, it behaves also as a low-power transmitter—as anyone knows who has tried to operate two such receivers within half a mile of each other.

The s.r.o. can successfully combine high sensitivity with high r.f. levels because it is sensitive only during a very short interval between pulses, and at this point in the quench cycle the valve anode current, and hence the generated shot-noise, is low. During the bursts of r.f. oscillation, however, large peak voltages can be attained without affecting the detection process. There is, though, one important difference between a s.r.o. used for n.q.r. and one used as a communications receiver. In the last-mentioned case the circuit is adjusted to operate in a completely incoherent condition because then the gain of the circuit is a maximum, whereas a certain degree of coherence is essential for resonance excitation.

The term " incoherent " refers to the random phase relationships which exist between successive bursts of oscillation when each one builds up from noise voltages only, i.e., when each burst is completely damped before the next pulse starts to build up. When the r.f. output of such an oscillator is monitored on a receiver one finds that there is no definite oscillation frequency present but only a band of noise spread over several hundred kHz. Such a signal is useless for exciting nuclear resonances because negligible power is present in the relatively narrow width (a few kHz) of the resonance line. The situation changes, however, if the oscillations are less severely damped between pulses, because then the starting phase of each pulse is determined partly by the tail of the previous pulse and partly by noise. In other words the coherence is increased. The effect on the monitor receiver is to cause discrete frequencies to appear, and since the oscillator is pulsed, they are spaced at integral multiples of the quench frequency on either side of the oscillator's fundamental frequency.

The available power is now concentrated into narrow frequency bands and many of them are sufficiently strong to excite a resonance in a sample of material placed in the s.r.o. tank coil. Such resonances are then simultaneously detected by the circuit because the precessing macroscopic magnetic moment induces an r.f. voltage in the coil, and this voltage provides an input signal for the s.r.o., now acting in its role as a receiver (Fig. 3). The operation might be crudely pictured as that of a radar system: the s.r.o. sends out a pulse which excites the spin-system in the sample, making it ring like a high-Q tuned circuit, and the ringing signal is then picked up as the " response."

In practice, the " ringing " time, or to use its correct name, the " spin-phase relaxation time ", is of the order of milliseconds and is considerably longer than typical quench periods (10 to 100 microseconds). This is why the nuclei " see " the r.f. waveform as its Fourier components (or sidebands) rather than as individual

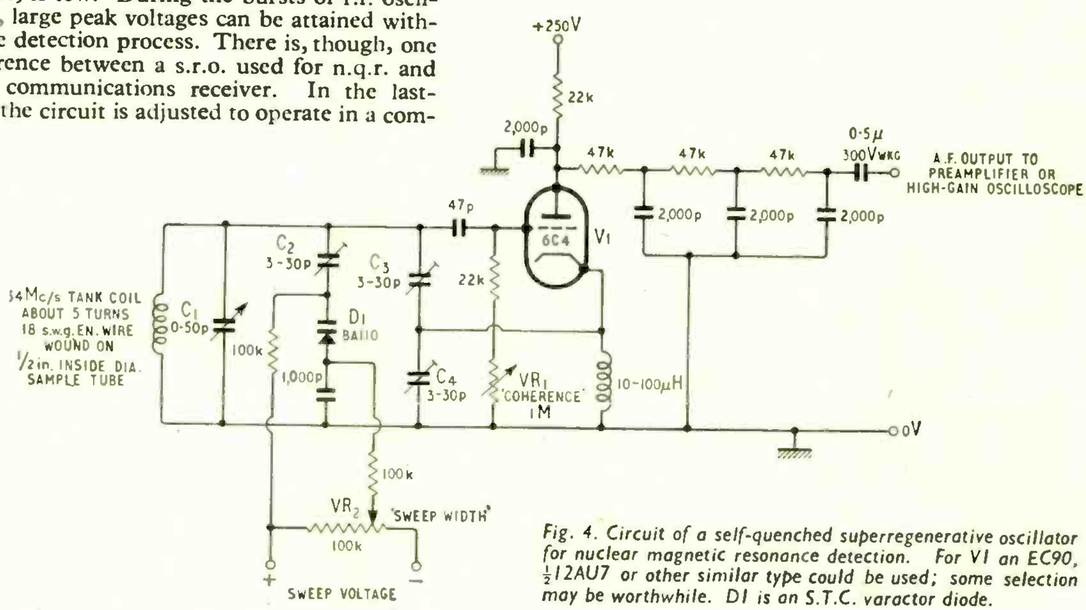


Fig. 4. Circuit of a self-quenched superregenerative oscillator for nuclear magnetic resonance detection. For V1 an EC90, ½12AU7 or other similar type could be used; some selection may be worthwhile. D1 is an S.T.C. varactor diode.

bursts of oscillation, as it appears on a wide-bandwidth oscilloscope.

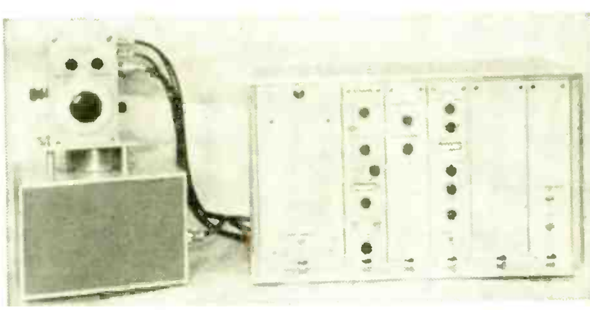
SUITABLE APPARATUS

A very simple circuit which has been widely used to detect n.q.r. in the 15 to 50 MHz range is shown in Fig. 4. The circuit is a self-quenched Colpitts oscillator, the quench frequency and coherence depending on the grid time-constant, which can be varied by VR_1. It is also self-detecting because when a signal is present the quench rate increases slightly, and this results in an increased voltage drop across the anode load resistor. After filtering out the quench frequency components the audio output signal is amplified in a conventional low-noise preamplifier, such as that of Fig. 5.

A suitable setting for VR_1 can be arrived at by monitoring the r.f. output on a receiver, the correct adjustment being half-way between that giving a very sharp series of sidebands and that which results in a broad band of noise. Since the gain of the detector depends on the coherence, VR_1 can also be adjusted by observing the noise level at the output of the preamplifier. In this case the correct setting is somewhere between the ones giving maximum and minimum noise amplitudes.

In order to observe a resonance line directly, some method is required of repetitively sweeping the oscillator frequency back and forth over a range of up to several hundred kHz, while simultaneously observing the output on an oscilloscope. Many oscilloscopes have a terminal which allows a connection to be made to the timebase output, and if this is the case, it is only necessary to connect this output in such a way as to always reverse-bias the variable capacitance diode D1. Care must be taken, however, not to exceed the maximum rated reverse voltage for the diode (30V for the BA110), or to drive it into forward conduction. The depth of modulation can be adjusted by both VR_2 and C_2. If a sweep output is not available from the oscilloscope, a sinusoidal sweep can be obtained from a mains transformer giving say 20V output, together with a suitable battery connected so that the diode is never forward-biased. Finally, if an oscilloscope is not available, it is still possible to detect a resonance by listening to the output on a pair of headphones or a loudspeaker.

The construction of the circuit should follow good v.h.f. wiring practice, keeping all r.f.-carrying wires as short and direct as possible. Beehive trimmers are suitable for C_2, C_3 and C_4, but a good quality tuning capacitor is essential for C_1, together with a good slow-motion drive. Since the resonances to be detected are likely to be only two or three times larger than the noise level at first, careful tuning is required, and the



Decca prototype n.q.r. spectrometer. (An automatic frequency marker unit is missing from this particular example and would normally occupy the blank panel space.)

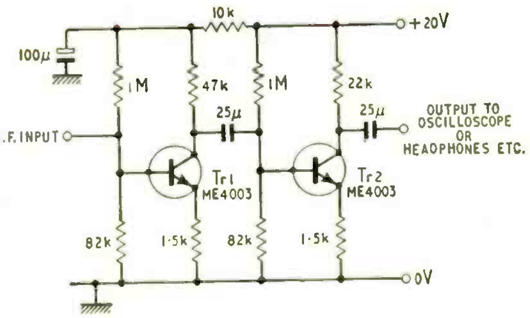


Fig. 5. A suitable audio frequency preamplifier for use with the Fig. 4 circuit.

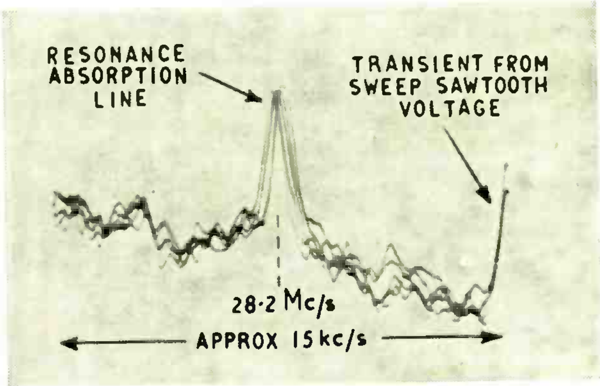


Fig. 6. Photographically recorded c.r.o. trace showing the ^{35}Cl n.q.r. line in potassium chlorate at room temperature, obtained with a circuit similar to that of Fig. 4. The position of the centre of the resonance line was slightly different on each of the five sweeps recorded because of jitter on the sawtooth generator used for the frequency sweep. Slightly higher signal-to-noise ratios can be expected for ^{35}Cl in para-dichlorobenzene.

h.t. supply should be well smoothed to eliminate hum. The r.f. choke in the cathode circuit is a rather critical component and if the oscillator exhibits dead-spots, i.e., ranges over which oscillations cease, it is likely that the particular choke has a series resonance in the range. The solution is to try a different choke.

A suitable substance which at room temperature gives a strong signal at about 34.27 MHz and another weaker one at 27.01 MHz is para-dichlorobenzene. The signals are due to the n.q.r. of the ^{35}Cl and ^{37}Cl nuclei, respectively, and the two frequencies are in the ratio of 1.2688 to 1, which is the ratio of the quadrupole moments of the two nuclei. In nature, the two isotopes occur with relative abundances of approximately three to one and this accounts for the different intensities of the two resonance lines. To observe the stronger, ^{35}Cl, line the oscillator should be set to sweep around the 34 MHz region by monitoring on a receiver, or by temporarily injecting a signal at 34.27 MHz into the s.r.o. from a signal generator. Careful tuning of C_1 should then enable the resonance signal to be seen (or heard). Final adjustments to C_3, C_4 and VR_1 should then be made in order to obtain best signal-to-noise ratios. With the para-dichlorobenzene sample contained in a glass tube of half-inch internal diameter and packed tightly to a depth of about one inch, a signal-to-noise ratio of at least ten should be attainable with a good oscillator valve. It is important to have as much sample material as possible within the coil volume and therefore the sample tube should have thin walls and the coil should be wound tightly on the sample tube itself.

Because of the sidebands present in the oscillator power spectrum, several responses are seen for each true resonance line, and for serious work some way of eliminating all but the fundamental is required. Usually this requires the use of the slightly more complicated externally-quenched s.r.o., but the methods used generally rely on the fact that if the quench frequency is altered, only the fundamental response will be unmoved. Unfortunately, with the self-quenched circuit the coherence, and hence the gain, varies as the quench rate is altered (using VR_1), but the effect should still be observable.

Sometimes the circuit will display apparent resonances which are in fact not due to the sample. These may be recognized by removing the sample, when of course a true n.q.r. signal would disappear. A neater method, however, is to place a small magnet near to the sample, whereat any n.q.r. line will be broadened so much that it will be effectively erased. This effect arises because of the interaction between the individual nuclear magnetic moments and the field, which results in a splitting of the resonance line into several components. The extent of the splitting is dependent on the orientation of the magnetic field with respect to the internal reference axes of the crystal and, in a powdered sample with its random distribution of angles, the effect is to broaden the line. Any line which does not show this behaviour cannot be attributed to n.q.r.

Another effect which can be easily demonstrated is that of temperature. If the sample is heated, the resulting expansion causes small changes in the internal electron distributions of individual molecules and leads to a change in the n.q.r. frequency. If the sample is subject to a non-uniform temperature, caused, for example, by body heat during handling, or by a nearby soldering iron, different parts of the sample have different resonance frequencies and the line is broadened. It is always advisable, for this reason, to wait five or ten minutes after handling the sample before trying to detect a resonance. Since the n.q.r. frequency depends only on the nuclear quadrupole moment, a constant of nature, and the e.f.g., a property of the particular chemical compound, it has been suggested that n.q.r. be used as a thermometer[3]. Such a thermometer would be useful in situations where frequent calibration is impossible, e.g., remote weather stations or space probes. A suitable sample in such applications is potassium chlorate, whose ^{35}Cl resonance is at 28.2133 MHz at 0°C. Its advantage lies in its low natural line-width of about 500 Hz, which means that more accurate frequency measurements are possible, and in its fairly large temperature coefficient of about −4.8 kHz per degree.

Other nuclei whose n.q.r. frequencies fall in the frequency range of the circuit of Fig. 4 are ^{69}Ga, ^{71}Ga, ^{63}Cu, ^{65}Cu, and ^{59}Co. Cobalt and gallium compounds are not readily available but a suitable copper compound is cupric oxide. This shows two broad resonance lines at 25.955 MHz and 24.028 MHz, at 28°C, corresponding to the ^{63}Cu and ^{65}Cu nuclei respectively. Finally, to give the reader an idea of the results to expect with the apparatus described, a photograph of the ^{35}Cl n.q.r. line in potassium chlorate at room temperature is shown in Fig. 6.

In conclusion the writer would like to point out that apparatus basically identical to that described above is being used in laboratories throughout the world for serious research in n.q.r.

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A Logical Bassoon

THE bassoon is notorious for the difficulty of its fingering (the pattern of raised and lowered fingers necessary to produce a particular note), and certain orchestral passages such as in Stravinsky's *Rite of Spring*, can daunt the most accomplished player. Dr. G. S. Brindley, F.R.S., a physiologist at Cambridge University, has attempted to ease the player's task by designing a new type of bassoon which uses electronic logic circuits to simplify the fingering. He gave a demonstration of the new instrument, which is based on a German bassoon, at a meeting of the British Acoustical Society held at the B.B.C. Research Department on 5th December.

Acoustically the Brindley bassoon is similar to a conventional instrument except that the acoustic column, constructed from Sapele wood, is of rectangular cross-section instead of circular. The player's fingers operate a set of keys incorporating micro-switches, and the on-off signals from these are fed to diode-transistor logic circuits which control solenoids powered from a 24 V supply. The solenoids raise and lower pads over the holes in the acoustic column. The logic circuits are arranged to separate the "holing" (patterns of open and closed holes) from the fingering, so that for each note it has become possible to choose the holing that is best acoustically and the fingering that is best for facility. (It would be possible to use a fingering system as for the piano.) First the microswitch signals are fed into "recognition" logic circuits—a series of AND gates—where each pattern of raised and lowered fingers causes a particular "note output" terminal to be activated. The signals from these terminals then pass into "programming" logic, comprising a series of OR gates, the outputs of which directly operate the holing solenoids. All the electronic circuitry, except the solenoid power supply, is mounted on the outside of the acoustic column.

Another helpful innovation in the bassoon is a 15-W electric heater, which is used not only to get rid of condensation but to tune the instrument. When being played the bassoon stands on the floor between the player's legs and causes no obstruction to his line of sight. Ordinary bassoon reeds are used. The timbre has a slight suggestion of saxophone quality.

Also at the B.A.S. meeting H. D. Harwood (B.B.C. Research Department) described and demonstrated a new B.B.C. monitoring loudspeaker which is outstanding in both its freedom from colouration and its repeatability of frequency characteristic. This has been achieved mainly by the use of a new cone material, a type of sheet polystyrene called Bextrene, which is shaped by a vacuum forming technique.

R.F. Measurements and Standards

SINCE July the British Calibration Service has been in operation and is seeking to establish centres of expertise in r.f. measurements on a larger scale than has been possible hitherto. An indication of the interest in r.f. measurements and standards, which until recently suffered from lack of official support and recognition, was provided by the attendance of about 150 at a conference on the subject held at the National Physical Laboratory from November 14th to 16th. Organized by the Institution of Electronic and Radio Engineers in collaboration with the Institution of Electrical Engineers, the conference was formally opened by Sir Leonard Atkinson, president-elect of the I.E.R.E., and a total of 18 papers was presented.

There is nothing comparable in this country to the strong central facility in the United States at the Radio Standards Laboratory of the National Bureau of Standards, although a new Division of Electrical Science has recently been formed at the National Physical Laboratory and one of its first tasks will be to establish a laboratory for r.f. measurements. Close co-operation with other European countries is also desirable and it might be a sensible plan to arrange some division of the work between countries if we are to attempt to reach the same standards of accuracy as the N.B.S. over the whole field of measurement.

COMPARISON WITH ABROAD

At the conference a review of the present position in measurement capability presented the state of the art in the U.K. in comparison with the range of standards developed in Europe and the United States. The fields covered in the range 100 kHz to 3 GHz were frequency, power, impedance and reflection co-efficient, current and voltage, attenuation, noise, field strength and power density. It was clear that further effort was required in several fields to match the best of foreign standards but at least one speaker made the point that small teams in this country had achieved results in their selected areas quite as good as those, for example, of the N.B.S. The Electrical Inspection Directorate of the Ministry of Technology, has played a leading part in improving our r.f. standards and measuring procedures and standards of impedance, power, attenuation and bridge and reflectometer methods were described. Developments are in progress to extend the accuracy of impedance standardization to 0.1% over the range 200 MHz to 3 GHz and with a new piston attenuator it is hoped to achieve an accuracy of ±0.01 dB in 100 dB. The present accuracy of power measurement is ±1% between 2 and 80 mW but a new form of dry load calorimeter is under construction. This makes use of a sensitive thermal convertor of the multi-junction type developed by Wilkins at N.P.L. to detect the temperature rise in the metal-film load resistor. The frequency range is from audio frequencies to about 5 GHz and the expected accuracy is ±0.2% for powers of 40 mW to 4 W.

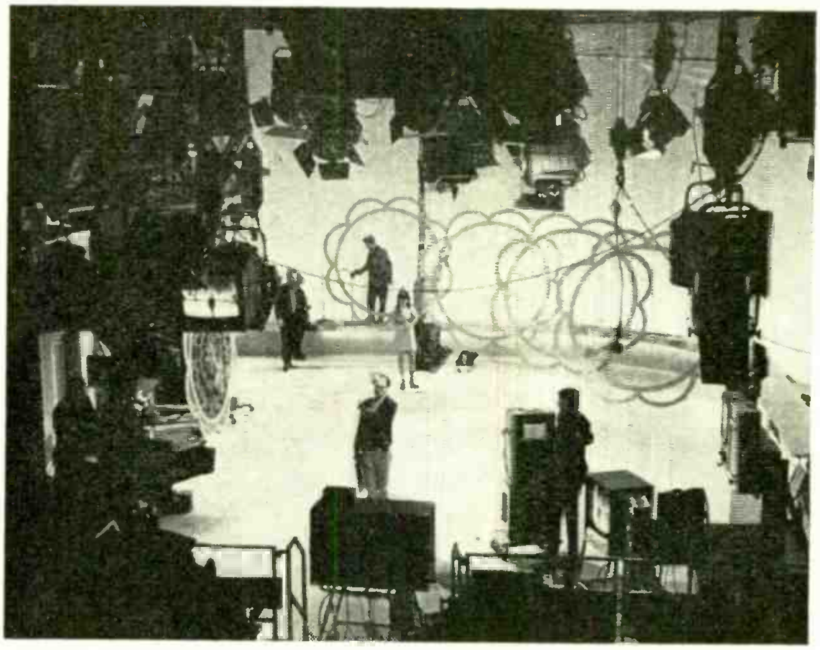
Another approach to power measurement was described by Marconi Instruments in developing a range of commercial power meters extending from 100 mW to 1 kW. Unlike the E.I.D. instrument the thermo-element is here incorporated in the r.f. circuit, the heater of the junction forming part of the connection to the load resistor. By adopting a thin-film form of construction for the heater and by changing from co-axial to slab-line geometry the insertion of the thermal element can be arranged without causing appreciable discontinuity. The e.m.f. generated by the thermo-junction is very nearly proportional to the $(\text{current})^2$ passing to the load resistor and is read on a millivoltmeter calibrated directly in total incident power to an accuracy of ±5%.

Thin films form the load resistors in both the E.I.D. and Marconi instruments: they also find application at the other end of the system in the source resistor of the thermal noise standard developed by Ferranti. The resistor, an alumina tube coated with pyrolitic carbon, is maintained at a temperature of 1,000°C in a vacuum enclosure. It is matched to a 50 Ω coaxial line at the operating temperature. There are indications that the present temperature co-efficient of resistance, amounting to several parts in 10,000, can be reduced and this will enable the standard to be used over a range of temperature, indicated by a platinum/rhodium thermo-couple, without appreciable mis-match. These sources have been examined on the noise comparator designed by the Services Valve Test Laboratory and the mean value at 300 MHz agrees closely with two different types of noise diode, giving confidence that an absolute accuracy of ±0.1 dB has been achieved. Comparison with other sources suggests that this holds up to 1 GHz.

The measurement of attenuation is central to many r.f. procedures and several papers described methods for the comparison of attenuators. The arrangement favoured by both Marconi Instruments and E.I.D. was parallel i.f. substitution with the standard attenuator operating at a fixed frequency, usually 30 or 60 MHz. This method imposes severe requirements on the linearity of the first mixer stage and in the E.I.D. equipment the thermionic diode used is linear to better than 0.01 dB over the range −7 to −107 dBm, from a frequency of 108 MHz to more than 1 GHz. The sensitivity and stability of the equipment enables a change of 0.001 dB to be detected under good signal-to-noise conditions. The Post Office Research Station has also under development equipment which it is hoped will enable insertion gain and loss to be measured to an accuracy of ±0.01 dB in 60 dB at frequencies in the range 0-50 MHz, the accuracy falling progressively to ±2 dB at frequencies of 1-2 GHz (see p. 599, December issue).

An interesting paper from the University of Southampton described the problems arising in measurements on very small thin-film and monolithic circuit components, in the frequency range 100-1,000 MHz. For thin films it is permissible to scale-up the measurement and the resistance and capacitance per unit area are obtained from test pieces evaporated in concentric form which then provide convenient terminations for the coaxial lines of the admittance/impedance measuring equipment. For monolithic components the measurement must be conducted in situ and it is necessary to reduce the dimensions of the standard 50 Ω coaxial lines to an area of about 0.01×0.01 inch while remaining well shielded from each other. The transition is made by the use of a micro-stripline formed by laying a gold ribbon between two layers of dielectric sheet and clamping between thick brass plates. The connection to the chip is made by a gold wire or by extending the gold ribbon but a significant reduction in the residual inductance of about 1 nH can be achieved by making the final link in the form of a uniline.

B.B.C. COLOUR SERVICE



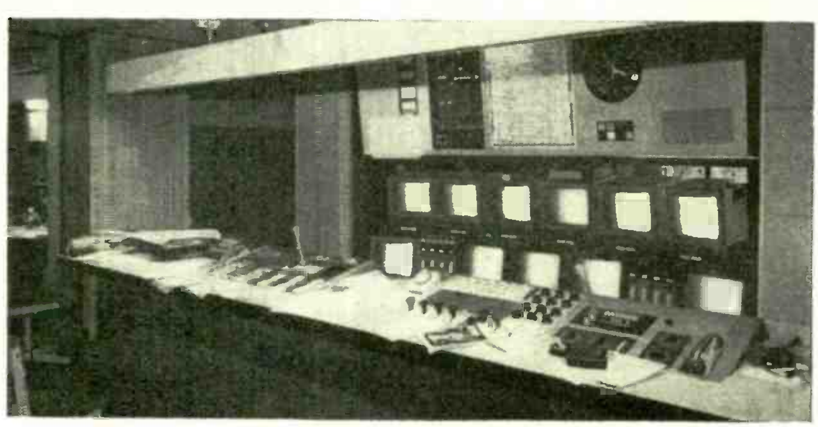
A view from the audience seating in colour studio 8 at the B.B.C. Television Centre during a rehearsal.

FOR the past ten months or so the B.B.C. has been gradually installing colour equipment at the Television Centre, in West London, so that when its colour service was officially inaugurated on December 2nd two production studios, a continuity studio and two mobile control rooms were fully operational. As a result, up to 25 hours of the 30 or so hours of programmes on BBC-2 each week are now in colour.

Each of the two production studios is equipped with four Marconi Mk. VII four-tube cameras and the continuity studio with three Peto-Scott three-tube Philips plumbicon cameras. Peto-Scott cameras are also used in the mobile control rooms. A third production studio, which will be brought into service in the Spring, will have four E.M.I. four-tube cameras. The new studio, which is at Alexandra Palace, is being equipped with three Marconi cameras and will be brought into service in colour in January; until then the news will be in monochrome.

All the cameras are equipped with zoom lenses and not fixed-focus lenses in a turret. The main reason for this being that it is extremely difficult to maintain in a matched condition the colour characteristics of different lenses. Cameras have to be warmed up for two hours before line-up can

Sound controller's position with tape and disc backing facilities, in the sound control room associated with one of the two colour studios.

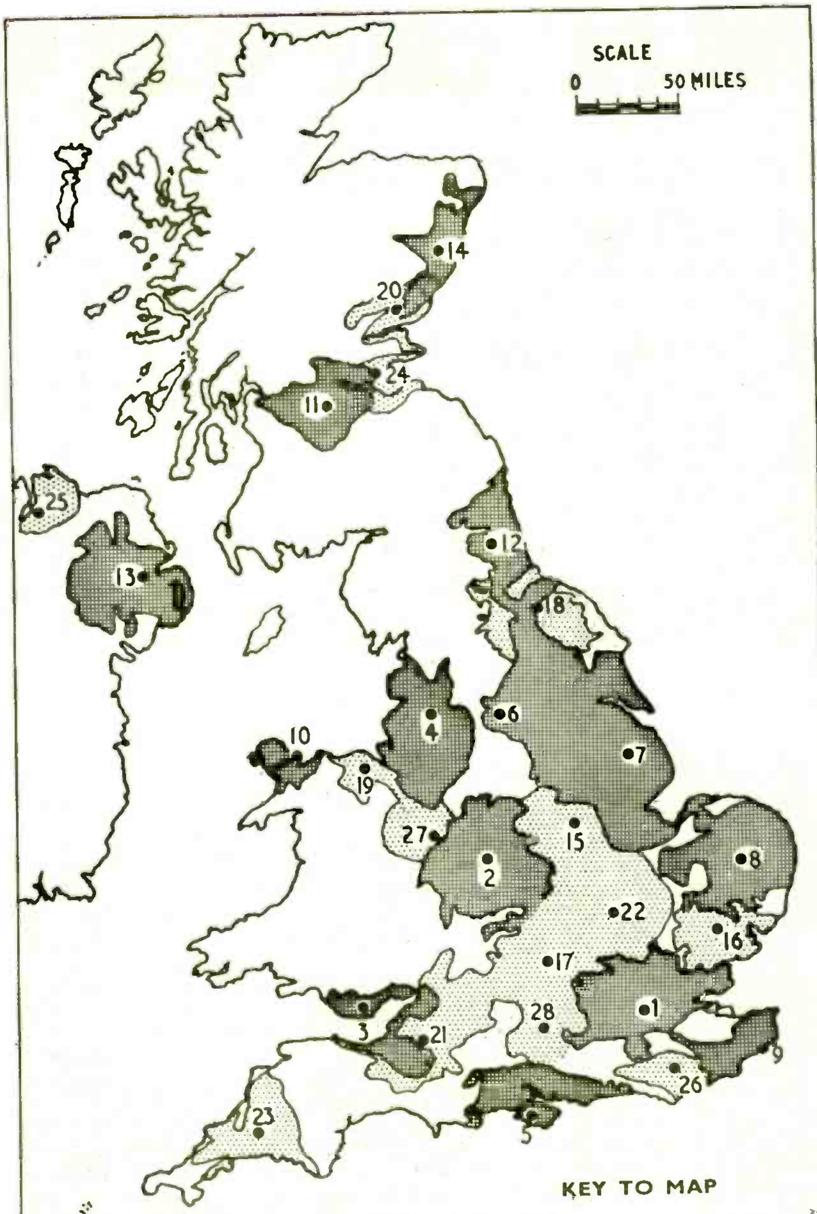


The vision and lighting control room studio one. It is equipped with what is called a "Q-file" lighting control, made by Thorn, by means of which up to 100 lighting combinations and levels can be pre-set and brought into operation sequentially.

be undertaken and the line-up itself takes a further hour and a half. Care is neccessary to keep the colour temperature of the lighting constant. Colour studios are operating on a level of 1615 lux (150 ft. candles). To provide the extra and more evenly distributed illumination necessary for colour the B.B.C. has developed a dual-purpose lantern one end of which produces a spot source and the other a soft-light.

Cameras are, of course, only part—albeit a crucial part—of the colour installation. The backing-up facilities already in use at the Television Centre include four Ampex 2000 videotape colour recorders (a further two will be installed early in the new year); one mobile Ampex 2000 (a second is planned for next Spring); and one R.C.A. TR70 vision tape recorder for news at Alexandra Palace where a Pye 16mm telecine unit using a four-tube camera will also be brought into service in January. Telecine equipment at the Television Centre includes four 16mm and five 35mm Cintel twin-lens units and a further three will be added in the Spring. Then, of course, one must not forget the field store convertor, developed by Rainger for the conversion of American 60-field colour signals to 50 fields and vice-versa (described in our October 1967 issue). There is also a SECAM/PAL transcoder.

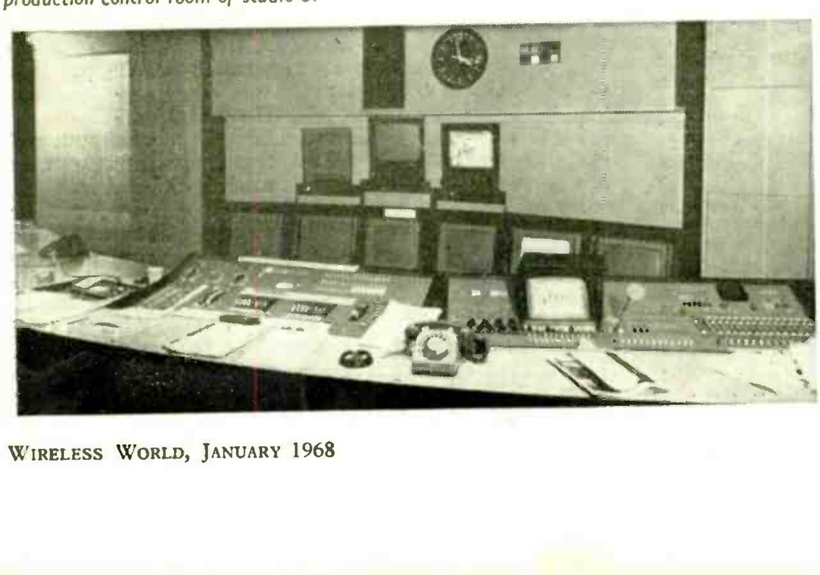
The PAL system: next page



Service areas of the 14 stations which transmitted colour television on the opening of the service on December 2nd are shown with a line tint. The other stations shown are scheduled to be in operation by early 1969, in fact the first six (Nos. 15-20) are expected to be ready for use in 1968. The key to the stations gives in parentheses the channels for BBC-2

KEY TO MAP

1	Crystal Palace	(33)
2	Sutton Coldfield	(40)
3	Wenvoe	(51)
4	Winter Hill	(62)
5	Rowridge	(24)
6	Emley Moor	(51)
7	Belmont	(28)
8	Tacolneston	(55)
9	Dover	(56)
10	Llanddona	(63)
11	Black Hill	(46)
12	Pontop Pike	(64)
13	Divis	(27)
14	Durris	(28)
15	Waltham	(64)
16	Sudbury	(44)
17	Oxford	(63)
18	Bilsdale	(26)
19	Moel-y-Parc	(45)
20	Balcalk	(63)
21	Mendip Forest	(64)
22	Sandy Heath	(27)
23	Caradon Hill	(28)
24	Craigkelly	(27)
25	Londonderry	(55)
26	Heathfield	(52)
27	Staffordshire	—
28	North Hampshire	(45)



General view of the control desk and monitors, only two of which are for colour, in the production control room of studio 8.

THE PAL COLOUR TV SYSTEM

A simplified explanation of how it works

By S. C. RYDER-SMITH, B.Sc.

A TELEVISION set giving a black-and-white picture is a fairly complex piece of equipment. With colour the complexities obviously multiply, and a host of fresh terminology is introduced into the subject. What follows is an attempt to explain, in fairly simple terms, how the PAL system operates. The explanation offered goes no further than outlining the background theory, and building on this to the point where a PAL receiver block diagram can be understood.

The first question to be considered is: how can we set about analysing the colour content of any scene, and then reproduce the scene so that the full range of colours is preserved? Fortunately, the solution to this problem has already been discovered in colour photography, and is fairly familiar. A colour may be analysed into its red, green and blue components, and then reconstructed by adding red, green and blue light in the same proportions as discovered in the original. This is illustrated in the simple colour television system shown in Fig. 1.

In this system three television cameras view a scene simultaneously. One, by looking through a red filter, transmits the red component only, the next, with a green filter, the green component only, and the last with a blue filter, the blue component only. Each camera output drives a cathode ray tube monitor. The monitor receiving the "red" camera output has a red filter in front of it, and therefore gives a red image, which is focused by a lens on to a viewing screen. The monitors receiving the "green" and "blue" outputs similarly give green and blue images on the viewing screen, and so the original scene is reconstructed in full colour.

The major difficulty with this scheme is the impossibility of aligning the three separate colour-component pictures, red, green and blue, as each is taken from a slightly different viewpoint. The answer, at the camera end, is to use a single camera lens system, and, with suitable mirrors and filters behind the lens, separate out the red, green and blue parts of the image, and project each on to a separate camera tube. (See front cover.)

S. C. Ryder-Smith graduated from Queen Mary College, University of London, with a degree in Electrical Engineering in 1956. After initial training as a graduate apprentice with S.T.C. he joined the staff of their transistor division applications laboratory. Here, besides general circuit design work, he made a special study of voltage breakdown in transistors, and published various works on this subject. He now heads the market developments group in the S.T.C. component marketing division.

At the receiver end of the chain, there is also the problem of aligning the three separate colour pictures, and presenting them on a single screen. This may be overcome by depositing three different phosphors, in some pre-determined pattern, on the screen of a c.r.t. which is equipped with three separate electron guns. One phosphor emits red light when excited, another green, and the last blue. It is arranged that the three electron beams coming from the guns scan together under the influence of a single set of scan coils, but that the beam from one gun can excite only the red phosphor, the beam from the next gun only the green, and the beam from the last gun only the blue. The way in which this is achieved in the shadow-mask tube has been described in detail in the March 1967 *Wireless World* but a diagram from this article is repeated here as Fig. 2 to show the basic principle. A tube of this sort is capable of producing three superimposed pictures, one red, one green and one blue, in which the strengths of the red, green or blue components can be independently varied by changing the grid voltages on the appropriate electron guns.

A more practical form of the colour system shown in Fig. 1 can now be devised. This is shown in Fig. 3.

The system arrived at in Fig. 3 would make an excellent basis for a colour service, if it weren't for two drawbacks. In the first place, three separate transmission paths are needed, and hence three times the bandwidth. Secondly, any normal black-and-white receiver could receive only one of these colour signals, and would get a picture with grossly distorted tonal values (equivalent to looking at a scene through a strong red, green or blue filter).

The problem, then, is to find a way of transmitting the R (red,) G (green) and B (blue) information in such a way that a black-and-white set, with no modifications, will display a good picture with no tonal distortion. In addition, the total bandwidth used for the transmission must be no greater than that allocated for normal black and white, and yet a colour receiver must be able to recover from this signal the R, G and B information.

The way in which the R, G and B signals are coded to form a single combined signal for transmission is ingenious. First, a new signal, Y, is formed, by adding portions of the R, G and B signals:

$$Y = 0.30R + 0.59G + 0.11B$$

In this equation, it is assumed that a maximum red output is represented by $R=1$, and a zero red output by $R=0$. A similar assumption is made for G and B.

By adding together the red, green and blue picture signals in this way, what results is a signal representing the black-and-white view of the scene. A normal monochrome set can therefore receive the Y signal and reproduce the correct black-and-white picture. The reason why only 0.11 of the blue signal is used, whereas 0.59 of the green is used, is a matter of human physiology. The human eye is much less sensitive to blue than to green. A bright green appears to the human eye lighter

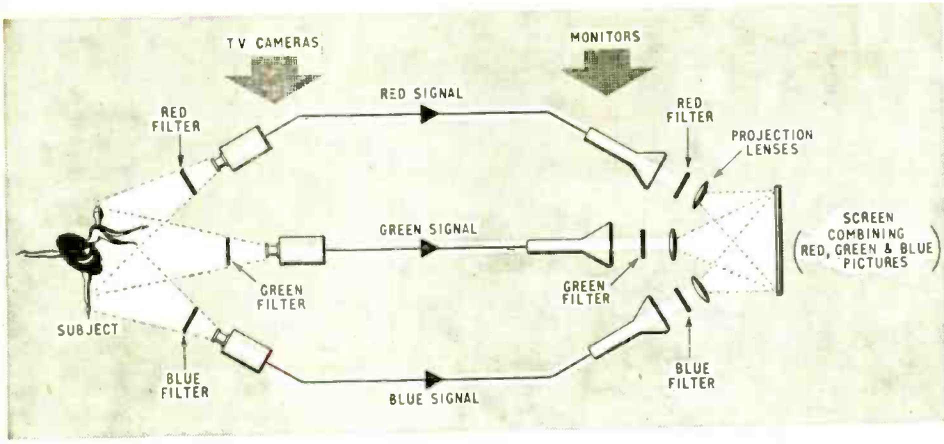


Fig. 1. Simple colour television system.

than a bright blue. Therefore, when a brilliant green is being televised, $G=1$, $R=B=0$, and $Y=0.59$ (a light grey). When a brilliant blue is being televised, $B=1$, $R=G=0$, and $Y=0.11$ (a darker grey). Producing Y according to the equation given above therefore results in a black-and-white picture with a tonal range acceptable to the human eye.

So far, the encoding described has merely reduced the colour signals to a black-and-white signal. How does a colour set separate out the original R, G and B signals?

First, for the sake of compatibility with black-and-white sets, it has been necessary to produce the Y signal. Further independent signals must now be provided so that a colour set can use them in conjunction with the Y signal to produce the original R, G and B information. There are, in fact, two additional signals:

$$(R-Y) \text{ and } (B-Y)$$

and these are called colour-difference signals because, as can be seen, they result from *subtracting* the Y signal from colour component signals.

Adding the Y signal to the two colour difference signals gives

$$(R-Y)+Y=R$$
$$(B-Y)+Y=B$$

Therefore a colour receiver can use the incoming Y, $(R-Y)$ and $(B-Y)$ signals to produce the original R and B signals. There is still the problem of obtaining the G signal in the receiver. This can be done by making use of the following mathematical relationship.

$$\begin{aligned} 0.30(R-Y)+0.59(G-Y)+0.11(B-Y) &= 0.30R+0.59G+0.11B \\ &\quad -0.30Y-0.59Y-0.11Y \\ &= 0.30R+0.59G+0.11B \\ &\quad -Y(0.30+0.59+0.11) \\ &= 0.30R+0.59G+0.11B-Y \end{aligned}$$

$$\text{But } Y=0.30R+0.59G+0.11B$$

$$\therefore 0.30(R-Y)+0.59(G-Y)+0.11(B-Y)=0$$

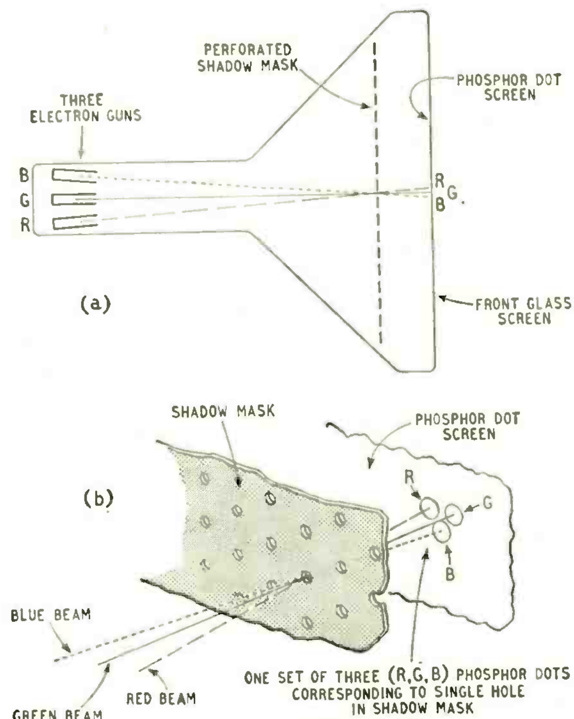
It follows from this that

$$-(G-Y)=\frac{0.30}{0.59}(R-Y)+\frac{0.11}{0.59}(B-Y)$$

In other words, if the two incoming colour difference signals $(R-Y)$ and $(B-Y)$ are added together in the correct proportion, and the sign of the resulting signal is changed, a signal equal to $(G-Y)$ can be produced.

A simplified schematic of the decoding in the receiver is shown in Fig. 4.

(Below) *Fig. 2. Principle of shadow mask c.r.t.: (a) beams converging on mask and diverging on to screen; (b) close-up of mask and screen.*



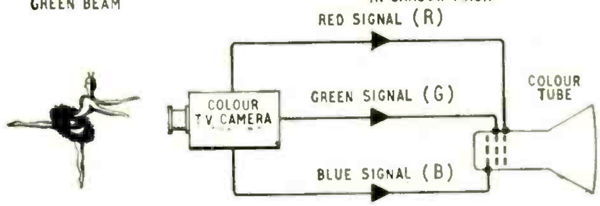


Fig. 3. More practical form of Fig. 1 system.

Note that the final comparison between the colour difference signals and Y is achieved by feeding a negative-going voltage proportional to Y (indicated as $-Y$) to the cathodes of all three electron guns, while voltages proportional to the colour difference signals are fed to the grids of the appropriate guns. The beam current in any gun is determined by the difference between the cathode and grid voltages. Thus, in the red gun the beam

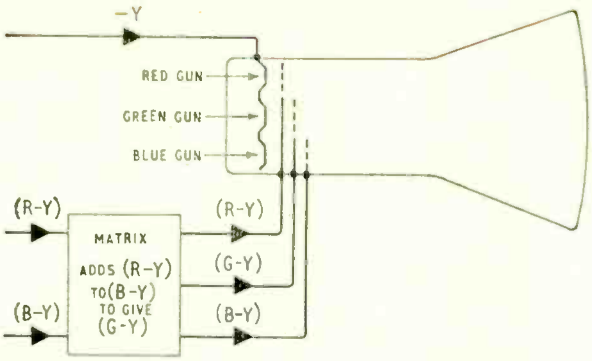


Fig. 4. Decoding in the colour receiver.

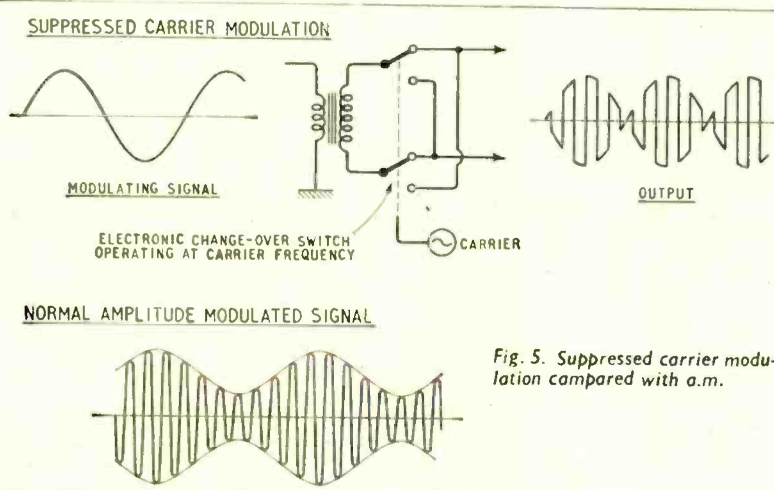


Fig. 5. Suppressed carrier modulation compared with a.m.

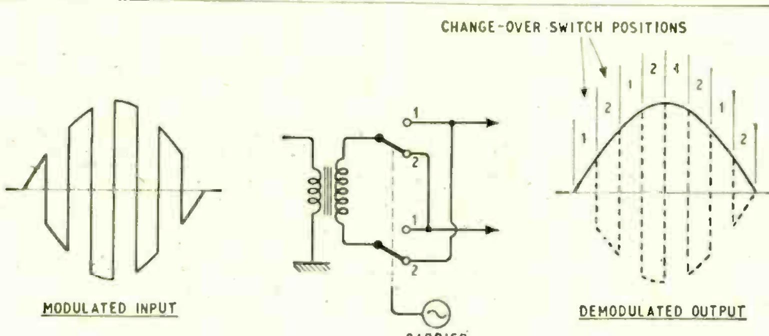


Fig. 6. Suppressed carrier demodulation in the receiver.

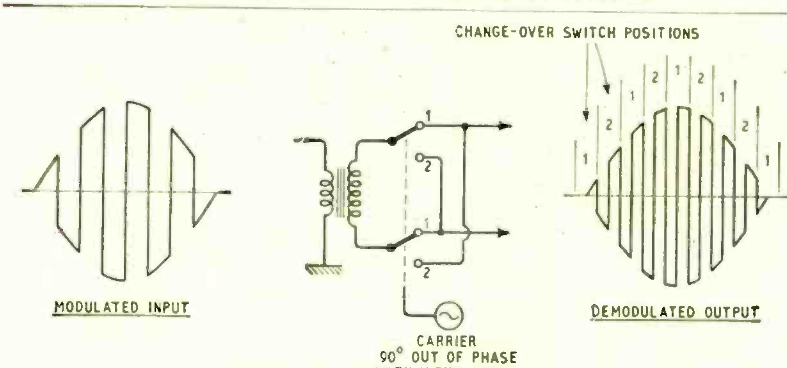


Fig. 7. Demodulator oscillator 90° out of phase.

current and hence the amount of excitation of the red phosphor, is proportional to:—

$$(R - Y) - (-Y) = R$$

Similarly, for the green and blue guns:

$$(G - Y) - (-Y) = G$$
$$(B - Y) - (-Y) = B$$

The same effect could be produced by adding the colour difference signals to the Y signal before reaching the colour tube.

It has already been noted that the Y signal gives a good black-and-white representation of the scene being televised. What do the colour difference signals represent? First, assume that a scene containing no colour—only black, white, and the intermediate greys—is being televised. Pure white may simply be defined as having equal quantities of red, green and blue. Therefore $R = G = B = n$, where $n = 1$ for full white, intermediate values for greys, and zero for black.

$$Y = 0.30n + 0.59n + 0.11n$$
$$= n$$

The colour difference signals become

$$R - Y = n - n = 0$$
$$G - Y = n - n = 0$$
$$B - Y = n - n = 0$$

Therefore, when a black and white picture is being transmitted, Y continues to have a value representing the tonal value, or luminance of the scene, but the colour difference signals disappear. The colour difference signals only have a value once colour is introduced into the scene. It becomes obvious therefore, that the function of the colour difference signals is simply to provide information as to the colour of a scene, while the brilliance, or luminance, of the scene is conveyed in the Y signal. For this reason, the Y signal is called the luminance signal and the $(R - Y)$, $(G - Y)$, $(B - Y)$ signals are called the chrominance signals.

Experiment has shown that while the human eye is sensitive to detail arising from differences in luminosity, it is relatively insensitive to details arising from colour changes only. A benefit of this is that while the Y signal must be transmitted at full bandwidth to get good definition, the chrominance signals can be transmitted with a considerably reduced bandwidth.

The remaining problem in constructing a practical colour television system is how to transmit the $(R - Y)$ and $(B - Y)$ signals without (a) increasing the overall bandwidth of the system, and (b) interfering significantly with the operation of a normal black-and-white set displaying the picture due to the Y signal.

The methods described so far are common to all colour systems. Where

N.T.S.C., PAL, and SECAM differ is in the methods adopted in transmitting the $(R - Y)$ and $(B - Y)$ signals.

Most of the credit for making colour television possible must go to the developers of the N.T.S.C. system. PAL is basically N.T.S.C. with modifications based on the now extensive experience of the problems and operation of N.T.S.C. in the U.S.A.

N.T.S.C. TRANSMISSION SYSTEM

The basic problem has been outlined above: How to transmit the $(R - Y)$ and $(B - Y)$ signals in addition to the Y signal without increasing the transmission bandwidth, or interfering unduly with the reception of the Y signal by a normal black-and-white receiver. The problem is complicated by the fact that the $(R - Y)$ and $(B - Y)$ signals can have either a positive or a negative value. Normal methods of modulation deal only in magnitude and not with sign.

The solution adopted in N.T.S.C. has been to use suppressed carrier modulation. A simple way of looking at this type of modulation is to assume that the modulating waveform is chopped by the carrier. The waveforms resulting from this operation are shown in Fig. 5. For comparison, a normal a.m. signal is also shown.

Note that when the modulating signal is zero, with suppressed carrier modulation the output is also zero. With amplitude modulation, on the other hand, a zero modulating signal is represented by a carrier of constant amplitude. Demodulating an amplitude modulated signal is simple: a normal diode detector will do the job. With suppressed carrier modulation, however, demodulation is a major difficulty. The method normally employed is to make use of a second electronic change-over switch operated in exact synchronism with the modulating switch. The demodulation process is illustrated in Fig. 6.

For this sort of demodulation to work successfully, there must exist within the receiver an oscillator which is not only precisely locked in frequency to the carrier oscillator at the transmitter, but is also closely in phase with the transmitter oscillator. Fig. 7 shows what happens when the demodulating oscillator is 90° out of phase with the incoming signals.

In this case, when the high frequency elements of the output are filtered out, the net output is zero.

Although there is obviously a drawback in the fact that the local oscillator in the receiver must be phase as well as frequency locked to the carrier oscillator in the transmitter, advantage can be taken of this phase sensitivity. It has been shown that if the carrier modulating the signal is 90° out of the phase with the receiver oscillator, then demodulation produces zero output (after filtering the high frequency components). Take the case where the modulated signal and the local demodulating oscillator are exactly in phase, and a correctly demodulated output is being obtained. If a second signal is added to the original modulated signal, having an identical carrier frequency but being 90° out of phase, then this second signal will not produce any changes in the demodulated output, just because it is 90° out of phase. However, if a second demodulator is used, driven from the same local carrier oscillator, but with a 90° phase change introduced, then this demodulator *will* produce an output

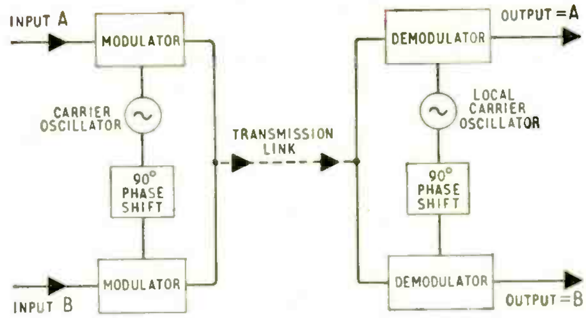


Fig. 8. Technique for conveying two independent sets of information.

from the second signal, and the original signal will give a zero output. This is illustrated in Fig. 8.

Thus it is possible for a single signal to carry two independent channels of information.

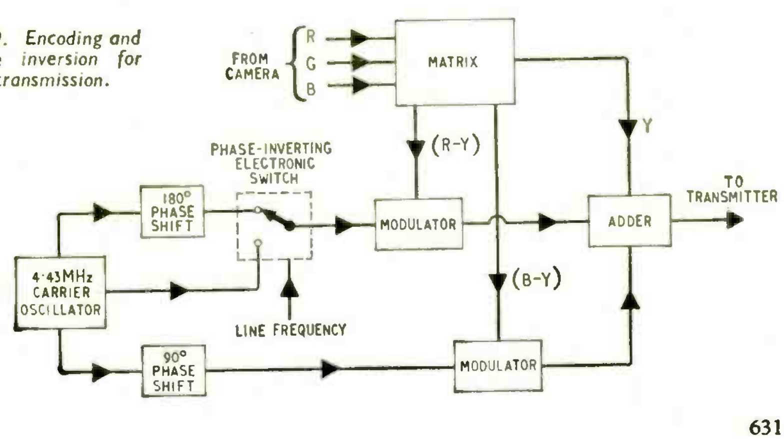
In the N.T.S.C. colour system advantage is taken of this by using a single suppressed carrier modulated signal to convey both the $(R - Y)$ and $(B - Y)$ information. The carrier frequency selected is in the region of 4.4MHz. The Y signal is, of course, transmitted in the normal amplitude modulation mode used for black-and-white transmissions. The suppressed carrier chrominance signal, centred on 4.4MHz, and containing both the $(R - Y)$ and $(B - Y)$ signals, is then added to the Y waveform, and treated as normal video information.

Although this method neatly solves the problem of transmitted $(R - Y)$ and $(B - Y)$ information with no increase in the overall bandwidth, two questions immediately spring to mind. Surely the chrominance signal will appear on the screen as normal high frequency video? Secondly, will high frequency video arising from the picture content be interpreted as chrominance information, and affect the colour? In other words, the luminance, or Y, signal can interfere with the chrominance signals $(R - Y)$ and $(B - Y)$ and vice-versa.

This cross coupling does in fact occur. But by a careful choice of chrominance carrier frequency—in PAL it is 4.43361875MHz—the effects can be minimised. The chrominance signal produces a fine and unobtrusive pattern of dots across the screen, and fine detail in the picture content can produce a small distortion in the colour. However, both of these effects are small.

There still remains the problem of ensuring that the local carrier oscillator in the receiver is in frequency and phase lock with the transmitted carrier. This is done by

Fig. 9. Encoding and phase inversion for PAL transmission.



choosing a part of the transmitted waveform where video information is not present—i.e., during the sync pulse and fly-back period, and transmitting a short burst of carrier. A gate in the receiver separates this from the rest of the video wave-form, and feeds it to the local oscillator to synchronize it.

Although there are, of course, a number of sophistications to the N.T.S.C. system not described here, the main outline of the method has been covered.

PAL

The major shortcoming of the N.T.S.C. system has proved to be its sensitivity to phase errors in the chrominance channel. Fairly exact phase relationships must be kept if proper separation between the $(R - Y)$ and $(B - Y)$ channels is to be achieved. Once phase errors do occur, then false $(R - Y)$ and $(B - Y)$ information is given, and colour reproduction deteriorates. A particularly sensitive area for phase errors to occur is, of course, the transmission path between the transmitter and receiver. N.T.S.C. receivers must therefore be equipped with a "hue" control to correct for these phase errors, and under adverse conditions fairly frequent adjustments to this control are necessary.

The purpose of PAL is to take the N.T.S.C. system, and modify it to make it less sensitive to phase errors in the chrominance channel. This is done by inverting the carrier phase of the $(R - Y)$ signal on alternate lines. This is why the system is called PAL—Phase Alternation Line. Fig. 9 shows how the phase inversion is obtained at the transmitter by an electronic switch. In the receiver, a corresponding switch is operated on alternate lines, which restores the $(R - Y)$ signal to its correct phase. The consequence of this phase alternation is that any phase error which occurs during one line is balanced by an equal phase error in the opposite sense in the following line. (Originally, of course, the phase error is always in the same sense on each line. But alternate lines are phase reversed in the receiver to correct the phase alternation of the $(R - Y)$ signal. The phase error is therefore also inverted on alternate lines, and the average phase error is reduced to approaching zero).

It is of course necessary for the receiver to identify what line is being transmitted—one with $(R - Y)$ normal or phase inverted. This is done by phase inverting the burst of colour carrier on alternate lines in synchronism with the phase inversion of the $(R - Y)$ signal.

In PAL, phase errors in one line are balanced by equal and opposite phase errors in the following line. In a simple PAL receiver, PAL-S, averaging of these errors is left to the human eye. Where the errors are small, this can be quite satisfactory. However, large errors lead to a coarse line structure, sometimes referred to as the Hanover blind effect. A more satisfactory solution is to perform the averaging electronically. This is done in a PAL-D receiver by means of a delay line which delays the chrominance signal for the exact duration of one line. Each line of chrominance information, as well as being directly fed to the c.r.t., is also fed into the delay line, and added to the following line, where the phase errors cancel.

The block diagram of a complete PAL-D receiver is shown in Fig. 12. This looks at first rather terrifying.

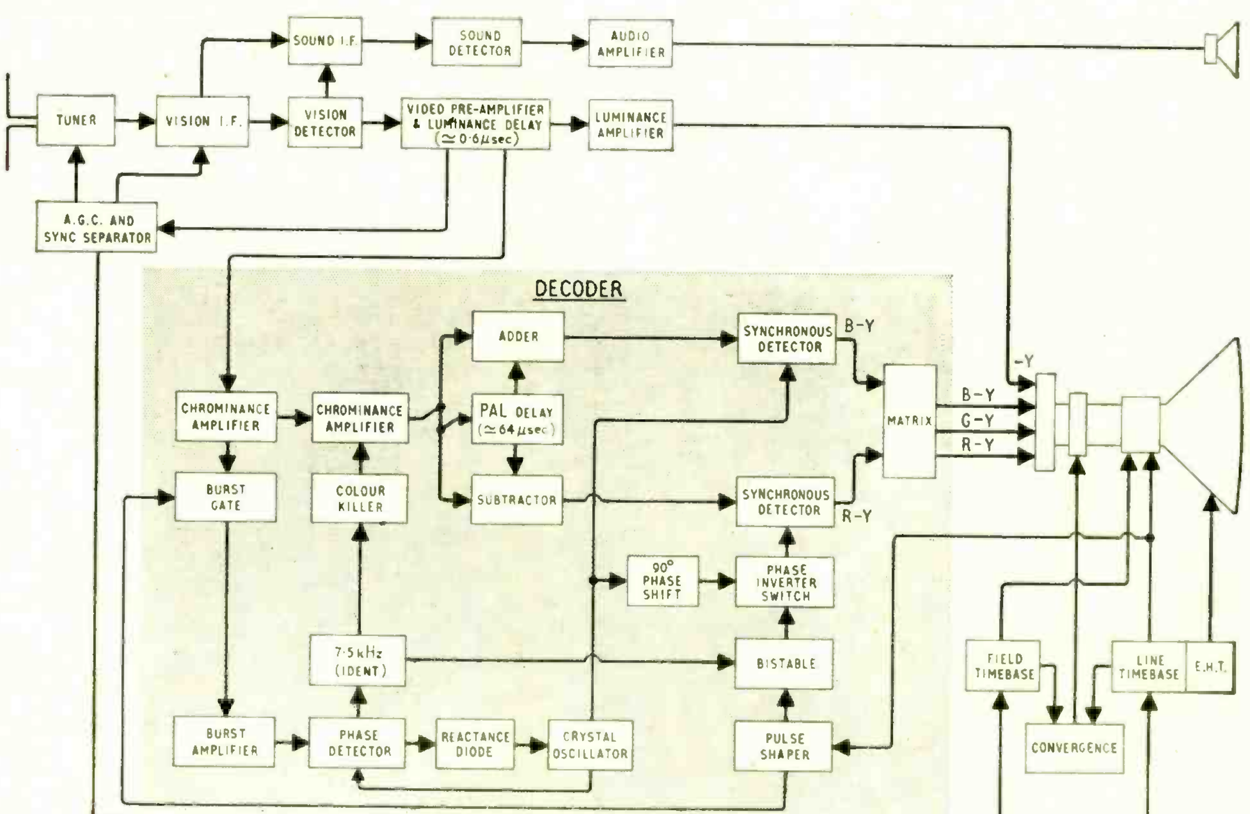


Fig. 10. Schematic of PAL-D colour receiver.

Taken bit by bit, and in the right order, however, it turns out to be relatively harmless.

The signal from the aerial is fed into a normal tuner, identical with the tuner used in a black-and-white set. The output of the tuner, at i.f., is fed to the vision i.f. amplifier, from which it goes into the vision detector. The sound signal is picked off from the vision i.f. amplifier, or alternatively, the vision detector, and goes through a normal sound channel to the loudspeaker.

The video output from the vision detector is fed through a video pre amplifier, a delay line giving a delay of approximately $0.6\mu s$ and the luminance amplifier (basically a normal video output stage). The output signal consists of the luminance signal Y, plus the unwanted, but unavoidable, encoded chrominance information. This output is fed to the cathodes of the three c.r.t. guns. The delay circuit of $0.6\mu s$ is not the main PAL delay line. Its function is to compensate for the short delay which the chrominance signals undergo in passing through the decoding circuits.

Before going through the $0.6\mu s$ delay line, the video signal is also fed to two other circuits. The first is the a.g.c./sync separator. This circuit provides (a) the required sync pulses, which are taken to the line and frame timebases, and (b) an a.g.c. signal which is used to control the gains of the tuner and vision i.f. amplifier. The second circuit to receive the video signal is the chrominance amplifier. Here, that part of the video signal which contains the chrominance information is filtered out and amplified prior to demodulation.

PHASE LOCKING SYSTEM

At this point it is as well to leave the direct chrominance signal path, and follow the parts of the circuit used to provide a correct phase locked carrier for the chrominance demodulation. The burst gate is connected to the output of the first chrominance amplifier. This gate is opened for a short period during the start of each line scan by a signal derived from the line timebase. The colour burst, transmitted to phase lock the local oscillator of the receiver, occurs during the period when the burst gate is open. The burst amplifier therefore receives the colour burst, but no other part of the video waveform. The output of the burst amplifier is compared in phase with the output of the local oscillator, which is crystal controlled.

It will be remembered that the phase of the colour burst alternates from line to line, and that the phase of the colour burst on any one line provides information on whether the $(R - Y)$ signal has its normal phase, or is phase inverted. In fact it is arranged that the colour burst phase changes back and forth by 90°. On one line it leads the required local oscillator phase by 45°, and on the following line it lags the required phase by 45°. The output of the phase detector is, therefore, a signal varying positive and negative at half line frequency. It is arranged that the circuit containing a reactance (variable capacitance) diode used to control the phase of the crystal oscillator is much too slow to follow the line to line variations in the output of the phase detector. Instead, it takes up a mean position, which is, of course, the required phase.

Meanwhile, the 7.5kHz (half line frequency) signal at the phase detector is used for two purposes. A bistable circuit is driven from the output of the line oscillator and changes state at the start of each line. Its output is used to phase invert the drive to the $(R - Y)$ demodulator on each alternate line, in order to correct for the phase inversion given to the $(R - Y)$ signal on alternate lines at the transmitter. However, it is obviously necessary to phase invert the $(R - Y)$ demodulator drive on the same lines as which the $(R - Y)$ signal is phase inverted. Information on which lines have the phase inverted $(R - Y)$ signal is contained, as already explained, in the phase of the colour burst. As the alternation in phase of the colour burst from line to line gives rise to the 7.5kHz signal at the phase detector, this 7.5kHz signal can be used to identify the line with $(R - Y)$ phase inverted. For this reason, this signal is referred to as the " ident " signal. It is fed to the bistable which is constrained to operate in phase with the ident signal. In this way, the phase inversion of the drive to the $(R - Y)$ demodulator is made to occur always on the alternate lines on which the $(R - Y)$ signal is phase inverted.

A second function of the ident signal is this. When a black-and-white picture only is being transmitted, it is important that no luminance information gets through the chrominance channel. If it did, parts of the picture where fine detail were present might appear coloured, and this is obviously very undesirable in a black-and-white transmission. This problem is solved quite simply. When a black-and-white picture is being transmitted, no colour bursts are included in the video waveform. The 7.5kHz signal therefore does not appear at the phase detector. In its absence, the colour killer circuit comes into operation, and turns the second chrominance amplifier off. It follows that when the colour bursts are absent, no information at all can get through the chrominance channel.

Let us return now to the chrominance signal at the output of the chrominance amplifier. This is fed into the PAL delay line, and also into a circuit which adds it to the output of the delay line, and another which subtracts the output of the delay line. Remembering that the output of the delay line represents information from the preceding line, in which the $(R - Y)$ information will have an opposite phase, the result of adding and subtracting adjacent lines of information can readily be calculated.

If the signal emerging from the delay line is $\pm (R - Y) + (B - Y)$ then the signal coming from the chrominance amplifier output, representing the following line of information, will be

$$\mp (R - Y) + (B - Y)$$

Adding these two lines gives

$$\pm (R - Y) \mp (R - Y) + 2(B - Y) = 2(B - Y)$$

Subtracting gives

$$\pm (R - Y) \pm (R - Y) + (B - Y) - (B - Y)$$
$$= \pm 2(R - Y)$$

This part of the circuit, the delay line, adder and subtractor, therefore carries out two functions: it provides the phase error correction by averaging between succeeding lines, which is a basic feature of PAL, and it also separates the $(R - Y)$ and $(B - Y)$ signals. Both signals are fed into synchronous detectors (these are the demodulators described earlier). The $(B - Y)$ demodulator is driven direct from the phase locked crystal oscillator. The $(R - Y)$ demodulator derives its drive from the crystal oscillator, after it has first passed through (a) a 90° phase shift circuit, and (b) the phase inverter switch described above.

The two demodulators produce at their outputs the original $(B - Y)$ and $(R - Y)$ signals. These then go to a matrix where they are added in the correct proportions to produce the $(G - Y)$ signal. Finally, all the colour difference signals are taken to the grids of the appropriate guns in the shadow-mask colour cathode-ray tube.

Emitter-coupled, Emitter-timed Multivibrators

1: Astable Circuits

By G. B. CLAYTON B.Sc., A. Inst. P.

ASTABLE and monostable multivibrators are well known and widely used pulse circuits. The astable multivibrator switches repetitively between two quasi-stable states generating a series of rectangular pulses. The monostable circuit has one stable state in which it remains until a suitable trigger pulse is applied, causing it to switch rapidly to a quasi-stable state, in which it remains for a period of time, before returning to its original state; thereby generating a single rectangular pulse for each trigger pulse. The characteristics of these circuits that are normally considered to be of importance are: stability of pulse amplitude and width with respect to changes in supply voltages, temperature, spread in transistor parameters and switching time between states.

The most common forms of the multivibrator circuits are the collector base coupled versions shown in Figs 1 and 2, in which the timing function is performed in the base circuit. The transistors are normally saturated in order to stabilize pulse amplitude against changes in transistor parameters, but the pulse amplitude is still dependent on supply voltage and pulse durations are affected by changes in temperature. The less well known emitter-coupled, emitter-timed forms of the circuits possess definite advantages in that the timing operation is performed in the emitter circuit resulting in a pulse

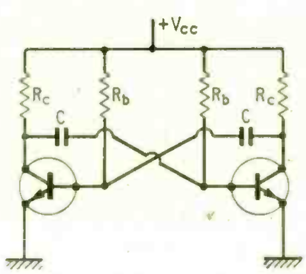
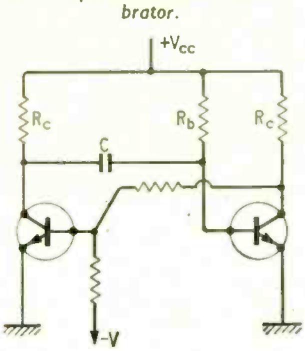


Fig. 1. (left) A conventional collector-base coupled astable multivibrator.

Fig. 2. (right) A conventional-base coupled monostable multivibrator.



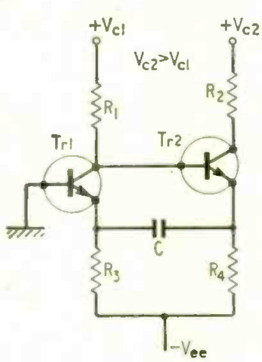


Fig. 3. (left) Basic emitter coupled, emitter timed, multivibrator.

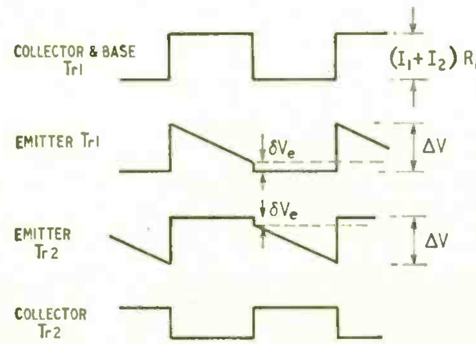


Fig. 4. Waveforms of an emitter timed multivibrator.

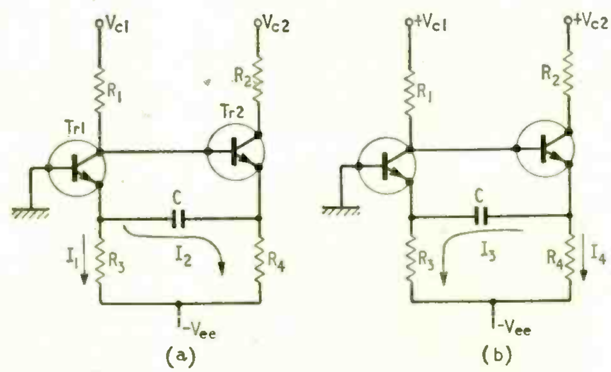


Fig. 5. Equivalent circuit of Fig. 4. (a) Tr1 on—Tr2 off; (b) Tr2 on—Tr1 off.

duration which is far less dependent on transistor parameters and, therefore, on temperature variations. In addition the pulse duration and amplitude can be made less dependent on power supply variations and the minimum switching times for a particular transistor type can be realized. Also a square waveform can be produced and the circuits have a completely " free " collector.

The circuit of an emitter-timed astable multivibrator is given in Fig. 3 and its idealised waveforms in Fig. 4. The circuit loop between the emitter of Tr1—collector Tr1—base Tr2—emitter Tr2 and the emitter of Tr1 is regenerative, so that both transistors conduct together only during the rapid switching between states. As Tr1 switches on the potential at its collector, and at the base of Tr2, falls rapidly causing Tr2 to cut off. The emitter current of Tr1 is then made up of two components (Fig. 5a), I_1 flows through R_3 and I_2 charges capacitor C causing the potential at the emitter of Tr2 to fall. After a time t_1, Tr2 comes into conduction again and a regenerative action takes place causing the emitter

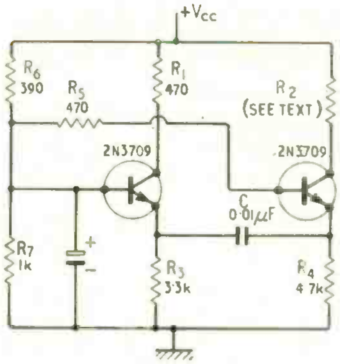


Fig. 6. Practical emitter timed astable requiring only a single power supply.

of Tr2 to be driven suddenly positive. This change is communicated by capacitor C to the emitter of Tr1, cutting it off. The emitter current of Tr2 is then also made up of two components (Fig. 5b), I_4 through R_1 and I_3 charging capacitor C and causing the potential at the emitter of Tr1 to run down for a period t_2. Then Tr1 comes into conduction again and the cycle repeats.

An approximate analysis of the circuit may be carried out if it is assumed that the negative step at the collector of Tr1 is small compared with the negative supply, the charging currents will then be taken as being constant during the timing periods. The effect of leakage currents will be ignored for silicon transistors.

The negative step at the base of Tr2 is $\alpha_{cb}(I_1 + I_2)R_1$ which is approximately equal to $(I_1 + I_2)R_1$ since $\alpha_{cb} \approx$ to unity.

Capacitor C must charge by an amount:

$$\Delta V = (I_1 + I_2)R_1 - (\delta V_e + V_{be2}) \quad \ldots \quad \ldots \quad (1)$$

Where δV_e is the step at the emitter of Tr2 and V_{be2} is the difference between the base emitter voltage of Tr2 when switching occurs and the base emitter voltage when the current I_4 is flowing.

$$\text{Current } I_3 \approx I_1 = \frac{V_{ce} - V_{be1}}{R_3} \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

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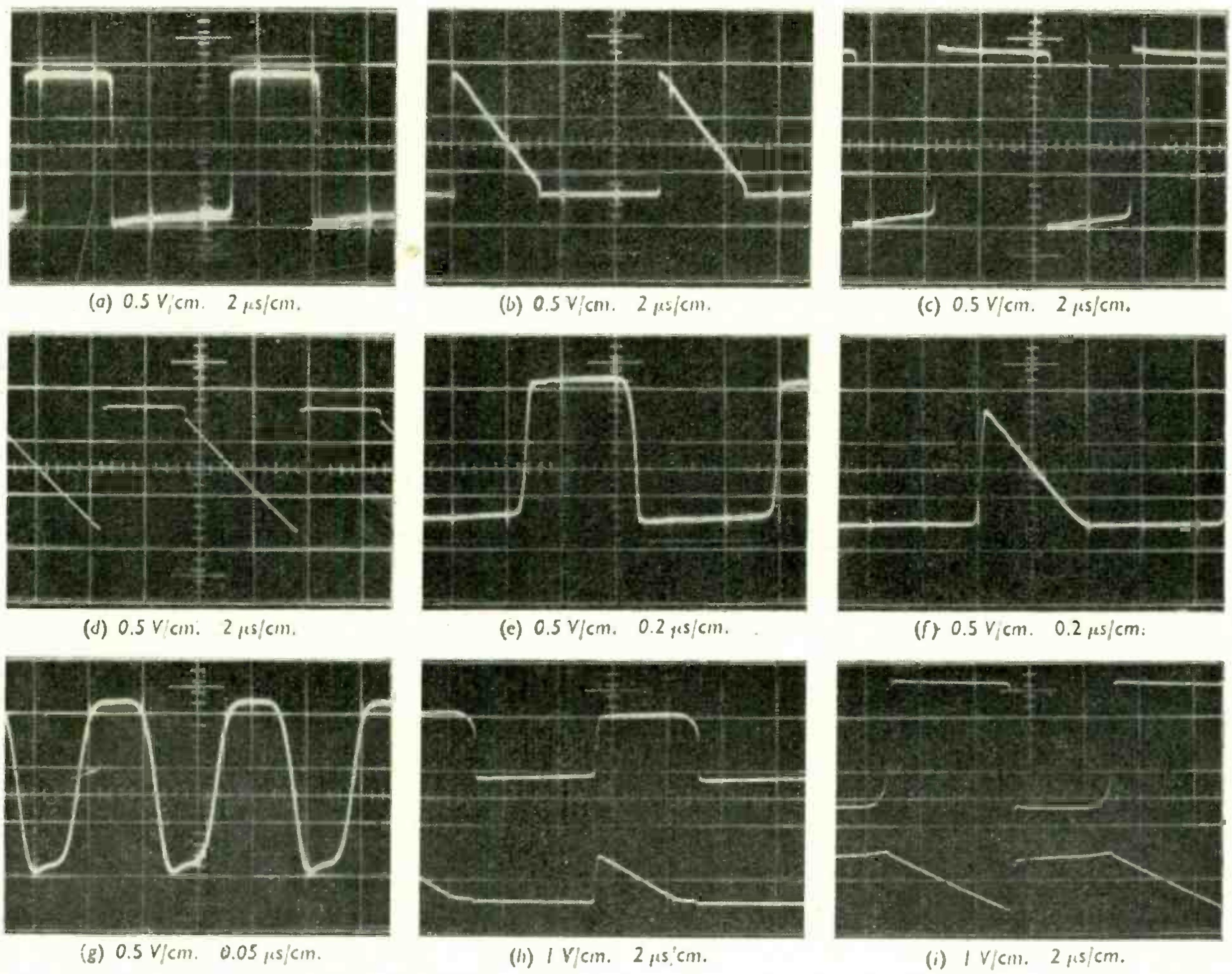


Fig. 7. Waveforms present in the circuit of Fig. 6. (a) taken at the collector of Tr1; (b) emitter Tr1; (c) the collector at Tr2; (d) emitter of Tr2; all taken with R_2 at 220 Ω. The slope at the top and bottom of the waveforms is due to the charging currents not remaining constant. (e) Waveform at the emitter and (f) at the collector of Tr1 where the timing capacitor = 1,000 pF. (g) Collector of Tr2 when the timing capacitor is reduced to 100 pF, the smallest rise time for a particular transistor type is realized. (h) Upper- collector and lower- emitter of Tr1 (i) Tr2 when the timing capacitor = 0.01 μF and R_2 = 470 Ω. The effect of allowing Tr2 to saturate can be clearly observed.

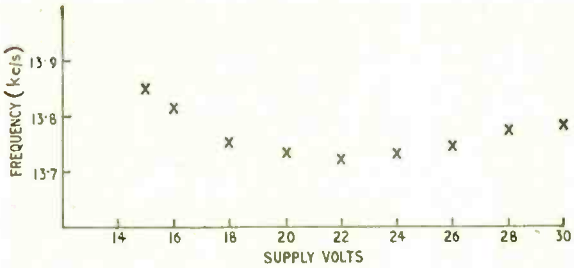


Fig. 8. Variation of frequency plotted against supply voltage for the circuit shown in Fig. 6 with C = 0.1 μF, R₂ = 470 Ω.

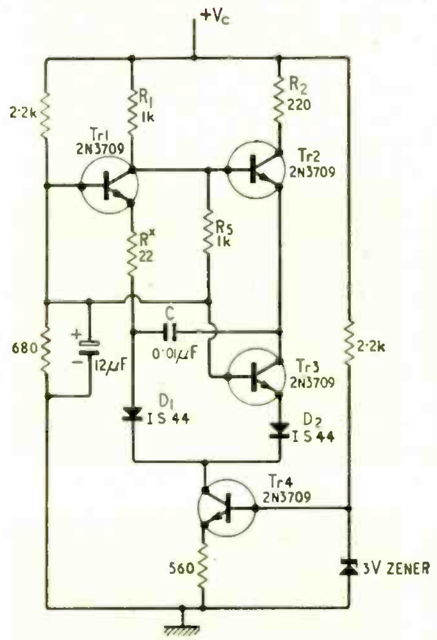


Fig. 9. Improved astable multi-vibrator.

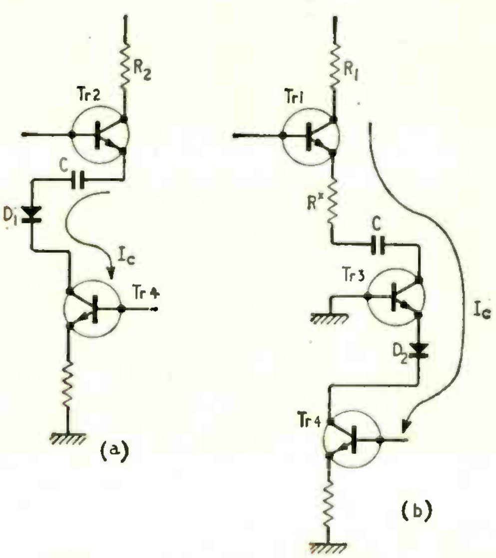


Fig. 10. Showing charging paths in the circuit of Fig. 9: (a) Tr2 on—Tr1 off; (b) Tr1 on—Tr2 off.

and $$I_3 \approx I_2 = \frac{V_{c1} + V_{ee} - V_{be2}}{R_1} \quad .. \quad .. \quad (3)$$

The time period $t_1 \approx \dfrac{\Delta VC}{I_2} \approx \dfrac{(I_1 + I_2)}{I_2} R_1 C$

$$t_2 \approx \frac{\Delta VC}{I_3} \approx \frac{(I_1 + I_2)}{I_1} R_1 C$$

The term $(\delta V + \delta V_{be2})$ is neglected. Substituting for I_1 and I_2 gives:

$$t_1 \approx \left[1 + \frac{R_4}{R_3} \frac{1}{1 + \dfrac{V_{c1}}{V_{ee} - V_{be1})}}\right] CR_1$$

$$t_2 \approx \left[1 + \frac{R_3}{R_4}\left(1 + \frac{V_{c1}}{V_{ee} - V_{be1}}\right)\right] CR_1$$

V_{be1} is assumed equal to V_{be2}.

If the currents I_1 and I_2 are made equal, $t_1 = t_2$, and the frequency is approximately equal to $1/(4CR_1)$

Both timing periods are seen to depend on the ratio $V_{c1}/(V_{ee} - V_{be1})$ which indicates the possibility of obtaining a multivibrator with very good frequency stability against changes in supply voltage. Increasing the supply voltages, with this ratio held constant, causes an increase in the charging currents, but it also causes the same fractional increase in the voltage step through which the capacitor has to charge. The constancy of the ratio can be assured by using only one power supply and a resistive divider (R_6, R_7). The need for the second positive supply may be removed by including the resistor R_5; the circuit is shown in Fig. 6.

In the above equations we can now replace V_{c1} by:

$$V_c' = V_{cc} \frac{R_5}{R_1 + R_5} \quad \text{and } R_1 \text{ by } R_1' = \frac{R_1 R_5}{R_1 + R_5}$$

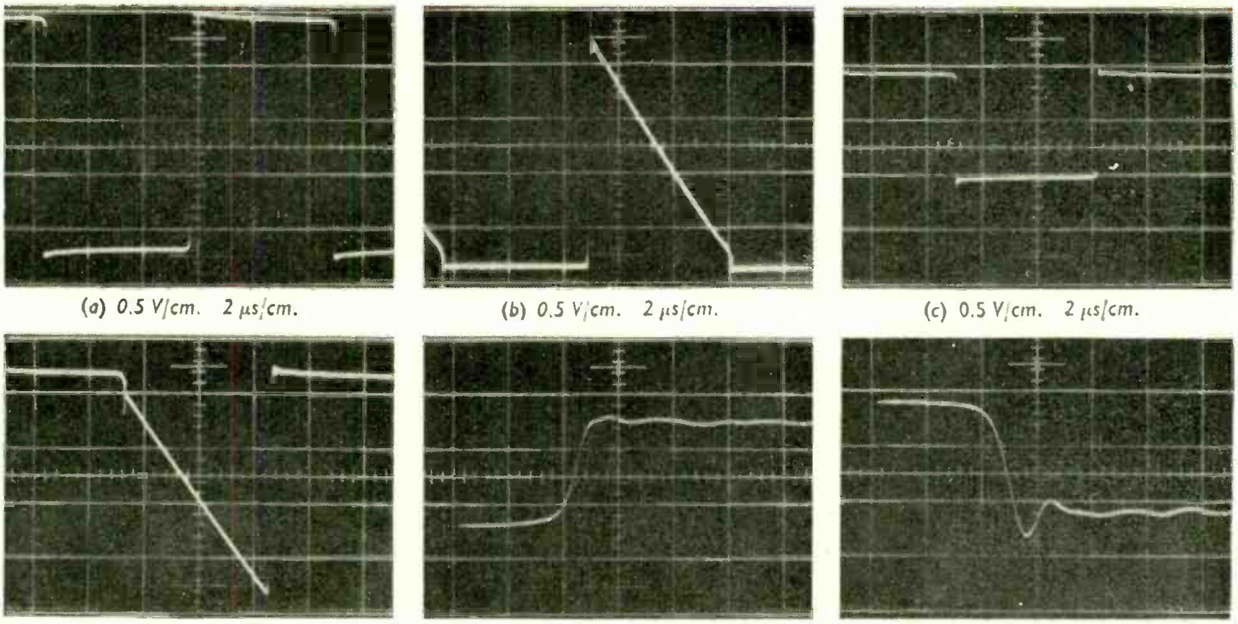
An emitter-coupled emitter-timed multivibrator is required, operating frequency around 100 kc/s and a mark-space ratio not far from unity. The design procedure is as follows. Using $f = 1/(4CR_1')$, if C is made 0.01 μF then R_1' must be 250 Ω.

But $R_1' = R_1R_5/(R_1 + R_5)$ so we make $R_1 = R_5 = 470$ Ω.

With a nominal supply voltage of 20 V the resistive divider was chosen to give an effective emitter supply of − 15 V. This makes $V_c' = 2.5$ V. The approximate values of the charging currents are determined from equations (2) and (3). $R_3 = 3.3$ kΩ. $R_4 = 4.7$ kΩ. makes $I_1 \approx I_2 = 3.5$ mA. The value of R_2 determines the amplitude of the signal at the collector of Tr2. Two different values were tried, 220 Ω and 470 Ω. It was found that the 470 Ω resistor caused Tr2 to saturate. The transistors employed were inexpensive plastic encapsulated general purpose silicon planar type made by Texas Instruments.

Fig. 7 shows the oscillographs taken from the circuit of Fig. 6 and demonstrates clearly the effects of altering the values of R_2 and the timing capacitor.

The frequency dependence of the circuit on supply voltage was measured with $R_2 = 220$ Ω and $R_2 = 470$ Ω. In the former case a supply change from 15 to 25 V caused the frequency to change from 132 to 124 kc/s, whilst in the latter case a change from 15 to 30 V caused a much smaller change in frequency from 126 to 123 kc/s. The frequency dependence of the saturating circuit was also measured with a timing capacitor of 0.1 μF. The results are indicated graphically in Fig. 8. A change of



(a) 0.5 V/cm. 2 μs/cm. (b) 0.5 V/cm. 2 μs/cm. (c) 0.5 V/cm. 2 μs/cm.

(d) 0.5 V/cm. 2 μs/cm. (e) 0.5 V/cm. 0.05 μs/cm. (f) 0.5 V/cm. 0.05 μs/cm.

Fig. 11. Oscillograms taken in the circuit of Fig. 9. (a) collector Tr1; (b) emitter Tr1; (c) collector Tr2; (d) emitter Tr2. It can be seen that the mark-space ratio is very close to unity and the top and bottom of the waveforms are flatter than those of the circuit of Fig. 3. (e) The rise time and (f) the fall time of the waveforms at the collector of Tr2 showing the rapid switching time.

supply from 15 to 30 V changed the frequency by less than 1 % overall. The difference in behaviour between the saturating and the non-saturating circuits are considered to be largely due to the terms δV_e and V_{be2} as these alter with changes in charging currents. However, these changes are smaller when Tr2 is allowed to saturate.

A modified circuit was designed which has the rapid switching and sharply defined waveforms associated with non-saturating operation but whose frequency stability against changes in power supply voltage is superior to the saturating circuit discussed above. The mark space ratio of the waveforms is very close to unity and the pulse height varies little with changes in supply voltage. The circuit is shown in Fig. 9; the emitter resistors are replaced by Tr4 which acts as a constant current source. Diodes D1, D2 and transistor Tr3 cause the whole of this current to charge capacitor C during the timing periods.

Assume that a regenerative action has just resulted in Tr1 being driven into cut off. The constant current supplied by Tr4 charges capacitor C, the charging path being through Tr2 and D1 (Fig. 10a). D2 and the emitter base junction of Tr3 are reverse biased. The potential at the emitter of Tr1 falls at a uniform rate, and, after a period of time t_2, Tr1 comes into conduction and a regenerative action switches off Tr2. The forward bias across the emitter base junction of Tr1 and the voltage drop across R^*, prevents D1 from conducting and the constant current charges C through Tr1, Tr3 and D2 (Fig. 10b). The emitter of Tr2 falls at the same uniform rate at which the emitter of Tr1 fell (assuming the α_{cb} of transistor Tr3 is close to unity), for a time t_1 until Tr2 comes into conduction again and the regenerative action switches off Tr1 repeating the cycle. If we neglect the step in the emitter voltage of Tr2, δV_e and the small term δV_{be2} (eq. 1) capacitor C has to charge through a voltage $\Delta V = I_c R_1'$. Where I_c is the constant current

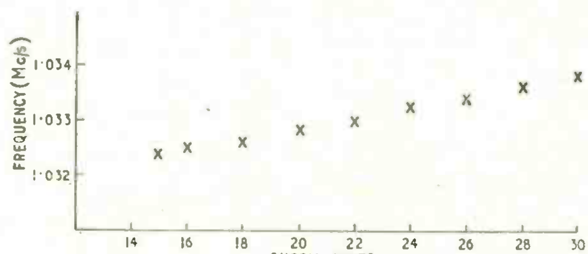


Fig. 12. Variation of frequency with supply voltage for the circuit of Fig. 9. C = 1,000 pF.

supplied by Tr4, R_1' is the effective collector load resistance of Tr1. The rate of charging is the same in both cases $\frac{I_c}{C}$ V/sec.

$$\text{so: } t_1 = t_2 = \frac{\Delta V \cdot C}{I_c} = C \cdot R'$$

The frequency of oscillation, $f = 1/(2C \cdot R')$. The performance of the modified multivibrator is illustrated by the oscillograms of Fig. 11. The frequency dependence on the supply voltage was measured, a change of supply from 15 to 30 V caused a change of frequency of 0.5 %. With a timing capacitor of 1000 pF stability was good and is illustrated in Fig. 12. A change in supply from 15 to 30 V altered the frequency by 0.14 % and the pulse height, at the collector of Tr2, by less than 10 %.

(Next month: monostable circuits)

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WORLD OF WIRELESS

Post Office Receiving Station Refurbished

THE TRANSITION from Nissen huts and manually operated equipment to brick buildings and automatically tuned radio receivers is now complete at the G.P.O. high-frequency (4 to 27 MHz) radio receiving station at Bearley in Warwicks. The new installations cost about £0.5M. This station will combine efficient and reliable reception of long-distance radiotelephone and radiotelegraph communications with the maximum possible economy. Although much of the future transoceanic signal traffic will be carried by submarine cables and Earth satellites, h.f. radio can still play a useful role in world communications in lightly loaded routes for communicating with ships and for auxiliary and standby purposes alongside cable and satellite systems.

An outstanding feature of Bearley is the frequency generating equipment which controls the accuracy of the receiver synthesizers. It consists of three 100 kHz crystal controlled oscillators sunk into 30 feet deep boreholes where the temperature remains within about 0.5°C of 10°C without any artificial control. The accuracy of this master frequency can be maintained to within one part in ten million, with adjustment at about yearly intervals, or, if required, to 1 in 10^8 with adjustments about once a month. This central master frequency source provides, by synthesis, the extremely accurate beat oscillator frequencies. The majority of the 60 receivers at this station are solid-state i.s.b. types suitable for the reception of telephony or multi-channel telegraphy and were designed by Plessey Electronics Group to a Post Office specification. The PVR 800, as it is called, is a quadruple superheterodyne receiver capable of remote control for tuning either to any one of the six predetermined frequencies or by fully synthesized control selecting any one of the 200,000 discrete channels available (in increments of 125 Hz). Because of the accuracy of the synthesized frequencies the receiver can carry out an automatic carrier search process for, and identify, a wanted carrier signal. When the wanted transmission is found, the receiver can automatically maintain correct tuning, providing the transmitter frequency variations do not exceed internationally agreed limits.

The original aerial system has been retained more or less unchanged. A ring of rhombics (70ft high), efficient over the important band of frequencies above 8 MHz, combines global coverage with facilities for special aerial diversity reception.. Diversity operation is necessary to achieve efficient reception of telegraph transmissions. In this case, two similar aerials spaced several wavelengths apart feed two separate receivers whose outputs are combined. This method of space-diversity reception (compared with single aerial reception) is said to be equivalent to increasing the power of the distant transmitter by upwards of 30 times. All rhombics at Bearley are bi-directional, each rhombic end being terminated at the internal aerial distribution board, where, by means of a wideband passive hybrid network, it can serve up to four receivers simultaneously

New Earth Satellite Station in Australia

WITH work well up to schedule, the new Earth station being built at Moree, in northwest New South Wales, by the Australian Overseas Telecommunications Commission, is expected to be in service by the beginning of the year. The total cost of the project is more than $A4 million. It is the eighth space communications establishment built or in the planning stage in Australia. The Moree satellite communications station will be employed to link Australia into the Intelsat II satellite system, providing commercial communications and television transmission and reception with North America and major points in the Pacific. Countries which will be served will include the U.S., Canada, Japan, the Philippines, Hong Kong and other countries of Eastern Asia. It will supplement the $A250 million broad band coaxial cable system which Australia and other Commonweath partners have built across the Pacific and Atlantic Oceans. The new station will send and receive signals via the Intelsat satellite positioned directly over Fiji. Intelsat II was launched from Cape Kennedy for the International Satellite Consortium of which Australia is a foundation.

A high degree of accuracy was required in siting the structure of the Moree Earth station. It had to run precisely due north and south. Margin for error was only 0.000008 % or 10ft in 23,000 miles. The station has been built on a 257-acre site and it includes a 90ft parabolic antenna weighing 200 tons, mounted on a four-storey operations building. Australia's other space communications establishments are at Cooby Creek, Queensland, three stations near Canberra, in the Australian Capital Territory, two stations associated with the Woomera Rocket Range installations, and two in Western Australia, at Muchea and Carnarvon. NASA is reported to be considering establishment of a further station in the Canberra area, but no official announcement has yet been made about this project. Altogether more than $A100 million has been spent in Australia on these projects in the past six years.

Changes in Maritime Radio Regulations

SUBSTANTIAL amendments have been made to those parts of the 1959 Radio Regulations and Additional Radio Regulations which apply to the maritime mobile service. This is a result of the World Administrative Radio Conference which was convened in Geneva on the 18th September by the International Telecommunication Union and which completed its work on 3rd November with the signing of the Final Acts. These will come into force on the 1st April 1969. The amendments have been determined substantially by the fact that since the last revision of the regulations in 1959, there has been a significant drop in the number of passenger ships owing to the growth of air travel, and a notable increase in the number of cargo ships. There has also been a rapid expansion in fishing fleets and other craft. Thus requirements for radiotelephone and radiotelegraph channels have increased considerably.

Among the decisions of the Conference are the following: the gradual introduction up to 1st January 1982 of s.s.b. radiotelephony in the bands allocated to the maritime service between 1605 and 4000 kHz; the gradual introduction up to 1st January 1978 of s.s.b. radiotelephony in the bands between 4 and 23 MHz; allocation of frequencies for narrowband direct printing telegraph systems (teleprinters) and data transmission systems; assignment of frequencies for the transmission of oceanographic data; and in general measures to increase safety at sea (signal code, watch on distress signals, etc.), including conditions governing the use of emergency position-indicating radio beacons.

Subscription Television

IT APPEARS from American press reports that a decision authorizing subscription television on a regular basis has been delayed for yet another year by Congress. Ever since the Zenith Radio Corporation first demonstrated the technical feasibility of this form of television viewing twenty years ago there has been controversy. The Federal Communications Commission is faced with the problem of putting pay television into operation while providing adequate protection for existing commercial stations who, with theatre owners, strongly oppose such a system, which they say, would ruin "free" television and the theatre. At the same time the F.C.C. has to consider the right of the public to choose a system where they were willing to pay for programmes uninterrupted by commercials.

Here in Great Britain a subscription television system has been operating experimentally in London and Sheffield by Pay-TV and during the past year the programmes have included feature films which were screened six months after general release. An indication of the prospects for subscription television in this country is expected soon from the Postmaster-General.

Communications Experiments

THE THIRD in a series of five applications technology satellites, ATS-C, was launched from Cape Kennedy on 3rd November. Among the nine experiments carried on board is one concerned with communications. This will be conducted using two microwave repeaters (receiver/transmitter) which constitute the spacecraft's s.h.f. communications subsystem. Both repeaters operate in three modes, the first two (multiple access and frequency translation) are used in a microwave communications test, and the third mode, wideband data, is used for transmitting television pictures from the spacecraft's spin scan cloud cover camera to the ground. The basic objective of operating the repeaters in the first mode is to evaluate the s.s.b. technique for multiple access communications. This technique is a promising approach to the development of a multiple access system where two or more ground stations use the spacecraft simultaneously, since it affords a maximum number of voice channels in the minimum bandwidth of the overcrowded radio frequencies. The repeaters are operated in the third mode for evaluating a high quality f.m. system for relaying wideband data such as colour television, digital and facsimile signals. The f.m. system used for these tests is a refinement of those installed in the Telstar and Syncom communications satellites.

Sophisticated Surplus

A NEW generation of surplus electronic equipment is now becoming generally available on the open market as computer after computer ends its days at the breaker's yard. For instance, at the recent R.S.G.B. exhibition one could buy a bank of 26 unused thermionic digital indicators neatly mounted on a paxolin printed circuit strip and marked with all power supply voltages for the princely sum of 10s (less than the cost of one of the indicators). Clearly there are many bargains about provided the reader is prepared to search for them and separate the wheat from the chaff. Some boards are coated with a thin layer of epoxy resin rendering it extremely difficult, though not impossible, to salvage any usable components. A range of boards, ex I.B.M. computers, do not suffer from this defect and in many cases are usable more or less as they stand for the original purpose they were intended. These boards contain gates, bistables, differential amplifiers, etc., and cost in the region of a couple of shillings each. One example contained four two-input NAND gates that operated quite happily from a 6-V supply; such boards should prove very useful to schools and colleges. Buying these items is something of a lucky dip and a good deal of time must be spent in tracing out individual circuits to discover what one actually has. The I.B.M. boards may be obtained from Pattrick & Kinnie or L.S.T. Components.

Information Services provided by the I.E.E. in the fields of physics, electrotechnology, and control are known collectively as INSPEC. Exploitation and development of this facility is to be assisted by a grant from the Office for Scientific and Technical Information, and by collaboration with the Institute of Electrical and Electronics Engineers, and the American Institute of Physics. The object of this expansion programme in 1968 is to extend the present service (limited to publication of *Science Abstracts* and *Current Papers*) to include a service of selective dissemination of information S.D.I. The above facilities will be changed to a computer-based service, and the present publications will be produced by computer methods from the January issues in 1969. From the same date S.D.I. will come into operation, and magnetic tapes containing data concerning all literature processed by INSPEC will be available.

The possibility of a nationally recognized qualification and **title for technician engineers** was discussed by 31 engineering institutions and societies and members of the Council of Engineering Institutions on the 1st December. The result was that those organizations who are outside the C.E.I. would group into like interests, and each group prepare and submit recommendations for a joint meeting with C.E.I. in February next.

ANNOUNCEMENTS

Ten weekly lectures on **studio audio control equipment** begin at the Northern Polytechnic, Holloway, London N.7, on January 11th. The fee is 21s and application forms can be obtained from the Head of Department of Electronic and Communications Engineering.

A series of 12 weekly lectures on **piezo-electric devices and their applications** will be held at Southall College of Technology, Beaconsfield Road, Southall, Middx., commencing January 17th. The course fee is 6 gn.

A course of six lectures on **u.h.f./s.h.f. techniques** will be held at Norwood Technical College, Knight's Hill, London, S.E.27, commencing 20th February. The lectures will take place each Tuesday evening. Fee is 15s.

Mr. E. W. Weaver, Director of the London Telecommunications Region of the G.P.O., formally opened **London's first p.c.m. telephone link** (between Sunbury, Middlesex and Central London) on November 27th.

A new company, **Electronic Brokers Ltd.**, has been formed to collect and offer prompt payment for electronic equipment and components at present lying unused in many British companies. The head office of this company is at 8 Broadfields Avenue, Edgware, Middx.

A series of one-week courses on **vacuum technology** will be held during 1968 at Edwards High Vacuum Ltd., Manor Royal, Crawley, Sussex. Details are available from the Customer Training Officer.

AEI-Thorn Semiconductors, Lincoln, are providing a **mask-making service** for industrial, academic and research establishments. Sample masks within ten days are offered. Plates of up to two-inches square can have a registration to within 40 μin.

Film strips and slide sets produced by Mullard will now be distributed by Educational Systems Ltd., ESL House, Imperial Drive, North Harrow, Middlesex. (Tel: 01-868 4400.)

PERSONALITIES

R. I. Walker has been appointed chief engineer of the Semiconductor Division of the Ferranti Electronics Department at Gem Mill, Oldham, Lancs. Mr. Walker, who has been with the company for seven years, occupying the position of deputy chief engineer, was formerly with the Services Electronics Research Laboratory, at Baldock, where he was responsible in the late 1950s for much of the early development work on silicon mesa transistors. Ferranti also announce the appointment of **Alan Williamson** as product marketing manager, discrete components, and **Brian Down** as product marketing manager, intergrated circuits. Mr. Williamson has been with the company for seven years latterly as senior field sales support engineer, and Mr. Down, who was formerly in the application group of the Ferranti Semiconductor Division, has rejoined the company after two years with Texas Instruments.

John S. Walker, M.Sc., F.I.E.E., who recently joined De La Rue Instruments Ltd., as managing director, has for the past 10 years been with Texa Instruments Ltd. where he was latterly manager of the Research and Development Department. From 1949 to 1953 Mr. Walker was at Manchester University where he took a course in physics, which

J. S. Walker

he followed by an M.Sc. course in electrical engineering in 1952/53. He then spent two years with Standard Telephones and Cables. In 1955 Mr. Walker joined International Computers and Tabulators and then the British Tabulating Machine Co. before going to Texas Instruments. Mr. Walker is a member of the I.E.E. Panels on Semiconductor Devices and Integrated Circuits.

G. H. Stearman, B.Sc.(Eng.), M.I.E.E., for the past ten years lecturer at the College of Aeronautics, Cranfield, where he specialized in electronics and digital techniques, has joined Feedback Ltd., of Crowborough, Sussex, as development department manager. He obtained his degree at Brighton Technical College and was with Cable & Wireless Ltd., for

G. H. Stearman

two years before joining Southern Instruments Ltd. in 1951 where he stayed for six years. In 1964 Mr. Stearman was seconded for a year to the National Aeronautical Laboratory at Bangalore.

D. G. Smee, M.B.E., A.M.I.E.E., commercial director of the Marconi Company since 1965, has been appointed chairman of the board of directors of Elliott-Automation Microelectronics Ltd., which forms part of the Elliott-Automation group of companies recently acquired by English Electric (parent company of Marconi). In this new position he will be responsible for coordinating the activities of Marconi and E.A.M. in the field of microelectronics. Mr. Smee, who is 50, joined the Marconi Company in 1933, working at the Research Laboratories until the outbreak of war in 1939, when he joined the Royal Signals. He returned to Marconi in 1946, and in 1950 became assistant commercial manager. Six years later he was appointed manager of the Company's Broadcasting Division.

D. H. Roberts, B.Sc., M.I.E.E., F.Inst.P., for some time head of solid-state research at Plessey's Allen Clark Research Centre at Caswell, Northants, has become general manager of the company's Semiconductor Division at Swindon in succession to **Brigadier J. D. Haig** who is appointed general manager of overseas plant operations. Mr. Roberts joined the Plessey laboratories at Caswell in 1953 after graduating in physics at Manchester University. Also transferred from Caswell to the Swindon production team are: **W. Holt,** B.Sc., A.R.C.S., aged 34, who joined Plessey in 1961 from Marconi's Research Laboratories, and has been chief development engineer at the Allen Clark Research Centre; **R. C. Foss,** B.Sc., Ph.D., M.I.E.E., aged 31, principal engineer, integrated circuit development, at the Centre, who joined Plessey in 1964 from E.M.I. Electronics; and **M. J. G. Gay,** A.M.I.E.E., aged 30, who joined Plessey from the Mullard Thin Film Unit in 1964 and has been in charge of circuit techniques research at the Caswell Research Centre.

S. N. Ray, M.Sc., B.Sc.(Eng.), M.I.E.E., F.Inst.P., acting head of the Department of Electrical and Electronic Engineering, Borough Polytechnic, London, for the past year, has retired. Born in Calcutta in 1902, Mr. Ray came to this country after receiving his M.Sc. degree from Calcutta University in 1925 and continued his studies for his B.Sc. (London) and the Diploma of Faraday House. For 11 years he was in the radio industry and joined the staff at the Polytechnic in 1939. He was senior lecturer in radio engineering until he was appointed principal lecturer in applied electronics in 1961. He has been acting head of the Department of Electrical and Electronic Engineering since **V. Pereira-Mendoza,** M.Sc.Tech., F.I.E.E., became principal in 1966. The new head of the Department is **Kenneth W. E. Gravett,** M.Sc.(Eng.), M.I.E.E., A.M.I.E.R.E., who has been senior lecturer in electrical measurements at

K. W. E. Gravett

the Brighton College of Technology. After graduating at King's College, University of London (where he also obtained his master's degree), he served an apprenticeship with the British Thomson-Houston Company at Rugby. He subsequently held appointments at the Post Office Research Station and on the staff of the Battersea College of Technology.

Semiconductor Type Numbering

Some guidelines through the chaos of type code numbers that face you nowadays

By T. D. TOWERS,*
M.B.E., M.A., C.Eng.

THERE is a lovely old proverb that runs: "Who buys has need of a hundred eyes." How true this is when you set out to select a transistor or a diode nowadays from the host of different kinds of type numbers used, either from one of several "standard" sytems in operation, or from the non-standard systems used by individual manufacturers. In Great Britain you can come across transistors or diodes of almost any nationality. If you are going to find your way confidently among them, you have to know something of the basic numbering systems used, and these are discussed individually below.

JEDEC system.—Probably the oldest standard numbering system in current common use is the American "JEDEC."† In this, the Electronic Industries Association (E.I.A.), in the United States, registers devices from specifications put up by manufacturers. It uses a numbering system in which the first numeral shows how many diode junctions the device has, with a "1" for a diode, a "2" for a triode transistor and a "3" for a tetrode. After this initial numeral comes an "N," and then the number in serial order under which the device was registered with the authority. As an example, the "2N914" is the 914th triode transistor registered.

By the end of 1967, both 1N (diode) and 2N (triode) numbers registered had passed the 5,000 mark.

Any manufacturer, provided he meets the specification as registered by the original manufacturer with E.I.A., can supply devices to JEDEC numbers. The full details of any individual registered device can be obtained from E.I.A., 2001 Eye St., N.W., Washington, D.C., 20006. Unfortunately, they do not publish an easily available comprehensive authoritative list of JEDEC devices and their characteristics.

PRO ELECTRON system.—Although the JEDEC standard numbering has come into fairly common use in Europe, there is a European standard system, known as "PRO ELECTRON," which is also widely used here in parallel with JEDEC. The organizing authority is the Association Internationale PRO ELECTRON, of 10, Avenue Hamoir, Brussels.

As with the JEDEC system, the manufacturer registers with PRO ELECTRON a device he has developed. Any other manufacturer can then supply devices marked with the same registered number, provided his version also meets the electrical and mechanical specification registered with PRO ELECTRON.

The PRO ELECTRON system has one big advantage over JEDEC. All you can tell from a JEDEC number is whether the device is a diode, triode, etc., and some indication of the time of registration, since low numbers mean the device was registered years ago. With PRO ELECTRON, the letters and numbers used are much more significant.

The PRO ELECTRON type number always has five places: either two letters and three numerals (as in BC107) or three letters and two numerals (as in BCY72). The first letter indicates the bulk semiconductor material used: A=germanium; B=silicon; C=gallium arsenide; and R=compound photo-conductive material.

The second letter indicates the circuit type of the device: A=signal diode, non-power; B=variable capacitance diode; C=transistor, l.f., non-power; D=transistor, l.f., power; E=tunnel diode; F=transistor, h.f., non-power; G=multiple device; H=field probe; K=Hall generator; L=transistor, h.f., power; M=Hall modulator or multiplier; P=radiation sensitive device (photodiode, photo-transistor or photo-conductive device); Q=radiation generating device; R=specialized breakdown device; S=transistor, switching, non-power; T=controlling and switching device with breakdown characteristics, power (s.c.r. or thyristor, etc.); U=transistor, switching, power; X=multiple diode; Y=rectifier, power; and Z=Zener diode (voltage reference or regulator).

The final three places of the PRO ELECTRON five-place registration number give an indication of the general area of use and a serial number. Where three numerals are used (e.g., BC107) this indicates a device for "entertainment" or "consumer" use; i.e., for radio or television receivers, audio amplifiers, tape recorders, etc. The three numbers run from 100 to 999. Where a letter and two numerals are in the last three places (e.g., BCY72), this indicates a device for use in industrial and professional equipment. The letters (which bear no significance) in this case start from Z back through Y, X, etc. The accompanying serial numbers run from 10 to 99 only.

Sub-classifications are permitted in certain devices such as Zener diodes, power diodes and thyristors (s.c.rs) in the PRO ELECTRON system. These are indicated by further codings added after a hyphen at the end of the five-place basic number according to a significant system.

For Zeners, the code addition gives information on the nominal voltage and its tolerance. The tolerance appears first as a single letter: A=1 %; B=2 %; C=5 %; D=10 %; and E=15 %. The nominal voltage follows as a numeral plus the letter V in the position of the decimal point where necessary. Thus BZY88-C9V1 represents a silicon Zener for industrial use, with registration number Y88, tolerance 5 % and nominal voltage 9.1 V.

For rectifiers and thyristors, the additional PRO ELECTRON code numbers signify the repetitive peak reverse voltage in volts. Thus BYX36-100 indicates a silicon rectifier for industrial use with registration number X36 and a 100-V rating, while the BTY99-100 represents a silicon thyristor for industrial use with registration number Y99 and a 100-V rating. With

† Joint Electronic Device Engineering Council.

* Newmarket Transistors Ltd.

power rectifiers and thyristors, the cathode is normally connected to the stud mounting. Where the anode is connected to the stud ("reverse polarity"), a final letter R is added. By this a BTY99-100R signifies a reverse-polarity BTY99-100.

Recently supplementary codings have arisen for ordinary transistors, too. You may come across the well-known BC108 in versions coded BC108A, B and C. The final letter suffix in this case denotes a narrow-spread selection of current gain within the wider spread limits of the basic BC108 device.

Old European coding system.—The PRO ELECTRON system has become widely accepted in Europe during the 1960s, and is often referred to as the "new" European system. It has replaced the old European system under which semiconductors were indicated by an initial "O" (standing for zero heater volts in the then existing valve coding). After the initial O came a letter in the coding with A=diode, C=triode, etc., and a registration number. Many readers will remember with nostalgia such codings as the OC71 transistor and the OA81diode. Devices are still being marketed under this old system, but it is to be expected that they will ultimately disappear.

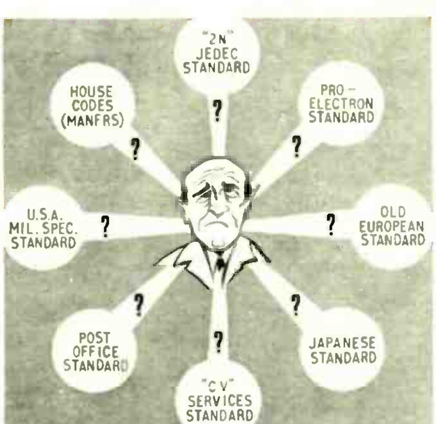
Japanese system.—Japanese transistors appearing for sale and in equipment in Britain over the last decade have faced engineers with a new set of numbers according to a standard widely used in Japan. The first two symbols of the code are "2S" for triode transistor, and the third gives an indication of the general characteristics of the transistor according to the following code: A=p-n-p, r.f.; B=p-n-p, a.f.; C=n-p-n, r.f.; and D=n-p-n, a.f. As an illustration, the 2SA49 is a p-n-p, r.f. transistor with registration number 49.

"Services" standard systems.—On the British market, the user will occasionally come across devices bearing type numbers according to some Government standard.

The commonest of these are the "CV" types, where the type designation consists of the letters CV followed by a four- (and recently five-) digit number. In the future this is likely to be supplemented by a separate British Standard (BS9000) series arising out of the work of the celebrated Burghard Committee.

The British Post Office, too, has in the past issued its own series of semiconductor specifications and users may come across these in a self-evident numbering series, PO1, PO2, etc.

The only other Government numbering system the ordinary user is likely to meet is the American "Mil. Spec." series corresponding to the British "CV" system. Under this coding, devices are normally specified as the corresponding commercial JEDEC number with the prefiex "JAN" added; e.g., JAN 2N3093 is the Mil. Spec. version of the 2N3093. This is the current procedure, but Mil. Spec. devices may also be found coded under the previous system, where the prefix indicated the branch of the services sponsoring the device. The single JAN prefix now used replaces the separate prefixes USA, USAF and USN formerly used. The "Mil. Spec." jargon name for these devices arose because they were related to a specification document numbered Mil-S-19500, where the individual devices were distinguished by a suffix number; for example, the 2N914 has the designation Mil-S-19500/373 in its military version.



Pity the poor engineer faced with the chaos of semiconductor device numbers in many different systems.

House Codes.—Most manufacturers sell semiconductor devices under their own special series of "house" numbers, as well as under numbers according to one of the standard systems. Some of these house codes have woven themselves firmly into the structure of the British market, and it will be long before they disappear.

Some guide to the transistor house codings is given in Table I, which shows the more common initial letters used by semiconductor manufacturers in the U.K. Diode house codes tend to be much more numerous and less distinctive than transistor codes and are not therefore included.

Apart from the house numbers put out in published data, semiconductor manufacturers sell a considerable portion of their output under special or "private" house numbers. Little guidance can be given on this to the general user, but, if he comes across a device the characteristics of which he cannot trace, he can always write to the manufacturer (whose name should appear on the device along with the type number).

A final mystifying feature of transistor numbers is that large users frequently lay down their own "in-house" specifications with their own code numbers, and manufacturers mark the devices they supply with these "in-house" numbers. When you come across one of these, it is, I fear, not easy to find out details of its specification.

INFORMATION ON SEMICONDUCTOR DEVICE TYPES

Having discussed the many different methods of coding a semiconductor device which may be met with in practice, the reader can be forgiven if he thinks: "That is all very well, but where can I go to find out the characteristics of any particular device?" In the case of a device in a standard numbering system such as JEDEC or PRO ELECTRON, he could write direct to the registration authority, but this can be a long and expensive procedure. The ordinary engineer-in-the-street usually turns to one of the commercial publications described below.

The most complete current commercial tabulations of data on semiconductor device types are published by Derivation and Tabulation Associates, Inc., of 32 Lincoln Avenue, Orange, New Jersey, 17050, U.S.A. Three of their publications circulate world wide among semiconductor users.

Transistor D.A.T.A. Book.—This is a characteristics tabulation for virtually every transistor (about 13,000 types at the time of writing) commercially available in the world. It is completely revised biennially in Spring and Autumn, with separate updating supplements in

Summer and Winter. The annual subscription is currently $30.50 in the U.K. It does not include obsolete transistors, but there is a separate publication for these.

Discontinued Transistor Yearbook and Replacement D.A.T.A. Book.—This is an annual edition issued each Summer and is a compilation of all discontinued types since 1956. Each edition costs $15.25 in the U.K. Diodes are covered by a third publication.

Semiconductor Diode and SCR D.A.T.A. Book.—This covers virtually every type of available diodes and already runs to some 66,000 entries. It is issued in complete revisions in Spring and Autumn and the annual subscription is $39.50 in the U.K. These three "D.A.T.A." books give sufficiently detailed tabulation of characteristics for most uses of the devices, and in addition give mechanical outlines. For the user of many semiconductor types, they have become almost "bibles." But they are expensive, and less ambitious students have to turn to more modest publications.

Iliffe's Radio Valve Data.—This data tabulation (covering transistors and diodes as well as thermionic valves) is the successor to the well-known *Wireless World* Valve Data Manual and still costs only a modest 9s 6d. Even so, it is probably the best easily available data tabulation for British semiconductor devices, and it has the useful feature of being brought up-to-date regularly.

Avo's International Transistor Data Manual.—This transistor tabulation, issued by Avo Ltd. for use with their commercial transistor tester, is also marketed separately at 45s. It, too, is a most useful general data tabulation, with many features not commonly found. For example, it contains listings of CV and Russian transistors.

Other commercial tabulations.—There are a number of other commercial listings of transistors published, but they are generally less useful than those described above, either because they tend to go out of date or are aimed primarily at a non-British market. For completeness, however, some of the more easily available are listed below:

(i) "Techpress" Transistor Specifications and Substitution Handbook, 1967, by Techpress Inc., Brownsburg, Indiana 46112.

(ii) Transistor Specifications Manual, by Foulsham-Sams Technical Books, W. Foulsham and Co., Ltd., Slough, Bucks.

(iii) "Datadex" Transistor Reference Book by M. W. Lads Publishing Co., Philadelphia, P.A.

(iv) British Transistor Directory, by E. N. Bradley, Norman Price (Publishers) Ltd., London.

(v) Guide Mondiale des Transistors, by Société des Editions Radio, 9 rue Jacob, 75, Paris, 6.

In all this, it should not be overlooked that if you write to any semiconductor manufacturer he will be pleased to send you information on his devices.

TABLE 1
INITIALS OF TRANSISTOR HOUSE CODES IN COMMON USE BY MANUFACTURERS IN THE U.K.

C, CP	SGS-Fairchild
DT	Lucas Semiconductors
FI, FK, FM, FSP, FT, FV	SGS-Fairchild
GET	Mullard-G.E.C. (Assoc. Semiconductors)
GM	Texas Instruments
HT	Emihus
M	Motorola
NKT	Newmarket Transistors
P	SGS-Fairchild
PEP	A.E.I. Semiconductors
V	Newmarket Transistors
SE	SGS-Fairchild
TI, TM	Texas Instruments
TK	S.T.C.
ZDT, ZT, ZTX	Ferranti Semiconductors
2G, 2S	Texas Instruments

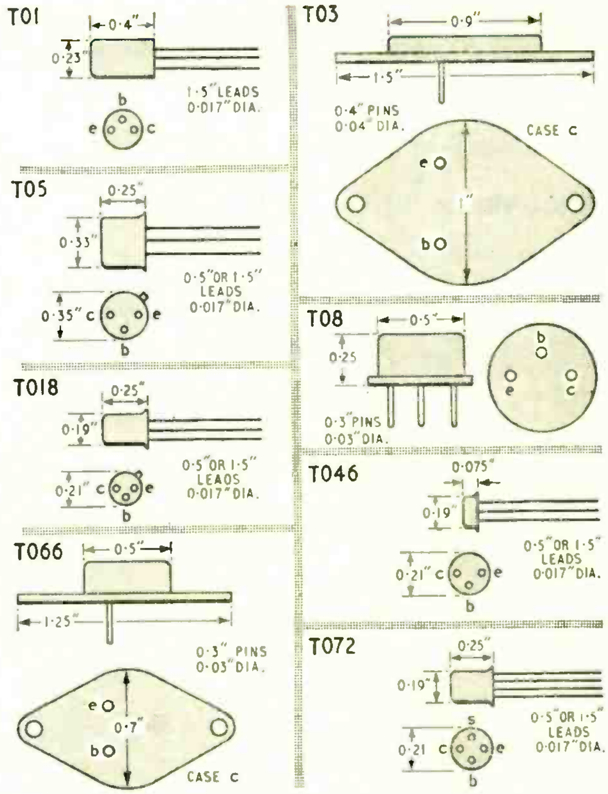


Fig. 1. Simplified mechanical details of the more common standard JEDEC "TO" transistor outlines (Typical dimensions only).

INFORMATION ON SEMICONDUCTOR OUTLINES

In the early days of transistors, fifteen years ago, manufacturers invented their own device shapes and lead configurations, but of recent years there has been considerable standardization.

JEDEC outlines.—As in device numbering, the E.I.A. in the U.S.A. led the way in outlines. It registered the dimensions of certain preferred cases or encapsulations for semiconductor devices under "TO" (transistor) and "DO" (diode) outline standard numbers. Full details of the outlines so registered can be found in the JEDEC publication 12E, "Registered Outlines and Gauges for Semiconductor Devices." You can also find the JEDEC outlines at the end of the D.A.T.A. publications described earlier.

Some of the registered JEDEC outlines have virtually dropped out of use with time, but certain "standard" ones have been adopted by most manufacturers. In transistors, the commoner outlines in use are TO1, TO3, TO5, TO8, TO18, TO46, TO66, and TO72. Simplified drawings of these are given in Fig. 1.

VASCA outlines.—Over here some moves towards outline standardization have been made. A "Record of Semiconductor Outlines" from the Electronic Valve and Semiconductor Manufacturers' Association, Mappin House, 156/162 Oxford Street, London, W.1, gives details of the VASCA system, in which outlines are registered under an "SO" (semiconductor outline) number related to the American "TO" JEDEC numbers. VASCA also registers semiconductor lead configurations under an "SB" (semiconductor base) series.

I.E.C. outlines.—A separate standard numbering system for registered outlines has been developed by the International Electrotechnical Commission (I.E.C.), 1 Rue de Varembe, Geneva, Switzerland, and issued in their Publication 191-2, "Mechanical Standardizataion of Semiconductor Devices." Both this and the VASCA publication relate their standard outline numbers to JEDEC and to other standards.

CV outlines.—In the numbering of semiconductor outlines, you may come across the British Government CV system which typifies various outlines according to an appendix number to a semiconductor code popularly known as K1007. Thus probably the commonest encapsulation for silicon small-signal transistors appears as K1007/A1-D14, as well as JEDEC TO18, I.E.C. 2-106, and VASCA SO12A.

CONCLUSION

Although we have examined most of the multifarious type and outline coding systems used by manufacturers, it would seem at long last standardization is beginning to take hold. The bulk of semiconductor devices used in the British market in the future are likely to be coded on either the PRO ELECTRON or the JEDEC numbering systems (with a few house codes sprinkled around), and outlines will generally be described by the JEDEC "TO" system.

Units and their Abbreviations

READERS may have noticed that we have been gradually introducing the hertz (Hz) as the name for the unit of frequency in place of c/s over the past few months. Much was said in support of both of these names in the course of an argument in our correspondence columns early in 1967, but there is no question that the hertz is now being widely adopted and is here to stay. *Wireless World* therefore intends to standardize on Hz, together with its multiples, kHz, MHz, GHz and THz.

Since the hertz is an internationally recommended name for one of the derived SI (Système Internationale) units,* this seems an appropriate time for *W.W.* to standardize on SI units generally. In practice this means that there are no changes to the most common electrical units and their symbols (V, A, Ω, W, C, J, F, H, etc.). Since, however, SI is really a development of the m.k.s. (metre-kilogramme-second) system and therefore brings in metric units for length and mass in place of British measures, some of the other SI units appropriate to electronics and communications may be rather unfamiliar. A selection of these is listed (right) with comments. With frequency it has only been necessary to change the *name* of the unit —its value has not been affected. The SI unit names in the table, however, represent units of different size from the older-established units, and so one has to use conversion factors to change the older units into SI units or vice versa.

Although the basic unit of length in the SI system is the metre, it would obviously be impracticable, at the present juncture, to abandon the British inch, foot, yard and other units of length completely. These will still be widely used in physical dimensions, for example chassis and cabinet sizes. We shall therefore adopt a policy of introducing the metric units of length gradually, in some cases using them alone, in others printing them alongside the British units. A similar method of gradual introduction will be adopted with other physical quantities for which the present, non-SI, units are widely used and familiar to our readers.

Quantity	Unit and Abbreviation	Remarks†
Short wavelengths (as in light)	micron (μm)	Replacing angstrom unit (Å)
Force (as in transducers)	newton (N)	= kg m/s^2. Replacing pound-force (lbf), poundal (pdl), dyne (dyn).
Pressure (e.g. acoustics, transducers)	newton per square metre (N/m^2)	Replacing lbf/in^2, dyn/cm^2, inH_2O, mmHg, torr, bar, atm. etc.
Magnetic flux	weber (Wb)	= V s. Replacing lines, Maxwell.
Magnetic flux density	tesla (T)	= Wb/m^2. Replacing gauss, lines/cm^2, Maxwells/cm^2.
Magnetic field strength	ampere per metre (A/m)	Replacing oersted.
Illumination (e.g. television, opto-electronics)	lux (lx)	= lm/m^2. Replacing foot-candle, lumen per square foot (lm/ft^2).
Luminance	candela per square metre (cd/m^2)	Replacing foot-lambert, cd/ft^2, cd/in^2

† Conversion factors between SI and other units are given in the N.P.L. booklet "Changing to the Metric System"

* See B.S. 3763: 1964 "The International System (SI) Units." Also "Changing to the Metric System" (N.P.L. booklet), H.M.S.O. 3s 6d. The basic SI units are the metre (m), kilogramme (kg), second (s), ampere (A), degree Kelvin (°K), and candela (cd). Supplementary units are the radian (rad) and the steradian (sr). All other units are derived from these, and the system is coherent in that any SI unit results from products and/or quotients of other SI units.

OUR COVER

THE theme of colour television is portrayed by the dichroic prismatic separation system employed in the Philips three-Plumbicon camera. Several of these cameras, which are marketed in the United Kingdom by Peto Scott, are being used by the B.B.C. for its colour service which opened on December 2nd.

2: THE DESIGN OF A CIRCUIT

By K. C. JOHNSON, M.A.

THE first article in this series considered the advantages and disadvantages of the class D principle of operation for power amplifiers in general and for transistor audio circuits in particular. The conclusion formed was that the class D principle does not lead to any overwhelming advantages and that such circuits are not likely to displace the conventional class B type on any large scale. Nevertheless, they do have considerable intrinsic interest and readers may like to see a circuit that the author has developed which attempts to exploit as many of the special features of the class D principle as possible. This circuit uses the simple feedback form of modulator for generating the switching wave form, despite its comparatively poor distortion characteristics, since any improvement requires unjustifiable extra complexity. The last two stages work in class D; three might have been so employed to give a lower standing current in exchange for a lower maximum output amplitude and lower efficiency at the larger output levels. The top-cut filter at the output is a simple choke, although some small improvement in performance could be gained by using a more complicated network.

OUTPUT STAGE DESIGN

The circuit diagram of the complete amplifier appears in Fig. 4. It will be seen that the two final transistors Tr6 and Tr7 are employed as switches to provide a powerful square-wave voltage source from which current is drawn through an audio band filter to the loudspeaker; essentially as shown in Fig. 2 last month. The diodes D2 and D3 are included because the relatively low frequency current required for the loudspeaker in such an arrangement will often be flowing "backwards" with respect to the voltage being generated by the switching action and this backwards current is carried by these diodes. It cannot be carried by the transistors unless they are made to meet severe "symmetrical" ratings in addition to the other difficult requirements, since the currents involved are substantially equal to the peak currents that the devices must be able to carry in the forward direction. Notice that this reverse current is carrying power back from the reactive components in the filter network to the power supply, and that it is directly because of this returning of unwanted power that the class D system is potentially so highly efficient.

The two transistors thus work in conjunction with the diodes opposite to them, as is indicated in the drawing; when large amplitudes are being handled only one such pair is switching the real current at any one time while the other carries little or nothing. Because the variations in the audio signal are comparatively slow it is possible to connect the centre-tapped inductor L_1 as shown on the diagram without any significant effect on the basic switching action. When, however, real transistors are being switched at a speed approaching the limit of their capabilities it will always in practice be found difficult to ensure that a perfect "break-before-make" action is obtained, and this inductor helps to prevent any serious build-up of unwanted current due to this transient overlap of transistor conduction. In this circuit the strapping of the bases of the drive stage, Tr4 and Tr5, ensures that such overlaps will never be very serious, but the extra inductor costs little and enables the transistors to be switched that tiny bit faster with better standing current. The detailed design of this stage, and indeed of the whole circuit depends on the characteristics of the transistors selected for the positions Tr6 and Tr7. As has been said already this choice is difficult; if it were not so, a complementary pair of devices would be employed and several advantages realized, but at present it is difficult to find a single adequate type and hence an arrangement of the form familiar in conventional circuits is used, where only the drivers Tr4 and Tr5 need be complementary. Accordingly a single transistor type serves for both positions, so that reasonable matching is easily achieved. The device chosen is the Fairchild BC119, this allows a maximum current of 1 A, with guaranteed saturation to 1.5 V when the base drive is 100 mA, it has a cut-off frequency of at least 40 Mc/s and a maximum voltage, at any allowable current level, of 30 V without avalanche breakdown. It is an n-p-n silicon planar epitaxial transistor in a TO5 case.

The use of this device, to within its ratings, fixes the power supply voltage at a maximum value of 30 V. If, as proposed last month, the modulation level is restricted to 60% of the ultimate value on account of the sideband distortion effects, then the available output amplitude at the loudspeaker cannot possibly be guaranteed to exceed ± 7.5 V because of the allowances that must be made for ohmic losses in both the transistors and the filter network. If, moreover, the current is also held within the allowable limit then the maximum useful value will be about ± 0.8 A after taking into account the ripple in the filter. Therefore, the maximum output power that can be guaranteed is 3 W average into a loudspeaker system that has been adjusted to present a load of exactly 9.5 Ω. Into a speaker of different impedance the power limit will be lowered, since either the voltage or the current will be unable to reach its full value.

Needless to say any pair of transistors of this type will almost certainly be found to function perfectly well at twice this current and at larger voltages as well, so that more power will in fact be obtainable, but there can be no guarantee of this and neither the manufacturers nor the author can be blamed if devices fail. In a conventional circuit these same transistors can be used up to 60 V where they are always cut off before voltages above 30 are applied. Since the full 1 A current can also be used the power limit for a pair in class B working is about 14 W into a load of 28 Ω; over four times more than with class D! For this output to be maintained for any length of time heat-sinks are mandatory, but this presents no real difficulty, while the very high frequency cut-off allows a large factor of feedback to be applied without any serious stabilization problem.

The diodes for the positions of D2 and D3 must be able to carry the same peak voltages and currents as the power transistors and here the selection of a suitable type is even more difficult since the forward voltage drop must be small to avoid unnecessary turning on of the opposite transistor[5] and the switching speed has to be fast. The Fairchild type EB 383 can stand the reverse voltage, but the published limit values of stored charge and capacitance are barely adequate while the forward characteristic is not specified at all for currents exceeding 50 mA. To be able to guarantee the performance of the circuit a more exotic diode type ought have been employed; unfortunately none are readily available. However, the specimens of EB 383 that the author tested have proved to be entirely satisfactory. The diodes for use with these transistors should really be able to carry a forward current of 1 A at less than 1.5 V, a capacitance of not more than 10 pF and a charge-storage characteristic equivalent to a time of perhaps 10 ns.

The driver stage, comprising Tr4 and Tr5, requires a pair of complementary devices each capable of delivering a peak current of 100 mA or more to the final transistors, with approximately matched speed and saturation characteristics. Notice that in this form of circuit the drive current is not delivered unless the load demands it, and that the final transistors are not turned on at all unless the output current exceeds perhaps 25 mA in the appropriate direction (due to the low value used for the resistors R_{18} and R_{19}). This low value for the base resistors also ensures that the final transistors are switched off rapidly when required. The driver transistors must be able to stand the full supply voltage without breakdown and have adequate speed, but the current levels are so much lower that the selection of suitable types is comparatively easy. From the Fairchild range type BC 125 will serve in n-p-n position while BC 126 is the matching p-n-p device. Both these types are TO5 size but are encapsulated in plastic. The bases of the drive transistors are connected directly together since there is no critical adjustment of cross-over current needed and a bit of "slack" is indeed desirable to reduce the effects of both the top and bottom devices being turned on at the same time.

The centre-tap of the inductor L_1 provides a symmetrical output for the switching stage and it is from here that the "bootstrap" capacitor C_8, the feedback network R_3, and the main filter inductor L_2 are all driven. The value of L_2 is chosen to be 250 μH and represents a compromise between the need to keep down the ripple current at the switching frequency, which causes inefficiency and reduces the available output current, and the requirement that the high audio frequencies must not be restricted. Clearly a more complicated filter network with a sharper cut-off could have been used, but the design of such an arrangement would involve nothing new and, moreover, it is rather doubtful whether the improvement would justify the trouble. Remember that these inductors must be able to carry the full loudspeaker current without magnetic saturation effects being significant, while the resistance of the windings is a major contribution to inefficiency at high power levels and must be kept low. Thus these components must inevitably be comparatively expensive and bulky.

Fig. 5 shows how both of the inductors L_1 and L_2 can be made as a single unit using two pieces of standard ferrite aerial rod for the magnetic circuit. If the reader can obtain properly designed ferrite "pot" cores then a conventional winding for each inductor can of course be used, but remember that an adequate air-gap is essential and that the capacitance between the ends of L_2 must be kept particularly small to avoid high frequencies reaching the loudspeaker leads.

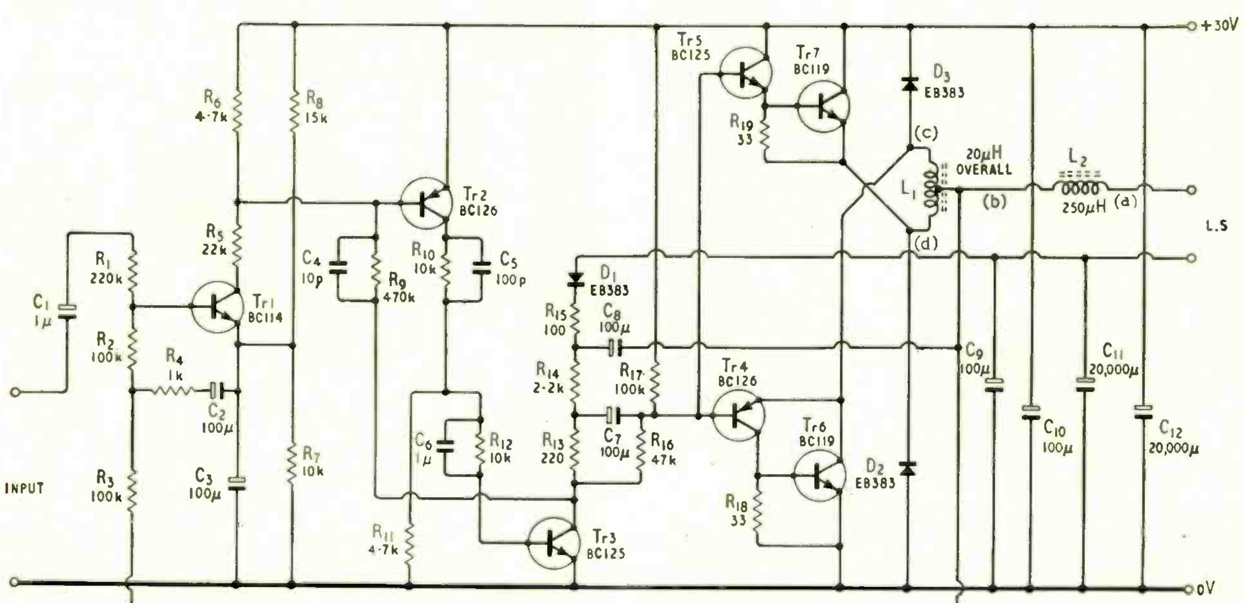


Fig. 4. The circuit diagram of the amplifier.

To construct the coils wind a layer of thin insulating tape round two pieces of ferrite rod 0.3 inches in diameter and 1.5 inches long. L_2 is made up of 50 complete figure-of-eight turns of 32 s.w.g. enamel covered copper wire, care being taken to ensure tight packing at the cross-over point. L_1 consists of 10+10 turns wound in a single layer, round both rods, using the same wire. The assembly is completed by winding with a layer of insulating tape to hold the turns in place. Using this form of construction the measured values of the coils were: $L_1=5.6\,\mu$H. $0.16\,\Omega$ (each half). $L_2=250\,\mu$H. $0.8\,\Omega$. The 50 or so complete turns required are not difficult to wind by hand and form an inductor with a not too inefficient arrangement of copper, ferrite and air-gap which has a very low capacitance and doesn't require a specially made core assembly. Notice that the mutual inductance of the two coils wound in this way is comparatively negligible so that there is no question of having to connect L_1 the proper way round, and also that no exact balance between the two halves is necessary.

The loudspeaker is connected directly to this inductor while the d.c. blocking capacitors, C_9 and C_{11}, in parallel are between the loudspeaker and the power supply. This is a transposition of the arrangement shown in Fig. 2 last month, but there is of course no difference in the method of operation. The change is made partly to avoid the appearance of signal voltages on components which will inevitably be large, but mainly so that the "bootstrap" circuit can draw its current from these capacitors and so get it for "half price." This rather surprising possibility comes from the fact that the voltage on C_9 remains substantially constant at about half the supply voltage and that the switching circuit maintains this value by an efficient transformation action. If a current averaging 10 mA is drawn from C_9 then a current of this magnitude will flow in the inductor L_2, but the transistors Tr5 and Tr7 will carry this current, on average, for only half the time, so that the steady drain at the power supply is only 5 mA or thereabouts instead of 10. A further power saving in the "bootstrap" action is obtained by using a diode D1, rather than the usual resistor, to draw the current for charging the capacitor C_8. This becomes possible in the class D circuit since the regular switching action ensures that this capacitor is fully recharged every cycle of the carrier frequency. The capacitor C_8 is, therefore, maintained at almost half the voltage of the power supply, when the circuit is in operation, and provides a source of extra voltage to ensure that Tr5 is adequately saturated when Tr3 is cut off, in the usual way.

It will be noticed that C_9 and C_{11} are shown to be connected in parallel on the circuit diagram and also that C_{10} and C_{12} are similarly arranged. This is done simply to emphasize the point that return capacitors for the fast switching currents must be mounted within one inch or two of the transistors to reduce radiation. It will not be practical to mount the whole of the large capacitor that is required at this position. Accordingly it is suggested that a relatively small part of the capacitance (even 100 μF is only 0.5 % of the total) should be mounted close to the transistors while the remainder may perhaps be a few feet away as convenient. It will be seen that these capacitors are not connected as a bridge, but that C_{10} and C_{12} are across the whole voltage while the half-way rail is only bypassed downwards. This is done to reduce the effect on the signal of ripple on the supply due to the use of a simple cheap rectification circuit. If a good smooth power source is available then the capacitors can be used more economically if C_{12}

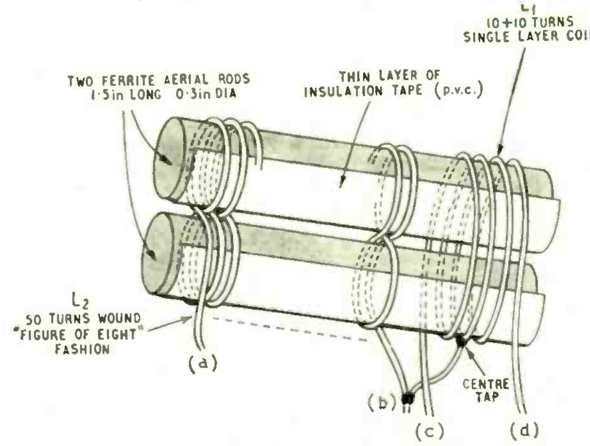


Fig. 5. Showing how to wind the inductors.

has its negative end transferred to the half-way rail, smaller values will then serve for the same low frequency performance. With this circuit the switching action may start appreciably sooner after switching on if the capacitors are connected as a bridge, but this is not a very important consideration for most applications.

INTERMEDIATE STAGES

The two stages comprising Tr2 and Tr3 together form the hysteresis circuit shown in Fig. 3 last month. Complementary transistors are used in these positions but the requirements are not as severe as for the more powerful stages, except that Tr3 has to be able to carry a slightly greater peak voltage due to the "bootstrap" circuit arrangement. The current level is so very much lower that the same types can be used as in the driver stage without any worry about the ratings being exceeded.

It has already been described how the capacitor C_8 carries a "bootstrap" voltage generated from the switching square-wave by the action of the diode D1. The resistor R_{15} is included solely to limit the diode current to a safe value during transients; note that R_{14}, below it, is the main load resistor for Tr3. The drive voltage developed by this resistor is transmitted to Tr4 and Tr5 through the capacitor C_7, and the a.c. coupling action of this capacitor ensures that the drive is substantially balanced in the two directions. Thus both Tr4 and Tr5 receive adequate currents to make certain that they saturate properly and that the minimum voltage is dropped in the final transistors so as to give both high efficiency and to avoid the generation of second and other even harmonics that would result from unbalance in the action. Once the proper operation of the circuit is established the few microamps carried by R_{16} and R_{17} become negligible in comparison with the base currents that the driver stage receives through C_7. These resistors must be included, however to ensure that there is a sufficient amount of d.c. coupling between these stages to give a satisfactory "self starter" action. If at any time the circuit is not self-oscillating, there is a feedback action which automatically brings the various voltages towards their correct values, since with these resistors in circuit there is a d.c. coupling at every stage round the loop. If, for example, the voltage on the capacitor C_{11} is too low, then this feedback cuts off Tr1, so that Tr2 and

Tr3 are also cut off. R_{1} causes Tr5 to conduct, and the voltage across C_{11} is made to increase. Conversely, if C_{11} has too high a voltage it is "pulled down" by both Tr3 and Tr4. This action may be expected to take a few seconds whenever the amplifier is turned on. As it comes to an end the trigger circuit, Tr2 and Tr3, will switch, and when this happens a relatively large current flows through C_7 so that a powerful action occurs and the correct voltages for the proper working of the amplifier are set up within a few milliseconds.

The coupling from the collector of Tr2 to the base of Tr3 is designed to transmit switching edges as effectively as possible. When Tr2 is turned on the small capacitor C_5 injects a "shot" of charge into the base of Tr3 so that is comes on very quickly. When turning off is required, the relatively large capacitor C_6 is available to provide a reverse bias equal to the maximum permitted base-emitter voltage and the comparatively low value of R_{11} allows a considerable reverse current to flow, so that again the action is very rapid. R_{10} fixes the steady base current in the on condition while R_{12} is used to set the voltage on C_6. The changes of mark-space ratio that are an essential feature of the action cause small variations in the voltage on the capacitor C_6, but these have no serious effect on the working.

The reverse coupling through R_9 and C_4 causes the required trigger effect by contributing a positive feedback current to the base of Tr2. Again there is a small capacitor to deliver a "shot" of charge to the base, it works both ways this time, and a resistor to give a d.c. action. It will be noticed that this feedback is taken directly from the collector of Tr3 whereas the resistor R_{13} is included in series with the capacitor C_7 which transmits the main current to the output stages. This resistor serves two purposes. First, it evens out the quantity of current sent to Tr4 as C_7 discharges and its voltages gets less during loud low notes when the mark-space ratio may differ from 50:50 by a considerable amount for a comparatively long time. Secondly, it ensures that each action of the trigger circuit is irrevocably started before any significant slackening of the drive to the output stages is allowed to occur.

THE INPUT STAGE

It will be remembered that in the simple feedback modulation arrangement, which was explained last month (Fig. 3) and which is used in this amplifier, the first part of the circuit serves to integrate the error of the system. Notice that this error signal is not small, as in most ordinary feedback systems, since the output from which the feedback is taken is the full size switching square wave without any smoothing from the filter choke L_2. It is an essential feature of this system that the low frequency components in this error are kept small by the operation of the circuit. They cannot, however, be made to be exactly zero in this simple arrangement, as will be seen in the final article, and it is this finite error which causes most of the distortion in this form of amplifier.

In Fig. 4 the error is obtained as a current resulting from unbalance in the negative feedback network formed by R_1, R_2, R_3 and R_4, and it is made to flow into the base of transistor Tr1. The integration action comes from the familiar Miller effect, using the capacitance between collector and base within the transistor itself together with the voltage swing developed at the lower end of R_5. No extra capacitance is added to ensure that the contribution to this voltage from the resistor R_5 is made as large as possible in comparison with the swing at the base of Tr2. This is because the latter will contain a component due to the positive feedback current from R_9 and perhaps also some non-linearity which will both introduce inaccuracy into the integration action and hence possible extra distortion at the output. Observe that the value of R_5 can be altered if an adjustment of the carrier frequency of the finished circuit is required for any reason. The current in Tr1 thus essentially slides smoothly up and down, with the integration of the error, between limits at which it causes the trigger pair, formed by Tr2 and Tr3, to switch by overcoming the positive feedback current from R_9.

The level of current chosen for Tr1 is a compromise between the requirement that the transistor must carry enough to accommodate the necessary swing without serious non-linearity at the emitter, and the need for it to still have sufficient collector voltage, even when R_5 is made relatively large, for saturation to be avoided and for the collector-base capacitance to be reasonably constant. The choice of R_6 determines this current, since this resistor must develop the right voltage to keep Tr2 near its switching point, the average value in this circuit is made to be about 120 μA. A transistor type must thus be used which has a good performance at low levels of operation, for this the Fairchild BC 114 is very suitable. It has a typical current gain of over 200 at this current as well as both low noise and adequate ratings for voltage and speed. This device again is packaged in plastic but is of the small TO 18 size.

The emitter of this stage is held at almost half the supply voltage by the resistor chain R_7 and R_8, while C_3 provides a bypass path to the negative rail. Since the feedback through R_3 and R_2 is fully effective at very low frequencies, due to the inclusion of C_1 and C_2, this arrangement automatically holds the average voltage at the output of the final switching pair at the centre of the available range. This also means that the mark-space ratio of the switching square wave is made to have an average value of 50:50. Ordinary tolerance resistors will normally serve adequately for the positions R_7 and R_8, but their values may be adjusted if more exact fixing of the average level is needed.

The use of a split attenuator for the feedback, with C_2 at its centre returned direct to the emitter, allows Tr1 to draw an appreciable amount of steady base current without upsetting this d.c. action, while at the same time it permits a high value of gain to be obtained in the audio band where C_2 has a low impedance and the attenuator has its full effect. The feedback then sets the overall voltage gain at a value which in this circuit is about 45 times. The input impedance is determined directly by the resistor R_1, since the base of Tr1 is a "virtual earth," and the value chosen, 220 kΩ, is a compromise between the gain obtained in the amplifier and the distortions introduced by the inaccuracies in the feedback action due to the current and the voltage swing at the base of Tr1.

FEEDBACK ERRORS

An estimate of the magnitude of these inaccuracies can be obtained by considering the working conditions of the first transistor. Its mean collector current is around 120 μA and the variations necessary to give switching of the trigger arrangement will be perhaps ±20 μA. Thus the voltage swing at the base-emitter junction needed by the mutual conductance, will be roughly ±10 mV, while the base current changes required by the current gain will typically be ±0.1 μA. Now these two effects are essentially similar, and as the impedance of the feedback network as seen by the base is about $100\,k\Omega$, assuming a high impedance at the amplifier input terminals, the current swing is just equivalent to a further $\pm 10\,mV$ so that the two effects can be combined as a single effective voltage of $\pm 20\,mV$ at the base. However, we can if we wish consider this voltage as if it were an extra unwanted input added to the normal input, and its effective value is then $\pm 64\,mV$ as we must allow for the action of R_1 and R_2. The waveform of this voltage corresponds to the integral of the error of the overall feedback loop, by virtue of its derivation. That is to say that it is approximately triangular in shape with the peaks at the well defined constant levels quoted above but with the sloping parts changing with the input waveform. But since the error of the modulation system we are using is known from the theory to be given next month, its integral is also known. Each component of the error will be multiplied at the output by the factor $1-j\ (2/\pi)\ (f_c/f_E)\ (64/300)$ where j and the frequency ratio are the direct result of the integration, f_c being the carrier frequency and f_E the frequency of the error component under consideration; $2/\pi$ is a constant and the 64/300 is a measure of the magnitude of this effect compared with the input required to give a fully modulated square wave at the output. It will be noticed that this distortion effect appears to be most serious at low frequencies, but as we shall see next month this is just where the basic modulation distortion is least, so that the results are not necessarily so catastrophic as they seem.

A further inaccuracy in the action of the feedback arises from the fact that when the trigger circuit, Tr2 Tr3, switches there is a small step in the voltage at the base of Tr2, apart from the quick kick due to the action of C_4. This causes a corresponding step in the current through Tr1, due to the action of the integration capacitance in holding a constant voltage at the collector. It has already been pointed out that the use of a relatively large resistor for R_5 reduces this effect, but even with this circuit the voltage step will be perhaps 200 mV, so that the current will jump about $\pm 5\,\mu A$. This means that in addition to its smooth integration current change the transistor is carrying a further $\pm 5\,\mu A$ of current swing which follows the square wave switching action. In exactly the same way as before this can be represented as an additional signal at the input terminals, and its effective value is then $\pm 16\,mV$. There is no integration involved here and the effect is to increase not only all the distortion components by a uniform factor of $1+16/300$ but the main signal as well, so that there is no practical effect on the distortion at all. The ratio 16/300 comes from the effective amplitude at the input due to this effect and the input required to fully modulate the square wave as before.

Notice that both these imperfections only introduce distortion in proportion to that which has already been generated by the failing of the basic modulation process itself. If this could be reduced these effects could become less important. Clearly, however, the design of this stage could be altered fairly easily so as to reduce them directly at the expense either of a loss of overall amplifier gain or a need for additional transistors. In this circuit the gain and economy have been preferred to the relatively small advantage that would result from their reduction. It is interesting to observe that it is the second of these two effects, the one that increases the gain by a more or less constant factor, that governs the success of the feedback in eliminating the distortions caused by errors in the edge timings and the amplitude of the square wave at the output. The factor 16/300 indeed also represents the amount to which these effects are reduced by the feedback action. An apparently dramatic improvement might perhaps be gained here by the simple addition of a resistor of about $3\,M\Omega$ directly between the collectors of Tr2 and Tr1. This could be adjusted so as to exactly compensate the effect of the voltage step, but the author has not investigated this.

CONSTRUCTION AND TESTING

In constructing this circuit it must not be forgotten that switching edges of duration shorter than $1\,\mu s$ are essential in its working, so that the layout must be neat and compact *with no signal leads more than an inch or so in length.* All the components, except the two large capacitors, can easily be mounted on a plastic board about 4in×3in, and there are no special heat sink arrangements required for the final transistors. The power supply must be able to provide about 300 mA maximum current at 30 V, usual input and loudspeaker arrangements being made.

When switched on a circuit of this type should begin to function within a few seconds, but a brief pause must be expected as the voltages on the capacitors are brought to the correct values and then a faint "tick" will be heard as the self-oscillation commences. When switching on for the first time it may save needless expense if resistors of about $100\,\Omega$ are put in series with both the loudspeaker and the power supply. This form of circuit is not worse than class B in this respect, indeed it is rather better, but these resistors may prevent serious damage to the expensive semiconductors in the event of faulty components or wiring errors. With them included in the circuit low amplitude signals should be reproduced reasonably well and the various voltages and currents may be checked before they are removed.

If the circuit is not functioning correctly then a fault has to be found, and as the reader may be perhaps unfamiliar with this type of circuit some guidance will be given. If the circuit is not oscillating then each stage round the loop must have its d.c. state examined until a point is found where the output is not as would be expected bearing in mind the present d.c. input conditions (regardless of the a.c. input). When this is done the fault is usually found quickly and correct functioning obtained. If on the other hand, the circuit is already oscillating then there is little difficulty in finding a break in the signal path in the usual way.

The circuit as shown in Fig. 4 has more than enough sensitivity to give a good output when driven directly from a normal crystal pickup or microphone, but there is, of course, no objection to the use of any of the usual forms of pre-amplifier if more gain or tone control facilities are required. As explained already, no claims for outstanding quality of reproduction can be made for this circuit, but it is hoped that some contributions have been made towards the exploration of the possibilities. To obtain more bass response simply increase the value of all the electrolytic capacitors; but for almost any other improvement, more power, less distortion, more gain or higher efficiency, it will almost certainly be necessary to find a superior type of transistor for the final stage and modify the design along lines that have been suggested.

Next month's article will discuss in more detail just what the errors introduced by pulse width modulation are, and how they could in principle be reduced.

REFERENCE

5. Letters to the Editor, M. D. Salmain, *Wireless World,* June 1965.

LETTERS TO THE EDITOR

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

Burghard Committee and Common Standards for Components

WITH great enthusiasm many are engaged in preparing or awaiting the publication of the new British Standards for electronic parts in the B.S.9000 series—the common standards recommended by the Burghard Committee. Common standards they may be in some respects but they will be lacking in one important detail—a common system of identification or part numbering.

Very soon now tens of part makers will be busy allocating their own identification numbers and sales codes to all the many styles, values, tolerances, wattages, etc., covered by the new specifications: and early next year a hundred companies intending to use these parts will be busy preparing their schedules of part numbers for use by their drawing offices for purchasing or stock control purposes. And then later, each parts manufacturer will need to prepare a cross reference list showing the equivalence between his many customers' part numbers and his own.

The Services, too, will be allocating their N.A.T.O. stock numbers to the items they intend to purchase.

What a waste of national effort! What an opportunity missed—to have a British Standard part number that all could use.

Time is slipping by and it is now too late to grasp this nettle in the first specifications to be published: but there are more to come. Can nothing be done?

E. P. STANTON
(Quality Control Manager)
Plessey Components Group, Swindon

"Honour to whom Honour"

E. AISBERG, Director of our Paris contemporary *Electronique Industrielle*, has written commenting on the origin of the term "class D" given by K. C. Johnson in his article last month. He writes:—

L'auteur attribue l'invention de ce montage et l'appellation "classe D" à P. J. Baxandall. Celui-ci a en effet consacré aux amplificateurs classe D un article dans *Proceedings I.E.E.* en 1959.

Cependant, l'amplificateur classe D a été inventé par l'ingénieur francais Roger Charbonnier, à l'époque directeur de "Rochar Electronique". La brevet correspondant a été déposé au nom de cette maison le 6 janvier 1954. Et la première description a paru sous la signature de J. P. OEhmichen dans le numéro 1 (mars-avril 1955) de notre Revue *Electronique Industrielle*.

J'ai tenu à préciser ce petit point d'histoire afin de rendre à César ce qui lui est dû.

Buy British

I SUPPOSE that most of your readers will agree with your editorial in the December number of your journal, but I must say that I think that the industry must bear part of the blame for the situation. I will not use your space to recount, in detail, my attempts to get data or products out of British firms. It may be some consolation to Mr. Thompson that I would not rate the chances of a small buyer of getting an answer as better than one in five. On the other hand, my only letter to an American firm was answered by return, and the goods were despatched on receipt of my firm order and cheque.

I would be only to happy to buy British i.cs if I knew that they were available. So far, I can recall seeing only American i.cs offered on the retail market, and I have had some of them. I expect to buy more i.cs, but, on their past performance, I am reluctant to spend time and money on fruitless enquiries to British firms. It therefore seems that my choice is between buying foreign, and buying nothing. While I should prefer to "Buy British," I have no intention of going without these fascinating devices. Will any British firm, perhaps by the appropriate advertisement, giving price and channels of availability, in your journal, prove me wrong?

J. B. G. PARKER (G3SOL)
London, E.6.

I DOUBT very much if "any" young engineer, as you suggest in your December Editorial, would be allowed to buy American at will, if only because of import duty. Certainly this is not so in my establishment. We buy American usually when the item is not made here, or when the American article is obviously superior—one might add, there is often little difference in the price, and delivery has so far been good.

You may be interested to know that a British instrument advertised in *W.W.* at the end of 1966, and ordered by me near the beginning of this year, had still not been delivered at the end of November when I cancelled it as it was not yet in production!

British makers seem to think they get a raw deal—perhaps some of them do. Undoubtedly, however, there are a number who get what they deserve. And if certain foreign firms can do incomparably better, as they can in some fields, we have no right to play the hurt, misunderstood British routine. If British makers can produce, the profession will gladly buy.

"ENGINEER"

Bailey Amplifier Mod.

I HAVE received one or two queries regarding the cut-off frequency of the treble filter in the pre-amplifier circuit I described in the December 1966 issue. I have looked into this and have discovered that the capacitors used were about 50% greater in capacitance than their marked value. In order to obtain the correct performance this means that all the capacitors should be uprated by 50% in the treble filter. The new values will therefore be 0.015 and 0.0075 μF or as near as possible. The large tolerance on capacitors had been overlooked in this instance so it is important that capacitors of at least 10% tolerance should be used. If a slightly lower cut-off frequency is desired there is no reason why the values cannot be increased to 0.02 and 0.01 μF, there being more convenient values to obtain.

ARTHUR R. BAILEY

Sub-surface Propagation

Some points from an I.E.E./I.E.R.E. conference on m.f., l.f. and v.l.f. radio

IT has been known from the early days of radio that in round-the-world transmission the energy is confined between the earth and the ionosphere, thus overcoming the diffraction losses round the curve of the earth. On v.l.f. the height of the lower boundary of the ionosphere is no longer large compared with the wavelength and the ray method of studying the propagation characteristics, so useful at h.f., is only practicable for use at short distances. For long distances it is necessary to treat the region between the earth and the ionosphere as a waveguide and to study the propagation in terms of mode theory.

In a survey paper at the recent I.E.E./I.E.R.E. conference on propagation J. R. Wait, himself a leading expert in this field, referred to the fundamental researches of K. G. Budden giving the full wave treatment of the modes, including the effects of the curvature and of the magnetic field of the earth. He treated the problem in a severely mathematical way that many engineers must find difficult to appreciate, but the basic results emerging from this study are proving most valuable as a means of interpreting v.l.f. field-strength measurements in terms of possible electron distributions in the D region of the ionosphere.

GEOLOGICAL WAVEGUIDE

A further interesting development of the waveguide concept is the proposed application to long-distance propagation in sub-surface geological strata. It is suggested that at depths of several miles there may exist extensive strata of very low conductivity between regions of much greater conductivity, constituting a waveguide with very low attenuation. While much has been written on the theoretical side, based on highly idealised models, and communication has been established over several miles, the technical and economic problems are immense and considerable doubt has been expressed about finding strata of sufficiently low conductivity of the required extent in the desired places.

There is evidence that such communication between subterranean points may sometimes be achieved by the "up-over-and-down" mode whereby energy from the transmitter travels up to the surface, escaping into the air and travelling, possibly with the help of the ionosphere, along the surface of the earth, some of it then being refracted into the earth to the receiving point below.

The attenuation of radio waves through sea water is very great, but it decreases with decreasing frequency and the use of v.l.f. for submarine communication is being actively pursued. The rigid mathematical theory is exceedingly difficult, but simple physical principles show that contact between a base above ground and submarines anywhere on the earth can be achieved by using v.l.f. The wave travelling over the earth is vertically polarised and is refracted vertically downwards and is receivable on a suitably oriented horizontal dipole on a submarine that is sufficiently near to the surface.

It follows similarly that communication between submarines, too far apart for direct propagation through the water, must be by an "up-over-and-down" mode with the implied limitation in depth below the surface, and that using electric dipoles they should be horizontal and end-on to one another. Very little practical information is available, but the theoretical analysis makes reference to magnetic dipoles even though the available size of a loop regarded as a single turn would be very inefficient compared with an electric dipole at these frequencies.

For communication purposes the use of v.l.f. is inevitably restricted by the limited bandwidth available, but the advent of extremely accurate reference clocks and frequency-stabilized v.l.f. transmissions has prompted their use for time signals and navigational aids with a world-wide coverage. The latter application depends for its success upon the high stability of the D region of the ionosphere as a reflector of v.l.f. waves, the height of reflection by day being nearly constant at about 70 km and changing at sunset in a well-predictable way to about 85 km at night and back again at sunrise.

This stability in relation to a phase-comparison navigational aid is much greater than for the corresponding use of the E and F layers at higher frequencies, but much work is still needed to take account of sudden phase anomalies due to ionospheric disturbances, especially in the polar regions. A suggestion has been made for the automatic suppression of errors due to diurnal and seasonal variations in the ionosphere by working at two frequencies symmetrically displaced about 12 kHz.

In his opening address at the conference on m.f., l.f. and v.l.f. propagation, J. A. Ratcliffe deplored, as a scientist, the very limited use that had been made of v.l.f. transmissions for the study of the lowest regions of the ionosphere during the period when ionospheric sounding at high frequencies had been developed for the study of the E and F layers and the prediction of the propagation characteristics of high-frequency communication. In this he was perhaps over-modest in view of the work of the team that he directed for so many years at the Cavendish Laboratory using the transmissions from Rugby GBR.

SCIENTIFIC RESEARCH

It was notable that the recent conference was mainly concerned with the use of v.l.f., not as a means of communication but as a tool for scientific research. The advent of rockets and satellites has given an immense impetus with the possibility of receiving signals in the ionosphere from terrestrial v.l.f. transmitters and of transmiting v.l.f. signals to earth. The study of the wave forms of atmospherics from lightning flashes is greatly advancing our knowledge of the earth-ionosphere waveguide and of resonance effects at e.l.f. The associated phenomenon of whistlers with their large frequency dispersion in the audio band has been explained in terms of the magneto-ionic theory of propagation in the ionosphere, but the observations made in the ionosphere have revealed that the v.l.f. ionograms are as complicated as those being obtained by sounding at h.f. from the original satellite Alouette I which is now in its sixth year of operation.

NEWS FROM INDUSTRY

'ELECTRONIC CAM'—THE BEST OF BOTH WORLDS?

FILM offers television companies a medium by which programme material can be interchanged between countries without regard to line standards or the colour system in use. Producing a film using motion picture methods is an expensive and time-consuming process and it has long been considered desirable to devise a system for exposing film using television multi-camera techniques. The film camera is not "interested" in whether black and white or colour stock is being used and does not suffer from the degradation in picture quality associated with telecine machines. The basic idea of marrying a television camera to a film camera to enable the scene to be monitored remotely is not a new one, this latest system "Electronic Cam" was devised by Arnold and Richter of Munich and has been developed by engineers from Rediffusion Television Ltd. over the past two years.

Basically the system consists of the marriage of an Arriflex 35mm camera and a plumbicon camera tube; light from the scene is reflected by a mirrored segment on the shutter to the plumbicon during the film pull-down period. The output of the plumbicon drives a small television monitor that acts as the camera view-finder and also drives other monitors throughout the studio. In the complete installation three such cameras are employed, the film motor of each camera being controlled remotely by means of switches on a central production control console. Four monitors are employed on this console, one for each camera and, in addition, one for the camera that has been selected. Switching, or cutting, between cameras can be carried out in about one-third of a second, this being the time taken for the camera mechanism to reach operating speed or, if desired, all cameras can be left running, only one being used for the "take," allowing instantaneous "cutting" between cameras but wasting large amounts of film stock. Rehearsals can be carried out without film in the cameras and in this case footage counters on the control console make it possible to predict the amount of film required in each camera for the actual take, eliminating wastage. Identification and synchronizing marks are recorded on both the film and the magnetic tape used for the sound track indicating which camera it came from and facilitating the assembly of the film and sound track. In a pilot production film, taken to assess the performance of the system, a fifteen minute film was made in approximately one hour on the studio floor. The film was divided into three sections, each being filmed as a continuous take, the director cutting between cameras as required, achieving a film utilization ratio of 1.52:1.

CODE OF PRACTICE FOR AERIAL INSTALLATION

WITH the advent of colour television the question of aerial installation has become of greater importance and it is felt strongly both by the Radio and Television Retailers Association (R.T.R.A.) and the Radio and Electronic Component Manufacturers Federation (R.C.E.M.F.) that high standards will have to be adhered to. To this end a code of practice for aerial installation has been agreed by the two bodies and in future all members of the R.T.R.A. will be expected to conform to these standards. Any serious departure from them may result in disciplinary action being taken by the Association. It is also suggested that any member that does not erect his own aerials should forward a copy of the code to the company concerned in order that an undertaking may be given that installations will be made in accordance with the code. Copies of the code are available free from the R.T.R.A., 19-21 Conway St., London, W.1.

NUCLEONIC INSTRUMENT FIRM EXPANDS

THE largest company in the nucleonics field in Europe will be formed as a result of a major rationalization of the nuclear instrument industry in the U.K. Nuclear Enterprises of Edinburgh, founded as recently as 1956, has taken over the nucleonics interests of E.M.I. at both Hayes, Middlesex and Wells, Somerset, as the first stage in a triple acquisition. Nuclear Enterprises is also, subject to necessary consents, acquiring Isotope Developments Ltd. and the Baldwin Instrument Company, both members of the Elliott-Automation Group situated near Aldermaston. The Nuclear Enterprises range of radiation detectors and instruments will be supplemented with medical, physics, and data handling equipment from E.M.I., low cost laboratory and medical instrumentation from I.D.L. and industrial nucleonics instrumentation for gauging, analysis and process control from Baldwin Instruments.

Cable and Wireless Ltd. have placed contracts with Submarine Cables Ltd. (an A.E.I. company) for a deep sea submarine telephone cable that will provide a maximum of 640 telephone circuits between Canada and Bermuda. The project, which is known as CANBER, requires 800 nautical miles of cable, 81 submersible repeaters and five submersible equalizers worth a total of £3.5M. The cable will be jointly owned by the Canadian Overseas Telecommunications Corporation and Cable & Wireless Ltd. Some of the new materials needed for fabricating the cable will come from Canadian sources. CANBER is due to be laid in 1969 by the 8,960-ton cable ship *Mercury* from the Cable and Wireless fleet. CANBER will land in Canada in the vicinity of Mill Village, Nova Scotia, permitting connections with the Canadian satellite earth stations.

The information services of the Government of Hong Kong have announced that steps are being taken to prevent manufacturers wrongly describing radio receivers by incorporating into them **non-functioning transistors.** In talks with the manufacturers the Colony's Commerce and Industry Department found that the manufacturers were opposed to this practice and that the dummy transistors had been included at the request of overseas buyers! As from January 1st the Commerce and Industry Department will institute checks to determine whether any local transistor receiver factory is incorporating non-functioning transistors and legal action will be considered against any that are continuing with the practice.

Orders for four **harbour radar systems** worth a total of £128,000 to be installed at Montreal, Brisbane, Rostock (East Germany), and Wallasey (Cheshire), have been received by Decca Radar Ltd. The installation for the port of Montreal is to be completed in two phases. The first of these consist of installing a two-channel radar and two 16-inch displays that will provide a traffic control service. In the second phase the radar coverage will be increased by a remote scanner, controlled by a u.h.f. link relaying its information back to the control room via a microwave system. The other three systems will not have the remote scanner and differ from the Montreal system only in aerial and display sizes.

The G.P.O. has placed an order with **Standard Telephones and Cables Ltd.,** for a 6 GHz microwave system to link the Post Office tower in London with Norwich. The equipment, type RL6D, will provide six broad-band radio channels between London and Stoke Holy Cross (Norwich), with repeater stations at Kelvedon Hatch and Sibleys in Essex and at Wickhambrook and Mendlesham in Suffolk. The RL6D provides a 10-W power output; the aerials used will be of the cassegrain type for single or bipolar operation.

1968 CONFERENCES AND EXHIBITIONS

LONDON
Mar. 11-14 — Alexandra Palace
Physics Exhibition

Apr. 8 & 9 — Imperial College
Thick Film Technology

Apr. 18-21 — Hotel Russell
Audio Festival & Fair

Apr. 22-24 — I.E.E., Savoy Pl.
Interference Problems and Microwave Communications Systems

May 13-18 — Olympia
Instruments, Electronics and Automation Exhibition

May 20-31 — Royal Lancaster Hotel
Communication-Satellite Earth Stations

July 29-Aug. 2 — Olympia
Ships' Gear International Exhibition

Sept. 9-12 — Queen Mary College, E.1
Elementary Particles

Sept. 9-13 — I.E.E., Savoy Pl.
International Television Conference

Sept. 20-Oct. 2 — I.E.E., Savoy Pl.
Tropospheric Wave Propagation

Oct. 2-5 — R.H.S. New Hall
R.S.G.B. Radio Communications Exhibition

BELFAST
Apr. 1-3 — Queen's University
Heavy Particle Collisions

BRIGHTON
Oct. 8-10 — Hotel Metropole
National Electronics Packaging Conference & Exhibition

BRISTOL
Jan. 2-4 — The University
Integrated Circuits Symposium and Exhibition

Mar. 27-29 — The University
Thermodynamics and Fluid Mechanics

CARDIFF
Apr. 18 & 19 — Cathays Park
Audio-Visual Aids Conference and Exhibition

CRANFIELD
Mar. 25-28 — College of Aeronautics
Aerospace Instrumentation Symposium

DURHAM
Apr. 2 & 3 — The University
Semimetals and Narrow Gap Semiconductors

EDINBURGH
Aug. 5-10 — The University
I.F.I.P. Data Processing Congress & Exhibition

FARNBOROUGH
Sept. 16-22 — R.A.E.
Electronics and Air Show

GLASGOW
Mar. 8-16 — Kelvin Hall
NORBEX—North British Engineering Exhibition

HARROW
Mar. 12-14 — King's Head Hotel
Public Address Show

HARWELL
May 9 & 10 — A.E.R.E.
Low Energy Electron Diffraction

LOUGHBOROUGH
Apr. 16-19 — University of Technology
Modular Education for Industry

MANCHESTER
Jan. 3-6 — Inst. of Science and Technology
Solid State Physics Conference

Sept. 24-28 — Belle Vue
Electronics, Instruments, Control and Components Exhibition

Nov. 4-6 — Hotel Piccadilly
Electronic Instruments Exhibition

NOTTINGHAM
Sept. 11-13 — The University
Physical Aspects of Noise in Electronic Devices

PAISLEY
Apr. 17-19 — College of Technology
Automation Techniques in Industry

SOUTHAMPTON
Jan. 9 & 10 — The University
Materials for Acoustic & Vibration Damping

Apr. 22-24 — The University
Nucleation, Growth and Structure of Thin Films

SWANSEA
July 15-18 — University College
Electrical Contact Phenomena

TEDDINGTON
Jan. 17 & 18 — National Physical Lab.
Holography—Recent Advances and Applications

OVERSEAS (Jan. to May)
Jan. 16-18 — Boston
Symposium on Reliability

Jan. 26 & 27 — Detroit
Colour Television Conference

Feb. 14-16 — Philadelphia
Solid-state Circuits

Feb. 28-Mar. 1 — Washington
Scintillation & Semiconductor Counter Symposium

Mar. 7-12 — Paris
Festival du Son

Mar. 21-23 — Boston
Microwave Power

Apr. 1-6 — Paris
Components Exhibition & Colloquium *also* **Electroacoustic Exhibition**

Apr. 9-11 — Houston
Telemetering Conference

Apr. 16-18 — New York
Turbulence of Fluids and Plasmas

Apr. 22-24 — Atlantic City
Frequency Control Symposium

May 8-10 — Washington
Electronic Components Conference

May 14-17 — Miami
Quantum Electronics Conference

BOOKS RECEIVED

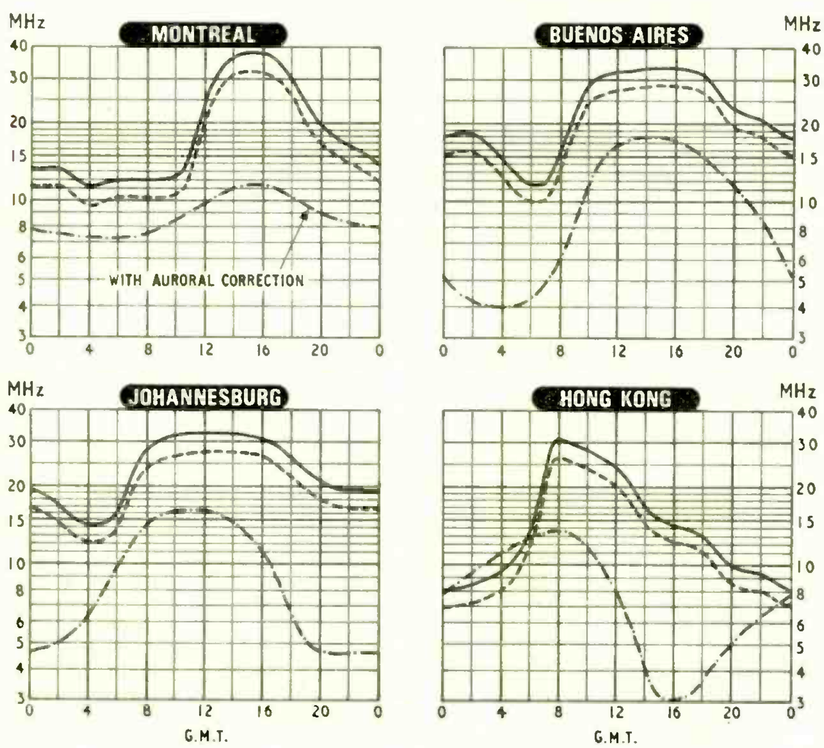
Microwave Valves by C. H. Dix and W. H. Aldous, presents an account of the basic physical processes and the operation of microwave valves. Although only the essential mathematics is included the book is intended for readers with H.N.C. or a degree. The approach to the subject begins with a description of the the motion of electrons and the properties of the various types of r.f. circuits and transmission lines that are used in the devices. Although microwave triodes are discussed, the emphasis is on beam devices both linear and crossed field, and in describing these the space-charge wave approach is used. Further chapters cover the formation and focusing of electron beams, the noise properties of microwave devices, construction and applications. Pp. 269. Price 55s. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

The Practical Aerial Handbook, by Gordon J. King. The introductory chapters provide a grounding in the principles of radio propagation and aerial design. Different types of aerial are discussed and guidance is given on choosing the best aerial system for a particular need together with practical installation information. The remainder of the book covers methods of combining signals received by separate aerial systems; methods of supplying several receivers from one aerial; improving reception using aerial booster amplifiers; shared aerial systems as used in blocks of flats, etc.; and combating interference. Appendices give information on aerials for colour television, aerials for stereo radio; the distant reception of v.h.f. and u.h.f. signals. Pp. 224. Price 35s. Odhams Books Ltd., 40 Long Acre, London, W.C.2.

Introduction to Vector Analysis by W. D. Day. Suitable for self-tuition, because of the numerous worked examples and graded exercises, this book presents the theory of vector analysis in a form suitable for the electronics engineer. Starting from basic definitions and notation, the concept of scalar and vector products of two vectors, triple products, differentiation, line and surface integral is established. The differential equations of electron motion in uniform magnetic and electric fields at right angles are considered in some detail. The scalar point, scalar potential, divergence, curl, cartesian, cylindrical and spherical co-ordinates are all examined. The remaining chapters are devoted to more general vector fields in particular to the time varying electromagnetic field governed by Maxwell's equations. Pp. 260. Price 42s. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

Techniques of Pulse-Code Modulation in Communication Networks by G. C. Hartley, P. Mornet, F. Ralph and D. J. Tarran. This book, from the I.E.E. Monograph series, is published at an opportune moment with the recent opening of London's first p.c.m. link. After the introduction and an historical review, the principles of p.c.m. are outlined and such topics as time sampling, signal reconstruction, quantization, companding, etc., are discussed in some detail. The remainder of the work is devoted to the application of p.c.m. communication principles, basic system elements and factors affecting system design, a glossary of terms is also included. Pp. 110. Price 30s. Cambridge University Press, Bentley House, 200 Euston Road, London, N.W.1.

H. F. PREDICTIONS — JANUARY



The maximum usable frequency is, by definition, that at which communication should be possible for over 50% of the time. Satisfactory communication will, of course, be possible above the MUF but for decreasing percentages of time as frequency is raised.

Operation below the MUF will give improved probability of communication (90% at FOT) but worsening signal/noise ratio. LUF is the frequency at which a specified signal/noise ratio will be obtained for a given percentage of time. The curves were drawn by Cable & Wireless Ltd. for reception of point-to-point telegraph circuits in the U.K. When evaluating, an assumption is made that communication probability will be 100% at the LUF, this is not always valid as shown by the Hong Kong curve.

LETTER FROM AMERICA

SOME controversy has been caused among electronics engineers over here during the past few months by S.I.As. What are S.I.As.? Well, they are basically very small stub antennas which have built-in transistors to give extra gain. They are usually 1/25th wavelength and the inventor, Edwin Turner, of the Air Force Avionics Laboratory in Dayton, Ohio, claims that S.I.As could be built into TV sets and "would out perform aerials many times the size." However, there are doubters. Harry Greenberg, chief electronic engineer of Channelmaster Corporation, says categorically, "In our opinion, they would not perform as well as ordinary rabbit ears aerials, let alone replace roof-top aerials." It is well known that the smaller the aerial length, the lower the signal strength received. Hence, the signal-to-noise ratio tends to get worse as the pick-up aerial gets shorter. However, this is offset to some extent by the fact that atmospheric noise is very high at high frequencies and so the signal-to-noise ratio is less dependent on the aerial or receiver. So a smaller aerial will not *necessarily* mean a small signal-to-noise ratio although the signal itself will be less. In *Time* magazine Turner states, "We have in effect substituted a short aerial carrying a large current for a long aerial carrying a small current." He went on to say, "A S.I.A. at 1/16th wavelength instead of ½ is about equal in signal-to-noise ratio to a dipole aerial or tunable rabbit ears, even at 1/25th the noise characteristic is comparable with a dipole when mismatches in the dipole were considered." Turner claims that S.I.As provide a wide impedance match and quotes ratios of up to 50 to 1. In one version the transistor d.c. current is controlled to move the optimum bandwidth matching range. Considerable work in this field has been carried out by Hans Meinke at the Munich Technical University and a circuit was published in *Electronics* last July. But so far from silencing the critics, it provoked more opposition. One, Wilfred Carson, said, "It was obvious that one stage was about to break into oscillation and so the stage gain would be abnormally high." At the Canadian International Electronics Conference Dr. Flachenecker said "from v.l.f. up to 30 MHz S.I.As show field strength sensitivities nearly equal to the external noise-field strength if the aerial height is around 1 metre." So the debate continues.

THE FIRST commercial colour television receiver was introduced back in 1954 by R.C.A. This was a 15-in model costing about $1,000. Some 10,000 sets were sold that year, but by January 1967, the total number of colour sets in the U.S.A. had soared to 9,750,000. Early in 1967 experts forecast total sales of colour sets at six million and at the end of October the sales had reached 4,086,521 for colour, compared with 4,394,857 for monochrome. At a recent E.I.A.* merchandising seminar, a speaker caused a stir of interest when he said his firm was already campaigning for that second colour TV in every home. Support for this expression of "Gracious Living" came from R.C.A., who are now pioneering a low cost 14-in portable. Says the Sales President, "In pioneering the new 14-in diagonal screen size, we are counting heavily on a second set market for colour that will appear much sooner than it did in black-and-white TV. The colour set viewer who is spoiled by colour in the living room won't accept a monochrome substitute in the den or bedroom." (I could add from experience —neither will the children!) How about prices? Well, they range from about $199 for a portable to around $500 for a console with a 23-in screen. Tube sizes are a little confusing as some manufacturers use diagonal measurements while others stick to the tube face area. Philco have just released a large screen portable (267 sq in) at $299.95. They ask, "Why should the least expensive large screen colour set cost a working man a month's pay?" Why indeed! This price is certainly very reasonable but it is possible that some of the Japanese imports will be cheaper still. The modern colour sets are very easy to operate but ingenious devices are fitted to some models to ensure accurate tuning. For instance, Motorola uses an automatically switched indicator lamp to show "on the nose" tuning and Westinghouse sets have a tuning bar. When this bar is depressed vertical black bars appear on the screen and the trick is to turn the fine tuning control until only one bar is seen. The circuit is quite complicated and it employs two multivibrators with a gating valve and variable relay. Incidentally, some Motorola models use transistors throughout but most other designers prefer hybrid circuits. At the moment, integrated circuits are widely used for audio stages or i.f. sections, etc. They are also employed in f.m. tuners, receivers and amplifiers—R.C.A. even has an i.c. pre-amplifier built in a pickup cartridge. Westinghouse has just released a single i.c. audio amplifier which can replace nearly all the components in low power record players or tape recorders. The input is high impedance so a ceramic pickup can be used and the output is rated at 1 W for 5% distortion.

AMPEREX HAVE an interesting i.c. called a "Bifet" which consists of a mosfet coupled to a transistor emitter-follower plus biasing resistors all housed in a normal three-lead TO-18 can. Input impedance is very high, being of the order of 10[illegible]. Noise is exceptionally low—the total voltage measuring less than 25 microvolts! This is comparable with the best valve amplifiers and so the "Bifet" will be particularly useful for low-level microphone pre-amplifiers, photo-cell head amplifiers, etc.

NEW TRANSISTOR devices are appearing almost every day but one of the most interesting is called a "Pitran" transducer. This is a silicon planar transistor that has the emitter-base junction mechanically coupled to a tiny diaphragm located at the top of the can. When a pressure is applied to the diaphragm a large reversible change is produced in the transistor characteristics. Sensitivity is quoted as 4 V per gramme point force and linearity is said to be better than 1%.

THE VIETNAM WAR has given a tremendous impetus to electronic research and development—particularly in the communications field. Probably one of the most bizarre inventions concerns enemy—or rather *people*—detection. It consists of a pump that pipes in air to a colony of bedbugs. The presence of human beings causes the bugs to become agitated so modulating a r.f. field to give audible or visual indication. Sensitivity is said to be very high but it is not stated whether the bugs discriminate between Viet Cong and Americans! G. W. TILLETT.

* Electronic Industries Association.

WORLD OF AMATEUR RADIO

World-wide Network of Amateur Radio Beacons?

PROPOSALS for the establishment of a world-wide network of amateur radio beacon transmitters to operate on frequencies in the amateur 21- and 28-MHz bands have been put forward by a scientific ionospheric observation group within the German national amateur radio society. The group, which has 100 regular observers, is continuing work done in Germany during the International Geophysical Year (I.G.Y.) and in the subsequent International Quiet Sun Years (I.Q.S.Y.), and its proposals visualize the setting up of one beacon in each of the five continents to operate in the 21-MHz band and at least two beacons in each continent to operate in the 28-MHz band. Each beacon will use a main and a secondary frequency, the main frequency being common to all beacons in a particular band. Secondary frequencies will be spaced in an arrangement of channels of 2.5-kHz wide below the main frequency. The secondary frequency assigned to a particular station will be transmitted when the main frequency is not being used.

Transmissions on the main frequency will be arranged in accordance with a time-shared world-wide schedule, which will enable radio amateurs and scientific institutes to monitor automatically, or by means of pen-recorders, etc., the actual world-wide propagation conditions on the band concerned. Transmissions on the secondary frequencies will supplement observations on the main frequency and will allow permanent checks on conditions for a certain general path direction and provide a means to monitor the effect of sudden solar events, and of band openings, which cannot be covered by the main frequency transmissions because of time sharing.

It is also hoped to provide a similar world service on a frequency in the 50-MHz (six-metre) band but unfortunately this band is not generally available to amateurs in Europe and Asia. Special facilities, however, are visualized for this scientific project. The proposals for a world-wide network of amateur radio beacon transmitters are to be submitted to the International Amateur Radio Union for consideration by the 75 national societies that form the Union.

European Fox Hunting Championships.—Teams from the Soviet Union, Yugoslavia and Hungary were respectively placed 1st, 2nd and 3rd in the 80-metre section of the European Fox Hunting Championships held recently in Czechoslovakia. The individual winner (a Russian) located the four hidden transmitters ("foxes") in 49 mins 6 secs and the time of the winning team was 118 mins 26 secs. The 2-metre section was won by a team from Hungary with teams from Bulgaria and the Soviet Union in the 2nd and 3rd places. The time of the winning team was 89 mins 53 secs (locating six "foxes") and the individual winner (another Russian) located three hidden transmitters in 37 mins 30 secs.

R.N.A.R.S. Code Proficiency Transmissions.—Morse code proficiency transmissions arranged by the Royal Naval Amateur Radio Society, now take place on the first Tuesday of each month at speeds of 15, 20, 25, 30 and 35 words per minute. Transmissions commence at 20.00 G.M.T. on 3,520 kHz and perfect (100%) copy at a particular speed is required to qualify for the appropriate Code Certificate. Completed logs, together with five 3d stamps, should be sent to R.N.A.R.S., 27, Oxted Rise, Oadby, Leicester.

QSL Cards for R.A.F.A.R.S. Members.—Cards depicting six Royal Air Force aircraft spanning 25 years of R.A.F. history are now available to the 450 members of the Royal Air Force Amateur Radio Society, to confirm contacts.

Slow-Scan Television.—The United States Federal Communications Commission has recently proposed that slow-scan television shall be authorized in certain parts of the amateur high-frequency bands, namely, 3.8-3.9, 7.2-7.25, 14.2-14.275 and 21.25-21.35 MHz as well as in the telephony bands at 10, 6 and 2 metres. The bandwidth will be that of a normal single sideband signal, nominally 3 kHz. It is not yet known whether similar proposals have been put forward by any licensing authority in Europe or Asia. Slow-scan television (although permitted in the United Kingdom for those holding an amateur television licence) has not, so far, attracted a great deal of interest.

Nigerian Award.—The 5N2 Award is available to any radio amateur or short-wave listener who can produce evidence of having worked or heard five Nigerian amateur stations (5N2 calls) on two or more amateur bands. (For example, four stations can be worked or heard on 21 MHz and one on 28 MHz.) The Award will be issued in three classes: telephony (including single sideband), telegraphy and mixed. Applications, together with a certified copy of the log (or QSL cards in the case of short-wave listeners) and accompanied by five international reply coupons should be sent to the Awards Manager, N.A.R.S., P.O. Box 2873, Lagos, Nigeria.

Amateur Radio in India.—New rules for amateur radio licences, drafted by the Indian Department of Communications, came into force on September 1st, 1967. They permit the issue of licences to young people aged 14 years and upwards. For some reason, which the Amateur Radio Society of India has not been able to discover, no new licences have been issued in India since the beginning of 1967 when the membership of the society was around 350.

Simulated Emergency Test.—In late January during a simulated emergency test, organized by the American Radio Relay League, the opportunity will present itself for all United States radio amateurs to take part in a nation-wide demonstration of amateur radio public-service facilities. The emergency test will take place during the weekend January 27th-28th, and will include all Amateur Radio Public Service Corps members in local and national exercises for the Red Cross, Civil Defence and similar organizations.

Championship of France.—The annual contests organized by the French national amateur society (R.E.F.), to decide the champions of France for 1968, will be held on January 27th/28th (telegraphy) and February 24th/25th (telephony). Both contests will commence at 14.00 on the Saturday and finish at 21.00 on the Sunday.

Monaco Amateurs to join I.A.R.U.—The Association des Radios Amateurs de Monaco is seeking membership in the International Amateur Radio Union. Formed in 1953, the Association now has 18 licensed transmitting members—the total number of licensed stations in the Principality. Licences are issued to visitors to Monaco who submit proof of being bona fide licensed amateurs in their own country.

V.H.F. Licences in Germany.—Call signs in a new series, DC6 followed by two letters, are now being issued to German amateurs who wish to operate on frequencies above 144 MHz. Holders of these calls have passed a technical examination but not a Morse code test. In the United Kingdom call signs in the series G8 followed by three letters are issued to amateurs who wish to operate on frequencies above 420 MHz.

JOHN CLARRICOATS, G6CL.

JANUARY MEETINGS

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

LONDON
2nd. I.E.E.—Colloquium on "The economical collection of meteorological data" at 2.30 at Savoy Pl., W.C.2.
4th. I.E.E.—Hunter Memorial Lecture "Changing patterns in communications" by J. H. H. Merriman at 5.30 at Savoy Pl., W.C.2.
5th. I.E.E.—"The practical use of radar and d.f. techniques in locating earth satellites" by Dr. H. G. Hopkins and W. A. S. Murray at 5.30 at Savoy Pl., W.C.2.
8th. I.E.E.—Discussion on "Logarithmically periodic aerials" at 5.30 at Savoy Pl., W.C.2.
8th. I.E.E.—Discussion on "Domain originated functional integrated circuits (DOFICS)" at 5.30 at Savoy Pl., W.C.2.
9th. I.E.E.—Discussion on "Electrical signals for data acquisition and transmission—what form should they take?" at 5.30 at Savoy Pl., W.C.2.
10th. I.E.R.E.—"Some aspects of electrostatic loudspeakers" by Prof. J. Merhaut at 6.0 at 8-9 Bedford Sq., W.C.1.
10th. S.E.R.T.—"Digital voltmeters" by J. R. Pearce at 7.0 at London School of Hygiene & Tropical Medicine, Keppel St., W.C.1.
11th. Inst. of Electronics—"Modern semiconductor devices" by D. F. Dunster at 6.45 at the School of Hygiene and Tropical Medicine, Keppel St., W.C.1.
16th. I.E.E. & I.P.P.S.—Colloquium on "MOST devices" at 2.30 at Savoy Pl., W.C.2.
17th. Inst. Navigation—"Sub-surface navigation" by Dr. W. P. Williams at 2.15 at the Royal Inst. of Naval Architects, 10 Upper Belgrave St., S.W.1.
17th. I.E.E.—"Colour television receiver design" by B. J. Rogers at 5.30 at Savoy Pl., W.C.2.
18th. R.T.S.—"London schools television service" by W. Kemp and P. W. Lines at 7.0 at the I.T.A., 70 Brompton Rd., S.W.3.
22nd. I.E.E.—Colloquium on "Microwave integrated circuits" and "Microwave solid state sources" at 10 a.m. at Savoy Pl., W.C.2.
22nd. I.E.E.—Discussion on "Microwave electrostatic wattmeter" at 5.30 at Savoy Pl., W.C.2.
24th. I.E.R.E.—"Studio colour equipment" by G. Parker at 6.0 at 8-9 Bedford Sq., W.C.1.
26th. R.T.S.—"Television aids to film production" at 7.0 at the I.T.A., 70 Brompton Rd., S.W.3.
29th. I.E.E. & I.E.R.E.—Discussion on "Diathermy" at 5.30 at Savoy Pl., W.C.2.
31st. R.S.G.B.—"The development of a u.h.f. television service" by R. C. Hills at 6.30 at the I.E.E., Savoy Pl., W.C.2.

ABERDEEN
10th. I.E.E.—"The engineer and the law" by H. B. Morton at 7.30 at Robert Gordon's Institute of Technology.

BIRMINGHAM
24th. R.T.S.—"The transmission of colour television signals over Post Office links" by E. Howorth at 7.0 at the Medical Institute, Harborne Rd., Edgbaston.
29th. I.E.E. & I.P.O.E.E.—"Design considerations in microwave links" by G. Wanless and E. Jamieson at 6.0 at M.E.B., Summer Lane.

BOURNEMOUTH
31st. I.E.R.E.—"Some circuit aspects of M.O.S. transistors" by N. E. Broadberry and L. N. M. Edward at 7.30 at the College of Technology.

BRISTOL
16th. S. Inst. Tech.—"Instrumentation in medicine" by D. H. Follett at 7.30 at the Dept. of Physics, the University.
18th. I.E.R.E., I.E.E. & R.Ae.S.—"Concord" by H. Hill at 7.0 at the University.
25th. I.E.E.—"The best method of educating engineers—full time or sandwich?" by D. M. Dummer and P. L. Arlett at 6.0 at the Technical College.

CARDIFF
10th. R.T.S.—"The philosophy of colour camera design" by C. B. B. Wood at 7.30 at the Angel Hotel.
24th. I.E.R.E.—"The development of satellite communications" by J. K. S. Jowett at 6.30 at the Welsh College of Advanced Technology.

DUNDEE
11th. I.E.E.—"The engineer and the law" by H. B. Morton at 7.0 at Robert Gordon's Institute of Technology.

EDINBURGH
10th. I.E.R.E.—"Microwave and optical communication systems of high traffic capacity" by R. W. White at 7.0 at the Dept. of Natural Philosophy, the University.

GLASGOW
11th. I.E.R.E.—"Microwave and optical communication systems of high traffic capacity" by R. W. White at 6.0 at the University of Strathclyde.

HAMBLE
17th. I.E.E. & R.Ae.S.—"Telecommunications in aviation" by W. P. Nicol at 8.0 at the College of Air Training.

HUDDERSFIELD
30th. I.E.E.—"The role of the systems engineer" by Dr. Wilson at the College of Technology.

HULL
25th. I.E.E.—"The engineer and the law" by H. B. Morton at 6.30 at Y.E.B. Offices.

ISLE OF WIGHT
26th. I.E.E.—"The work of the Engineering Institutions Training Board" at 6.30 at the Technical College.

LEEDS
23rd. I.E.E.—"The future use of solid-state devices in the microwave field" by Dr. J. E. Carroll at 6.30 at the University.

LIVERPOOL
8th. I.E.E.—"Electromagnetic levitation" by H. R. Bolton at 6.30 at the University.
17th. I.E.R.E.—"Manufacturing aspects of the shadowmask tube" by P. T. Funnell at 7.0 at the Regional College of Technology, Byrom St.
22nd. I.E.E.—"Jodrell Bank radio telescope" by R. Lascelles at 6.30 at the University.

MALVERN
22nd. I.E.E.—"Electronic telephone exchange" by L. R. F. Harris at 7.30 at the Abbey Hotel.

MANCHESTER
22nd. I.E.E.—Faraday Lecture "Medical electronics" by Dr. D. W. Hill at 7.30 at the Free Trade Hall.
23rd. I.E.E.—Faraday Lecture "Medical Electronics" by Dr. D. W. Hill at 2.30 (Schools) and 7.30 at the Free Trade Hall.
31st. I.E.E. Grads.—"Superconductivity" by Dr. A. C. Rose-Innes at 7.0 at U.M.I.S.T.

MIDDLESBROUGH
11th. I.E.E. & S. Inst. Tech.—"System reliability and safety assessment" by G. Hensley at 6.30 at the Cleveland Scientific Inst.

NEWCASTLE-UPON-TYNE
10th. I.E.R.E.—"Some applications of electronics to oceanographic sensors" by A. M. East at 6.0 at the Inst. of Mining and Mechanical Engrs., Westgate Rd.
15th. I.E.E.—"Microelectronics" by Dr. S. S. Forte at 6.30 at Rutherford College of Technology.

NOTTINGHAM
16th. I.E.E.—Faraday Lecture "Medical electronics" by Dr. D. W. Hill at 7.15 at the Albert Hall.

OXFORD
10th. I.E.E.—"The future of the Institution of Electrical Engineers" by Dr. G. F. Gainsborough at 7.0 at S.E.B., 37 George St.

PLYMOUTH
3rd. R.T.S.—"Graphics in television" by Don Baker at 7.30 at the Studios of Westward Television Ltd.

PORTSMOUTH
17th. I.E.E.—"The problems of digital s.s.b. systems" by R. T. A. Standford at 6.30 at the College of Technology.
24th. I.E.E.—"Project control—critical path analysis" by E. H. Harrhy at 6.30 at the College of Technology.

READING
11th. I.E.R.E.—"Parametric amplifiers" by Prof. D. P. Howson at 7.30 at the J. J. Thomson Physical Lab., the University.

RUGBY
3rd. I.E.E.—"Fabrication uses of the electron beam" by H. N. G. King at 6.15 at the College of Engineering Technology.
10th. I.E.R.E. & I.P.P.S.—"Atomic measurement of time" by Dr. L. Essen at 6.30 at the Col. of Advanced Technology.

SOUTHAMPTON
16th I.E.R.E.—"Microwave ultrasonics" by Dr. R. W. B. Stephens at 6.30 in the Lanchester Theatre, the University.
23rd. I.E.E.—"The introduction of direct digital control" by Dr. V. Latham at 6.30 at the Lanchester Theatre, the University.

STEVENAGE
15th. I.E.E.—"Post Office Tower" by D. G. Jones at 7.0 at the College of Further Education.

WOLVERHAMPTON
31st. I.E.R.E.—"The use of a computer to control an industrial process" by D. G. Leak at 7.15 at the College of Technology, Wulfruna St.

NEW PRODUCTS

Stereo Tape Deck

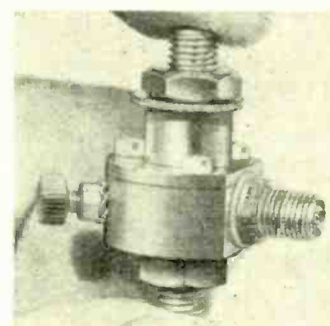
A COMPACT stereo tape deck offering off-tape monitoring, sound-on-sound, sound-with-sound, echo and duet effects, is available from Ampex Great Britain Ltd. Smaller than previous models in the Ampex line, the model 753 measures 15¾in wide × 13in deep × 6½in high. This deck has three heads—record, playback and erase—permitting precise monitoring and sound-on-sound recording and playback, eliminating the possibility of crosstalk often found on models with a single record/playback head. As with all Ampex open reel audio recorders, the magnetic heads are of the deep-gap design. Sound mixing features of Model 753 make it possible to mix narration with music tracks, add sound and musical effects to home-produced programmes, and to conduct language pronunciation studies. The sound-on-sound facility permits that while listening to recorded material, new material may be recorded on the same sound track without erasing the original material. With sound-with-sound, recorded material on one track can be played and new material recorded on the second track permitting playback in stereo. Off-tape monitoring permits material to be played back as it is recorded, allowing instant adjustment for best recording fidelity. By switching a control knob to an "echo" position material may be recorded with echo effect. With "duet effect," material being recorded on one track may also be recorded on the second track, but with slight delay, achieving a special depth of stereo sound on playback. This is said to be especially useful in recording and playing back musical soloists. Model 753 has pre-amplifiers and offers a unique line-jack that permits the recorder to be connected to any type amplifier with consistent performance. It also features twin vu-meters, all solid-state electronics, automatic shut-off, and dual capstan drive, which reduces flutter and wow to a minimum. Overall record/reproduce frequency response measured at the pre-amplifier output is ±3 dB at 40 Hz—15 kHz at 7½ i.p.s. and ±4 dB at 50 Hz—7.5 kHz at 3¾ i.p.s. Signal-to-noise ratio from peak record level to broad band noise at the pre-amp output is 46 dB (unweighted) at 7½ i.p.s. and 43 dB (unweighted) at 3¾ i.p.s. The deck model weighs 23 pounds. The price is 79 gns. Ampex Great Britain Ltd., Acre Road, Reading, Berks.

WW 301 for further details

GUNN DIODE OSCILLATOR

THE oscillators in the CL8 series by Mullard are intended primarily for experimental purposes and for performance assessment in microwave systems. They can also be used in speed checking equipment and bench-top microwave demonstration systems for schools and colleges. Each oscillator has a gallium arsenide device fitted in a small cavity which can be mechanically tuned over 1 GHz. Self-contained, a typical continuous output of 5 mW can be obtained with a supply of 7 V d.c. There are four oscillators, the CL8 360, 370, 380 and 390, covering the range 8 to 12 GHz. Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.

WW 302 for further details



Operational Amplifier

FLEXIBILITY of the Westinghouse WC306 operational amplifier (dual in-line package) is indicated by the fact that (a) a choice of inputs is available, a high impedance 300 kΩ pair of differential inputs and a low impedance 3 kΩ pair, (b) outputs are, a differential pair of output terminals as well as the regular single-ended output, and (c) bandwidths can be selected up to the 30 MHz unity gain of this device, using the low input impedance terminals; 40 dB of gain can be achieved at 10 MHz. Most of this amplifier's 1,100 to 4,400 open loop gain can be used without exceeding 0.2% distortion. Only sufficient feedback to maintain d.c. operating point stability is necessary. With a worst case situation of 5 kΩ source impedance, and a 150 kHz bandwidth the noise is only 12 μV r.m.s. In many low-frequency instrumentation applications where noise is serious, lower source impedances and restricted bandpass will substantially lower this figure. Common mode rejection (83 dB) retained at high frequencies, low thermal drift (5 μV/°C) and an output voltage swing of ±7 V are additional features of this op-amp. Applications include high-frequency video amplifier for driving push-pull loads such as c.r.t. deflection plates, servo motors and speaker coils. The differential outputs could also be used for driving balanced transmission lines. It can also be used as a high-fidelity pre-amplifier for audio work. Westinghouse Electric Corporation, Molecular Electronics Division, Box 7377, Elkridge, Md. 21227.

WW 303 for further details

Coaxial Attenuator

A Kay Electric (U.S.A.) in-line attenuator, the Series 110 has a frequency range of d.c. to 4 GHz attenuated over 132 dB in 1 dB steps. It employs a segmented intrinsic cavity switch assembly. A simple slide switch operation controls individual steps of 1, 2, 3, 6, 10, 20, 30, 30, 30dB. The overall accuracy is 2% up to a maximum of 1 dB at 1 GHz and 5% up to a maximum of 5 dB at 4 GHz. The U.K. agents are Wessex Electronics Ltd., Royal London Buildings, Baldwin Street, Bristol, 1.

WW 304 for further details

TRACKING FILTER

IN order to reject harmonic and rattling distortion from the control accelerometer signal of an electro-magnetic vibration system, Derritron have introduced the solid-state tracking filter TF1. This provides precise tracking at high sweep rates. Automatic bandwidth switching between five crystal filters (3, 10, 30, 100 or 300 Hz bandwidth) may be selected by three separate programmes derived from the compressor functions of the Derritron vibrator control oscillator, VCO1, with which the TF1 is specifically designed to operate. A band reject output is available in addition to bandpass and d.c. analogue outputs. The tuning signal can be derived from any audio oscillator provided the amplitude variation does not exceed 40 dB. It is primarily designed for use in sine, random, sine-random and swept-random vibration testing or for precise analysis and measurement of audio signals. Derritron Electronic Vibrators Ltd., Sedlescombe Road North, St. Leonards-on-Sea, Sussex.

WW 305 for further details

Silver Bearing Solders

SOLDERING of silver-coated glass and ceramic surfaces and silver-plated components presents difficulties when using conventional tin/lead solders. Enthoven Solders Ltd. have produced a range of silver-bearing solders for such work, since the solubility of silver in tin is said to be greatly reduced by using a solder alloy already bearing a specific silver content. This does not affect the inherent solderability of the tin-rich alloys. The melting ranges of the silver bearing solders lie within the normal soft solder range. Enthoven Solders Ltd., Dominion Buildings, South Place, London, E.C.2.

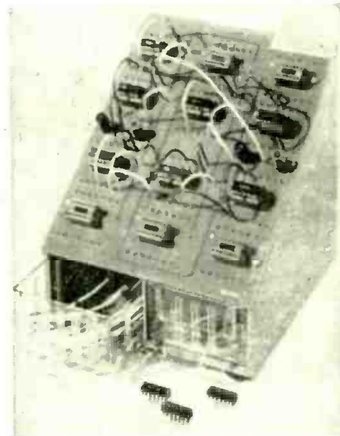
WW 306 for further details

Resin Disintegrator

A disintegration solvent for use with epoxy and polyester resins is available from Oxley-Developments Co. Ltd., Priory Park, Ulverston, North Lancashire. De Solv 8090, as it is called, is non-corrosive to metals (in normal use), non-inflammable and is of low toxicity. It is for use in recovering embedded electronic circuits, and for any applications where the removal of resins, paints and lacquers of the epoxy and polyester type is desirable. The disintegrator can be recovered for further use by filtering out the sediment.

WW 307 for further details

I.C. Breadboard



AN integrated circuit breadboard for dual-in-line i.cs is manufactured by Spectrum Electronics Ltd. The first unit to be offered is the ICB.707 which has provision for interconnecting twelve dual-in-line circuits. From the wide range of digital and linear dual-in-line circuits available, complex systems can be quickly built, demonstrated and proved. This device features solderless interconnections throughout, and reduces to a minimum the damage to i.cs. Each pin of the twelve high grade fourteen-lead i.c. sockets is brought out to a five-way socket which may be connected to any desired adjacent socket by colour coded leads. I.C. sockets and five-way sockets are coded for easy identification. Common power and earth points are available at each i.c. socket and are terminated in 2mm binding posts. Two coaxial sockets and binding posts with interconnection sockets are available for input and output signals. Sections of prototype systems can easily be isolated and monitored for demonstration or circuit optimization. Easy insertion and removal reduces the stockholding by making the i.cs immediately available for other experimental designs. Systems connections can be changed quickly to investigate a new design or evaluate an alternative supplier's product. The unit is ideal for prototype educational and feasibility studies. A logic handbook is provided for i.c. interconnection leads, and an i.c. extractor tool. The breadboard is $6\frac{1}{4} \times 6\frac{1}{4}$in and weighs $1\frac{1}{2}$lb. Spectrum Electronics Ltd., Deneway House, Potters Bar, Herts.

WW 308 for further details

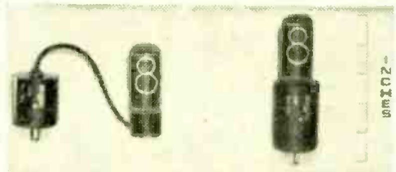
High-frequency Sampling Adaptor

IN the AIM sampling adaptor the gate is open for only 350 picoseconds. This refinement of circuit technology can be better understood if expressed in more practical terms; during the time the gate is open for each sample, a beam of light would travel only five inches. This waveform sampling adaptor type WSA114 gives a 1 GHz bandwidth to x-y recorders, oscilloscopes and audio spectrum analysers. It permits the examination of complex repetitive waveforms containing frequencies up to 1,000 MHz. It has four modes of operation, each with good sensitivity and linearity. In "auto" mode it may be coupled to an x-y recorder or low-frequency oscilloscope. Both x and y inputs are provided independently. In "coherent" mode, the unit provides a very slow representation of the original waveform. This may be fed to an x-y recorder, or a spectrum analyser and the original waveform can thus be recorded, analysed or recovered from noise. "Manual" mode provides the facility of scanning point by point through the original waveform. Moreover, in all these modes it is possible to magnify a single section of the waveform by a factor of up to 50. Finally, the "in-coherent" mode permits the measurement of peak, average or r.m.s. voltage of r.f. waveforms, without the necessity of adjusting synchronization. The technique used in the WSA114 is essentially a stroboscopic one, where samples of the high-frequency waveform are taken at successive intervals, stored for a time in an integral memory, and then assembled into a low-frequency representation of the original waveform. This technique permits recovery of signals which are obscured by up to 20 dB of noise. Moreover, the accuracy of representation of the waveform is said to be better than that of high-speed sampling oscilloscopes. In practice, the input signal is applied to an electronic gate which opens a little later in each scan of the high-frequency waveform so that over, say, 1,000 gate cycles, sufficient samples of the high-frequency trace are collected to permit faithful reconstruction at low speed. The stroboscopic sampler is locked to the incoming signal, and no delicate adjustment is needed to find and then follow a signal whose frequency is drifting. AIM Electronics Ltd., 71 Fitzroy Street, Cambridge.

WW 309 for further details

Counting Modules

A RANGE of plug-in integrated circuit counting modules is being marketed by Darang Electronics under the trade name DIGIC. Each counting stage is encapsulated in an anodized aluminium can, the range being originally designed for use in Darang's Digicron digital clocks, counters and tachometers. The modules are available either with the display tube as an integrated part of the module or with a flying lead up to six feet in length between the display tube and the module. Counting ranges between 0 and 2, 3, 4, 5, 6, 7, 8 or 9 and intermediate ranges 2-4, 3-8, 1-7 are available. The module provides a n.b.c.d. (8421) output and in addition a slave display may be driven from the display tube termination point. The display tube is a standard Mullard type



(ZM 1040) giving a 30 mm digit height; the power requirements are +6 V at 50 mA and +240 V at 5 mA. The input pulse requirements are amplitude +1.5 to 4 V, duration 150 ns minimum and the rise time must not exceed 1 μs/V. The devices will operate in the temperature range 0-60°C. Darang Electronics Ltd., Restmor Way, Hackbridge Road, Hackbridge, Surrey.

WW 310 for further details

LOGIC SYSTEMS

IN the Farnell logic system simulator, stepped progress can be made from simple logic functions to more complex logic techniques. Binary arithmetic is also introduced and the accompanying manual has a section on Boolean algebra and De Morgan's theorems. The simulator consists of a plinth unit to support the logic modules, a power supply and a range of modules including NOR, AND, NAND units, lamp, switch and binary units. Additional modules available are shaper, generator, photocell and proximity units, and 150 mA and 500 mA driver units.

WW 312 for further details

Variable Delay Line

A VARIABLE delay line adjustable between 10 and 18 μsec with a dynamic signal-to-noise ratio of 7 : 1 minimum is available from Sealectro. Deltime LG14 produces 40 mV minimum output across 4.7 kΩ when driven with 10 V at 60 mA peak current. This model is solder-sealed for military applications.

WW 313 for further details

Function Generators

TRIGGER, phase lock and tone burst capabilities are now available in two portable function generators by Wavetek, U.S.A. The Model 115 offers triggered or gated operation as well as phase lock capability. In the trigger mode, a manual or external voltage of ±0.5 V will generate one cycle. In the gated mode, a discrete number of cycles can be generated by applying a ±0.5 V gate The unit will phase lock to the fundamental of the dial frequency with specified accuracy. Model 116 has all the capabilities of the model 115 with the addition of tone burst operation, which may be generated automatically in the trigger mode. Selectable from a front panel control the 116 will generate from 1 to 256 discrete cycles. Both models will also generate sine, square, triangle, ramp and sync pulse waveforms. Nine simultaneous outputs are available over a frequency range of 0.00015 c/s to 1 Mc/s. Additionally, both units are voltage controlled, allowing a 20 : 1 frequency sweep over the full dial spread.

These two portable instruments have the following common specifications: dial accuracy—0.5 % of reading, frequency response amplitude change with frequency less than 0.1 dB, amplitude stability is 0.1 % of maximum peak-to-peak values for 30 minutes, and d.c. offset stability is 0.1 % of maximum peak-to-peak values for 30 minutes short term. Sine wave distortion is less than 0.5 %. Triangle and ramp linearity greater than 99 % to 100 kc/s. The square wave rise and fall time is less than 5 nsec. Both models use silicon semiconductors throughout and have individually calibrated dials; each is available in both a.c. and battery-powered versions. General Test Instruments, Gloucester Trading Estate, Hucclecote, Glos.

WW 311 for further details

Linear Motor

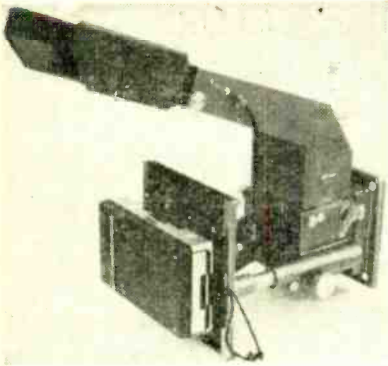
AN electric actuator with linear movement is the description given to the linear motor produced by AB Lineara of Sweden. This type of motor has a stator fixed to a solid member, and a metal guide complete with two end stops. When current is applied to the stator, the guide moves at a speed of 1.2 metres (4 feet)/sec in 20ms with horizontal mounting and unloaded armature. Direction of movement is changed by reversing the current. Although in principle the length of the stroke is infinite, the standard motor has an armature giving a 250mm (10in) stroke length, while the force along the stroke length is constant. For use in moving doors, valves, rejecting packages, moving items in packaging systems, this motor is said to permit a great deal of freedom in design. It can be mounted in any position, although minimum friction between stator and guide occurs when both are vertical. If the guide is fixed, then the stator moves and this method of operation is useful where a mounted or suspended item has to be moved over a definite length. This type of motor is intended for single phase 220 to 240 V 50 c/s operation, thus a phase-shift capacitor is required and is delivered as a standard accessory. The motor control and regulation can be achieved with conventional electronic equipment. The armature is made from copper as standard, but the material can be any electrically conductive non-magnetic material. The length of the armature is not limited, and its movement can be stopped mechanically without causing motor damage. Motors can be mechanically coupled in series or parallel. The price is £25 10s. The general agent and distributor in Great Britain is Hird-Brown Ltd., Bolton, Lancashire.

WW 314 for further details

Portable Oscilloscope

THE Cossor CDU130 solid-state portable oscilloscope has a bandwidth of d.c. to 15 MHz. Field effect transistors are used to reduce Y amplifier drift, eliminate microphony and ensure accuracy at slow timebase sweep speeds. The sensitivity is 5 mV/division at full bandwidth. The operation of this instrument is possible with external a.c. or d.c. supplies; it will also operate for five hours from the internal battery provided as a standard. A battery charger is contained within the 'scope and the battery is protected against reverse charging. Weight complete is 16½lb.

WW 315 for further details



OSCILLOSCOPE CAMERA ACCESSORIES

POLAROID film pack backs are now available at no extra cost as alternatives to the present roll-film backs fitted to Telford Type A oscilloscope cameras. The 3,000 ASA eight-exposure pack film is said to be quicker and easier to load and manipulate. As each exposure is processed away from the camera, it is no longer necessary to await for the 15s processing time between successive shots, and multiple photography is greatly simplified where banks of cameras are used. Owners of Type A cameras with roll-film backs can buy pack backs separately, for £30. The pack back, when it is used with the Telford slide plate permits the taking of up to 13 exposures on one print. Also available is a high-speed f/1.3 lens, whose wide aperature means that rise times in the order of 10-15 nsec/cm can be photographed, using 10,000 ASA film. Telford Products Ltd., 4 Wadsworth Rd., Greenford, Middx.

WW 316 for further details

POWER TRANSISTORS

FOR use in radar pulse circuits as well as in high-power u.h.f. transmitters, the two transistors 2N5177-8 by TRW Semiconductors Inc. have an r.f. power output of 25 and 50 W respectively. Mounted in a grounded emitter strip-line package, both devices will produce their outputs at 500 Mc/s with a V_{CE} of 28 V. The following parameters are common to both types: V_{CBO} 55 V; V_{CEO} 35 V; and V_{EBO} 3.5 V. The dissipation, collector current and base current for the 2N5177 are 33 W, 4 A and 1 A respectively, and the same parameters for the 2N5177 have the following figures, 65 W, 8 A, and 2 A respectively. M.C.P. Electronics Ltd., Alperton, Wembley, Middlesex.

WW 317 for further details

Thermoelectric Generators

A STEADY and reliable electric power output, at working temperatures of up to 300°C, is claimed for the range of thermoelectric generator modules by G. V. Planer Ltd. Exploiting the Seebeck effect, these modules are intended for use in marine and aircraft navigational aids, telecommunications systems and remote weather stations. The generators are constructed from 50 thermo-elements which in turn are produced from *p* and *n* type semiconductor alloys based on bismuth telluride. Although the elements are connected electrically in series, in order to produce the necessary "hot" and "cold" faces, they are placed in parallel thermally. The establishment of a temperature difference between the faces produces a voltage (Seebeck effect), the magnitude of which is determined by the temperature gradient and the matrix configuration. The array is encapsulated to give a monolithic, mechanically strong assembly which is capable of operation at elevated temperature. Both types have a maximum hot sink temperature of 300°C and an open circuit voltage of 3.6 V for a temperature difference of 200°C. Type TPG/205 has a matched load output of 750 to 900 mW, and Type TPG/210 has a matched load output of 400 to 500 mW. G. V. Planer Ltd., Windmill Road, Sunbury-on-Thames, Middlesex.

WW 318 for further details

Broadcast Receiver

COVERAGE of the long- and medium-wave broadcast bands and continuous coverage of the shore-wave bands down to below the popular 16-metre band, is provided by the Eddystone EB36 solid-state broadcast receiver. It is completely self-contained, having its own audio amplifier stages and loudspeaker, but an audio output is available for an external tape recorder of hi-fi amplifier. Battery power supplies are provided within the receiver unit, to make the complete receiver independent of any external supply. In this way, it can be operated in a wide variety of portable roles, including road vehicles, small boats and even light aircraft without any additional facilities apart from an aerial. An a.c. mains power unit is available to replace the battery in the receiver. The EB36 incorporates the well-known Eddystone tuning control, with a high tuning ratio to enable precise frequency settings to be obtained. The tuning control is loaded with a heavy flywheel, which makes it possible to spin the dial to cover large changes in frequency very rapidly. Five frequency scales are provided, covering long-wave, medium-wave and three short-wave bands (from 1.5 to 22 Mc/s). An additional scale, calibrated in arbitrary units, can be used in conjunction with a small vernier dial to provide a very precise definition of points on any of the five frequency scales. The price of the EB36 is £54 5s 7d. Eddystone Radio Ltd., Eddystone Works, Alvechurch Road, Birmingham 31.

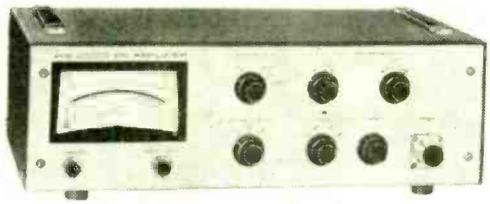
WW 319 for further details

Component Packs

FIRST two in the new range of component packs presented by Peak Sound, designed for use with the "Cir-Kit" system, are available at 15s each. Each pack contains full building and layout instructions. Pack No. 1 contains 15 components to build any one of a range of five different circuits; a high input impedance pre-amplifier with a gain of ×100, a multiple output signal injector, a multimeter high ohms range extender, multimeter low current range extender, and a mono pre-amplifier for moving coil microphones, giving a gain of ×100. Pack two contains components to build various types of pre-amplifier and multimeter range extenders. Other packs contain components for building amplifiers, pre-amplifiers, and power packs. Peak Sound (Harrow) Ltd., 10 Asher Drive, Ascot, Berks.

WW 320 for further details

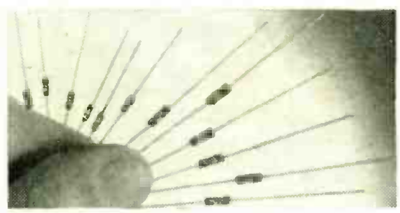
D.C. Amplifier



A D.C. amplifier, the 104, providing nanovolt resolution and millisecond rise time for d.c. voltage measuring systems is offered by Keithley Instruments Inc., 28775 Aurora Road, Cleveland, Ohio 44139, U.S.A. The gain range of 100 to 100,000 has an accuracy of ±0.01% and the linearity is ±5 p.p.m. of full scale. It is particularly useful for process control and automated data handling applications where it is used with a digital voltmeter for measurement of nanovolt and microvolt signals. It has a 10 V full scale output with 10% average for all gain ranges at up to 1 mA at full scale. The peak-to-peak noise varies from 10 nV (±50 p.p.m.) at a gain setting of 10^5 to 1 μV (±5 p.p.m.) at a gain setting of 10^2. Input impedance is greater than 50 MΩ and the output impedance is less than one ohm. Rise times are selectable at nominal settings of 0.05, 0.5, and 5 seconds.

WW 321 for further details

Ceramic Capacitors



MINIATURE ceramic capacitors covering the range 10 pF to 2700 pF are available from Erg Industrial Corporation Ltd., Luton Road, Dunstable, Beds. Although the standard tolerance is ±10%, other tolerances are available. The standard temperature coefficient conforms to MK-C-11015C which means that the value observed at 25 °C will be maintained within ±15% over the range −55 to +125 °C. Working voltages are from 50 to 200 V d.c., and these capacitors can withstand a d.c. potential of 400% of rated voltage applied at 25 °C for five seconds with current limited to 50 mA maximum. Standard leads are tinned copper and dual purpose weldable/solderable leads of gold flashed dumet are available.

WW 322 for further details

Digital Integrated Circuits

A NEW series of digital integrated circuits have been introduced by the Raytheon Company of America. Designated RM2000, the series consists of a quad level translator, a current driver, and a lamp driver. The RM2000 quad level translator consists of four level-shifting inverters, each with two alternative inputs. Signal inputs are at 28 V for one input, 14 V for the other. The RM2001 is a monolithic high voltage (40 V), high current (250 mA) driver with inputs compatible with the 930 Series DTL. Because of this compatibility, the circuit offers logic flexibility in addition to its current and voltage capabilities. Intended primarily for use as a relay or lamp circuit, the RM2002 is a high voltage (40 V), high current (250 mA) unit. The inputs to the driver are compatible with 930 DTL Series circuits. A 930 DTL gate is also provided on the chip for additional logic capability.

The RM2000 Series is guaranteed over a temperature range of −55 °C to +125 °C. The hermetic seal limits leakage to 5×10^{-8} cm^3/s of helium. Raytheon Overseas Ltd., Lexington, Massachusetts 02173, U.S.A.

WW 323 for further details

Frequency Doubler and Phase Shifter

THE Brookdeal DP325 frequency doubler/phase shifter has been designed particularly for use in the reference channel of a phase-detection, small signal recovery system where the information frequency is twice that of the excitation or modulating waveform. The output level of 3 V r.m.s (f.s.d.) can be monitored on the output meter, and inputs from 10 mV to 100 V (f.s.d.) can be accepted. Facilities are provided for phase shifting the output with or without frequency doubling, giving greater than 180° control. The frequency range is 30 c/s to 300 kc/s. Input and output impedances are 100 kΩ and 600 Ω respectively. Compensation is provided within the instrument for input sine waves of poor wave shape, and circuit stabilization is achieved through a high degree of d.c. and signal frequency feedback. Brookdeal Electronics Ltd., Myron Place, London, S.E.13.

WW 324 for further details

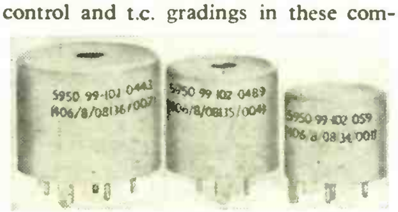
STEREO AMPLIFIER

AVAILABLE in kit or assembled form from Daystrom, the TSA-12 Heathkit stereo amplifier has an output of 12 W r.m.s. per channel into an 8 Ω load. The output is also suitable for 15 Ω loudspeakers (8 W r.m.s. per channel) and there are three inputs for gram, radio, and auxiliary signals. Channel separation is 45 dB or better, and the frequency response is stated as 13 Hz to 60 kHz ±1dB and 7 Hz to 95 kHz ±3dB. Total harmonic distortion at 1 kHz at 0.5% or less at rated output; and at 20 Hz to 20 kHz it is 1% or less at the rated output. It possesses the usual complement of controls and employs 17 transistors and six diodes.

WW 325 for further details

Tunable Pot Cores

ENCAPSULATED tunable pot core assemblies in the Plessey Alpha range have been designed with the close requirements of telecommunications work in mind. One of these requirements is that of temperature co-efficient control and t.c. gradings in these components fall into two broad categories arising from the intrinsic characteristics of the ferrites appropriate to the frequency bands. Generally, t.c. is linear for frequencies up to 2 Mc/s and non-linear for frequencies between 2 and 8 Mc/s. This range is suitable for t.c. performance and grading from 0 to 120 p.p.m./°C over a temperature range −25 °C to +55 °C. The encapsulated assemblies are housed in hot tin-dipped copper screening cases, the encapsulant being flexible silicone with good dielectric properties up to 8 Mc/s



WW 326 for further details

Low-Level SCRs

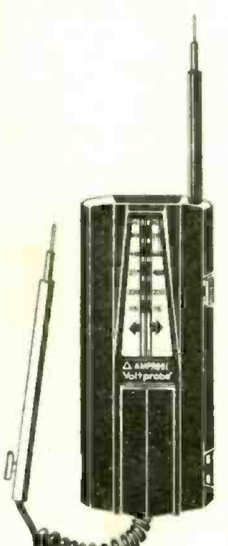
A sensitive gate s.c.r. series rated at 800 mA (forward current r.m.s.) has been designed by Motorola for low-level power control circuits. The series consists of four device types—2N5060 to 2N5063 inclusive, with voltage ranges from 30 to 150 V. Gate current requirements for these units is only 200 μA. The new geometry used in these devices features larger bonding areas on the die to provide better power dissipation. Additional features include low holding current (5.0 mA max at 25°C), a 6 A peak surge for protection, a 1.7 V peak forward "on" voltage (1A at 25°C), and low blocking currents (50 μA maximum at rated voltage and 125°C). Motorola Semiconductor Products Inc., York House, Empire Way, Wembley, Middlesex.

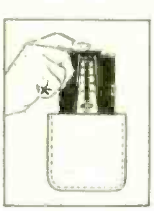
WW 327 for further details

VOLTAGE PROBE

ON the VT100 Amprobe voltage tester, voltages are shown "thermometer" style via a series of lit windows that correspond to the following voltage levels; 115, 220, 277, 440, 550 V a.c. and 115, 220, 400, 600, 750 V d.c. When the probe is connected to the a.c. supply the window indicating the relevant voltage lights up and a buzz is heard the pitch of which is determined by the supply frequency. This instrument will also indicate correct d.c. polarity. The body incorporates a sliding probe and there is another probe attached to an expanding coil cord, thus permitting measurement of points of up to three feet apart. Soss Manufacturing Company, Lynbrook, New York 11563, N.Y., U.S.A.

WW 328 for further details





The Unknown Warriors

SEEING that the time to ring out the old, ring in the new, is almost upon us, it was the intention of Old Moore Vector to gaze into his crystal ball to report upon the future of the electronics industry. One preliminary sidelong peek however, and common humanity made him desist. After all, you are going to have quite enough to put up with as it is, what with forking out for mother-in-law's present, and treading on the holly which the kiddiwinks have installed by their bedsides as a Santa auto-alarm.

So instead I thought it would be nice and seasonable if we paid tribute to the forgotten men of the radio industry. The men who, long after the factories have closed and the labs have locked up for the Christmas, will be tootling around until the small hours of the morning on behalf of those whose sets have gone up in smoke at the last moment. I mean, of course, the chaps in the little shop around the corner; the fellows who have the privilege of repairing that television receiver you bought at cut price in the Tottenham Court Road. Those Tail End Charlies of the receiver industry, the small retailer and his serviceman (often one and the same person).

As we all know to our cost, there are dealers and dealers. There is the city shark with the flashy chromium shop front who welcomes every stranger in with gently smiling jaws (although that was a crocodile wasn't it?). He lives by the late Mr. Barnum's dictum that there is one born every minute and he has never had occasion to quarrel with the sentiment. Then we have an immense variety of chain stores, furniture emporiums, bicycle shops, ironmongers and so on, who run radio as a sideline. Some have qualified personnel; many don't. There's no telling until you've been a customer.

Another phenomenon is the man who, on the strength of having built a simple kit set or two, sets up a pin-money repair business at home. The bonafide dealers love him for his artless habit of adding or subtracting components from the circuit as the mood takes him, then washing his hands of the whole business when the set refuses to work. This chap also has a mysterious source of supply from which he can offer leading makes of receivers at a "little bit off." The dealers love him for that, too.

Finally there is the genuine article; the dealer who runs an honest business and backs it with first-class service. He may be in a big way of business; he may be found in a small village store (one of the best dealer-service engineers I know sells tobacco on the other side of the shop). The tragedy is that from a superficial pavement inspection the genuine article is quite indistinguishable from the riff-raff.

Possession of well-known receiver agencies offers no criterion, for although much lip service is offered by manufacturers to the importance of an efficient service department, a commanding position in the shopping area and a good window-frontage can work wonders in the appointment of a dealer.

One truly startling feature of the radio receiver industry is that prices are actually lower today than they were 45 years ago. You don't believe it? Neither did I, until I came across some radio magazines of 1924 vintage. The price of a reputable two valve set was then roughly £20. So you can get a 10-transistor portable today for less than the price paid for a two valve set in 1924 (off-hand I would say that the quality of reproduction was about comparable, too, but that's another matter). Compare the price of a television receiver of 1939 vintage with one of today's models and you will see the same downward price trend.

This is in contrast to the "times six" price increase in motor cars and most other commodities over the same period. Receiver manufacturers will argue that this is a tribute to their efficient mass production techniques; in fact, it is more of a tribute to their genius for trying to slit each others' throats and thereby killing the golden goose, if I may mix my metaphors.

The effect on the poor old dealer is all too plain. It means that he is working on the same, or perhaps even a lower, profit margin than he did in 1924. Not merely in percentage but in cash. If he made £5 profit per set in the 1920's he still makes £5 today, in spite of the huge increase in overheads. Take servicing equipment for instance. In the early days he could get by with little more than a buzzer and battery. Today even a modest service department houses many hundreds of pounds worth of equipment. Considering the doldrums in sales which have existed these many years it's not surprising that a lot of dealers have taken a one-way ticket to Carey Street. The wonder is that any have survived at all.

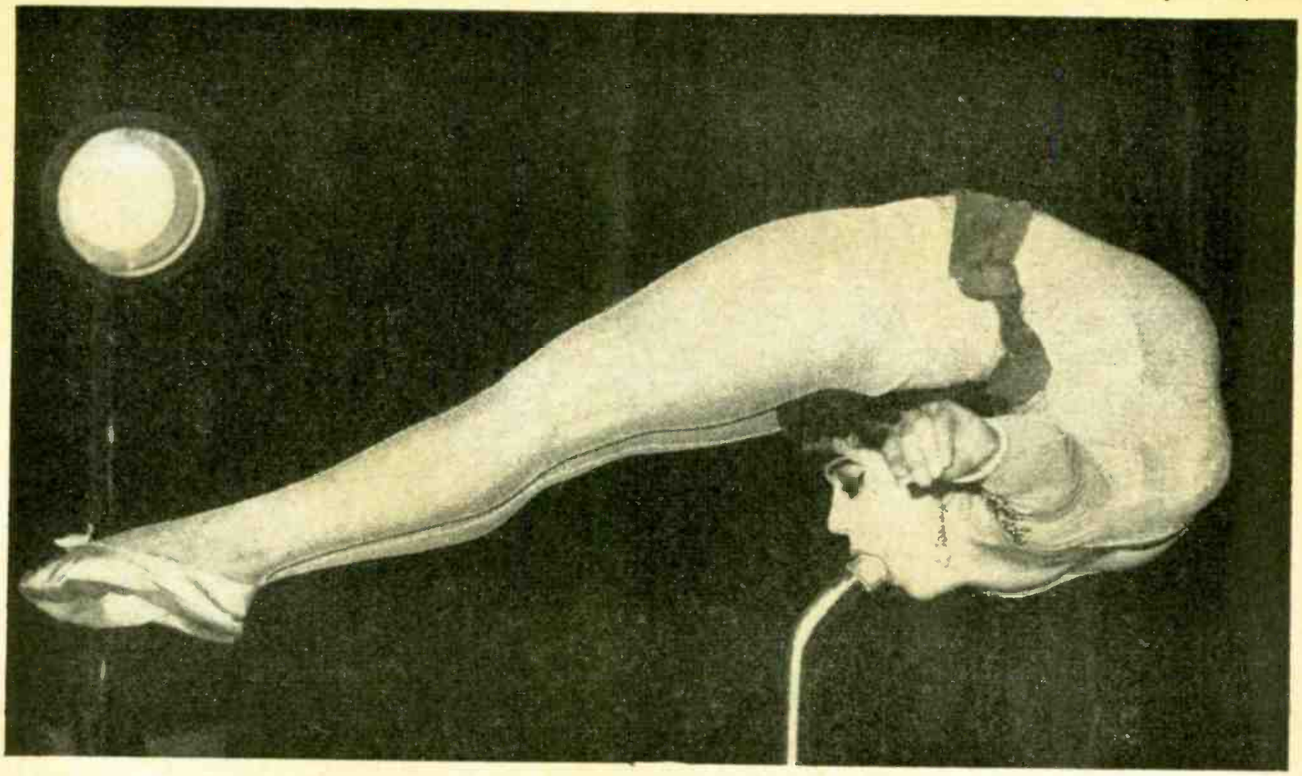
Now colour is with them, like an angry dawn portending more stormy weather; more very expensive servicing equipment and a lower mean time between failures to swallow the extra profit margin. In the cities and stockbroker belts things may not be so bad, but spare a thought for the little man in a remote farm-labouring area. He can count his colour-sales prospects on the fingers of one hand and still have plenty of digits left, but if he sells one colour set he still has to provide the means of servicing it, just as surely as if he was selling them by the hundred.

There was one man, Frank Murphy, away back in the 'thirties, who came up with some ideas which were regarded by his fellow manufacturers as completely screwball. He started making receivers which were engineered to professional standards, with price a secondary consideration (oddly enough, they were only a little higher than average). He appointed his dealers very carefully, making sure that their service departments were of a high standard, but, once appointed, they had exclusive territories of considerable size.

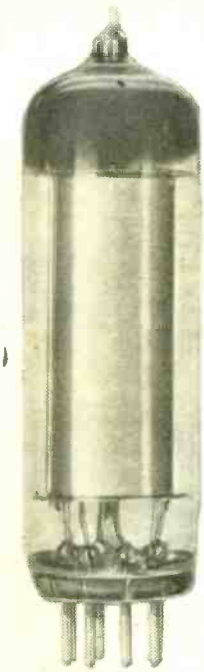
He made the dealer into an external arm of his manufacturing effort by requiring him to provide a monthly return of repairs effected to his sets. If, then, a component was seen to be giving trouble, a better one was substituted, even if production had to be halted temporarily.

The customers were happy because their sets kept working year in, year out. The dealers were happy because their appointment was in effect a certificate of competence and even though their discount was rather less than average, they didn't have any significant free servicing to do. The man who dreamed the system up was happy with a modest profit. Then, surprisingly, he got out of the business altogether, to the great loss of the industry.

Meanwhile, like any junkie, the industry has relied on periodic shots in the arm to keep it going; the latest of these is colour, over which no doubt, the suicidal price-cutting policies will continue.



Voltage Stabilisers



DATA

Type	Service type	Operating voltage approx. (V)	Striking voltage (V) ○	Striking voltage (V) ●	Tube current range (mA)	Regulation max. (V)	Base
OA2	CV1832	150	185	225	5-30	6.0	B7G
OA2WA‡	CV4020	150	165	225	5-30	5.0	B7G
OB2	CV1833	108	133	210	5-30	3.5	B7G
OB2WA‡	CV4028	108	133	210	5-30	3.0	B7G
OC2	CV8766	75	115	145	5-30	4.5	B7G
QS75/20	CV284†	75	110	160	2-20	6.0	B7G
QS75/60	CV434	75	117	—	5-60	5.0	B8G
QS92/10	CV188††	92	140	—	1-10	5.0	Br.4-pin
QS95/10	CV286	95	110	—	2-10	5.0	B7G
QS108/45	CV422	108	120	—	5-45	5.0	B8G
QS150/15	CV287	150	170	—	2-15	5.0	B7G
QS150/45	CV395	150	170	—	5-45	5.0	B8G
QS1202‡	CV4052	108	133	210	2-15	3.0	B7G/F
QS1203‡	CV4053	150	180	225	2-15	4.5	B7G/F
QS1215	CV5173	90	115	115	1-40	8.0	B7G

‡ A rugged and reliable type ○ In normal lighting ● In total darkness †† Also CV1070 (operating voltage 100V) † Also CV4083 (operating voltage 70V)

This range of Voltage Stabilisers is available from the following E.E.V. stockists. Prices are highly competitive.

Coventry Factors Ltd
Coronet House, Upper Well Street,
Coventry. Tel: Coventry 21051

Downes & Davies Ltd.,
G.P.O. Box 555, 72 Chapeltown Street,
Manchester 1. Tel: Ardwick 5292

Edmundson Electronics Ltd.,
60-74 Market Parade, Rye Lane, Peckham,
London SE15. Tel: New Cross 9731

Gothic Electrical Supplies Ltd.,
Gothic House, Henrietta Street,
Birmingham 19
Tel: Birmingham Central 5060

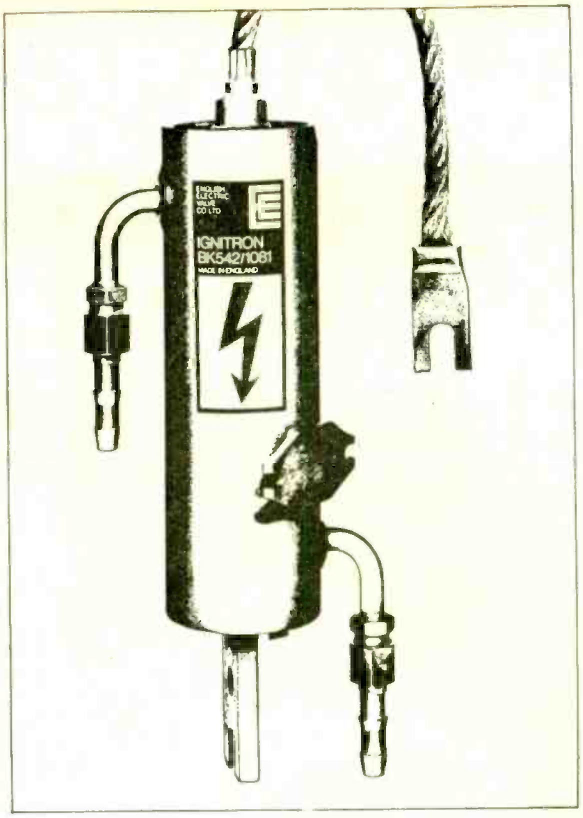
Harper Robertson Electronics Ltd
97 St. George's Road, Glasgow C3
Tel: Douglas 2711

The Needham Engineering Co. Ltd
P.O. Box 23, Townhead Street,
Sheffield 1. Tel: Sheffield 27161

Smith & Cookson Ltd.,
49/57 Bridgewater Street,
Liverpool 1. Tel: Royal 3154-7

Wireless Electric Ltd.,
Wirelect House, St. Thomas Street,
Bristol 1. Tel: Bristol 294313

ENGLISH ELECTRIC VALVE COMPANY LIMITED CARHOLME ROAD, LINCOLN. TELEPHONE 26352



This looks like a 'B' size Ignitron

but it controls 65% MORE POWER and saves money

The new EEV Mini 'C' Ignitron

It's well-known that 'B' and 'C' Ignitrons are often used for applications which call for something in between. You can either overwork a 'B' or underwork a 'C'. Whatever you do wastes money. To cut out this waste EEV have developed a new Mini 'C' Ignitron which has a standard international 'B' size envelope, but can handle 65% more KVA than the 'B' size. The new tube has a number of advantages. Take-over voltage is low to minimise misfiring at low current conditions, which in turn increases ignitor life. When used in place of a standard 'B' size ignitron, you will find that the Mini 'C' lasts nearly twice as long. The cooling water is in direct contact with the vacuum envelope, and the inlet has been streamlined for better water flow. This adds up to better cooling, especially at hot spots, and reduced clogging by sediment. Both water connections are of the quick release type. Plastic coating is optional. The Mini 'C' fits standard 'B' size sockets, so that you can use it to uprate existing equipment to provide new intermediate types. Makers of welding equipment will see in the Mini 'C' a means of extending their range, as there is no need for a new socket size calling for radical design changes. Use the Mini 'C' in place of an overworked 'B' size for longer life, or to replace an underworked 'C' size for lower running costs. In both cases it will save you money.

EEV's new Mini 'C' Ignitron is available from stockists throughout the country.

Harper Robertson Electronics Ltd, 97 St George's Road	**Glasgow C3** Tel: Douglas 2711
Downes & Davies Ltd, G.P.O. Box 555, 72 Chapeltown Street	**Manchester 1** Tel: Ardwick 5292
Smith & Cookson Ltd, 49/57 Bridgewater Street	**Liverpool 1** Tel: Royal 3154-7
The Needham Engineering Co. Ltd, P.O. Box 23, Townhead Street	**Sheffield 1** Tel: Sheffield 27161
Coventry Factors Ltd, Coronet House, Upper Well Street	**Coventry** Tel: Coventry 21051
Gothic Electrical Supplies Ltd, Gothic House, Henrietta Street	**Birmingham 19** Tel: Central 5060
Edmundson Electronics Ltd, 60-74 Market Parade, Rye Lane, Peckham	**London SE15** Tel: New Cross 9731
Wireless Electric Ltd, Wirelect House, St Thomas Street	**Bristol 1** Tel: Bristol 294313

ENGLISH ELECTRIC VALVE COMPANY LIMITED CARHOLME ROAD, LINCOLN. TELEPHONE: 26352

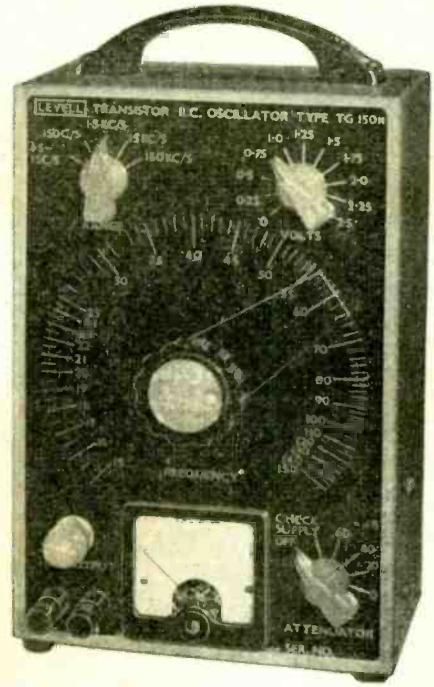
AP329

WW—009 FOR FURTHER DETAILS

LEVELL

PORTABLE INSTRUMENTS

R. C. OSCILLATORS



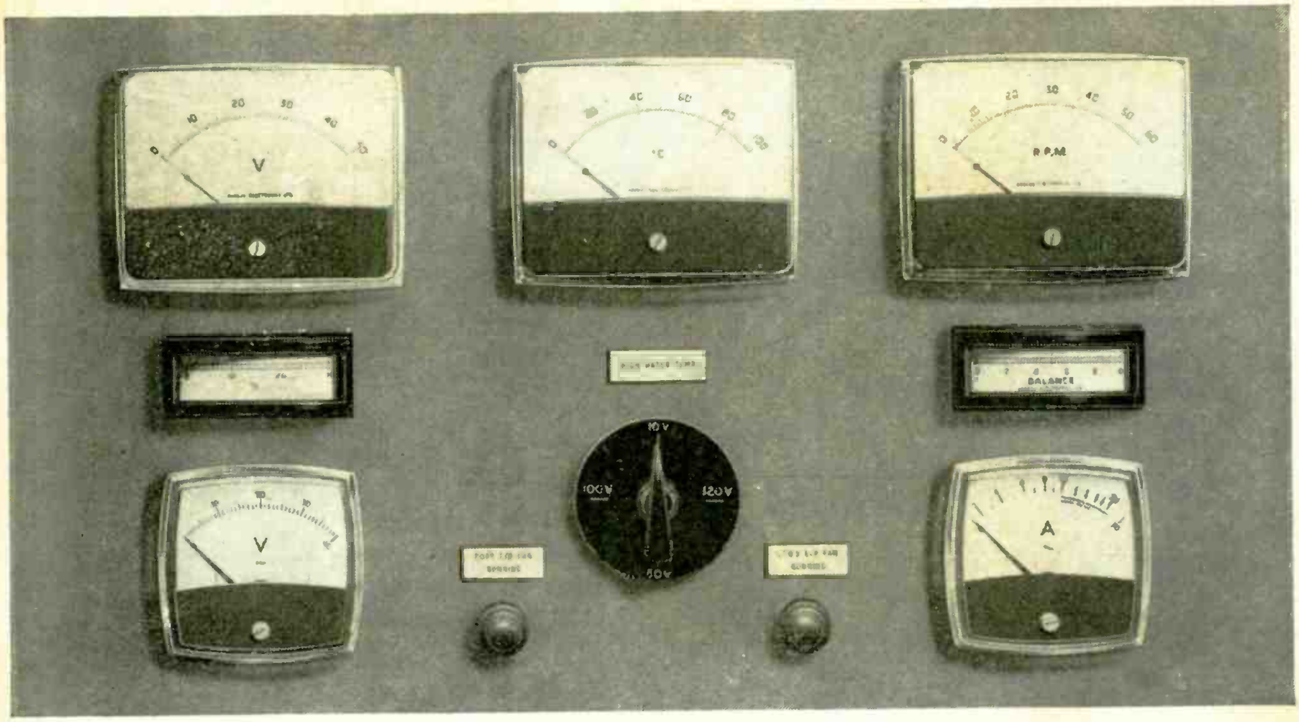
With DIGITAL or ANALOGUE Frequency calibration

TYPE	TG66A	TG66B	TG150	TG150M	TG150D	TG150DM
FREQUENCY	0.2Hz to 1.22MHz.		1.5Hz to 150kHz			
ACCURACY	±0.02Hz below 6Hz ±0.3% from 6Hz to 100kHz ±1% from 100kHz to 300kHz ±3% above 300kHz		±3% ±0.15Hz			
DISTORTION	<0.15% from 15Hz to 15kHz <0.5% at 1.5Hz and 150kHz		<0.1% at 1kHz, <0.3% from 50Hz to 15kHz <1.5% below 50Hz and above 15kHz			
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 3.5in.		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	7in. × 10½in. × 7in. Weight 12lb.		10in. high × 6in. wide × 4in. deep. Weight 6lb.			
PRICES	£150	£120	£32	£42	£35	£45
+ Mains Power Unit	included	£15	£7/10/-			
+ Leather Case	£5	£5	£4/10/-			

LEVELL ELECTRONICS LTD., Park Road, High Barnet, Herts. Phone 01-449 5028

WW—010 FOR FURTHER DETAILS

Meter panel of specialists



Here at Anders there's a panel of meter specialists daily creating panels of special meters. And just special meters on their own. For equipment manufacturers, research organisations, nuclear energy establishments. For anybody, in fact, whose meter requirements are a little out of the ordinary, like non-standard calibrations. Or a lot out of the ordinary, like non-standard calibrations plus special modifications, plus . . . well, you name it. Creating specials is an important part of Anders Meter Service.

Manufacture and distribution of electrical measuring instruments and electronic equipment. The largest stocks in the U.K. for off-the-shelf delivery. Prompt supply of non-standard instruments and ancillaries.
Sole U.K. distribution of FRAHM vibrating reed frequency meters and tachometers.

New comprehensive catalogue available free to manufacturers and bona-fide engineers.

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Ministry of Aviation Approved

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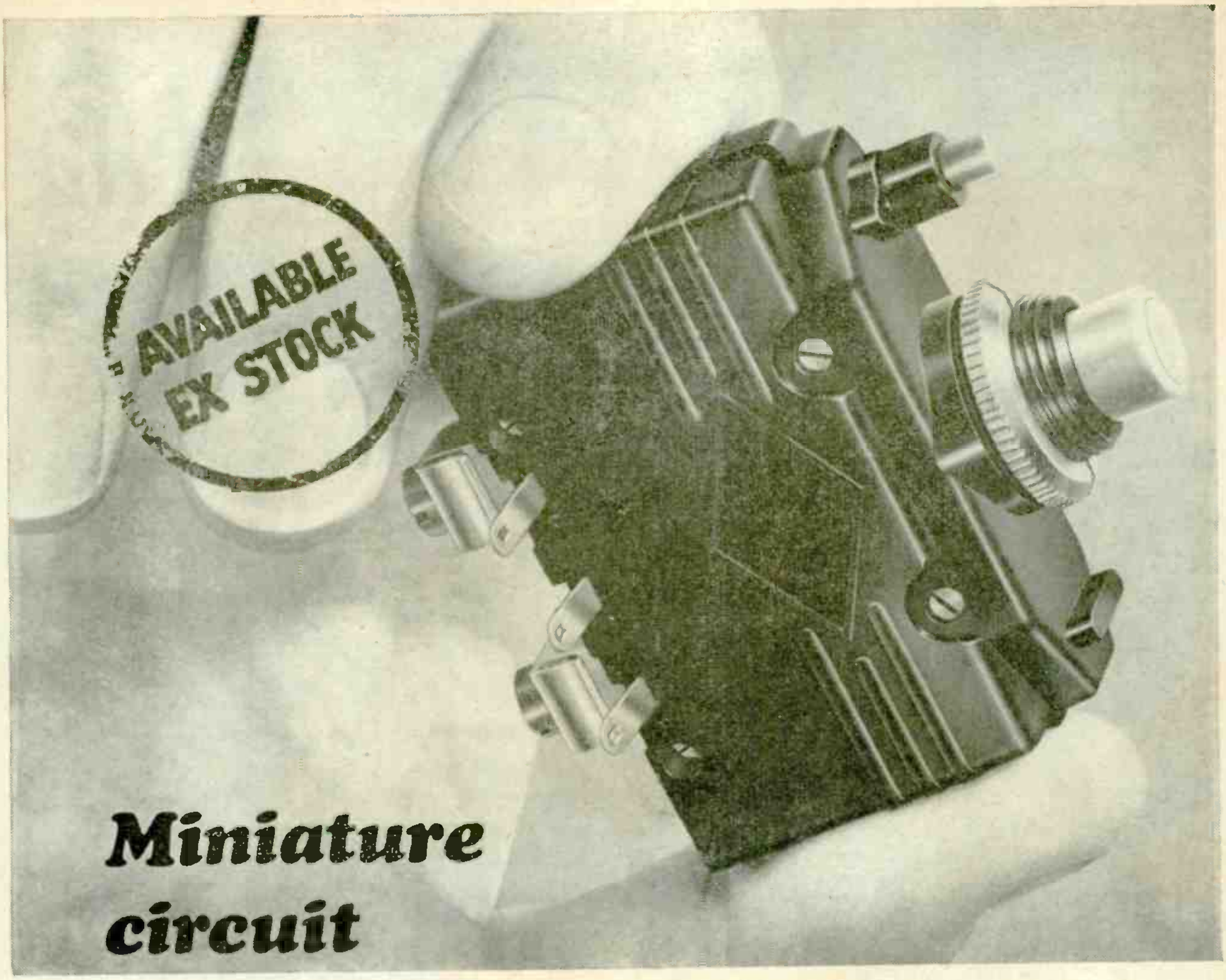


Miniature circuit breakers with BIG Advantages

The Belling-Lee "Securex" Miniature Circuit Breaker is a precision unit which provides protection, switching plus a clear indication of the circuit condition. Two basic types are available, thermal or thermal-magnetic. Available in many ratings from 300 mA to 15 A.

FOR FULL SPECIFICATIONS RING ENF 5393 OR WRITE FOR DATA SHEETS E17-E20

BELLING-LEE COMPONENTS

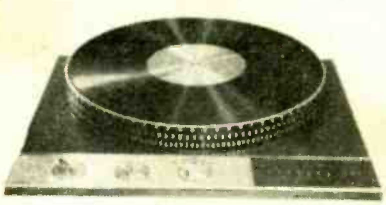
connecting research to industry

BELLING & LEE LIMITED, GREAT CAMBRIDGE ROAD, ENFIELD, MIDDLESEX

Telephone: 01-363 5393 Telex: 263265

WW—013 FOR FURTHER DETAILS

Three turntables from the world's greatest range of record playing units designed to enable you to get closer than ever before to your ideal in sound reproduction.



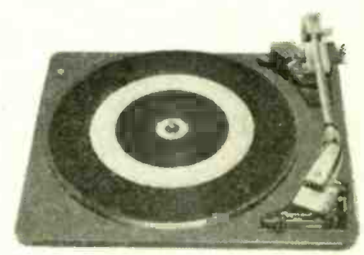
Garrard 401

With its magnetically shielded 4-pole induction motor, gear-cut stroboscopic marking illuminated by an integral high-intensity neon lamp, precise variable speed control, heavy non-magnetic diecast turntable, anti-static mat, and functional styling, the 401 is the ultimate in transcription turntables. It meets the most exacting requirements of radio, television and recording studios throughout the world and of Hi-Fi enthusiasts everywhere. Each unit is supplied with its own test report

Garrard LAB 80 Mk II

The LAB 80 Mk II is a transcription turntable with facilities for changing records when desired. Among the advanced features are low-resonance wood pick-up arm, pick-up bias compensator and cueing facilities on manual. Further refinements are finger-tip tab controls, integral calibrated fine stylus force adjustment, a record-repeat adaptor and automatic play of single records.

Optional extras—attractive teak-finish base (WB2) and rigid clear plastic cover (SPC2).



Garrard SP 25 Mk II

A single record-playing unit designed to give exceptional performance at moderate cost. The SP 25 Mk II incorporates a pick-up arm bias compensator and integral calibrated stylus-force adjustment. A special feature is a cueing device which allows the pick-up to be raised or lowered at any point on the record. When a record has been played, the pick-up arm automatically lifts and returns to its rest and the motor switches off.

Optional extras—attractive teak-finish base (WB1) and rigid clear plastic cover (SPC1).

Your Hi-Fi dealer will be pleased to show you these superb Garrard units. Ask for leaflets on the complete Garrard range.

Garrard Engineering Limited, Newcastle Street, Swindon, Wiltshire. Telephone: Swindon 5381

Garrard looks after your records

WW—016 FOR FURTHER DETAILS

QUAD for the closest approach to the original sound

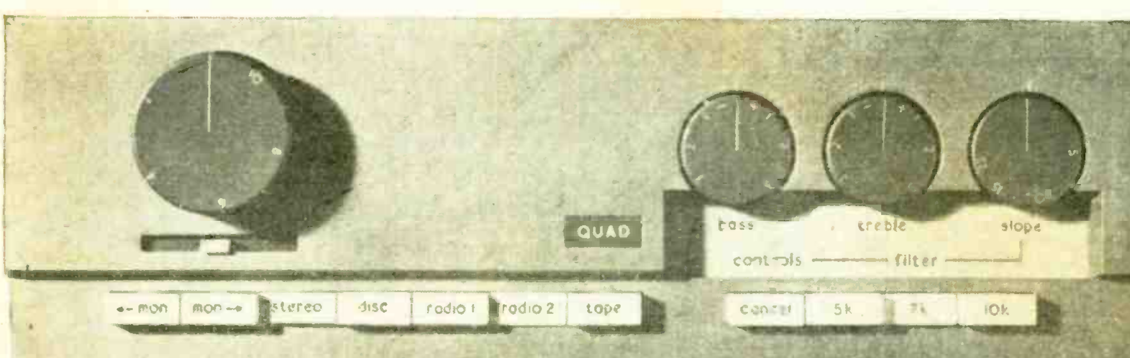
NEW

33 CONTROL UNIT
303 POWER AMPLIFIER

During December, most dealers will have available demonstration models, and full technical details.

QUAD

THE ACOUSTICAL MANUFACTURING COMPANY LTD.
Huntingdon, England
Telephone:
Huntingdon
(0480) 2561/2



WW—018 FOR FURTHER DETAILS

TIMERS

MICRO SWITCHES IMMEDIATE DESPATCH

PROCESS TIMERS

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.

approx. £5.0.0 each.

SYS MINI-TIMER

SYNCHRONOUS MOTOR & CLUTCH

★ 10 MILLION OPERATIONS
★ Instantaneous & Timed out 3 AMP contacts.
★ Repeat Accuracy ±½%. 10 secs. to 28 Hrs. May also be used as impulse start and automatic reset.

£9.15.0 dependent on quantity. approx.

MAINS OPERATED YL 2 GPA PROXIMITY SWITCH

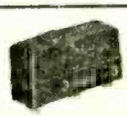
★ FOR BATCHING, CONVEYORS, MACHINE TOOL CONTROL, PACKAGING, SORTING, etc.
★ SENSES FERROUS OBJECTS
★ NEEDS NO MECHANICAL FORCE OR PRESSURE TO OPERATE
★ SOLID STATE SENSING HEAD INCLUDES CONSTANT VOLTAGE CIRCUIT

approx. £11.0.0 dependent on quantity

OTHER INDUCTIVE AND CAPACITY TYPES AVAILABLE

U.L. APPROVED (Appr. No. 32667) U.S. MIL. SPEC.
ALWAYS AVAILABLE FROM STOCK

S5G



★ 1 MILLION OPS.
5 amp. c/o Sub-miniature Micro-switch.
2/5 each per 1,000

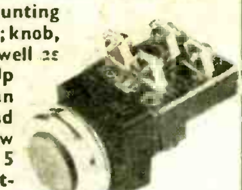
VAQ

★ 10 amp. c/o PUSH BUTTON
Panel mounting. Buttons in six colours.

4/2 each per 250.

HEAVY DUTY PUSH-BUTTON SWITCHES

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

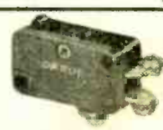
LIMIT SWITCH WL 10 FNJ

★ 10 AMP 2 CIRCUIT
★ 5 INCH FLEXIBLE ACTUATOR AS ILLUSTRATED

AS LOW AS 47/7 EACH.

FIVE OTHER STANDARD TYPES AVAILABLE

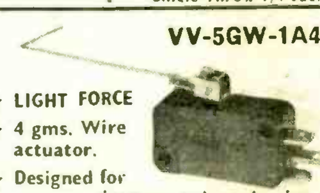
V-10-1B



★ 1 MILLION OPERATIONS.
★ 10 amp. c/o.
★ COMPARE OUR SPEC. & OUR PRICES WITH OTHER SIMILAR TYPES.

Screw Terms. 2/2 each per 1,000
V-10-1A Solder Tags 1/11 each per 1,000

VV-5GW-1A44



★ LIGHT FORCE
★ 4 gms. Wire actuator.
★ Designed for coin-operated mechanisms.

4/1 each per 1,000

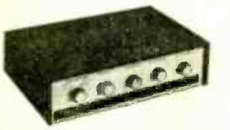
NEW RANGE OF SLOW BREAK-&-MAKE HEAVY DUTY PUSH-BUTTON SWITCH ACTUATORS. PANEL MOUNTING, TO BE USED WITH 1 to 4 D/P S/T SWITCH BLOCKS. COLOURED KNOBS. ALSO PUSH-ON/PUSH-OFF TYPES. SUITABLE FOR MACHINE TOOLS, MOULDING & PACKAGING MACHINES & CONTROL PANELS. FULL LITERATURE & DETAILS ON REQUEST.

(Dept. W.W.9) **OMRON PRECISION CONTROLS**
313 Edgware Road, London, W.2 Tel.: 01-723 2370

WW—021 FOR FURTHER DETAILS

See all these models, and many more ... in the latest HEATHKIT Catalogue

LOW-COST TRANSISTOR STEREO AMPLIFIER, TS-23



Incorporates all the essential features for good quality sound reproduction from record, radio and other sources ● 16 transistor, 4 diode circuit ● Good frequency response ● 3 watts r.m.s. (15 ohms) each channel ● 6 position selector switch easily handles your record, radio or tape inputs—stereo or mono ● Separate controls provide bass boost, treble cut, amplifier balance and volume ● Printed circuit board construction ● Compact, slimline styling ● Measures 3¾in. high x 13in. wide x 8in. deep ● Beautiful walnut veneered cabinet (optional extra) ● Attractive Perspex front panel.

KIT £17.15.0 (less cabinet) **KIT £18.19.0** (with cabinet)

Walnut veneered cabinet **£2/5/-** extra.

NEW! TRANSISTOR AM-FM STEREO TUNER, AFM-2

● 18 Transistor, 7 diode circuit ● AM-LW/MW, FM Stereo and FM Mono tuning ● Automatic stereo indicator light ● Stereo phase control for maximum separation, minimum distortion ● Automatic frequency control for positive "lock-in" tuning ● Automatic gain control for even, steady volume ● Preassembled and aligned "front end" FM unit ● Separate AM and FM printed circuit boards ● Self-powered ● Low-silhouette styling—matches AA-22U amplifier ● Handsome fully finished walnut veneered cabinet, available as optional extra. Comprising: AFM-2T RF Tuning Heart kit **£7/17/6** incl. P.T., AFM-2A IF Amplifier and power supply kit **£24/9/6.**

TOTAL PRICE KIT £32.7.0 incl. P.T.

Optional extra: Walnut veneered cabinet **£2/5/-** extra

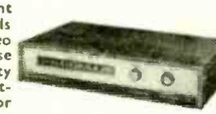
THE AVON COMPACT MINI SPEAKER SYSTEM

The ideal compact system for bookshelf or other small spaces ● 6½in. bass speaker ● 3¾in. totally enclosed treble unit ● Speakers rigidly mounted to 3/16in. thick aluminium alloy plate ● Inductor-capacitor cross-over unit ● Strongly constructed, fully finished walnut veneered cabinet ● Cabinet resonances are minimised by stout internal bracing and special acoustic absorbent filling ● Suitable for use with amplifiers having an output impedance of 8-16 ohms, and power output of 5 to 15 watts. ● Fast, easy assembly ● Gives best possible performance relative to smallest possible size ● Frequency response 50 c/s-19,000 c/s. ● Size: 7¾in. wide x 13¼in. high x 8¾in. deep. Comprising: Walnut veneered cabinet kit **£8/18/-**. Loudspeakers and cross-over network kit **£4/18/-** incl. P.T.

TOTAL PRICE KIT £13.16.0 incl. P.T.

TRANSISTOR FM STEREO TUNER, TFM-1S

(Mono version TFM-1M available)



● 14 transistor, 5 diode circuit for cool instant operation ● Mono TFM-1M and Stereo TFM-1S models available ● Automatic frequency control ● Stereo phase control to maximise stereo separation, minimise distortion ● 4-stage IF section ensures high sensitivity and selectvity ● Filtered outputs for direct "beat-free" stereo recording ● Automatic stereo indicator light ● Prealigned, preassembled "front-end" tuner and one circuit board for fast, simple assembly. Cabinet **£2/5/-** extra. Comprising: TFM-T1 RF Tuning Heart Kit, **£5/16/-** incl. P.T., TFMA-1M (Mono) IF Amplifier, Power supply **£15/3/-**. Kit or TFMA-1S (Stereo) IF Amplifier, Power supply **£19/2/-** Kit.

TOTAL PRICE KIT (Stereo) £20.19.0 incl. P.T.
TOTAL PRICE KIT (Mono) £24.18.0 incl. P.T.

Optional extra: Walnut veneered cabinet **£2/5/-** extra.

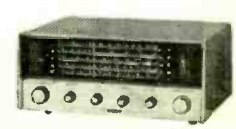
All models must perform to published specification when assembled in accordance with the instruction manual. ALL MODELS COVERED BY MONEY BACK GUARANTEE.

BERKELEY SLIM-LINE SPEAKER SYSTEM

● Specially designed to obtain optimum performance from the slim elegant cabinet ● Beautiful walnut veneered, fully finished cabinet ● Makes attractive addition to any room ● Stood on end only uses 17in. x 7¾in. of floor space ● Two specially designed loudspeakers give adequate power handling for most applications ● 12in. low resonance unit and 4in. Mid/High frequency unit, covers 30-17,000 c/s. ● Build it in an evening ● Professional attractive styling ● Use one for mono and a pair for stereo ● Outstanding performance at a low price ● Shelf or floor standing ● Use vertical or horizontal ● Designed to harmonize with modern or traditional decor.

KIT £19.10.0 Assembled £24.0.0

LOW-COST SHORTWAVE RECEIVER, GR-64E



● 4 bands—3 short wave bands cover 1 Mc/s to 30 Mc/s, plus 550 kc/s to 1,620 kc/s AM broadcast band ● Built-in 5in. permanent magnet speaker for a big, bold sound ● Illuminated 7in. slide-rule dial with extra logging scale ● Easy to read lighted bandspread tuning dial for precise station selection ● Relative signal strength indicator aids pin-point station tuning ● 4-valve superhet circuit plus two silicon diode rectifiers ● Variable BFO control for code and SSB transmissions ● Built-in external antenna connections ● Built-In AM rod antenna ● Fast, simple circuit board construction assures stability ● Handsome "low-boy" styling —charcoal grey cabinet, black front panel, and green and white band markings ● Headphone jack for private listening. Power requirements: 115, 230 v. 50-60 c/s A.C. 30 watts. Dimensions: 13¼in. wide x 6in. high x 9in. deep.

KIT £22.8.0 Assembled £27.8.0

LOW-COST SPEAKER SYSTEM SSU-1 (not illustrated)

● Build it yourself in an evening ● All wooden parts accurately pre-cut, drilled and sanded ● Wide frequency response ● Two specially designed loudspeakers ● Hi-Fi on a budget ● Glue, sandpaper, etc. are included in kit ● Use one for mono, two for stereo ● Finish it to match your own furnishing ● 16 page instruction manual ● 7in. or 15in. legs optional extra 14/6 ● Use vertical or horizontal.

KIT £11.17.6 (less legs)

GENERAL COVERAGE RECEIVER, GG-1U (not illustrated)

● Powerful 10 transistor, 5 diode circuit ● Tunes 580 to 1,550 kc/s and 1.69 to 30 Mc/s in five bands ● Bandspread on all bands ● Fixed-aligned ceramic IF transfilters for best selectivity ● Pre-assembled and aligned "front-end" for fast, easy assembly ● Built-in 6in. x 4in. speaker ● Tuning meter for pin-point tuning ● Completely self-contained for portability.

KIT £37.17.6 Assembled £45.17.6

NEW!

FREE CATALOGUE

Now with more Kits more colour. Fully describes these models along with over 150 models for Stereo/Hi-Fi, test and laboratory instruments, amateur radio gear, intercom, radio educational kits. Includes helpful Information on Hi-Fi in your home and planning your Hi-Fi system. Mail coupon or write Daystrom Ltd., Dept. WW1 Gloucester.

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233 TOTTENHAM COURT ROAD, LONDON, W.1
Open Mon.-Fri. 9 a.m.-5.30 p.m. Sat. 9 a.m.-1 p.m.
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INSTRUMENTS · HI-FI · RADIO · ELECTRONIC KITS

(Deferred terms available on all orders over £10, U.K. only)

NEW! 12+12W TRANSISTOR STEREO AMPLIFIER

Model TSA-12

Luxury performance at lowest cost

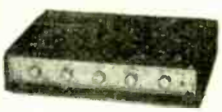
● 17 transistors, 6 diode circuit ● ±1 dB., 16 to 50,000 c/s at 12 watts per channel into 8 ohms ● Output suitable for 8 or 15 ohm loudspeakers ● 3 stereo inputs for Grams., Radio and Aux. ● Modern low silhouette styling ●Attractive aluminium, golden anodised front panel ● Handsome assembled and finished walnut veneered cabinet available ● Matches Heathkit models TFM-1 and AFM-2 transistor tuners.

Kit **£30.10.0** (less cabinet) Ass'ld **£42.10.0**

Beautiful Walnut cabinet **£2.5.0** extra.

20+20W TRANSISTOR STEREO AMPLIFIER

Model AA-22U



An International Class amplifier which offers superb realism and beauty of music at a very competitive price. Professional, elegant, compact, slim-line styling. The best of American transistor techniques a low high output with low distortion.

5 stereo inputs (five each channel) for pick-up, radio tuner, tape and two other sources. 20 transistor, 10 diode circuit. Beautiful, fully finished walnut veneered cabinet (optional extra).

Kit .. **£39.10.0** (less cabinet) Ass'ld. **£59.15.0** (inc. cabinet)

Walnut cabinet **£2.5.0** extra.

5 W HI-FI MONO AMPLIFIER KIT Model MA-5

A low-priced general purpose Hi-Fidelity amplifier based on the popular S-33 for those who do not require a stereophonic system. Separate bass and treble controls. Gram and Radio inputs. Suitable for most crystal pick-ups. A printed circuit simplifies construction.

Kit **£11.9.6** Assembled **£15.15.0**

STEREO CONTROL UNIT KIT Model USC-1

Incorporates all worthwhile features for Hi-Fidelity stereo and mono. Push-button selection, accurately matched ganged controls to ±1 dB. Negative feedback rumble and variable low-pass filters. Printed circuit boards. Accepts inputs from most tape-heads and any stereo or mono pick-up.

Kit **£19.19.0** Assembled **£27.5.0**

LW/MW TRANSISTOR PORTABLE RADIO KIT Model UXR-1

Beautiful leather case. Easy-to-read scale. 7 semi-conductors. Printed circuit board 7in. × 4in. Special loudspeaker. Pre-aligned IF transformers. 9-volt battery operated. Easy to construct, excellent in performance and value.

Kit **£12.11.0** (inc. P.T.)

"MOHICAN" GENERAL COVERAGE RECEIVER KIT Model GC-1U

This fully transistorised receiver which includes 4 piezo-electric transfilters, is in the forefront of receiver design. It is an excellent portable or fixed station receiver. The R.F. "front-end" is supplied as a pre-assembled and pre-aligned unit. Its many features include a 10-transistor circuit, printed circuit board, telescopic whip antenna tuning meter, and a large slide-rule dial giving a total length of approximately 70 inches. Housed in a steel cabinet and powered by two 6 volt dry batteries (not supplied), mounted internally, it gives frequency coverage from 580 kc/s to 30 Mc/s in five bands; thus enabling world-wide reception. Electrical bandspread covers the amateur bands from 80 to 10 metres—each band having a scale length of approximately 8 inches. BFO tuning and Zener diode stabiliser. Size 6⅞in. × 12in. × 10in.

Please write for specification leaflet.

Kit.. **£37.17.6** Assmbld... **£45.17.6**

STABILISED POWER PACK Models MSP-1M and MSP-1W

Specially recommended for industrial and laboratory use, meeting the need for a reliable and versatile stabilised power pack capable of a very high performance. Input 200-250 v. 40-60 c/s., A.C., fully fused. Output: H.T. 200-410 v. D.C. at 0-225 mA. in 3 switched ranges. Unstabilised A.C., 6.3 v. at 4.5 A. centre-tapped. Two 3in. "easy-to-read" meters for reading voltage and current simultaneously. Separate L.T. and H.T. supply transformers. All output circuits are isolated. Size 13in. × 8½in. × 9½in.

MSP-1M (with meters)

Kit.. **£36.12.6** Assmbled... **£43.12.6**

MSP-1W (less meters)

Kit.. **£29.17.6** Assmbld. .. **£36.17.6**

BALUN COIL UNIT KIT

Model B-1U. Will match unbalanced co-axial lines to balanced lines of either 75 or 300Ω impedance. Frequency range 10-80 m., input up to 200 watts.

Kit .. **£5.5.6** Assmbld. .. **£5.18.0**

TAPE PRE-AMPLIFIER KITS Models TA-1M and TA-1S

The Combined Tape Record/Replay Amplifier is available in both monophonic and stereophonic model. Model TA-1M can be modified to the stereo version with modification kit TA-1C.

TA-1M Kit **£19.18.0** Assmbld. **£28.18.0**
TA-1S Kit **£25.10.0** Assmbld. **£35.18.0**
TA-1C Kit .. **£6.15.0**

All prices are mail order and include free delivery in the U.K.

Deferred Terms are available on all orders above £10

AMATEUR TRANSMITTER KIT

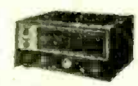
Model DX-100U

The World's most popular Amateur TX Kit

Completely self-contained. 150 w. D.C. input.
Built-in highly stable VFO and all Power Supplies.
The KT88 high-level anode and screen modulator stage gives over 100 watts of audio from less than 1.5 mV input.
Keying on CW is via the VFO and buffer amplifier cathodes; the other RF valves are biased beyond cut-off.
Provision has been made for remote control operation.
Covers all Amateur bands up to 30 Mc/s. 'phone or CW.

Kit .. **£81.10.0** Assembled .. **£106.15.0**

AMATEUR BANDS RECEIVER KIT



Model RA-1 The ideal economically priced fixed station, portable or mobile receiver covering the Amateur bands from 160-10 m., each band separately calibrated on a large illuminated slide-rule dial. Features: Signal strength meter, tuned RF amplifier stage, half-lattice filter, adjustable noise limiter. Freq. coverage 160, 80, 40, 20, 15, 10 metre bands. I.F. 1620 kc/s.

Kit .. **£39.6.6** Assembled .. **£52.10.0**

AMERICAN HEATHKIT SINGLE SIDE BAND EQUIPMENT

Transmitters. Receivers, Transceivers. Send for details of models. Fully illustrated American Catalogue of Heathkit range sent for only 1/- post-paid. Or see selection of models in British catalogue.

REFLECTED POWER METER KIT

Model HM-11U Indicates reliably but inexpensively, whether the R.F. power output of your transmitter is being transferred efficiently to the radiating antenna.

Kit .. **£8.10.0** Assembled **£10.15.0**

VARIABLE FREQUENCY OSCILLATOR KIT. Model VF-1U

Specially designed to meet the demand for the maximum possible flexibility from an amateur Transmitter which would otherwise be subject to certain limitations imposed by crystal control. Calibrated for all Amateur bands 160-10 metres, fundamentals on 160 and 40 m. Ideal for Heathkit DX-40U and similar transmitters.

Kit .. **£10.17.6** Assembled **£15.19.6**

Q MULTIPLIER KIT. Model QPM-1

A reasonably priced Q Amplifier for the amateur and short-wave enthusiast. This self-powered unit (200-250 v. 50/60 c/s.) may be used with communications receivers to provide both additional selectivity and signal rejection.

Models QPM-1 for 470 kc/s. IF. QPM-16 for 1.6 Mc/s. IF.

Kit, either model **£8.10.0**
Assembled **£12.14.0**

AERIAL TOWER KITS. Model HT-1, HT-1G

Height 32ft. sq. section 3ft. × 3ft. at base (no stays required). Accessories available as extras:

HT-1G Kit (galvanised) **£43.15.0**
HT-1 Kit (red oxide) **£37.15.0**

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MANUFACTURERS OF THE WORLD'S LARGEST-SELLING ELECTRONIC KIT-SETS

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Outstanding British Equipment by Heathkit

(All models available as easy-to-build kits or factory assembled).

FM TUNER KIT, Model FM-4U

Tuning range 88-108 Mc/s Flywheel tuning. Attractive perspex front panel in two tone grey with golden trim. Thermometer type tuning indicator, pre-aligned I.F. transformers. Own built-in power supply. Tuning heart model FMT-4U £2/15/- incl. P.T.

I.F. amplifier and power supply, Model FMA-4U. Complete with case and valves £13/13/- Sold separately. **Kit Total £16.8.0.**

STEREO DECODER SD-1

Ideal for use with valve FM Tuners.

Kit .. £8/10/0 Assembled £12.5.0

3+3 W HI-FI STEREO AMPLIFIER Kit Model S-33H

An inexpensive stereo-mono amplifier with the high sensitivity necessary for lightweight miniature ceramic pick-ups (e.g., Decca Deram). De luxe version of the S-33 with attractive two-tone grey Perspex panel.

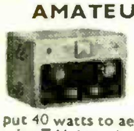
Kit £15.17.6 Assembled £21.7.6

MONO CONTROL UNIT KIT Model UMC-1

Ideal for use with MA-12 or similar amplifier. Output 0.25 v. *Send for full details.*

Kit £9.2.6 Assembled £14.2.6

AMATEUR TRANSMITTER KIT Model DX-40U



Covers all amateur bands from 80 to 10 metres, crystal controlled. Power input 75 watts C.W. 60 watts peak controlled carrier phone. Output 40 watts to aerial. Provision for VFO. Filters minimise T.V. interference. Modulator and power supplies are built-in. Single knob band switching is combined with a pi-network output circuit for complete operating convenience. A high-grade moving-coil meter indicates the final grid or anode current. Provision is made for the use of 3 crystals.

Prices now reduced to:—

Kit .. £29.19.0 Assembled £41.8.0

GENERAL COVERAGE RECEIVER KIT RG-1

An inexpensive communications type receiver specially designed for the short wave listener with many refinements found only in receivers costing much more. Freq. coverage 32 Mc/s.-1.7 Mc/s. in 5 ranges also M.W. band.

Kit .. £39.16.0 Assembled £53.0.0

Optional extras available.

GRIP-DIP METER KIT. Model GD-1U

Functions as oscillator or absorption wavemeter. With plug-in coils for continuous frequency coverage from 1.8 Mc/s. to 230 Mc/s.

Kit £11.9.6 Assembled £14.9.6

Additional Plug-in Coils Model 341-U extend coverage down to 350 kc/s. With dial correlation curves. 17/6.

TRANSISTOR INTERCOM KITS Models XI-1U and XIR-1U

9 v. battery operated. Up to five remote stations can be operated with each Master. The Master unit can call any one, a combination, or all five Remote stations and any Remote station can call the Master.

Model XI-1U (Master)

Kit .. £11.9.6 Assembled £17.9.6

Model XIR-1U (Remote)

Kit .. £4.9.6 Assembled £5.18.0

HI-FI STEREO AMPLIFIER KIT Model S-99

18 w. output (9 per channel with 0.2 per cent. distortion at 9 w. per channel). It has ganged controls Stereo/Mono gram, radio and tape recorder inputs and push-button selection. Ultra-linear push-pull output. P.C. boards. Attractive Perspex front panel with golden surround and grey metal cabinet.

Kit £28.9.6 Assembled £38.9.6

HI-FI SPEAKER SYSTEM KIT Model SSU-1

Ducted-port bass reflex cabinet "in the white." Frequency response is 40-16,000 c/s. Power rating 10 watts Matched speaker units 8in. high flux (12,000 lines) with hyperbolic cone and 4in. wide angle dispersion type for higher frequencies.

Kit (with legs) £12.12.0 (less legs) £11.17.6 (inc. P.T.)

A.M./F.M. TUNER KIT

Tuning range 88-108 M. (FM) 16-50, 200-550, 900-2,000 m. Flywheel tuning. Attractive Perspex front panel in two-tone grey with golden trim. Thermometer type tuning indicator, pre-aligned I.F. transformers. Switched wide and narrow A.M. bandwidths.

TUNING HEART Model AFM-T1 £4/13/6 (inc. P.T.) **I.F. AMPLIFIER and Power Unit Model AFM-1.** Complete with metal cabinet and valves £22/11/6. Sold separately.

Kit Total £27.5.0

ELECTRONIC WORKSHOP KIT EW-1

20 exciting experiments can be made with this one kit.

Kit £7.13.6 (incl. P.T.)

SINE/SQUARE GENERATOR Model IG-82U

Covers 20 c/s-1 Mc/s. in 5 bands. Simultaneous Sine and Square Wave outputs. Less than 0.15μS rise time on Square Wave. Less than 0.5% distortion on Sine wave. Up to 10 volts output. This attractively styled generator is designed for maximum operating convenience. Size 13in. x 8½ x 7in. deep.

Kit £25.15.9 Assembled £37.15.0

OSCILLOSCOPE TRACE DOUBLER KIT Model S-3U

This device will extend the use of your single-beam oscilloscope, and at a nominal cost, will give you the advantages of a double (or other multiple) beam 'scope.

Kit £13.10.0 Assembled £19.10.0

OSCILLOSCOPE ACCESSORY KITS

Demodulation Probe kit 337-C £2.17.6

Low-cap Attenuator Probe kit Pk-1 £3.12.6

See also Oscilloscope page

● Deferred Terms available on all orders above £10.

HI-FI MONO POWER AMPLIFIER KIT Model MA-12

A compact Hi-Fidelity power amplifier (including auxiliary power supply). 12 watts output. Wide frequency range and low distortion. A variable sensitivity control is fitted enabling it to be used with an existing amplifier in a stereophonic system. Other applications includes sound reinforcement systems, transmitter modulators, for use with tape recorders.

Kit £12.18.0 Assembled £16.18.0

"COTSWOLD" SPEAKER SYSTEM KIT

This acoustically designed enclosure measures 26 x 23 x 14½in., and houses a special 12in. base speaker with 2in. speech coil, elliptical middle speaker, together with a pressure unit to cover the full frequency range of 30-20,000 c/s. Its polar-distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, grille cloth, etc. Left in the white for finish to personal taste.

Kit £25.12.0

Also available assembled and finished £33.4.0

4½in. VALVE VOLTMETER KIT Model V-7AU

The world's most popular valve voltmeter with printed circuit and 1 per cent. precision resistors to ensure consistent laboratory performance. It has 7 voltage ranges measuring respectively D.C. volts to 1,500 and A.C. to 1,500 r.m.s. and 4,000 peak to peak. Resistance measurements from 0.1 ohm to 1,000 megohms, with internal battery. D.C. input resistance is 11 megohms and dB measurement has a centre-zero scale. Complete with test prod, leads and standardising battery. Power requirements, 200-250 v. 40-60 c/s. A.C. 10 watts.

H.V. and R.F. Probes available as optional extras.

Kit £13.18.6 Assembled £19.18.6

DECADE RESISTANCE BOX KIT

Model DR-1U. Range 1-99,999Ω in 1Ω Steps. Ceramic switches throughout. Current rating from 500 mA. to 5 mA. according to decades in circuit. Polished wooden cabinet supplied complete.

Kit £10.18.0 Assembled £14.18.0

● Prices include Postage U.K.

DECADE CAPACITOR KIT Model DC-1

Capacity values 100μμF to 0·11μF in 100μμF steps. Precision silver-mica capacitors and minimum loss ceramic wafer switches ensure high accuracy.

Kit £7.15.0 Assembled £10.18.0

TELEVISION ALIGNMENT GENERATOR KIT Model HFW-1

Offers the maximum in performance, flexibility and utility at the lowest possible cost. Several outstanding features have been incorporated in this model which are unusual in instruments in this price range. Frequency coverage 3.6 Mc/s. to 220 Mc/s. on fundamentals. Unique non-mechanical sweep oscillator system. High level output on all ranges. Sweep deviations up to 42 Mc/s. Built-in fixed and variable marker generator (5 Mc/s. crystal supplied).

Kit £38.18.0 Assembled £49.15.0

● Prices quoted are Mail Order Prices; retail prices slightly higher.

DAYSTROM LTD.

DEPT. W.W.1. GLOUCESTER, ENGLAND

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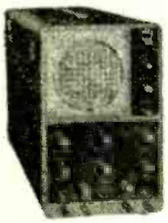
MANUFACTURERS OF THE WORLD'S LARGEST-SELLING ELECTRONIC KIT-SETS

Heathkit World-Leader in

INSTRUMENTS · HI-FI · RADIO · Electronic kits

The construction manual provided with the kit ensures successful assembly



5in. WIDE BAND GENERAL-PURPOSE OSCILLOSCOPE, IO-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 8¾ × 14 × 17in. deep. Net weight 23lb. 56-page construction and operation manual.

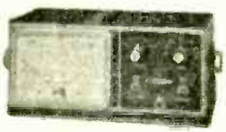
Kit £35.17.6. Assembled £45.15.0

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 Assembled £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$\frac{11}{16}$ × 4⅝in. Complete with test prod and leads.

Kit £18.18.0 Assembled £26.18.0

4½in. Valve Voltmeter-V-7A (not illustrated). Kit £13.18.6. Assembled £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 Assembled £20.8.0

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

Kit £23.15.0. Assembled £31.15.0.

See these and other Heathkit models in the FREE catalogue

NEW! PORTABLE STEREO TAPE RECORDER, STR-1

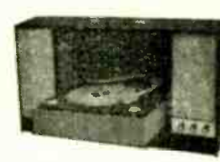
● ½ track stereo or mono record and playback at 7½, 3¾ and 1⅞ i.p.s. ● 18 transistor circuit ● Record level indicator ● Digital counter with zero reset ● Stereo mic and aux. inputs. ● Speaker/headphone outputs. ● Built-in audio amplifier gives 4 watts rms output per channel. ● Two high efficiency 8in. × 5in. speakers.

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

Kit £45.18.0 Assembled £59.15.0

NEW! PORTABLE STEREO RECORD PLAYER, SRP-1

● 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.



Kit £27.15.0 Assembled price on request.

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.

L/speakers and accessories available as extras.

"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 ● 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.

Kit £14.18.0 inc. P.T.

● Prices quoted are Mail Order, and include free delivery in U.K. ● Retail prices slightly higher.

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DEPT. WW.1, GLOUCESTER, ENGLAND

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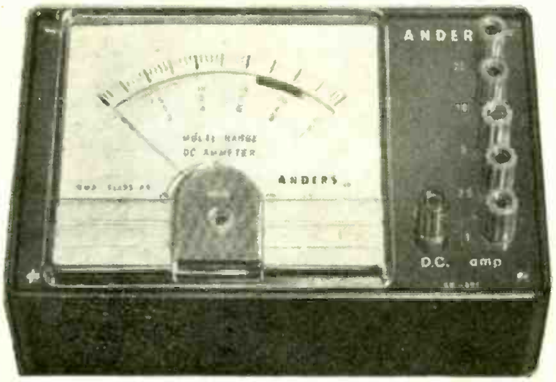
MANUFACTURERS OF THE WORLD-FAMOUS EASY-TO-BUILD ELECTRONIC KITS

WW—029 FOR FURTHER DETAILS

A NEW RANGE OF SINGLE-FUNCTION PORTABLE METERS AT REALISTIC PRICES



Produced, to Anders' specification, by a leading overseas manufacturer. D.C. accuracies within 1.5% F.S.D. A.C. accuracies within 2.5% F.S.D. Mirror scale approx. 3.5" Case dimensions $7\frac{1}{4}$" x $4\frac{1}{4}$" x 3". Dual connection terminals. Supplied complete with robust leads. Models marked with an asterisk have varistor protection against 50% overload.

*SM-301. DC MICROAMMETERS, with range selection by rotary switch.
RANGES: 50, 100, 250, 500 and 1,000 Microamperes. **£9.2.6** *nett*

*SM-311. DC MILLIAMMETERS, with range selection by rotary switch.
RANGES: 1, 5, 10, 25, 100, 250, 500 and 1,000 Milliamperes. **£8.0.0** *nett*

SM-321. DC AMMETER, with range selection by terminals.
RANGES: 1, 2.5, 5, 10 and 25 Amperes. **£8.0.0** *nett*

*SM-331. DC VOLTMETER, with range selection by rotary switch.
RANGES: 1, 2.5, 5, 10, 25, 50, 100, 250, 500 and 1,000 Volts.
SENSITIVITY: 20,000 Ohms per Volt. **£9.15.0** *nett*

*SM-351. AC MILLIAMMETER, with range selection by rotary switch.
RANGES: 5, 25, 100, 250 and 1,000 Milliamperes. **£8.10.0** *nett*

SM-361. AC AMMETER, with range selection by terminals, incorporating Current Transformer.
RANGES: 1, 2.5, 5, 10 and 25 Amperes. **£9.15.0** *nett*

*SM-371. AC VOLTMETER, with range selection by rotary switch.
RANGES: 5, 10, 25, 50, 100, 250, 500 and 1,000 Volts.
SENSITIVITY: 2,000 Ohms per Volt. **£8.15.0** *nett*

ANDERS ELECTRONICS LIMITED · 103 Hampstead Road · London NW1 · Telephone: Euston 1639

WW—030 FOR FURTHER DETAILS

CHASSIS and CASES

by Smith's of EDGWARE ROAD

H. L. SMITH & CO. LTD.

Electronic Components • Audio Equipment

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We shall be pleased to quote for all your component requirements.

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SAME DAY SERVICE

Of over 20 different forms made up to **YOUR SIZE.**
(Maximum length 35in., depth 4in.)

SEND FOR ILLUSTRATED LEAFLETS

or order straight away, working out total area of material required and referring to table below, which is for four-sided chassis in 16 s.w.g. aluminium.

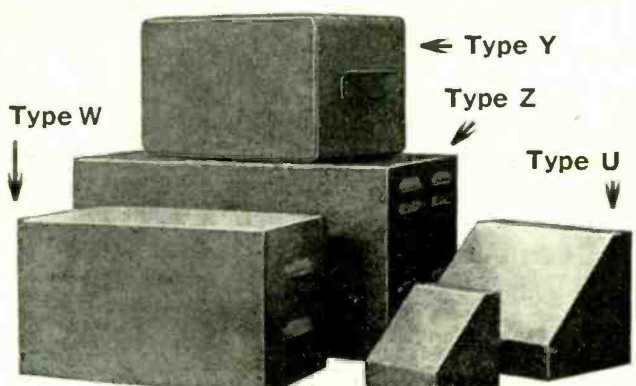
48 sq. in.	**4/6**	176 sq. in.	**9/10**	304 sq. in.	**15/2**
80 sq. in.	**5/10**	208 sq. in.	**11/2**	336 sq. in.	**16/6**
112 sq. in.	**7/2**	240 sq. in.	**12/6**	368 sq. in.	**17/10**
144 sq. in.	**8/6**	272 sq. in	**13/10**	and pro rata.	
P. & P. 2/6.		P. & P. 3/-.		P. & P. 4/6.	

Discounts for quantities. More than 20 sizes kept in stock for callers.

FLANGES ($\frac{1}{4}$in., $\frac{3}{8}$in.), **6d.** per bend.

STRENGTHENED CORNERS 1/- each corner.

PANELS: Any size up to 3ft. at **6/-** sq. ft. 16 s.w.g. (18 s.w.g **5/3**). Plus post and packing.



CASES

ALUMINIUM, SILVER HAMMERED FINISH

Type	Size	Price	Type	Size	Price
U	4 x 4 x 4*	10/-	Y	8 x 6 x 6*	26/6
U	$5\frac{1}{2}$ x $4\frac{1}{2}$ x $4\frac{1}{2}$	15/6	Y	12 x 7 x 7	41/-
U	8 x 6 x 6	21/-	Y	13 x 7 x 9	46/-
U	$9\frac{1}{2}$ x $7\frac{1}{2}$ x $3\frac{1}{2}$	22/-	Y	15 x 9 x 7	48/6
U	15 x 9 x 9	44/6	Z	17 x 10 x 9	66/-
W	8 x 6 x 6	21/-	Z	19 x 10 x $8\frac{1}{2}$	71/-
W	12 x 7 x 7	34/-	*Height		
W	15 x 9 x 8	44/-			

Plus post and packing.

Type U has removable bottom or back, Type W removable front, Type Y all-screwed construction, Type Z removable back and front.

WW—031 FOR FURTHER DETAILS

Pat. 110 mono-bloc connectors with closed entry contacts

FULLY APPROVED TO DEF 5325-5 STANDARD FOR 9, 15, 25, 37 AND 50 WAY CONNECTORS.

These connectors consist of one-piece Diallyl Phthalate moulding with hard gold plated plug pins, socket contacts, and beryllium copper contact clips. Closed entry contact design eliminates the risk of damage to the sockets by test probes. The shells are of passivated cadmium plated steel and the covers and cable clamps are of die-cast aluminium Grade LM6.

ELECTRICAL RATINGS Working voltage: 750 volts DC
Current capacity: 5 amps max per contact

CARR FASTENER CO LTD

the firm with the best connections

Stapleford, Nottingham.
Telephone: Sandiacre 2661.
Sales offices: Wembley,
Birmingham, Sale, Glasgow.

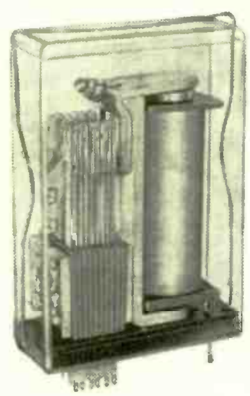
CARR FASTENER
UNITED-CARR GROUP

WW—036 FOR FURTHER DETAILS

FULLY APPROVED RELAYS QUICK DELIVERY

A.D.S. P.O. 3000 SERIES

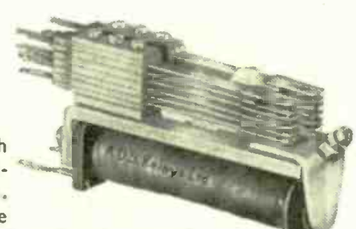
Throughout 30 years' telephone service, and automation refinements, the world's most versatile relay: 1 to 4 coils in limitless permutations from $\frac{1}{2}$ milli-amp to 20 amps (0.1 to 400 volts); fast, slow, and A.C. versions; 1 to 16 contact units (36 springs max.); Standard contacts 0.3 to 1 amp; 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 $1\frac{1}{32}$" x $3\frac{1}{4}$" x $2\frac{1}{2}$" 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.**



A.D.S. P.I. PLUG-IN 3000 TYPE

Plug-in version of 3000 and K3000 series; Coils and contacts to G.P.O./R.C.S. and variations; Standard contact insulation is 250v working; 400/750v also provided; bases available for immediate installations ex stock; Relays changed in seconds avoiding stoppages. Another approved Relay. Approx. dimensions $1\frac{1}{8}$" x 3" x $4\frac{1}{4}$".

A.D.S. P.O. 600 SERIES



Miniaturised 3000 Type with similar, but restricted, specification; requires only $\frac{3}{4}$in. chassis space (twelve in same length as nine 3000 Type): 1 or 2 coils: 1 to 6 contact units (14 springs max.). Approx. dimensions $1\frac{3}{16}$" x $3\frac{5}{8}$" x $1\frac{3}{4}$".

ads RELAYS

A.D.S. RELAYS LTD.

97 ST. JOHN STREET, LONDON, E.C.1.
Telephone: 01-253 3393

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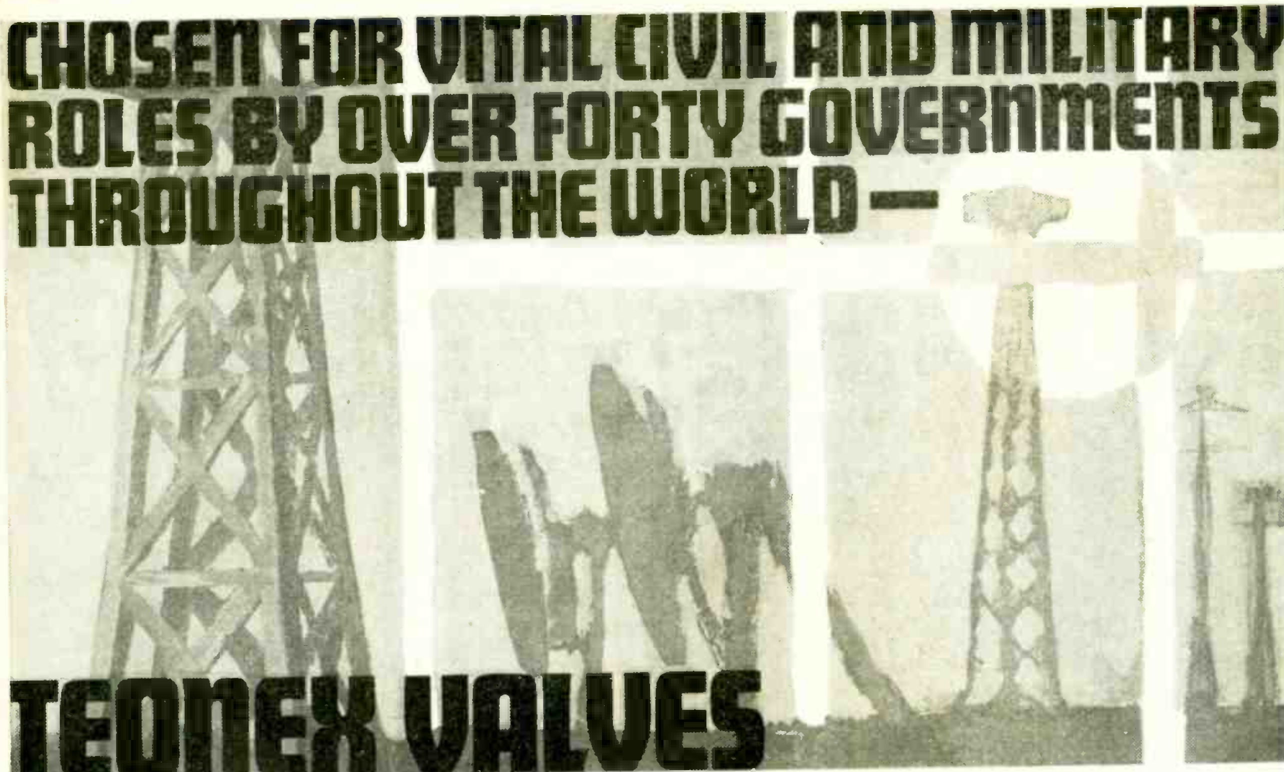
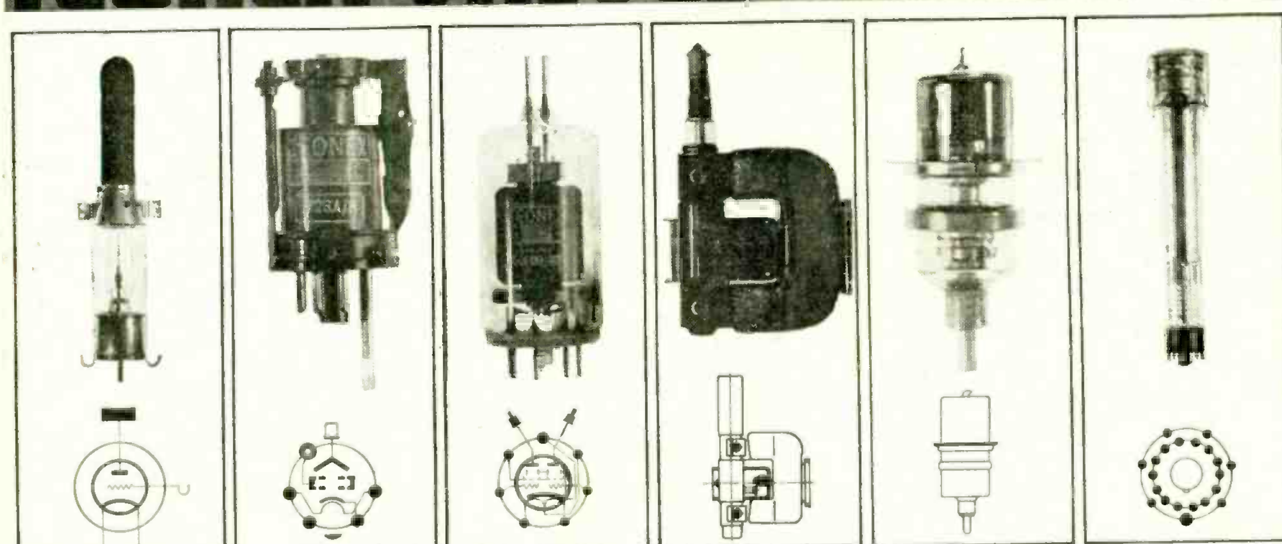




The same safeguards in manufacture and control that have won government contracts for TEONEX in over forty different countries apply equally to ensure top quality for private users too. When you require valves to comply with E.V.S. or M.I.L. standards – choose TEONEX.
The TEONEX range (for use outside the U.K. only) incorporates the entire series of British-produced valves or their Continental equivalents, including a wide range of colour T.V. valves.
Price list and technical specifications may be obtained from:-

Export Enquiries Only Please!

TEONEX LIMITED

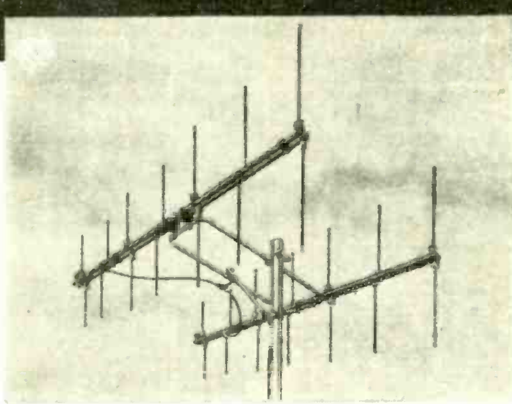
2a, Westbourne Grove Mews,
London, W.11
England.

REGD. TRADE MARK
TEONEX

WW—038 FOR FURTHER DETAILS

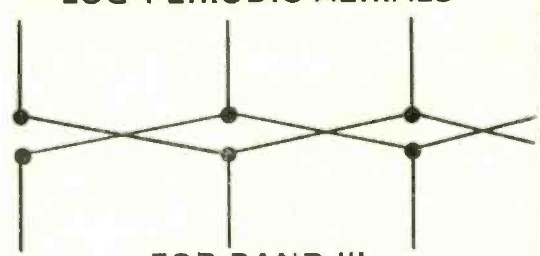
NOW FROM Antiference

IMPROVED RECEPTION AND A VITAL BREAKTHROUGH FOR THE FUTURE



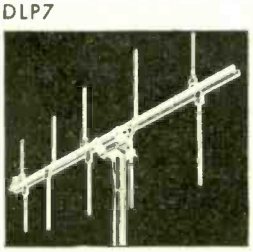
DLP7

LOG-PERIODIC AERIALS

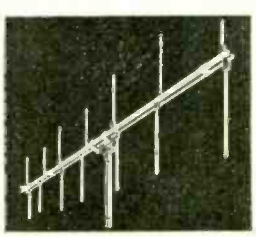


FOR BAND III

Fully covered by: Patent No. 808818 Regd. Des. No. 933070 and others pending.



LP5



LP7

Antiference are first with wide-band tv aerials using the 'log-periodic' principle. Here are aerials with incredibly even response throughout the whole of Band III – not just in respect of forward gain — the front/back ratio, beamwidth and impedance are constant too . . . . *No other aerials have cleaner polar diagrams!* The sophisticated technical design has been cleverly matched by uncomplicated aerial engineering. The transmission line feeding the elements is incorporated in the double boom. Because transmission line theory is an integral part of the log-periodic design these aerials stack more efficiently than Yagi's. No compromise has to be made electrically or mechanically. The result . . . . No present reception problem is too tough for the L.P. . . . . and for the future ? . . . . No matter what changes are made to Band III channels or standards, Antiference log-periodic aerials can cope better than any other. *Naturally L.P's cost a little more than ordinary Band III aerials – but they're worth it! Send for further details.*

Antiference

Antiference Limited Aylesbury Bucks Tel: 2511

Remember 'Antex'... 'Hilo'... 'Trumatch'

WW—041 FOR FURTHER DETAILS

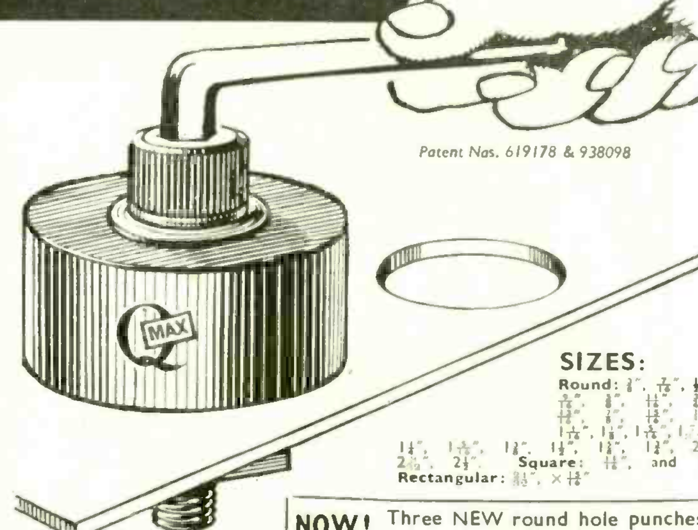
"Q-MAX" sheet metal punches
FOR QUICK AND CLEAN HOLES

- Simple operation
- Quick, clean holes (up to 16 gauge mild steel)
- Saves time and energy
- Burr-free holes—no jagged edges
- Special heat treatment maintains keen cutting edge
- Anti-corrosive finish prevents rusting
- Used all over the world

Used by all government services—Atomic, Military, Naval, Air, G.P.O. and Ministry of Works; Radio Motor and Industrial Manufacturers, Plumbing and Sheet Metal Trades, Garages, etc.

Obtainable from Radio, Electrical and Tool Dealers

WHOLESALE & EXPORT ENQUIRIES ONLY TO



Patent Nos. 619178 & 938098

SIZES:
Round: 3/8", 7/16", 1/2", 9/16", 5/8", 11/16", 3/4", 13/16", 7/8", 15/16", 1", 1 1/16", 1 1/8", 1 3/16", [illegible], 1 1/4", 1 5/16", 1 3/8", 1 1/2", 1 5/8", 1 3/4", 2", [illegible], 2 1/2". Square: 11/16", and 1" Rectangular: [illegible] × 15/16"

NOW! Three NEW round hole punches 2 5/8", 2 3/4", 3"

"Q-MAX" (electronics) LTD. Napier House, High Holborn, London, W.C.1.

WW—042 FOR FURTHER DETAILS

---

multi-range testing... mini style

A pocket size instrument with big performance. Measures A.C. and D.C. volts, D.C. current and resistance. Clear scale, knife edge pointer and tough Melamine cover. The movement is built into a pressed steel case, effectively screened from external magnetic fields.

Look at these features:-

- ☐ D.C. sensitivity 20,000 ohms per volt.
- ☐ A.C. sensitivity 2,000 ohms per volt.
- ☐ Small size, 5 3/8" x 3 3/8" x 2 1/8"
- ☐ Weight 18ozs.
- ☐ D.C. accuracy ± 2 1/2% F.S.D.
- ☐ A.C. accuracy ± 2 1/2% F.S.D.
- ☐ A.C. accuracy maintained up to 20kc/s.
- ☐ 20 ranges.

minitest multi-range test set

50 uA movement 20,000 ohms per volt

for only £7·17·6 (trade price)

Leaflet on request.

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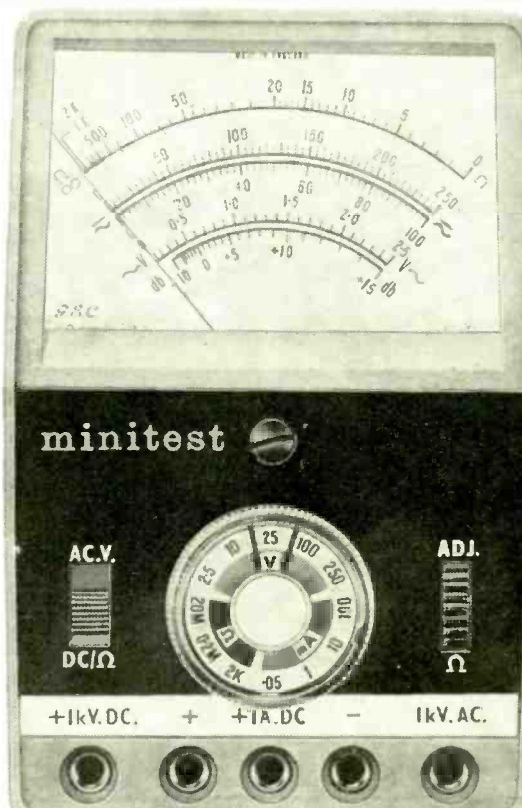
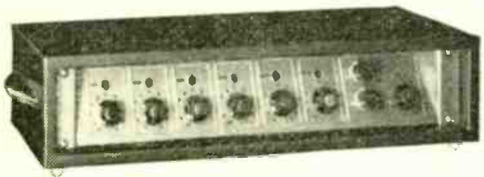
London Sales Office: Brook Green, Hammersmith, W.6. Tel: 01-603 9292
A Subsidiary of the General Electric Co. Ltd. of England.



WW—043 FOR FURTHER DETAILS

Audix SOUND SYSTEMS & ELECTRONICS



MXT/6 Mixer Unit complete with Modules

- HIGH PERFORMANCE
- COMPACT MODULAR CONSTRUCTION
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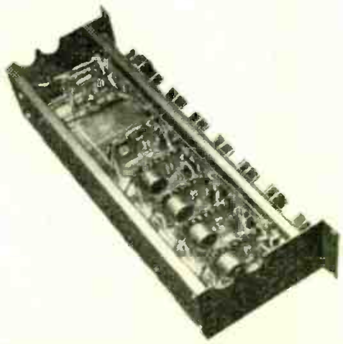
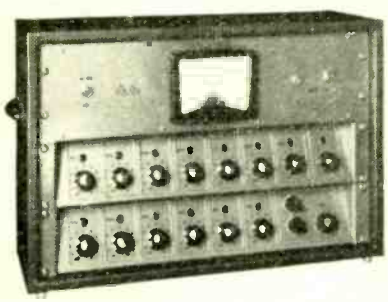


MODULAR AUDIO MIXERS



Assemblies, housing up to fourteen channels with combining amplifier etc., can be supplied for either Rack or Console mounting. Power supplies, v.u. meters can be incorporated to meet individual requirements.

SPECIFICATION

Combining Pre-Amplifier MXT/6. Output Imp. 2K ohms @ 170 mV balanced, or Zero dB @ 600 ohms balanced or floating. Tone Controls: Bass +10dB —8dB @ 100Hz. Treble: +8dB —10dB @ 10kHz.
MIC. Module MU/30. Input Imp. 50 ohms balanced. Frequency response 50Hz-20kHz. Sensitivity: −80 dB. 50Hz-20kHz. Sensitivity: −80 dB.
MIC. Module MU/200. Input Imp. 200 ohms balanced. Frequency response 50Hz-20kHz. Sensitivity: −74 dB.
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GRAM. Module GU/1. Input Imp. 1M ohm. Frequency response 20 Hz-20kHz. Sensitivity: −16 dB.
TAPE Module TU/1. Input Imp. 100 K ohm. Frequency response 20 Hz-20kHz. Sensitivity: −26 dB.
RADIO Module RU/1. Input Imp. 100 K ohm. Frequency response 20 Hz-20kHz. Sensitivity: −10 dB.
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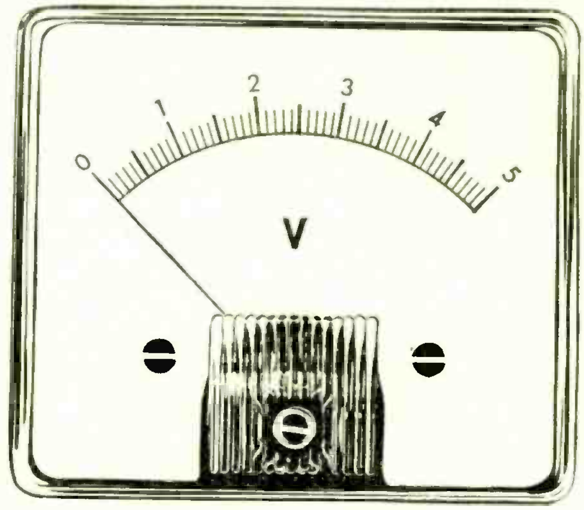

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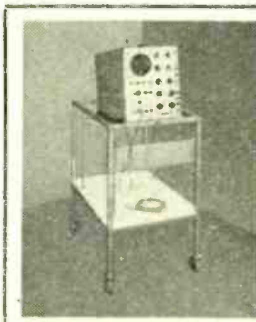

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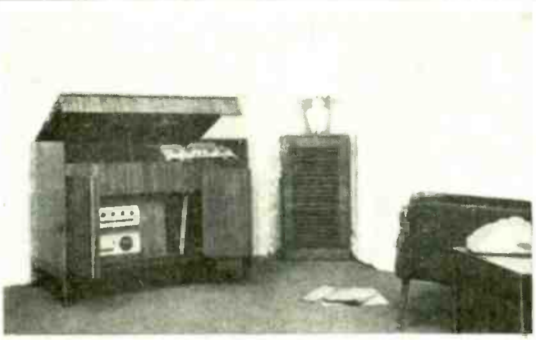

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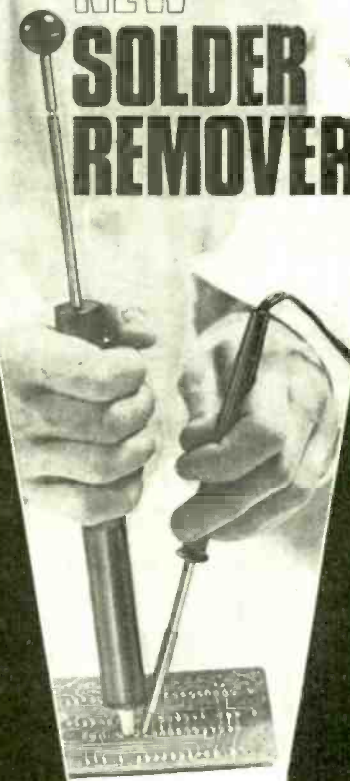

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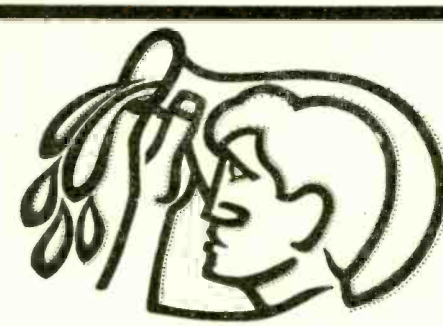

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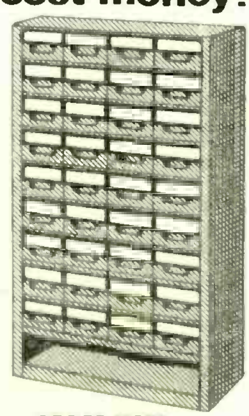

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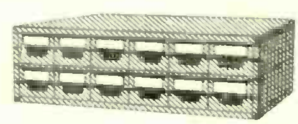

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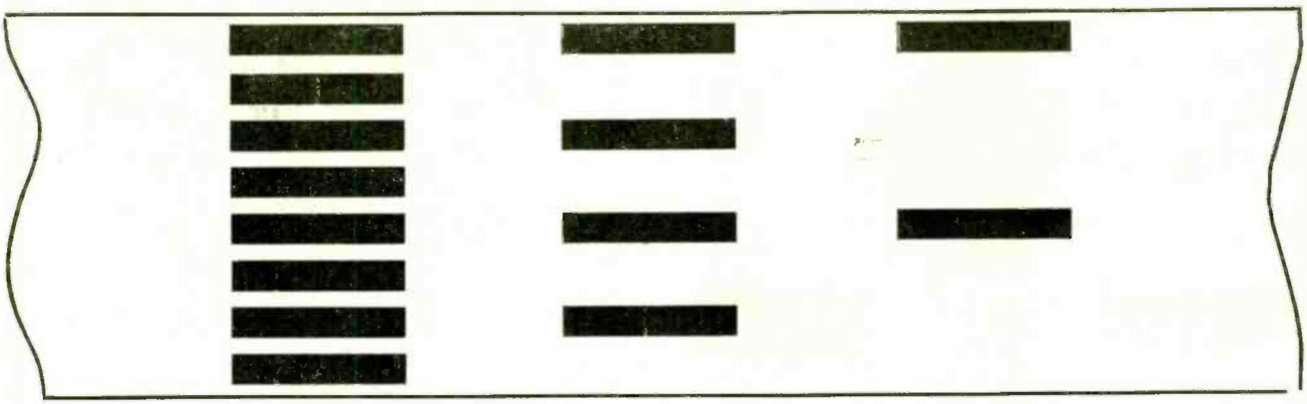
ON 1/4" TAPE



8/8 **4/8** **2/8**

The ever-increasing application of digital techniques to data acquisition has prompted Marriott Magnetics to investigate track density in $\frac{1}{4}$ inch wide magnetic tape. The possibility of using readily available and comparatively cheap tape and tape transport mechanisms opens up new and attractive avenues of approach to many applications which hitherto have been dismissed on cost grounds. This 8/8 head is a valuable newcomer to our standard range which now includes 4/8 and 2/8 in addition to the 4/4—2/4 and 1/4 configuration.

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Marriott Magnetics were the very first company in the world to mass-produce miniature heads, and in 1959 Marriotts scooped the world by mass-producing a four-track head. Well over 5 million heads have been sold since then, and it is the company's firm intention to continue leading the world in the design and manufacture of Magnetic Recording Heads.

RESEARCH AND DEVELOPMENT
Marriott Magnetics' research and development activities are directed towards continuously improving the mechanical and electrical characteristics of their heads through the use of many new ideas, engineering approaches and manufacturing techniques.
Much research and development effort is applied to the development of heads with unique configurations for many special and unusual instrumentation applications. A highly efficient pre-production group works closely with research and development to provide a fast service of prototypes, small quantity production and special heads.

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QUALITY CONTROL
Continuous piece part inspection and evaluation of each Sub-Assembly are the two basic points of Marriott Magnetics' quality control system. Incoming materials and parts are closely inspected to ensure that mechanical and electrical specifications are met. All completed heads are vigorously inspected and performance tested to ensure complete customer satisfaction.

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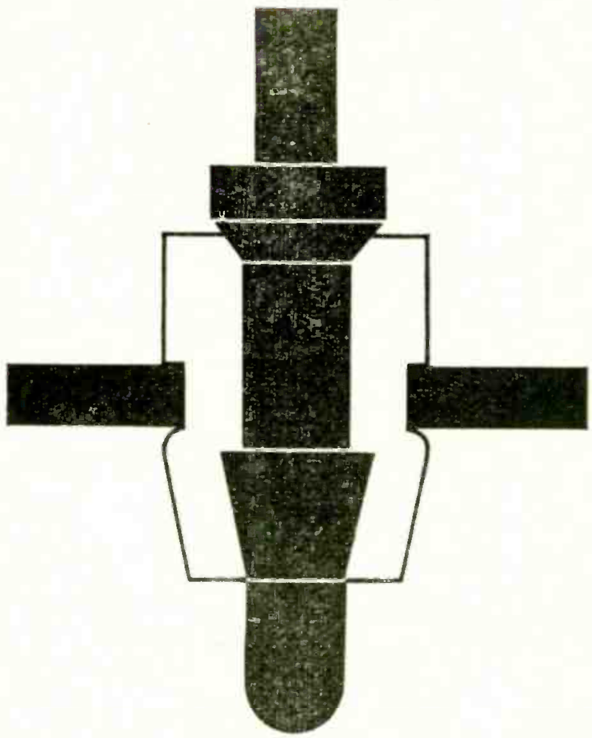
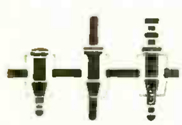
hole in one



OXLEY MINIATURE 'BARB' P.T.F.E. TERMINALS



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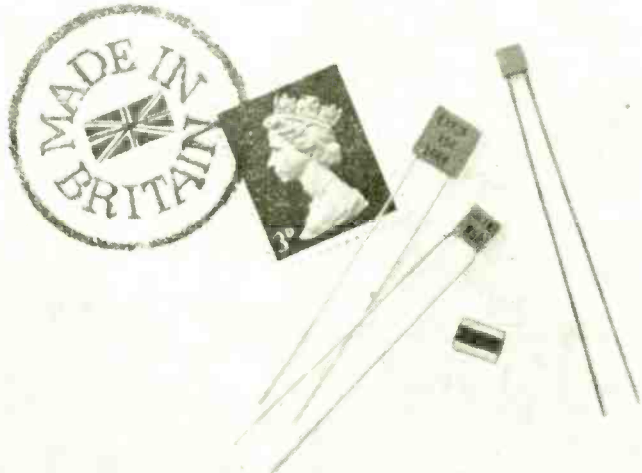

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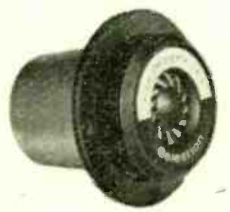
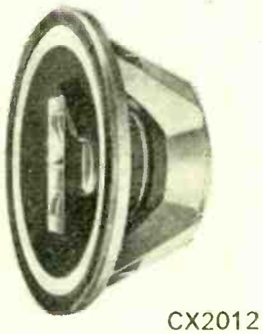
HF1300 Mk. 2





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★Sensitivity 20 m/v R.M.S. for rated output.
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P.A.30

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★5 inputs.
★<0.1% harmonic distortion.
★Signal to noise 60dB.
★Bass +15dB to −15dB at 30c/s.
★Treble ±15dB at 15 k/c.

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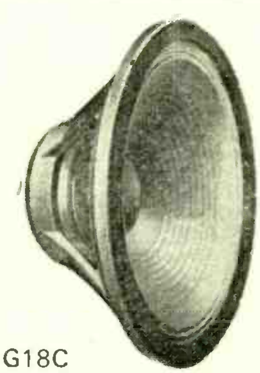

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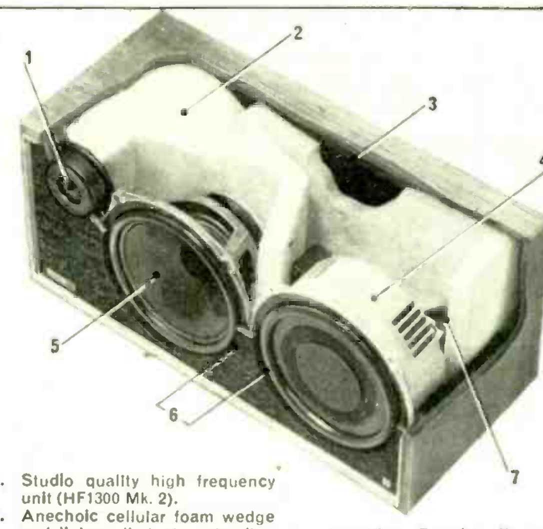

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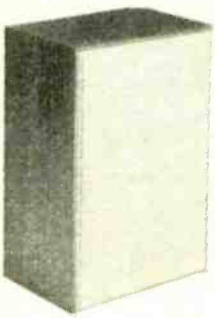

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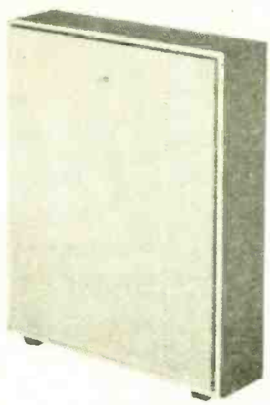
A 19″ × 12½″ × 8½″ completely enclosed acoustically loaded cabinet housing a 9″ graded melamine paper cone with siliconized cambric suspension giving a frequency response of 60Hz to 20KHz.



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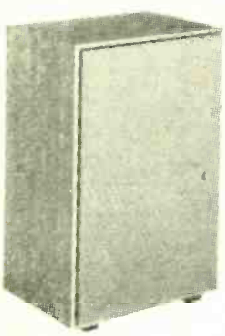

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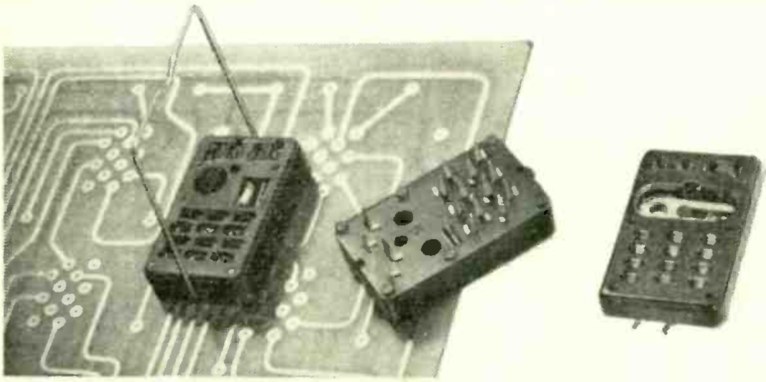

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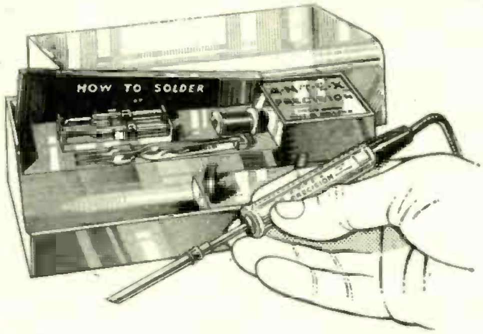

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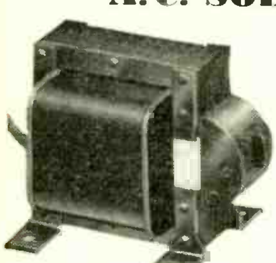

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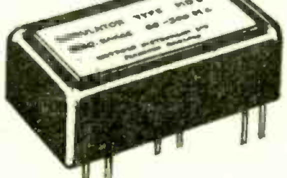

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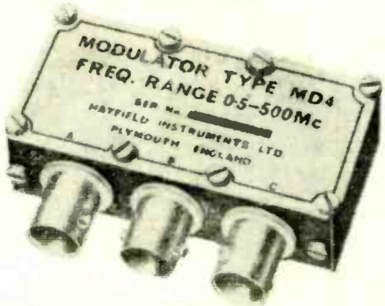
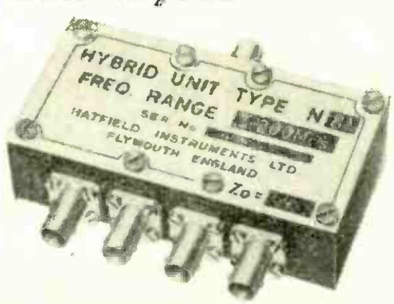


● New styles

3



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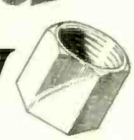

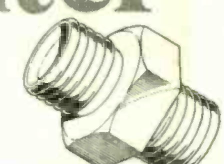

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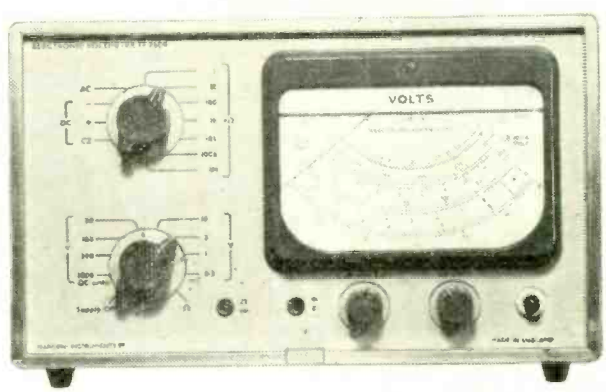

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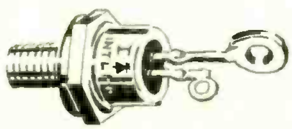

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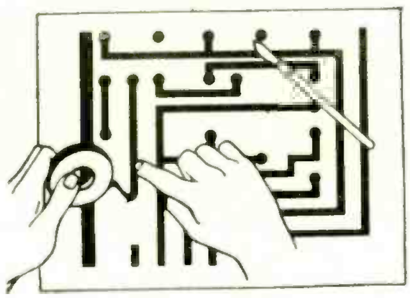

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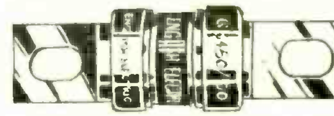

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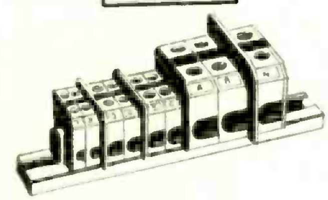

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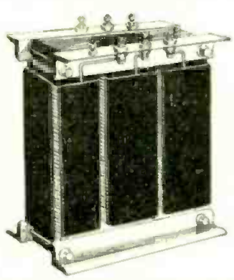

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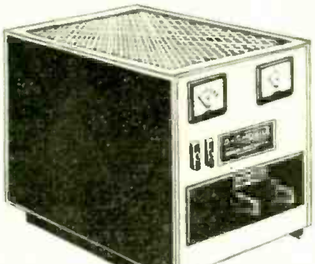

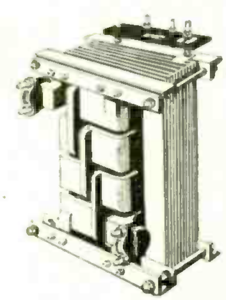

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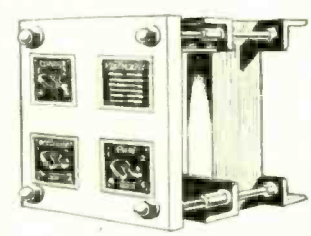

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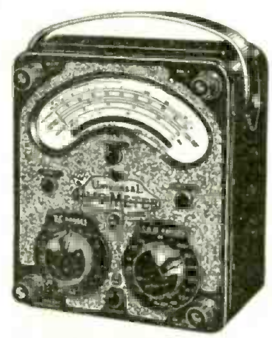

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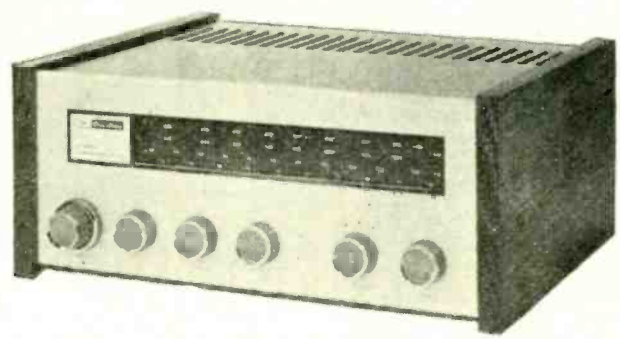

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There are **PROMOTION PROSPECTS** to posts above this level; the Authority's policy is to promote its existing staff whenever possible.

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QUALIFICATIONS—Normally a Higher National Certificate or its equivalent would be required but as excellent residential training courses are provided, young men who have not reached this standard will be considered provided their background and experience is suitable.

If you would like to enter this interesting and developing field of engineering, please apply to :—

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SCIENCE RESEARCH COUNCIL

RADIO AND SPACE RESEARCH STATION

DITTON PARK, SLOUGH, BUCKS.

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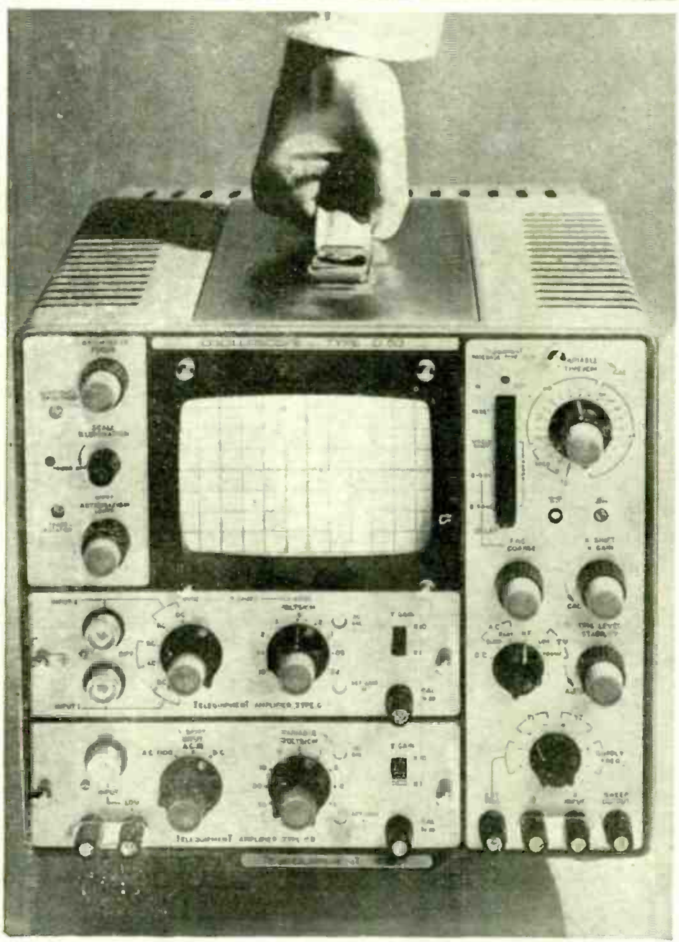
Telephone: SLOUGH 24411.

A LOT OF 'SCOPE FOR £221

WITH 1ST

rectangular double beam mesh CRT
signal and sweep delay
proven 25 Mc/s plug-ins



D53 by Telequipment sets the pace for a new generation of low cost oscilloscopes. By adding this new 'scope to the established S & D43 system, the potentialities of the system have been uplifted. D53 accepts the standard range of amplifiers developed for the Telequipment 43 series plus two additional units types CD & HD which utilise the ·25μ sec. signal delay facilities in the 53.

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Type CD	As type A plus 3 c/s—75 Kc/s, 100 μV/cm.
Type D	Envelope Monitor.
Type G	Differential, DC—10 Mc/s, 20 mV/cm; DC—500 Kc/s, 2 mV/cm.
Type HD	DC—25 Mc/s, 100 mV/cm; DC—5 Mc/s, 10 mV/cm.

D53 anticipates the demands of the electronics industry for a general purpose oscilloscope for years to come.

Prices in U.K. £207-£235, depending on choice of amplifiers.

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FIFTY-SEVENTH YEAR OF PUBLICATION

Wireless World

ELECTRONICS, TELEVISION, RADIO, AUDIO

JANUARY 1968

SHORT ITEMS

REGULAR FEATURES

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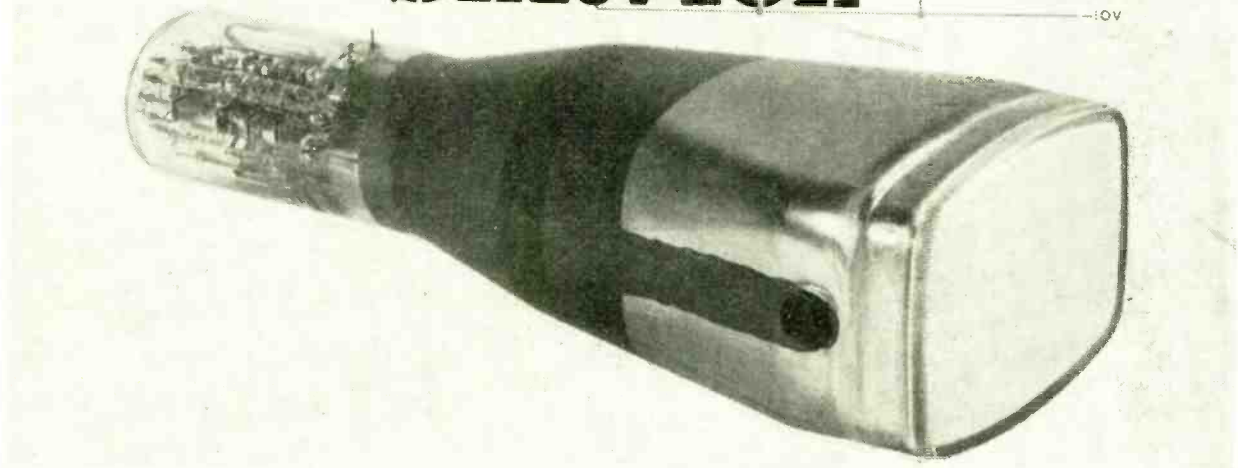
BEHIND EVERY BRIMAR OSCILLOSCOPE TUBE ...AN UNRIVALLED PERSONALISED SERVICE



There's a BRIMAR tube to meet the needs of every oscilloscope designer – ranging from general purpose tubes of medium bandwidth to tubes designed specifically for exacting applications requiring features such as short length, wide bandwidth or dual phosphors. Face plates range from 8½" large displays to 1" types for numerical and indicator presentations including the latest 7 x 5 cm rectangular size.

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Every BRIMAR oscilloscope tube is backed by a first-class technical service and assistance on any type of problem involving it – from special characteristics to circuit design. BRIMAR engineers are always available – contact is on a personal level. Just phone or write.

The BRIMAR D13-51GH is a modern Mesh P.D.A. 6 x 10 cm^2-area tube, which gives improved brightness, higher deflection sensitivities and higher ratios of screen to deflector voltage with no shrinkage of raster area. The D13-51GH displays single phenomena up to 30 MHz bandwidth and is suitable for use with transistorised circuits. It needs fewer control voltages than other mesh tubes. Length is only 13¼".

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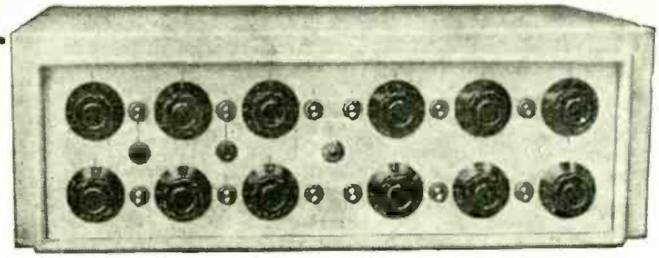
quality equipment

12-WAY ELECTRONIC MIXER



The 12-way electronic mixer has facilities for mixing 12 balanced line microphones. Each of the 12 lines has its own potted mumetal shielded microphone transformer and input valve, each control is hermetically sealed. Muting switches are normally fitted on each channel and the unit is fed from its own mumetal shielded mains transformer and metal rectifier.

FOUR-WAY ELECTRONIC MIXER

This unit provides for 4 independent channels electronically mixed without " spurious break through," microphony hum and background noise have been reduced to a minimum by careful selection of components. The standard 15-50 ohm shielded transformers on each input are arranged for balanced line, and have screened primaries to prevent H.F. transfer when used on long lines.

The standard 5 valve unit consumes only 18.5 watts, H.T. is provided by a selenium rectifier fed by low loss, low field, transformer in screening box. The ventilated case gives negligible temperature rise with this low consumption assuring continuance of low noise figures.

20,000 ohms is the standard output impedance, but the noise pick-up on the output lines is equivalent to approximately 2,000 ohms due to the large amount of negative feedback used.

For any output impedance between 20,000 ohms and infinity half a volt output is available. Special models can be supplied for 600 ohms at equivalent voltage by an additional transformer or 1 milliwatt 600 ohms by additional transformer and valve.

The white engraved front panel permits of temporary pencil notes being made, and these may be easily erased when required. The standard input is balanced line by means of 3 point jack sockets at the front, or to order at the rear.

Mixer for 200-250V AC Mains	**£40 8 6**
Extra for 600 ohm output model	**£1 18 6**
Extra for 600 ohm 1 milliwatt output	**£3 0 6**

Size 18¾in. wide × 11¼in. front to back (excluding plugs) × 6¼in. high.
Weight 22lb.

THREE-WAY MIXER and peak programme meter, for recording and large sound installations etc.

This is similar in dimension to the 4-Way Mixer but has an output meter indicating transient peaks by means of a valve voltmeter with a 1 second time constant in its grid circuit.

The meter is calibrated in dBs, zero dB being 1 milliwatt-600 ohm (.775V) and markings are provided for + 10dB and −26 dB. A switch is provided for checking the calibration. A valve is used for stabilising the gain of this unit. The output is 1 milliwatt on 600 ohms for zero level up to +12 dB maximum. An internal switch connects the output for balance, unbalance, or float. This output is given for an input of 40 microvolts on 15 ohms.

An additional input marked " Ext. Mxr." will accept the output of the 4-Way Mixer converting the unit into a 7-Way controlled unit. This input will also accept the output of a crystal pick-up but no control of volume is available. The standard input is balanced line by means of 3 point jack sockets at rear but alternative 2 point connectors may be obtained to order at the front or rear as desired.

The 8 valves and selenium rectifier draw a total of 25 watts.

P.P.M. for 200-250V AC Mains .. .. Price on application
Size 18¾in. wide × 11¼in. front to back (excluding plugs) × 6¼in. high.
Weight 23lb.

10/15 watt Amplifier with built-in mixers.
30/50 watt Amplifier with built-in mixers.
2 × 5-way stereo mixers with outputs for echo chambers, etc.

Full details and prices on request.

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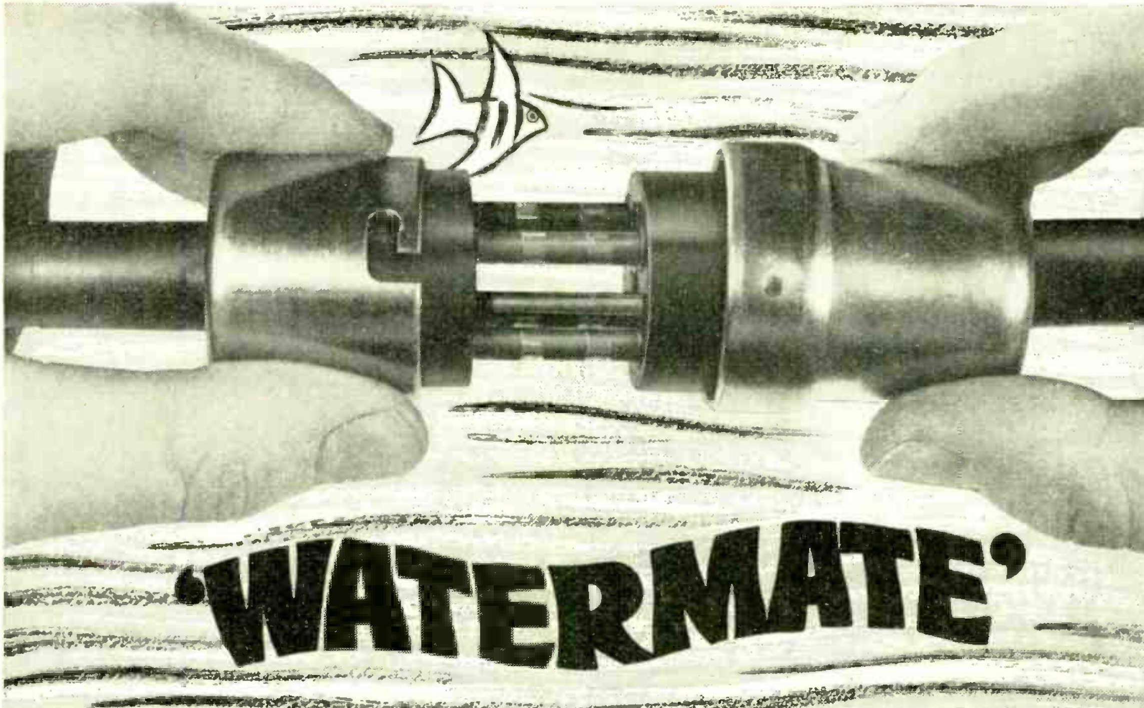

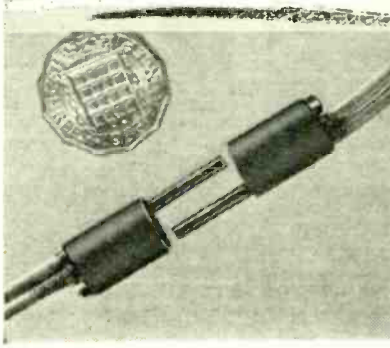

CONNECTORS

Depicted here are typical examples of a range of Waterproof Connectors of unique design enabling electrical circuits to be connected or disconnected even when under water. The range caters for electrical loads of 440 volts a.c. 175 amps. down to the signal current levels associated with instrumentation and similar arrangements.

The basic design incorporates a patented principle referred to as "Watermate". Both plug and socket are moulded of a specially compounded neoprene rubber with unusually high insulation resistance and non-wetting surface. As mating occurs water, salt deposits, sand and other foreign matter are wiped from the sockets and ejected from a duct in the socket to form a leak-proof seal. The wiping action assures a dry connection at the moment of contact resulting in a leakage resistance of not less than 100 megohms WHEN MATED UNDER WATER.

They are pressure balanced and will not block up under high pressures. There are no glands or threads to seize up in water and the method of moulding to the associated neoprene jacketed cable provides an extremely robust and simple connector for both Military and Civil applications.

For full details of these Connectors and a new Underwater Reed Switch Assembly, please write or telephone to the Technical Sales Department.

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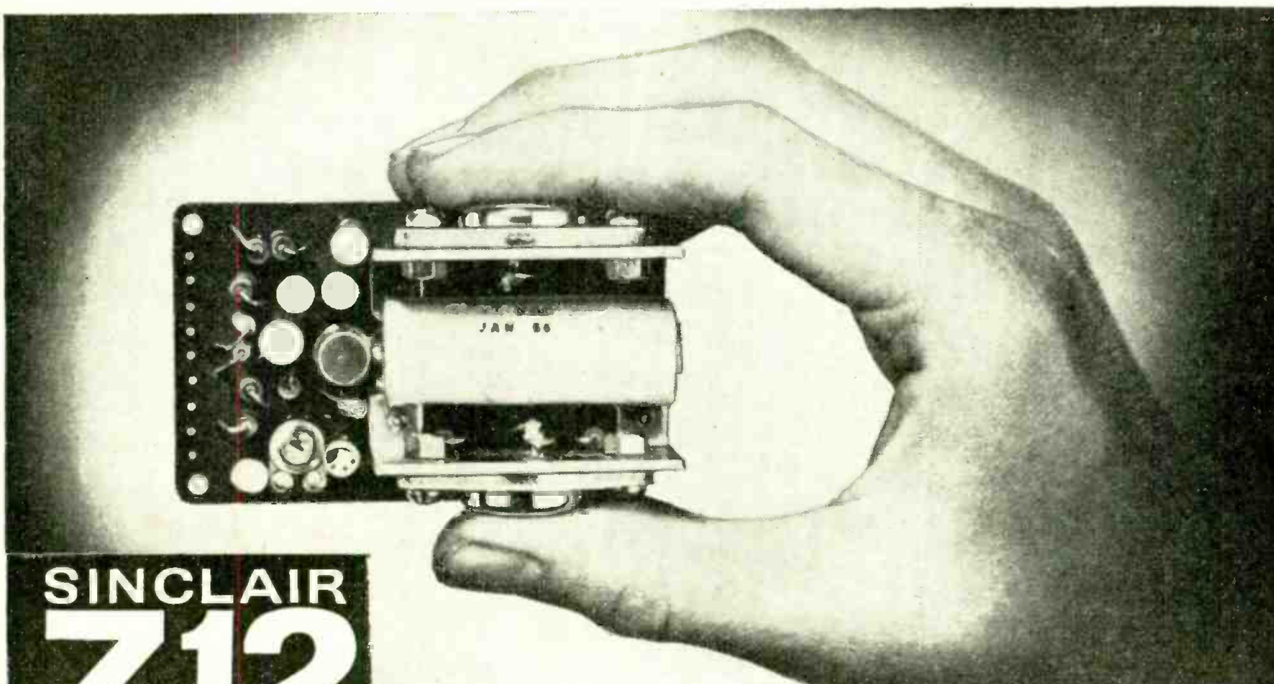


SINCLAIR Z.12

COMBINED 12 WATT HI-FI AMP AND PRE-AMP

Fantastic power & versatility

- 12 Watts R.M.S. continuous sine wave. (24 w. peak.)
- 15 watts music power (30 w. peak.)
- Ultralinear class B output
- Input —2mV into 2 K/ohm
- Output suitable for 15, 7.5 and 3 ohm speakers. Two 3 ohm speakers may be used in parallel
- 15-50,000 c/s ± 1dB
- Ideal for battery operation
- 3" x $1\frac{3}{4}$" x $1\frac{1}{4}$"

BUILT, TESTED AND GUARANTEED

89/6

The Z.12 proves beyond all question that high-fidelity can be combined with very low price. No other integrated amplifier system so successfully meets such a wide range of requirements. The Z.12 will operate from any power supply between 6 and 20 v. D.C. The output is suitable for any impedance between 1.5 and 15 ohms, and consequently for any loudspeaker including, of course, the Sinclair Q.14. This remarkable amplifier has facilities for matching to any types of conventional inputs, details of which are given in the Z.12 manual supplied.

Included amongst popular applications for the Z.12 are mono and stereo high fidelity systems (two are needed for stereo), guitars, electric organs, car radios and P.A. and intercom systems, etc. It is also of great value in experimental work where dependable standards are required.

"All you claim for it"

"The Sinclair Z.12 is all and more that you claim for it. Its performance is outstanding. Thank you for your prompt service."—S/Sgt. R...., B.A.O.R.

"Performance excels that of many systems"

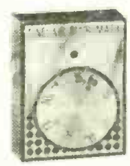
"I have built a stereogram employing 2 Z.12 amplifiers and a PZ.3. I am delighted with the reproduction which is better than some I have heard costing over double the price. It has also silenced some of the old brigade who stubbornly believe that nothing can beat valves." —R.H., Argyll.

A NEW SINCLAIR POWER UNIT

PZ.4. Heavy duty, stabilized power pack to meet requirements of Z.12 assemblies in stereo, etc. Output 18 V.D.C. at 1.5A **99/6**

SINCLAIR STEREO 25 PRE-AMP/CONTROL UNIT

For use with two Z.12s or any hi-fi stereo system. Frequency response 25 c/s to 30 kc/s ± 1dB. Switched inputs for P.U., Radio, Microphone, etc. Equalisation correct to within ± 1 dB on RIAA curve from 50 to 20,000 c/s. $6\frac{1}{4}$in. × $2\frac{1}{4}$in. × $2\frac{1}{4}$in. plus knobs.
BUILT, TESTED AND GUARANTEED £9.19.6



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The world's smallest radio now includes magnetic earpiece, yet costs less.

Prices of the Micromatic have been substantially reduced. Performance has been improved by the inclusion of a new magnetic type earpiece. These two facts mean that still more enthusiasts can enjoy even better performance from this fabulous little set—and it's all British, too. Keep a Micromatic to hand always—it plays anywhere. Size $1\frac{2}{3}$in.x$1\frac{3}{16}$x$\frac{1}{2}$in. *Formerly 59/6 in kit form and 79/6 built and tested.*

KIT NOW 49/6 Built and tested **59/6**

Two mercury cells for Micromatic—each 1/11.

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£5.19.6

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WW—119 FOR FURTHER DETAILS

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Lasky's Radio

TAPE RECORDERS

JUST ARRIVED—FANTAVOX TAPE CASSETTE PLAYER

This machine is the first of its type and is designed specifically to replay pre-recorded tape cassettes made for the PHILIPS and other cassette systems. The cassette is simply slipped into the machine and is immediately ready to play—each cassette gives over 40 minutes' play—(twin track), no loss of time in rewinding—simply turn cassette over. Constant tape speed 1⅞ i.p.s. Only two controls off/play and vol. Fully transistorised, powerful vol., built-in speaker, socket for personal earpiece. Operates on 6 pen-light batts. Very attractively styled shockproof plastic cabinet size 6½ × 4¼ × 2ins. with wrist strap. Complete with earpiece and batteries. There are now over 200 musicassette titles available. JAZZ, POP, SHOWS and CLASSICS—this machine allows you to play the music of your choice anywhere—anytime.

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OUTSTANDING VALUE—THE 'TELETON' 701

7-TRANSISTOR TWO-SPEED CAPSTAN DRIVE MAINS/BATTERY RECORDER

An outstandingly high quality machine that is unparalleled for value. Performance is equal on both mains and battery, excellent music and speech characteristics make this the ideal home or office recorder.

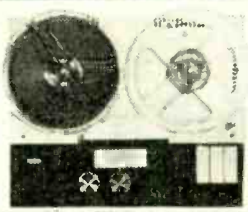
Look at these outstanding features:

● 7 transistor and 3 diode circuit—800mW output. ● Two speed, 1⅞ and 3¾ i.p.s. capstan drive system (wow and flutter better than 0.3% at 3¾ i.p.s.). ● Built-in 110/240 v. A.C. convertor for mains operation or uses 4 × 1.4 v. batteries. ● Takes 5in. spools giving 3 hrs. twin track recording at 1⅞ i.p.s. and 1½ hrs. at 3¾ i.p.s. ● Fast forward and rewind. ● Twin track A.C. bias recording system—frequency response 100 to 7,000 c/s. ● Record level meter (acts as battery check on replay). ● Piano key function controls, plus vol. and tone controls. ● Continental type 5 pin inputs for microphone, telephone adaptor pick-up and direct recording from radio or other recorder; switched input for earphone. ● 2½ × 4½ P.M. Dynamic speaker. ● Plastic cabinet in two-tone grey with chrome metal trim and carrying handle. ● **Accessories**: Dynamic stick microphone with clip-on stand, telephone pick-up, 5in. spool of tape and empty spool, earphone, direct recording lead mains lead with plug, batteries and instruction book with circuit comp. with all accessories. Fully guaranteed.

LASKY'S PRICE £22 Post FREE.

STUDIO DECKS

MAGNAVOX 363 TAPE DECKS



The very latest 3 speed model—1⅞, 3¾, 7½ i.p.s. available with either ½ track or ¼ 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 13¾ × 11 × 5¼in. deep below unit plate. For 200/250 v. A.C. mains, 50 c.p.s. operation. New unused and fully guaranteed.

LASKY'S PRICE ½ track model **£10.10.0**
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Carriage and Packing 7/6 extra

SPECIAL FOR OVERSEAS CUSTOMERS—the new Magnavox-Collaro 363 Deck for 110/125 v. 50 or 60 c.p.s. mains now available, prices as above. Post to any part of the world, 35/-.

NEW MARTIN TAPE RECORD REPLAY AMPS.

Now available from stock—for use with the Magnavox 363 Tape Deck.
½ track model .... **LASKY'S PRICE £14/19/6**
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Optional Extra: Control escutcheon to tape deck and amplifier controls.
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NEW INTERNATIONAL TAPE

FAMOUS AMERICAN MADE BRAND TAPE AT RECORD LOW PRICES

3in.	Message tape, 150ft.	2/6	5¾in.	Long play, 1,200ft. Acetate	12/6
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3in.	Message tape, 300ft.	7/6	5¾in.	Triple play, 2,400ft. Mylar	45/-
3¼in.	Triple play, 600ft. Mylar	10/-	5¾in.	Long play, 1,200ft. Mylar	15/-
4in.	Triple play, 900ft. Mylar	17/6	7in.	Standard play, 1,200ft. Acetate	12/6
5in.	Double play, 1,200ft. Mylar	15/-	7in.	Standard play, 1,200ft. Mylar	12/6
5in.	Long play 900ft. Acetate	10/-	7in.	Long play, 1,800ft. Mylar	19/6
5in.	Standard Play, 600ft. P.V.C.	8/6	7in.	Double play, 2,400ft. Mylar	25/-
5in.	Triple play, 1,800ft. Mylar	35/-	7in.	Long play, 1,800ft. Acetate	15/-
5¾in.	Double play, 1,800ft. Mylar	22/6	7in.	Triple play, 3,600ft. Mylar	50/-

1/- Post extra per reel; 4 reels and over Post Free.

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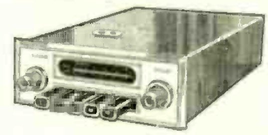
TWO BAND TRANSISTOR CAR RADIO BARGAIN!

MODEL CR-62



A new high-quality imported all-transistor superhet car radio that really breaks the quality/price barrier. Unique features of this set are the four M/W band station pre-selection buttons which you yourself set to your own four favourite stations—this is in addition to full M/W band cover over 150-300 kc/s. (IF frequency 455 kc/s) Externally adjustable aerial trimmers ensure maximum output. Six transistor (including one drift type) and one diode circuit provides powerful 2 W. output. The set is adjustable for use on either pos. or neg. ground 12 v. systems (external line fuse fitted). Standard mounting size 6¾ × 5⅞ × 2in.—front panel ½in. larger all round—finished in anodised aluminium with black push buttons. Complete with mounting brackets, full installation instructions and 2 baffle boards (for round or elliptical speaker). Fully guaranteed.

LASKY'S PRICE £9.19.6 Post 5/-.
6 × 4in. elliptical 8Ω dynamic speaker. 17/6 extra—Post FREE.

SPECIAL OFFER—LOCKING CAR AERIAL

Model 83003 five section 40in. extension heavy chrome telescopic wing mounting type with unique locking device to protect the antenna when closed. Complete with mounting bracket, lead and plug and two "keys."

LASKY'S SPECIAL PRICE 39/6 Post free with the Royal CR-62. Sep. Post 2/6.

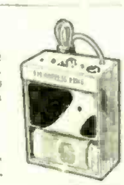
NEW *FOR THE RECORDING ENTHUSIAST* VOICE ACTUATED MICROPHONE

MODEL B 5001

This new voice actuated microphone is designed for use with tape recorders with facilities for remote control. The microphone is fitted with a three position switch allowing normal hand remote control, voice sensitivity action and off. The degree of voice or sound level required to operate the recorder can be adjusted. The microphone is self powered by one 9V (PP3 type) battery giving 6 to 10 hrs. operating time. Super sensitive 6 transistor circuit. Strong black plastic case. Length 7½ ins. Designed for hand-held use or lying flat. Fitted with 2.5 and 3.5 mm. plugs for fitting polarised sockets.

LASKY'S PRICE £6.19.6 Post 3/6.

EXPORT TTC B4002 FM WIRELESS MIC.



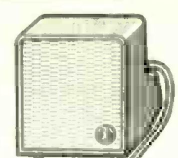
Highly sensitive—suitable for either static or mobile use. Signal can be picked up by any FM radio or tuner which receives frequencies between 96-104 Mc/s. over several hundred yards. Size only 3 × 2½ × 1in. (in leather case). Operates on one PP3 type battery. Complete with neck cord, clip-on dynamic extension mike (½ × ¾ × 5/16 in.) and battery.

LASKY'S EXPORT PRICE £6.19.6 Post Free. Anywhere in the World.

TTC 13/500. More powerful version of above—size 7½ × 1¾ × ⅝in. Operates on the PP3 type battery. **LASKY'S PRICE 12 Gns.** Post Free. Anywhere in the World.

MICROPHONE BARGAIN

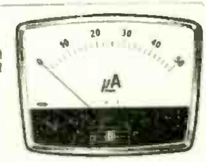
STC MODEL 414



A high quality omni-directional moving coil microphone—suitable for use with sound reinforcement and P.A. systems, tape recorders, transistor amplifiers, etc. Attractive grey moulded case for free standing or hand-held use—size 2¾ × 2¾ × 2¼in. Complete with 6ft. screened cable. New and unused in maker's cartons fully guaranteed.

Type A. Low imp. 200Ω. **LASKY'S PRICE £1/18/6**
Type B. High imp. 50KΩ. **LASKY'S PRICE £2/5/-.**
Post 2/-.

LASKY'S PANEL METERS



Precision made in clear plastic HIOKI of Japan. Each meter boxed and fully guaranteed with all fixing nuts and washers. Sizes are of front panel. Spec. quotes for quantities. Add 1/6 post on each.

TYPE KR-52 3 × 2¼in. (illus.)

1 mA. D.C.	32/6
5 mA. D.C.	32/6
300 V. D.C.	32/6
100µA	47/6
500µA	37/6
1 mA S Meter	39/9

TYPE MK-38A 1½in. square

1 mA DC	22/6
5 mA DC	22/6
300 V. DC	22/6
100µA	29/6
500µA	27/6
1 mA S Meter	29/6

TYPE KR-65 3¾ × 3in.

1 mA DC	36/-
5 mA DC	35/-
300 V DC	35/-
100µA	49/6
500µA	42/6
1 mA S Meter	39/6

TYPE MK-45A 2in. square

1 mA DC	25/-
5 mA DC	25/-
300 V DC	25/-
500µA	25/-
1 mA S Meter	35/-

TYPE MK-65A, 3in. square

1 mA DC	36/-
5 mA DC	35/-
300 V DC	35/-
500µA	39/6
1 mA S Meter	37/6

SINCLAIR SUPER MINIATURES

We stock the complete range. Write for details of package deals.

MICRO-FM (tuner/receiver) kit	£5 19 6
MICROMATIC miniature radio kit	£2 19 6
Fully built and tested	£3 19 6
Q-14 14 watt speaker system	£6 19 6
Z-12 12 watt amp. and pre-amp. fully built	£4 9 6
PZ-3 POWER PACK for Z-12	£3 19 6
STEREO 25 pre-amp. control unit, fully built	£9 19 6

LASKY'S FOR D.I.Y. CONSTRUCTION BARGAINS

P.T.O. FOR MORE NEWS

WW—123 FOR FURTHER DETAILS

Lasky's Radio

CONSTRUCTORS BARGAINS

THE SKYROVER DE LUXE

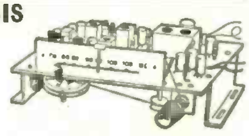
7 transistor plus 2 diode superhet, 6 waveband portable receiver covering the full Medium Waveband and Short Waveband 31-94M and also 4 separate switched band-spread ranges, 13M., 16M., 19M., and 25M., with Band Spread Tuning for accurate Station Selection. The coil pack and tuning heart is factory assembled, 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/- deposit and 11 monthly payments of 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. sep. 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.

TRANSISTOR FM TUNER CHASSIS



Fully tunable—range 88 to 108 Mc/s. Completely wired on printed circuit. 10.3 Mc/s. IF. 6 transistors and 3 diodes. Slow motion tuning drive. Size 6¾ × 4 × 2¼in. Operates from any 9 v. D.C. source. Full data and circuit.

LASKY'S PRICE **£6.10.0** Post 5/- extra.

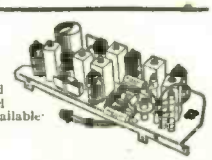
MULTIPLEX ADAPTOR

Now you can enjoy stereo sound with the FM Tuner above. Brief spec.: MPX input sensitivity 100mV. Output 150 mV. Self powered by a 9 v. battery. 4 transistor and 6 diode circuit. Size 5¼in. × 2in. × ¾in. Also suitable for use with other FM tuners with MPX input.

LASKY'S PRICE **99/6** Post 5/6.

PACKAGE PRICE IF BOUGHT TOGETHER £11.11.0. Post 5/-.

TELEVISION IF AMPLIFIERS



Famous Maker's Surplus. 38 Mc/s. Contains a large number of components: IF transformers, resistors, capacitors, etc., and the following valves: 2 × PCF80, 1 × EB91, EF80, EF183 and EF184. Overall size 11¼ × 3¼ × 4in. deep. Ideal for servicemen and experimenters. This IF amplifier when used with the Valve model UFH Tuner provides suitable conversion for B.B.C.2. No circuit available.

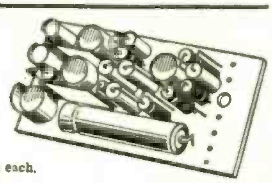
LASKY'S PRICE **29/6** Post and Packing 2/6.

BARGAIN—UHF TV TUNERS

Well known British maker's surplus stocks. Now available for the first time to the Home Constructor. Add 2/6 Post and Packing.

VALVE UHF MODEL. In metal case, size 4 × 6 × 1¼in. Fully tunable—complete with PC86 and PC88 valves. LASKY'S PRICE with valves, 29/6. Without valves 7/6.

LASKY'S MINIATURE TRANSISTOR AMPLIFIER MODULES



Incorporating the very latest circuitry to provide high sensitivity and good quality in conjunction with extremely small size and compactness. High quality Newmarket transistors used throughout. All designed to operate on 9 v. miniature battery. Add 1/- P. & P. on each.

TYPE LRPC 1. 3 transistor. Input sens. 50mV. output 150mW. output imp. 40Ω size 2 × 1 × ¾in. .... PRICE 27/6

TYPE LRPC 4. 5 transistor. Input sens. 150mV., output 330mW., output imp. 15Ω, size 2¼ × 1¼ × ¾in. .... PRICE 18/6

TYPE LRPC 5. 6 transistor. Input sens. 8mV., output 3W., output imp. 3Ω, size 5¼ × 1¾ × 1in. .... PRICE 59/6

LRPC 9. High to Low input matching preamplifier. Input imp. 1 megohm. output imp. 2 k/ohms. Size 1¼ × 1¼ × ¾in. .... PRICE 10/6

LRPC 10. Magnetic tape replay preamp. designed so that a 450 mH head can be matched into any of the audio amp. modules listed above. Size 2¼ × 1¼ × ¾in. .... PRICE 10/6

Note the LRPC 9 and 10 are ideal for use with the LRPC 1, 4 or 5 and are available at the reduced price of 7/6 if bought with the LRPC 4.

FULLY ENCAPSULATED MODULES

Special function modules—all one size 1¼ × 1 × 1¼in. Complete with detailed function and installation instructions. Send S.A.E. for specification sheets.

TYPE PA-1. Public address amp. for use with carbon, crystal or Dynamic microphones. 3Ω output imp. .... LASKY'S PRICE 30/-

TYPE GR-1. Gramophone amp.—provides sufficient power to fill average room. 3Ω output imp. .... LASKY'S PRICE 30/-

TYPE CO-1. Morse code practice oscillator—for use with morse key and 3Ω speaker .... LASKY'S PRICE 20/-

TYPE MT-1. Metronome module—provides audible and visual beat from 30 to 240 beats per minute (for use with 3Ω speaker) .... LASKY'S PRICE 22/6

COMMUNICATION RECEIVERS

NOW AVAILABLE FOR THE FIRST TIME IN GREAT BRITAIN. TWO NEW TRIO RECEIVERS

MODEL 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 1 kHz ● 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 lbs. Fully guaranteed, comp. with instruction manual and service data.

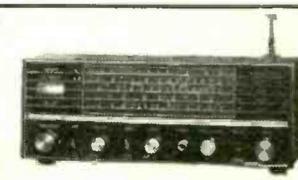
LASKY'S PRICE **£61.19.0** Carriage and Packing 12/6.

MODEL 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 A.C. Mains. Beautifully designed control layout finished in light grey with dark grey case. size: 7 × 15 × 10in. Weight 19 lbs. Fully guaranteed, comp. with instruction manual and service data.

LASKY'S PRICE **£36.15.0** Carriage and Packing 12/6.

FANTAVOX MODEL HE 50



Covers full medium waveband and 1.6-4.5 Mc/s. 4.5-12.0 Mc/s. and 11.0-30.0 Mc/s. in separate switched band spread ranges. Two aerials are fitted an internal loop and external telescopic. Controls include: B.F.O. Sensitivity. C.W.A.N.L. receiver/stand-by. S meter. Easy to read illuminated dial with logging scale. For 200/250 v. A.C. 4 valve plus rectifier. Fitted with internal speaker and socket for phones or external speaker. Cabinet size 13¼ × 8¼ × 5¼in. Complete with full instruction manual.

LASKY'S PRICE **£16.16.0** H.P. Terms available. Post 10/-.

NOW AVAILABLE—JOYSTICK AERIALS

Revolutionary Variable Frequency Antenna for transmission and reception, with a variable matching unit these antenna perform as a high "Q" device at any selected Medium or Short waveband. Send S.A.E. for descriptive leaflet.

VFA Standard	£4/15/-	Matching units	A.T.V. 3A	£3/12/6	
VFA De Luxe	£5/19/6		A.T.V. 4	£4/4/-	Send S.A.E. for
			A.T.V. 4/RF	£6/6/-	full information.

DEMONSTRATION STUDIOS

Lasky's High Fidelity Sound Centres

42 Tottenham Court Road, W.1 and 118 Edgware Road, W.2 are London's most comprehensive High Fidelity Sound Centres, designed to provide a real "Home-from-Home" for the discerning Hi-Fi Enthusiast. There you can see, hear and compare any combination of the finest quality equipment; our experienced staff are on hand to help you plan a complete system and to select the equipment most suitable to your requirements. In addition we are often able to offer considerable cash savings when you choose a complete system.

If you cannot call at any of our branches please send details of your requirements to our head office and we shall be pleased to quote without obligation. We operate the "Purchase Tax Free" scheme for overseas visitors. Full H.P. terms available.

PACKAGE DEALS

A Lasky's "Package Deal" allows you to purchase the complete Audio System of your choice at a worthwhile cash saving. We shall be pleased to quote our "Package Deal" price for any selection of equipment of your own choice. Send us details of your requirements. H.P. and Easy Credit Terms can be arranged on "Package Deals."

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207 EDGWARE ROAD, LONDON, W.2 Tel.: 01-723 3271
Open all day Saturday, early closing 1 p.m. Thursday

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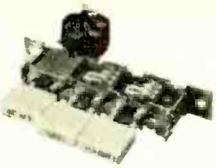
Open all day Saturday, early closing 1 p.m. Thursday

ALL MAIL ORDERS AND CORRESPONDENCE TO: 3-15 CAVELL ST., TOWER HAMLETS, LONDON, E.1 Tel.: 01-790 4821

3-PUSH SWITCH



for test meter, hi-fi amp., etc. 1st button operates mains on/off switch, the other two operate change-over switches. Knobs engraved On/Off, Bass, Treble, but engraving easily removed leaving clean surface for remarking. **2/9** each. **34/-** doz.

SATCHWELL OVEN THERMOSTATS

Type TO. With capillary tube and sensor, 20 amp. A.C. type and as fitted to many cookers. Adjustable by control knob (not supplied). **12/6** each.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (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.

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.—15-20w. **19/6**. Kit B—30-40w. **17/6**. Kit C—80w. **17/6**. Kit D—125w. **22/-**. Kit E—65w. **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.

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.

G.E.C. 13 AMP. SWITCHED SOCKETS

An excellent opportunity to re-equip your house or workshop, or if you are a contractor to restock for future ring main jobs. We offer 12 GEC switch sockets, Brown Bakelite surface mounting. Latest ring main type listed at **6/6** each. You can have a box of 12 for **30/-** only—thus showing a saving of **£2/8/-**. Postage and insurance 4/6 extra.

THERMOSTATS

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouse, airing cupboard. Has a spindle for pointer knob quickly adjustable from 30-80°F., **9/6**, plus 1/- post. Suitable box for wall mounting, 5/-. P. & P. 1/-

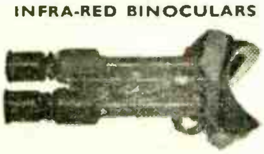
Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal screw alters the setting so this could be adjustable over 30° to 1,000°F. Suitable for controlling furnace, oven kiln, immersion heater or to make flame-start or fire alarm. **8/6**, plus 2/6 post and insurance.

Type "D" We call this the Ice-stat as it cuts in and out at 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.

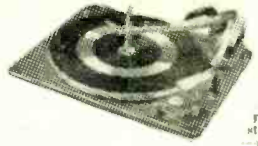
Type "E" This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperatures. **7/6**, plus 1/- post.

Type "F." Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is 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.

See in the Dark INFRA-RED BINOCULARS



These infra-red binoculars when fed from a high voltage source will enable objects to be seen in the dark, provided the objects are in the rays of an infra-red beam. Each eye tube contains a complete optical lens system as well as the infra-red cell. These optical systems can be used as lenses for T.V. cameras—light cells, etc. (details supplied). The binoculars form part of the Army night driving (Tabby equipment). They are unused and believed to be in good working order but sold without a guarantee. Price **£3/17/6**, plus 10/- carr. and ins. Handbook 2/6.



GARRARD AUTO RECORD PLAYER Model 2000

This is one of the latest products of the World's most experienced maker of fine record reproducers. Its superior features include automatic playing of up to 8 mixed size records—stopping and starting without rejecting—manual playing—pick-up pivots to give low stylus pressure—large diameter turntable for max. stability adjustments include pick-up height—pick-up dropping position and stylus pressure. Size is 13¼ x 11¾in., clearance 4¾in. above, 2¼in. below—fitted with latest hi-compliance cartridge for stereo—and mono, L.P. and 78. Supplied complete with mounting template and service sheet. Offered this month at the Special Snip price of **£6/19/6** plus 7/6 carriage and insurance.

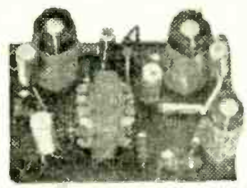
ADMIRALTY MOTOR ALTERNATOR

Admiralty motor alternator giving regulated 230v. 50 cycle output from 24v. DC supply. Wonderfully made to stringent specification. Rating is 80watts but like other Admiralty equipment this rating can be increased 50% with safety. In grey metal box size 24 x 10 x 14in. approximately. Controls are DC, on/off switch and changeover switch from mains to alternator. On the front panel also is output voltmeter and panel with fuses protecting input and output. Weight approximately 100lb., unused. Price **£37/10/-** each (probably one-tenth of cost to Government). Carriage extra at cost.

DRILL CONTROLLER

Electronically changes sped from approximately 10 revs. to maximum. Full power at all speeds by fingertip control. Kit includes all parts, case, everything and full instructions. **19/6**, plus 2/6 post and insurance. Or available made up **32/6**.

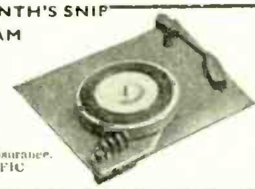
750mW TRANSISTOR AMPLIFIER



4 transistors including two in push-pull input for crystal or magnetic microphone or pick-up—feed-back loops—sensitivity 5mV. Price **19/6**. Post and insurance 2/6. Speakers 3in. **12/6**. 5in. **13/6**. 6 x 4in. **14/6**.

THIS MONTH'S SNIP

THE "TECHNICAL" GRAM MOTOR



4 speed, gram. motor with light-weight pick-up, motor electronically balanced and free from wow and flutter. Speed change by push button—16, 33, 45, 78 r.p.m. Price **39/6**. Cartridge extra, mono 10/6, stereo 15/- plus 4/6 post and insurance. DON'T MISS THIS TERRIFIC BARGAIN.

DOOR INTERCOM

Know who is calling and speak to them without leaving bed, or chair. Outfit comprises microphone, with call push-button, connectors and master intercom. Simply plugs together. Originally sold at £10. Special snip price **99/6** 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 4/5volts. 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.

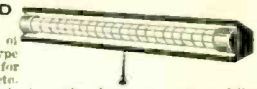
TUBULAR HEATERS

New and unused, made by G.E.C.—rated at 60 watts per ft.—these are ideal in airing cupboards, bedrooms, offices, stores, greenhouses, etc., curtains or paper can touch them without fear of scorching or fire. Supplied complete with fixing brackets and available in the following sizes.
8ft. **30/-**, 10ft. **36/-**, 12ft. **42/-**.
Prices which are about ⅓ of list price includes carriage by B.R.S.

'PILOT' CAPSTAN DRIVEN TAPE RECORDER

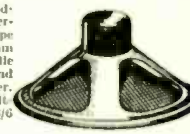
Capstan Driven, 4 Transistors
SPECIFICATION: 200/7,000 c.p.s.—400 mW. output—double track—twin speed (3¾ and 7½) fast rewind time—5in. spool gives one hour playing with standard tape. Complete with batteries, microphone—tape spool and instruction manual. Nothing to go wrong if you use a good tape and keep heads clean. Demonstration gladly given at our Croydon shop. Special Snip Price. This Month **£9/19/6** post and insurance 6/6.

INFRA-RED HEATERS



Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follw instructions—uses silica enclosed elements designed for the correct Infra-red wave length (3 microns). Price for 750 watts element, all parts, metal casing as illustrated, **19/6**, plus 3/6 post and insurance. Pull switch 3/- extra.

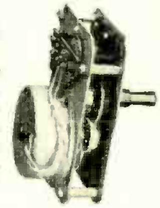
HI-FI SPEAKER BARGAIN



12in. High fidelity loudspeaker. High flux permanent magnet type with either 3 or 15 ohm speech coil. Will handle up to 10 watts. Brand new by famous maker. Price **29/6**. With built in Tweeter **35/-**, plus 3/6 post and insurance.

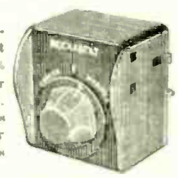
GEARED MOTOR

HALF REV. PER MINUTE



Made by famous Smith Electric, mains operated and quite powerful. Size 3¼ x 2¼ x 1¼in. deep. Secondary use as process timer. Internal switch can be made to break circuit within a period up to 2 mins. **17/6**. P. & P. 2/6 unless ordered with other goods.

BECKASTAT



An Instant Thermostat. Simply push it into 15A wall socket and plug your fire or other appliance into it. Knob setting. Will save its cost in a season. Normally £3. We offer at **19/6**, plus 2/- post.

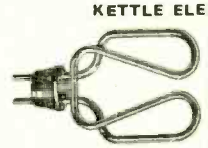
PHOTO-ELECTRIC KIT

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.

Multi Purpose Neon Test Unit

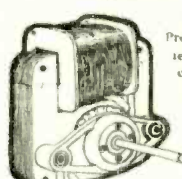
Robust, useful and instructive—tests insulation—capacity—continuity—resistor—volume controls—also acts as signal injector and L.T. fault finder—kit comprises neon indicator—4-way wafer switch—ebonite tubes—resistors-condensers—terminals, etc. with diagram only **9/6**, plus 2/- post and insurance.

KETTLE ELEMENT



Made by famous "Best" company, suitable for most kettles. 1¼in. dia. hole. 1,500 watts. 230/250v. Normally 30/- each. Our Price **15/-** each, plus 2/6 p. & p.

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.

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.

Where 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.

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***

IMMEDIATE DESPATCH
FULL SPARES AND SERVICE AVAILABLE

20 Amp. LT. SUPPLY UNIT

As supplied to Min. of Defence and Crown Agents for overseas Govt.

LATEST DESIGN HEAVY DUTY 12/24 VOLT D.C.

Output: Adjustable up to **20** AMPS. **CONTINUOUS** at 12/24 volts. **FULLY FUSED,** Neon indicator, 0-20 amp. meter. Size 16 × 12 × 20in high, in heavy gauge steel cabinet. Grey Hammer finish—Weight 50 lbs. Input: 220/230/240 v. A.C. 50 cycles.

ONLY **£32.10.0** Plus 40/- C. & P. G.B. (Inland)

30 Amp. LT. SUPPLY UNIT

UP TO 18 v. D.C. WITH SMOOTH STEPLESS VARIATION
Designed for CONTINUOUS use at max. loading

★ Fitted voltmeter and ammeter. ★ Instantaneous overload cut-out. Input: Mains A.C. Robust construction, 2 tone finish, steel case.

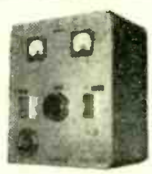
£55.0.0 C. & P. 40/-. G.B. (Inland).
Entirely suitable for plating plants, Laboratory supplies, etc.

5 AMP. A.C. & D.C. VARIABLE SUPPLY UNIT

Specification: Output: 0-260 v. A.C. 0-240 v. D.C.

- ★ Smooth stepless voltage variation from 0-Max.
- ★ Current consistent throughout the controlled range.
- ★ Ammeter and voltmeter fitted, and neon indicator.
- ★ Fully fused input and output.

Strong steel case, with carrying handle and rubber feet. 11 × 7 × 14in. high. Made In England.



£30.0.0 C. & P. 40/-. Gt. Britain (Inland).

CURRENT PRODUCTION — BUY DIRECT FROM MANUFACTURER

VARIABLE VOLTAGE TRANSFORMERS

Modern styling for modern equipment

'SLIDE-TRANS' & 'SLIDUP' MODELS

Fully rated current consistent at all points along the winding

AVAILABLE ONLY FROM I.M.O.

- ★ SMOOTH CONTINUOUS ADJUSTMENT
- ★ ALL MODELS SHROUDED FOR SAFETY (IDEAL FOR EDUCATIONAL AUTHORITIES)
- ★ BENCH OR PANEL MOUNTING
- ★ UP TO 260v. AVAILABLE FROM ALL MODELS

All models 230v. A.C. 50/60 c.p.s. input

1 Amp.	£4 . 10 . 0
2.5 Amp.	£5 . 17 . 6
5 Amp.	£9 . 0 . 0
8 Amp.	£13 . 10 . 0
10 Amp.	£18 . 5 . 0
12 Amp.	£19 . 10 . 0
20 Amp.	£32 . 10 . 0

C. & P. EXTRA

TRANSISTORISED MEGOHMMETER

★ PUSH BUTTON TO READ

500 v. - 1,000 Megohms. Superb, portable instrument. Supplied c/w batteries, probes and carrying case.

ONLY **£25.0.0** C. & P. 7/6.

36 FT. AERIAL MAST

NEW LATEST PATTERN TUBULAR MAST

Check these vital points:

- ★ Made from 6 × 1¾in. Sheradized steel sections, for durability and strength.
- ★ Extra strong locating base.
- ★ Top cap fitted with pulley and halyard.
- ★ 2 sets (8) Rotproof Guys.
- ★ Rustproofed Steel Picketing Stakes.

ONLY **£15.0.0** ex works

Carr. 20/-. Returnable wood case 30/-.

PORTABLE VARIABLE A.C. POWER SUPPLY UNIT

Designed for engineers whose requirements call for a visual indication of volts applied.

OUTPUT: 0-260 v. 1½ amps.

INPUT: 230 v. A.C. 50/60 c.p.s. Fitted with fuse, voltmeter, safety indicator on-off switch and lead. Size 8 × 5 × 5in. high.

PRICE **£8.17.6** C. & P. 12/6

CONSTANT VOLTAGE TRANSFORMERS

BEAT WINTER!

AUTOMATIC MAINS STABILISER

ONCE AGAIN WE CAN EXPECT THE USUAL VOLTAGE DROPS DUE TO THE COLD WEATHER

- ★ No attention
- ★ No Maintenance
- ★ No Moving Parts
- ★ Corrected Wave

Input: 190-250 v. A.C. **Output:** 240 v. A.C. **Accuracy:** ±1%. **Capacity:** 250 watts. Maintain "spot-on" test-gear readings at all times. **Weight:** 21 lb. Fitted signal lamp and switch. **Size:** 11 × 6½ × 6in. high.

£12 . 10 . 0 C. & P. 20/-

LATEST SOLID STATE VARIABLE VOLTAGE CONTROLS

- ★ COMPLETELY SEALED
- ★ COMPACT AND COMPLETE
- ★ PANEL MOUNTING

230 A.C. Input 25-230 volts output
5 amp. model £8
10 amp model £13/5/-

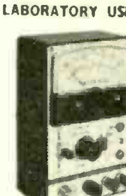
PORTABLE TRANSISTOR TESTER

SUITABLE FOR PRODUCTION & LABORATORY USE

SPECIFICATION:
Alpha 0.7 to 0.997
Beta 5-300
ICO 0-50μA. 5mA.

Capable of measuring GERMANIUM AND SILICON DIODES.

DESIGNED WITH RESISTANCE SCALE 200 ohms to 1 Megohm as an ADDED FEATURE. Housed in heavy duty plastic case, c/w internal battery.



Only **£6.19.6** Plus 7/6 C. & P.

I·M·O (ELECTRONICS) LTD. (Dept. W.W.7), 313 Edgware Road, London, W.2. 01-723 2233/4

RECEPTION SETS R220/R220
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 21¼ × 12¼ × 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/-.

POWER UNIT TYPE 24 FOR R.216 RECEIVER. A.C. operated 100-125 or 200-250 volts 50 c/s. BRAND NEW AND BOXED. **£9 19/6.** Carr. 10/6.

FILTER VARIABLE BAND PASS No. 1. Dual channel unit, each channel has variable slot frequency of 500-900 c/s., 1,200-1,600 c/s., and band pass facility. 600 ohms input and output, monitor input and high impedance output jacks. Standard rack mounting 3½in. deep panel. Mains operation 200/250 v. 50 c/s. BRAND NEW. **£5/19/6.** Carr. 10/-.

HRO TUNING METER. 0-1 ma. New and boxed 25/-. Post 2/-.

BC221
FREQUENCY METER 125 Kc/s. to 20 Mc/s.
This crystal controlled heterodyne frequency meter is too well-known to need further description. Those we offer are complete with correct individual calibration book and are carefully tested and guaranteed. New condition. **£30**

Laboratory Standard

Also some less calibration book, in working order. **£9/19/6.** Carr. 10/-.

V.H.F. SIGNAL GENERATOR
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.

BEAT FREQUENCY OSCILLATORS
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.

DISTORTION FACTOR METER
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. **£20.** 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.

AR-88 SPARES

Knobs, Medium size, Set of 8	10/-
Knobs, Large size	5/6
Condenser (3 × 4 mfd.). Post 4/6 ..	12/6
Mains Trans. (L.F.) (postage 9/-)	42/6

MINIATURE RELAYS
240 v. A.C. coils. Contact assembly 2 "makes" and 1 C.O. 5 amps. Size 2 × 1½ × 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.**

CRT Type 89D as used in the Cossor 1035 Oscilloscope. Brand New 59/6. P. & P. 4/6.

ADVANCE TEST EQUIPMENT

H1B Audio Signal Generator	**£30 0**
J1B Audio Signal Generator	**£30 0**
J2B Audio Signal Generator	**£35 0**
TT1S Transistor Tester	**£37 10**
VM76 AC/DC Valve Voltmeter	**£72 0**
VM78 AC Millivoltmeter (transistorised)	**£55 0**
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.

OSCILLOSCOPE TYPE 13A
Double beam. Time base 2 c/s. to 750 kc/s. Band width up to 5 Mc/s. Calibration markers at 100 kc/s. and 1 Mc/s. Operates from A.C. mains 100 to 250 volts. A completely reliable quality instrument. Supplied fully checked with circuit **£22/10/-.** Carr. 30/-.

HRO MODEL 5T £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.**

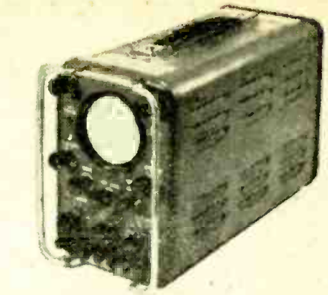
SENSITIVE VALVE VOLTMETER TYPE TF.1100
100μv to 300 v. A.C. in 12 ranges. 10 c/s to 10 Mc/s. Can also be used as a wide-band amplifier. **£50.**

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
T.F.1066.B/2 U.H.F. F.M. Signal Generator	£200
TF.1067 Hetrodyne Frequency Meter	£65
TF.1102 Amplitude Modulator	£40
TF.1221 Hetrodyne 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.

CHARLES BRITAIN (Radio) LTD.
11 UPPER SAINT MARTIN'S LANE
LONDON, W.C.2. *01-836 0545*
Near Leicester Sq. Station. (Opposite Thorn House)
Shop hours 9-6 p.m. (9-1 Thursdays). Open all day Saturday.



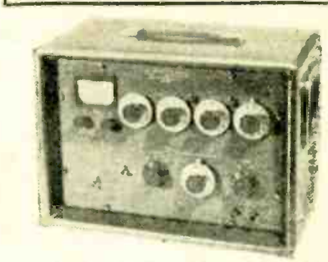
PORTABLE OSCILLOSCOPE CT.52.
A compact general purpose instrument with many unusual features. Size 9in. high, 8in. wide, 6½in. deep. Time base 10 c/s. to 40 kc/s. Y plate sensitivity 40 v. per cm. Tube 2¾in. Frequency compensated amplifier up to 38 dB gain. Bandwidth up to 1 Mc/s. Single sweep facilities. Operates from A.C. mains 100-250 volts, 50 c/s. Complete with all test leads, metal transit case, instruction book and circuit diagram. BRAND NEW. Tested and guaranteed. **£22/10/-.** Carr. 10/-.

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/-.

T.C.C. METALPACK CONDENSERS. 0.1 mfd. 500 v. D.C. wkg. at 70 C. Brand new, polythene wrapped, **7/6** doz., or **£2** per 100. **T.C.C. METALMITE** 350 v. D.C. wkg. 0.1 mfd. (CP37N); 0.05 mfd. (CP35N); 0.01 mfd. (CP.32N) all at 5/6 doz. or 32/6 per 100. **SPRAGUE METAL CASED CONDENSERS** 0.01 mfd. 1,000 v. D.C. wkg., 5/6 doz., or 32/6 per 100.

T.C.C. VISCONAL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71°C. CP 152 v. Size 3 × 1¾ × 5in. high. BRAND NEW (boxed), 8/6 each. **DUBILIER.** 4 mfd. 600 v. wkg. CP 130T or similar. 1¾ × 1¾ × 4¼in. high. BRAND NEW (boxed), 4/6 each. All post paid.

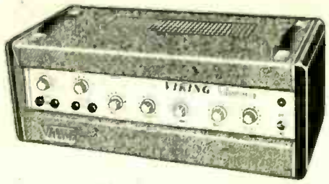
STANDARD TRANSFORMERS
Vacuum impregnated, interleaved, E.S. screen, universal mounting. Size 4 × 3½ × 2¾in. ALL BRAND NEW. **24/-** each. Post 4/6.
Type 1. 250-0-250 v. 80 mA. 6.3 v. 3.5 a., 6.3 v. 1 a., tapped at 2 a.
Type 2. As above but 350-0-350 v. 80 mA.
Type 3. 30 v. 2 a., tapped at 12, 15, 20 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.**

VIKING TRANSISTOR

40-50 WATT AMPLIFIER



OPERATING INSTRUCTIONS, GENERAL. An extremely reliable lightweight amplifier capable of giving 40-50 watts of undistorted sound, made possible by the use of the latest semi-conductors (transistors) and techniques which ensure space-age reliability under the most rugged conditions. It is designed as a general purpose amplifier particularly suitable for use with musical instruments that require exceptionally high treble response (not recommended for Bass Guitar). Tremolo facilities are available on Channel I only. **INPUTS—CONTROLS—CHANNEL I (Tremolo).** This contains two high gain input jack sockets controlled by **Volume Control I** which is mounted directly above the two sockets marked Tremolo. **BASS I.** Gives a controlled boost to the lower frequencies on Channel I only. **TREBLE I.** Gives a controlled boost to the high frequencies on Channel I only. **TREMOLO.** This operates on Channel I only and the variations of intensity and speed of the Tremolo beat is adjusted by the controls DEPTH and SPEED. A socket is provided in the rear of the amplifier so that the Tremolo may be switched on and off by the use of a footswitch plugged into the socket. If you wish the Tremolo to be used without the footswitch, this is possible as the footswitch is only used to short out the effect. **INPUTS AND CONTROLS—CHANNEL 2 (Normal).** This contains two high gain input jack sockets controlled by **Volume Control 2** which is mounted directly above the sockets marked **Normal. TREBLE.** Gives a controlled boost to the treble frequencies on Channel 2 only. **MAINS VOLTAGE.** Fully adjustable. 200-250 volts A.C., 50 cycles. **POWER OUTPUT** 40-50 watts sine wave British rating. Very little distortion. **OUTPUT IMPEDANCE** 3 ohms. **Price 21 gns.**, plus £1 postage and packing

VALVE VERSION OF THE ABOVE AMPLIFIER 40-50 watt, A.C. Mains 200/250 volts for 3 and 15 ohm speakers. **Price 27 gns.** plus £1 postage and packing. (No Tremolo facilities on this amplifier.)

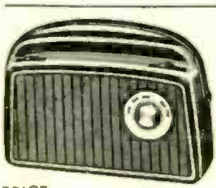
STAR SR 150 COMMUNICATION RECEIVER

Frequency range: 535 kc/s-30 Mc/s. 4 wavebands. 5 valve superhet. Incorporates BFO, bandspread tuning, "S" meter, external telescopic aerial and ferrite aerial. Built-in 4in. speaker. Easy-to-read dial. For 240 v. A.C. operation. Complete, brand new, with full instruction manual. **15 gns.** P. & P. 10/-.

NEW! The DORSET

TRANSISTOR PORTABLE RADIO

with BABY ALARM Facilities



PRICE:
£5.5.0 plus 7/6 P. & P.
Circuit and parts list 2/6, free with parts.

600 milli-watt 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.
The comprehensive easy-to-follow drawings supplied make this the easist-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 associatd 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.

NEW Transistorised SIGNAL GENERATOR

Size 5½ × 3¼ × 1½in. For I.F. and R.F. alignment and A.F. output. 700 c/s frequency coverage 460 kc/s to 2 Mc/s, in switched frequencies. Ideal for alignment to our Elegant Seven and Musette. Built and tested.

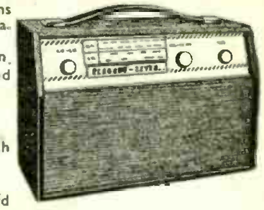
39/6 P. & P. 3/6

'ELEGANT SEVEN' MK IIIA

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.

- ★ De luxe wooden cabinet size 12½ × 8¼ × 3¼in.
- ★ 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.

SPECIAL OFFER



ONLY **£4.4.0** 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 7 transistor superhet radio for under £4/10/-. No one else can offer such a fantastic radio with so many de luxe star features.

ANTI-THIEF CAR BURGLAR ALARM

The Melguard Safermatic consists of an electrical device housed in small metal box 4 × 2 × 1½in., which has been designed and developed to provide protection required by the average motorist at an economic cost. Using this system, an alarm and the immobilised condition is set automatically as soon as you park the car. Should you leave the key in the ignition, no one but you can drive the car away. Upon entering the vehicle the method of starting the car is by switching on the ignition, depressing two hidden switches and simultaneously operating the starter. Location of the switches is known only to you. Should the alarm be set off it can be stopped by following the normal starting procedure. For 12 v. operation. List price **79/6. OUR PRICE 29/6** plus 2/6 P. & P. Full easy-to-follow instructions supplied.

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

600 mW SOLID STATE

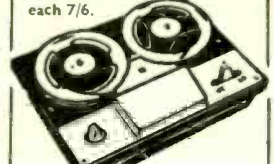
4-TRANSISTOR AMPLIFIER

Features NPN and PNP Complementary Symmetrical Output Stage. The elimination of transformers ensures maximum efficiency and frequency response. Automatic heat compensation. Combined A.C./D.C. feedback. Class B output stage, i.e. output power is proportional to total current consumption, this ensures long battery life. Under no signal condition (IQ) current drain is approx. 12 mA at 9 volts (4 mA in the output pair). Printed circuit construction. Size: 2¼ × ¾ × ⅝in. Speaker output impedance 12 ohms. Output power 600 mW at 5% distortion, 400 mW at 2.5% distortion, 750 mW at 10% distortion. Supply 9 volts. Total current consumption at a reasonable listening level approx. 35-40 mA at full power (speech and music) average 65 mA. Sensitivity for 50 mW output is 10 mW. Frequency response −3dB points 90 c/s. and 12 kc/s. **Price 15/-** plus 1/- P. & P. 7 × 4 speaker to suit, **13/6**, plus 2/- P. & P.

Fairchild Decade Counter, 9 silicon transistors, 17 diodes, divide-by-ten unit. Can be coupled to digitron tube type GR10K. Can be directly coupled to form an efficient digital counter. Zero pulse line incorporated so that all readings can be instantly reduced to zero. Power input +150 v. at 4.5 mA. −70 v. at 150 mA. including digitron feed. Maximum frequency 1 Mc/s. pulse width. Input pulse amplitude not less than 100 mV. £5 plus 2/6 P. & P.

BSR TAPE DECKS 200/250 v. 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 7/6.



EXTRACTOR FAN

A.C. mains 230/250 v., complete with pull switch. Size 6 × 6 × 4in. **Price 27/6**, plus 5/- P. & P.

3 TO 4 WATT AMPLIFIER

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Super Aeraxial (Fringe quality), 1/044, 1/3 per yard.

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3B*	25-30-35	20	£7 19 6	9/6
3C	25-30-35	10	£5 10 0	7/6
3D	25-30-35	5	£3 5 0	6/–
3E	25-30-35	2	£2 7 6	4/6
4A*	12-20-24	30	£9 15 0	10/–
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4D	12-20-24	5	£2 15 0	6/–
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5B	3-12-18	20	£5 9 6	7/6
5C	3-12-18	10	£3 5 0	6/-
5D	3-12-18	5	£2 5 0	5/–
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7B	6-12	20	£4 10 0	7/6
7C	6-12	10	£2 19 6	6/6
7D	6-12	5	£2 2 6	5/–
8A	12-24	1	19 6	4/–
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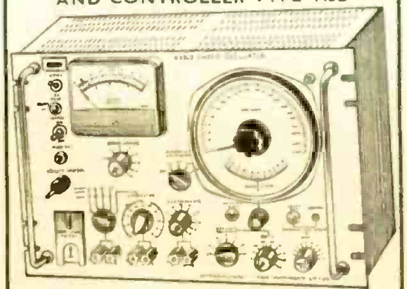

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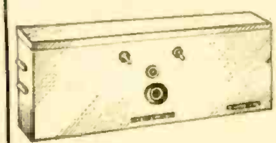

A.C. input 200-240 volts D.C. Output tapped to give 12 or 24 volts 8 amps. continuous rating. Fitted with panel fuse mains on/off switch and D.C. output socket. Built in strong metal case. Size 15×6×6in. An ideal general purpose L.T. supply unit for operating relays. Contactors, battery charging, etc., **£10/19/6**, Carr. 10/-.

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A.C. input 220-240 v. D.C. Output 12 or 24 v. 10 amps continuous rating. Selenium full wave bridge rectification. 3 inch scale ammeter, neon indicator, housed in strong metal case. Size 17×7×6¾in. **£14/10/-**. Carr. 15/-.

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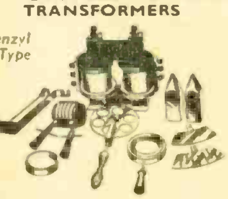

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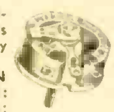

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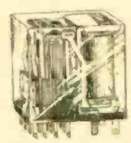

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1µF	25v	¾" × ¾"	W.E.	1	6
1µF	350v	1" × ¾"	W.E.	2	0
2µF	12v	⅞" × ⅜"	W.E.	1	6
2µF	150v	¾" × ⅜"	W.E.	1	6
2µF	275v	¾" × ½"	W.E.	2	0
2µF	350v	1" × ½"	W.E.	2	0
2µF	500v	1¼" × ½"	W.E.	2	6
4µF	25v	1" × ½"	W.E.	1	6
4µF	150v	¾" × ⅜"	W.E.	1	6
4µF	275v	1" × ½"	W.E.	2	0
4µF	350v	1" × ½"	W.E.	2	6
4µF	500v	1¼" × ⅝"	W.E.	3	0
5µF Rev ..	20v	1¼" × ⅝"	W.E.	2	6
5µF	50v	¾" × ⅜"	W.E.	1	6
5µF	70v	¾" × ⅜"	W.E.	1	6
6µF Rev ..	50v	1½" × ⅝"	W.E.	2	6
8µF Rev ..	20v	1¼" × ⅝"	W.E.	2	6
8µF	150v	1" × ½"	W.E.	1	6
8µF	275v	1¼" × ⅝"	W.E.	2	0
8µF	350v	1¾" × ⅝"	W.E.	2	6
8µF	500v	1½" × ⅝"	W.E.	3	0
10µF	6v	¾" × ⅜"	W.E.	1	6
10µF	50v	¾" × ⅜"	W.E.	1	6
10µF	150v	1" × ½"	W.E.	1	9
10µF	300v	1¼" × ½"	W.E.	2	0
16µF	250v	1½" × ⅝"	W.E.	2	0
16µF	350v	1¾" × 1	W.E.	3	0
16µF	500v	1¾" × 1	W.E.	3	6
25µF	12v	¾" × ½"	W.E.	1	6
25µF	25v	¾" × ½"	W.E.	1	6
25µF	50v	1" × ½"	W.E.	1	9
30µF	6v	¾" × ⅜"	W.E.	1	6
30µF	10v	¾" × ⅜"	W.E.	1	6
32µF	150v	1½" × ⅝"	T.1.	2	6
32µF	350v	2" × 1"	T.3.	3	6
32µF	450v	1¾" × 1"	W.E.	4	6
32µF	500v	2" × 1⅜"	T.2.	4	6

				s	d
50µF	12v	¾" × ¾"	W.E.	1	6
50µF	25v	1" × ½"	W.E.	1	6
50µF	50v	1¼" × ½"	W.E.	1	9
50µF	275v	1½" × 1"	T.1.	3	0
50µF	350v	2½" × 1"	T.1.	3	6
64µF	450v	2" × 1⅜"	T.1.	4	6
100µF	15v	1" × ⅜"	W.E.	1	6
100µF	25v	1" × ½"	W.E.	1	6
100µF	50v	1¼" × ⅝"	W.E.	2	6
100µF	100v	1¾" × ¾"	T.1.	4	0
100µF	250v	3" × 1"	T.1.	4	6
100µF	350v	3" × 1"	T.2.	5	0
100µF	450v	3" × 1⅜"	T.2.	7	6
125µF	500v	4" × 1⅜"	T.2.	9	0
200µF	275v	2" × 1⅜"	T.2.	6	0
200µF	350v	3" × 1⅜"	T.2.	7	6
250µF	12v	1" × ⅜"	W.E.	2	6
250µF	18v	1" × ½"	W.E.	2	6
250µF	25v	1¼" × ⅝"	W.E.	3	0
250µF	50v	1¾" × ¾"	W.E.	4	6
350µF	12v	1¼" × ⅝"	W.E.	2	6
350µF	25v	1½" × ¾"	T.1.	3	0
400µF	15v	1½" × ⅝"	W.E.	3	0
400µF	30v	1¾" × ¾"	W.E.	3	6
400µF	50v	1¾" × 1"	W.E.	4	0
400µF	275v	4" × 1⅜"	T.2.	9	0
500µF	6v	1¼" × ⅝"	W.E.	1	6
500µF	15v	1¼" × ⅝"	W.E.	2	6
500µF	25v	1½" × ¾"	W.E.	3	6
1,000µF	15v	2" × ¾"	W.E.	3	9
1,000µF	18v	1¼" × ¾"	W.E.	3	9
1,000µF ..	25v	1¾" × 1"	W.E.	4	6
1,000µF	50v	2" × 1⅜"	T.2.	7	6
1,500µF	25v	1½" × ⅞"	W.E.	5	6
1,500µF	50v	3" × 1"	W.E.	7	6
2,000µF	25v	3" × 1"	T.2.	6	0
2,000µF	50v	2½" × 1⅜"	T.2.	9	0

				s	d
2,500µF	30v	3" × 1⅜"	T.2.	7	6
2,500µF	50v	4" × 1⅜"	T.2.	10	0
4,000µF	25v	3" × 1⅜"	T.2.	9	0
5,000µF	25v	3" × 1⅜"	T.2.	10	0
10,000µF ..	25v	4" × 1¾"	T.2.	27	6
30,000µF ..	30v	4½" × 2"	T.2.	45	0
32 × 32µF ..	350v	2½" × 1"	T.3.	4	6
50 × 50µF ..	350v	2" × 1⅜"	T.3.	6	6
60 × 100µF	275v	2" × 1⅜"	T.2.	6	0
60 × 250µF	350v	4" × 1⅜"	T.2.	12	6
100 × 100µF	150v	3" × 1"	T.3.	4	6
100 × 200µF	275v	4" × 1⅜"	T.2.	9	6
150 × 200µF	350v	4" × 1⅜"	T.2.	12	6
250 × 250µF	325v	4½" × 1½"	T.2.	14	0

TERMINATION CODING

W.E. Wire Ended.
T.1. Tag each end of condenser
T.2. Single end tag termination
T.3. Single end tag termination
Twist prong fixing

				s	d
8 × 8µF	450v	1½" × 1"	T.1.	4	0
8 × 16µF ..	459v	2" × 1"	T.1.	4	6
16 × 16µF ..	275v	2" × ¾"	T.1.	4	0
16 × 16µF ..	450v	2" × 1"	T.1.	4	6
16 × 32µF ..	275v	1¾" × 1"	T.1.	4	0
32 × 32µF ..	275v	2" × 1"	T.3.	4	0
50 × 50µF ..	300v	2" × 1⅜"	T.2.	4	6
50 × 150µF	300v	3½" × 1"	T.2.	6	6
60 × 250µF	275v	4" × 1⅜"	T.2.	9	0
80 × 40µF ..	450v	4" × 1⅜"	T.2.	12	6
100 × 100µF	275v	3" × 1⅜"	T.2.	6	6
100 × 400µF	275v	4½" × 1¾"	T.2.	13	6
200 × 200µF	300v	4" × 1⅜"	T.2.	12	6
300 × 300µF	300v	4" × 1¾"	T.2.	14	0

The above list represents just part of the extensive range of electrolytic condensers we carry in stock. All condensers are new and carry a twelve month guarantee. Please do not hesitate to contact us for quotations on bulk quantities. If you do not see the exact condenser you require please let us know your exact requirements.

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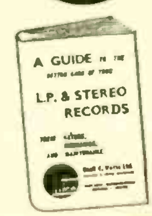

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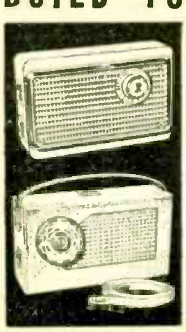

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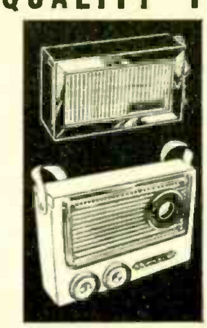

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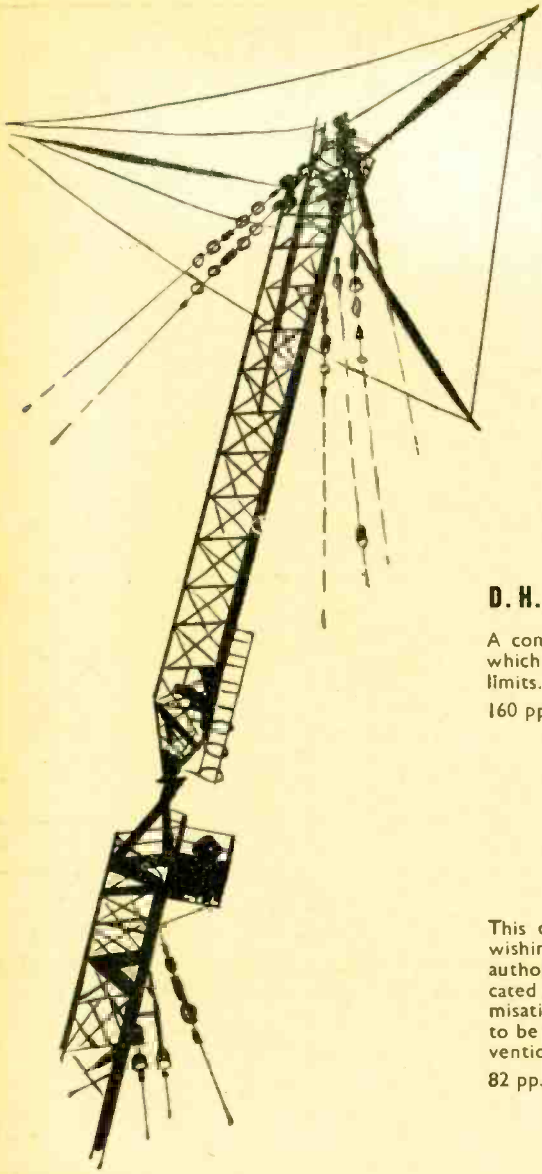

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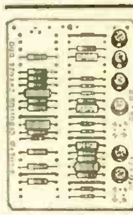

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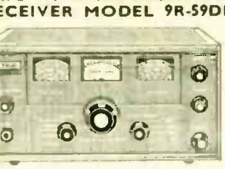

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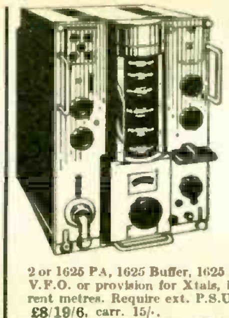

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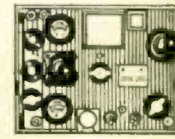

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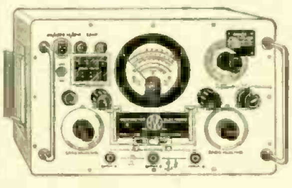

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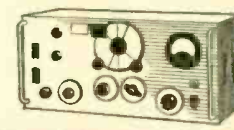

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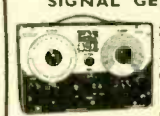
High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing, ¼in. dia. shafts. Bulk quantities available.
25 WATT. 10/25/50/100/250/500/1000/1500/2500 or 5000 ohms. 14/6. P. & P. 1/6.
50 WATT. 10/25/50/100/250/500/1000/2500 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.

ARF-100 COMBINED AF-RF SIGNAL GENERATOR



AF. SINE WAVE 20-200,000 cps. Square wave 20-30,000 cps. O/P HIGH IMP. 21 v. P/P 600Ω 3.8 v. P/P. R.F. 100 kc/s-300 Mc/s. Variable R.F. attenuation. Int./Ext. Modulation. Incorporates dual purpose meter to monitor. AF output and % mod. on R.F. 220/240 v. A.C. £27/10/-. Carr. 7/6.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20 cps to 200 kc/s. on 4 bands. Square: 20 cps to 30 kc/s. Output impedance 5,000 ohms. 200/250 v. A.C. operation. Supplied brand new and guaranteed with instruction manual and leads. £15. Carr. 7/6.

T.M.C. 1000 SERIES KEY SWITCHES

Brand New with knobs as follows.
1 way, 2 c/o 7/6; 1 way, 2 c/o 2b. 7/6; 1 way, 4 c/o. 8/-; 2 way, 3m., 3m. 8/6; 2 way, 2 c/o., 2 c/o. 8/6; 2 way, 2 c/o., 4 c/o. 10/-.
Post extra. Quantities available.

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.

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.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS.

0-20 Kc/s. Output 5K or 500 ohms. 200/250v. A.C. Offered in excellent condition, £12/10/-. Carriage 10/-.

G. W. SMITH
& Co. (Radio) Ltd.
3-34, Lisle St., W.C.2.
ALSO SEE OPPOSITE PAGE

ZI AND AERO SERVICES LTD

PEN RECORDERS

Elliot portable recording milliammeters.
As D.C. recorder: 1 mA. FSD. Movement resistance 1200Ω.
As A.C. current or voltage recorder: Movement resistance at 50 c/s. 1800Ω. Sensitivity 1 mA. A.C. FSD.
As decibel meter: source impedance 600Ω. Range +5 to −10 dB. Frequency response 50 c/s. to 15 kc/s.
Chart drive: 230 v. A.C. at 1in. and 6in. per hour. Movement is fitted with "high" and "low" alarm contacts which can be set for any value of the current.
Strip chart 3¼in. wide. Curvilinear trace. PRICE £40
Packing and carriage 15/-.

RECORD PORTABLE RECORDING MILLIAMMETERS

These are similar to the above but are somewhat smaller and lighter, and D.C. resistance of the movement is 400Ω. Other details as above. PRICE £42 10 0
Packing and carriage 15/-.
These are also available as decibel meters. Type 19 A.C.T.A. Range +3/0/ −3 dB 6 + with current of 500μA at 0 dB. Movement resistance 1900Ω £45 0 0

THYRISTORS

Type 3/40. 400 p.i.v., 3 amps., stud mounted: Gate voltage 3.0 v. at 20 mA 7/6
Blue Spot, 200 p.i.v., 5 amps., stud mounted: Gate voltage 3.25 v. at 120 mA. 12/6
Green spot, 400 p.i.v.; otherwise as above 17/6

TEXAS SILICON FULL-WAVE BRIDGE RECTIFIERS

1B20K10 100 p.i.v. 2 amps., dimensions 1.4 × 1.4 × .6in. 25/-
1B40K10 100 p.i.v. 4 amps., dimensions 1.4 × 1.4 × .6in. 30/-
1B100M10, 100 p.i.v. 10 amps., dimensions 2¼ × 2¼ × 1in. 85/-
Postage 1/6 per rectifier.

24-WATTS 210-240V. SOLDERING IRONS

Recently imported extremely attractive and sturdily built soldering irons, with angle bits. Chromium plated steel body and polished wooden handle. No Bakelite or breakable plastics used in construction.
Price 16/-
Spare bits 1/3
Spare heating element 3/-
Handling and postage 2/-.

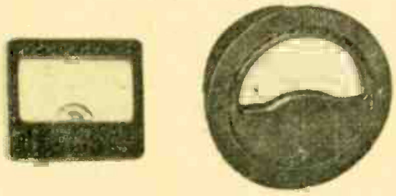
HEADPHONES No. 10 ASSY. (OR CANADIAN No. 1 ASSY)

Moving Coil Headphones with moving coil Hand Microphone fitted with press-to-talk switch. Rubber earpads. Cord terminated with army type 5-point moulded connector. Low impedance. Brand new, 20/- ea.
P. & P. 3/6 per set.

SLIDEWIRE WHEATSTONE BRIDGE

Battery Powered Portable Resistance Bridge. Range 0.5 to 50 ohms with multiplier settings of 0.1-1-100-1000, providing a measuring range of 0.05 to 50,000 ohms. Accuracy in the middle 3 ranges—0.5% approx.
PRICE £15 15 0

CURRENT PRODUCTION FIRST QUALITY MOVING COIL METERS



1.5% Accuracy
Type 70DA and 70DV. 80 mm. square flange. Flush mounted. 68 mm. dia. body. 40 mm. depth from the panel.
Type 85DA and 85DV. 85 mm. dia. flange. Flush mounted. 67 mm. dia. body. 48 mm. depth from the panel.
Type 120DA and 120DV. 120 mm. square flange. Flush mounted. 68 mm. dia. body. 40 mm. depth from the panel.

RANGE	70DA	85DA	120DA
40μA	—	58/-	82/-
60μA	66/-	53/-	78/-
100μA	62/-	49/-	74/-
150μA	—	44/-	—
250μA	54/-	42/-	65/-
400μA	52/-	—	
600μA	49/-	36/-	60/-
1mA	46/-	—	—
2.5mA	—	—	58/-
25mA	—	—	58/-
40mA	46/-	34/-	—
60mA	—	—	58/-
100mA	—	34/-	—
150mA	46/-		—
250mA	46/-	34/-	—
400mA	46/-		—
600mA	46/-	34/-	—
1A	46/-	—	58/-
1.5A	—	—	58/-
2.5A	46/-	—	58/-
4A	—	35/-	—
10A	—	35/-	60/-
40A	—	39/-	64/-

RANGE	70DV	85DV	120DV
6V	82/-	—	—
10V	—	40/-	—
15V	—	—	62/-
25V	—	40/-	—
40V	82/-	—	—
60V	82/-	—	62/-
100V	—	—	62/-
150V	82/-	46/-	—
250V	53/-	46/-	65/-
400V	—	47/6	69/-
600V	58/-	50/-	77/-

ZENER DIODES

5% 260 mW	15% 260mW	5% 1 Watt
OAZ200 4.7v 10/-	OAZ208 4.3v 6/6	Z2A24CF 2.4v
OAZ201 5.1v 9/6	OAZ209 4.7v 6/6	Z2A27CF 2.7v
OAZ202 5.6v 7/-	OAZ210 6.2v 6/-	Z2A30CF 3.0v
OAZ203 6.2v 7/-	OAZ211 7.5v 6/-	Z2A36CF 3.6v
OAZ204 6.8v 7/-	OAZ212 11.0v 6/6	Z2A160CF 16.0v
OAZ205 7.5v 7/-	OAZ213 12.0v 6/6	Z2A300CF 30.0v
OAZ206 8.2v 7/-		All at 5/6.
OAZ207 9.1v 9/6		

5% 10-WATT STUD MOUNTED

Z4.7v.; Z5.1v.; Z5.6v.; Z6.2v.; Z6.8v.; Z7.5v.; Z8.2v.; Z9.1v.; Z11.0v.; Z12v.; Z14v.; Z15v.; Z16v.; Z18v.; Z20v.; Z24v.; Z27v.; Z30v.; Z33v.; Z36v.; Z43v.; Z47v.—all at 7/6.

DRY REED INSERTS

Glass dry reed inserts approx. ⅛in. dia. x 1in. long with axial leads. One "make" contact of 100mA capacity at 50V. Can be operated by permanent magnet or 30-50 Amp-turns relay coils. PRICE 18/- per doz. post free.

BEEHIVE TRIMMERS

30pF and 50pF. 15/- per dozen, in any combination. 2/- P.P.

MICROWAVE DIODES

Cartridge Type

3000 mc/s.: 1N21, 4/-; 1N21B, 6/-; 1N28, 20/-.
6,000 mc/s.: CS2A, 5/-; CV101, 5/-; CV102, 5/-; CV291, 12/-.
9,375 mc/s.: 1N23, 4/-; 1N23A, 4/-; 1N23B, 6/-; 1N23C, 8/-; 1N23CR, 20/-; 1N23WE, 100/-; CS10B, 70/-.
10,000 mc/s.: CS3A (CV253), 20/-.
12,000 mc/s.: CS3B, 17/6; CS4B, 37/6; CS9B, 30/-; CS10BR, 70/-; CV111, 8/-; CV112, 8/-; CV2226, 70/-; CV2288, 85/-; CV2355, 200/-; S1M2 (CV2154), 37/6; S1M6 (CV2155), 37/6.
34,900 mc/s.: VX3136 (CV2391), 65/-.

AVALANCHE SILICON RECTIFIERS

Type RAS508AF, 960 p.i.v. at 6 amps. max., stud mounted 10/6

CATHODE RAY TUBES

2AP1—2in. screen, Green Trace Medium Persistence Oscilloscope Tube. EHT required 500 to 1000v. Sensitivity approx. 100v. DC/in to 200v. DC/in. 6.3v. heaters. USB11 Base. Overall length 7⅞in.
PRICE 40/-

3AFP31 = DH7-91—2¾in. screen Flat Face Green Trace Medium Persistence Oscilloscope Tube. EHT required 700-1000v. Suitable for symmetrical and asymmetrical operation. Sensitivity Y = 30v. DC/in; X = 50v. DC/in. 6.3v. heaters. B9G Base. Overall length 10in.
PRICE 110/-

3BP1—3in. screen Green Trace Medium Persistence Oscilloscope Tube. EHT required 1500 to 2000v. Sensitivity approx. 100-150v. DC/in. at 1500v. and 150-200v. D.C./in at 2000v. 6.3v. heaters. B14A base. Overall length 10¼in.
PRICE 55/-

4BP31—4in. screen Flat Face Green Trace Medium Persistence TWIN GUN Oscilloscope Tube. EHT required 1000 to 1800v. Sensitivity Y = 26v. DC/in; X = 40v. DC/in. 6.3v. heaters. B12F Base. Overall length 12in.
PRICE 100/-

Please consult our Catalogue for full range of Cathode Ray Tubes.

Current Production ZAERIX First Quality

VALVES FOR EXPORT

Here are a few examples from our stock of over 2,500 items.

OA2	3/-	2D21	3/11	6B4G	12/6	6SN7GT	3/2
OA3	5/9	2E26	18/4	6CY5	13/11	6V6GT	3/2
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OC2	14/4	3V4	3/2	6D84	9/2	311A	28/9
OC3	4/7	5U4GB	3/11	6J4	6/1	328A	23/-
OD3	4/4	5Y3GT	3/6	6J5GT	3/6	329A	23/-
1B3GT	3/6	5Z4GT	4/4	6J7	5/2	807	6/4
1U4	2/6	6AK5	3/6	6L6GC	4/11	811A	34/6
1V2	3/9	6AL5	1/9	6N7GT	4/4	813A	70/-
1Z2	20/2	6AQ5	2/8	6SL7GT	3/9	829B	52/-

THE ABOVE PRICES ARE FOR DIRECT EXPORT, I.E. FOR DELIVERY TO OVERSEAS ADDRESS, OR TO THE SUPPLIERS, FOR VALVES TYPE MARKED AND BULK PACKED, IN LOTS OF 100 PER TYPE.

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OUR NEW 1967/68 VALVE CATALOGUE AND PRICE LIST IS NOW READY. IT CONTAINS FULL REFERENCE DATA ON SEMI-CONDUCTORS, CATHODE RAY TUBES, ETC. Please send s.a.e. (quarto.).

R.S.T. VALVE MAIL ORDER CO.

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CBL31	15/-
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DCC90	7/-
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DF96	6/3
DH3/91	89/-
DK91	5/-
DK92	8/-
DK96	7/-
DL66	15/-
DL92	4/9
DL94	5/9
DL96	7/-
DL810	12/6
DL816	30/-
DL819	30/-
DM70	5/-
DY86	6/-
DY87	6/-
E88CC	12/-
E180F	17/6
E182CC	22/6
EABC80	6/6
EB91	3/-
EBC33	7/-
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EBF89	6/6
EBL31	27/6
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ECC33	15/-
ECC40	9/6
ECC81	3/9
ECC82	4/9
ECC83	5/9
ECC85	5/-
ECC88	7/-
ECF80	6/6
ECF82	7/-
ECH35	11/-
ECH42	9/-
ECH81	5/3
ECH83	7/-
ECL80	6/6
ECL82	6/3
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ECL86	8/9
EF9	20/-
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EF80	5/-
EF86	6/3
EF89	5/-
EF91	3/6
EF92	2/6
EF98	9/-
EF183	6/-
EF184	6/-
EF804	21/-
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PC97	7/6
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PL81	7/6
PL84	6/6
PL500	13/6
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PY32	8/6
PY33	8/6
PY81	6/-
PY82	5/6
PY83	6/-
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QQV03/10	30/-
QQV03/20	105/-
QQV04/15	105/-
QQV06/40	90/-
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QS70/20	5/6
QS75/20	5/6
QS75/60	20/-
QS83/3	7/3
QS92/10	4/-
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QS150/15	8/-

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U19	35/-
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U26	13/6
U191	13/6
U404	11/9
U801	23/6
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UAF42	8/9
UCH42	8/6
UCH81	6/3
UCL82	7/-
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UL41	8/9
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5V4G	8/-
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6AK5	4/6
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6AL5	3/-
6AM6	3/6
6AN8	10/-
6AQ4	4/-

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6AS6	6/-
6AS7	15/-
6AT6	4/-
6B4G	16/-
6BA6	4/6
6BE6	4/6
6BH6	7/-
6BJ6	7/-
6BK4	27/6
6BN6	7/6
6BQ7A	7/-
6BR7	8/6
6BS7	16/9
6BW6	7/-
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6C4	2/9
6CB6	5/-
6CD6G	20/-
6CH6	5/9
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6CW4	12/-
6D4	15/-
6DK6	9/-
6F23	13/6
6J5G	2/6
6J6	3/-
6J7G	4/9
6K7G	1/9
6K8G	3/-
6L6G	7/-
6Q7G	6/-
6SG7	5/-
6SJ7M	7/-
6SL7GT	4/9
6SN7GT	4/6
6V6G	4/6
6X4	3/6
6X5G	4/6
7B7	7/-
7C5	15/-
7C6	6/-
7H7	6/-
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11E3	42/-
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OC25	11/-
OC26	7/6
OC28	16/-
OC29	15/-
OC35	11/6
OC44	4/6
OC45	4/-
OC71	4/6
OC72	6/-
OC74	6/-
OC75	6/-
OC76	6/-
OC77	8/-
OC78	6/-
OC81	4/-
OC81D	4/-
OC81M	5/6
OC81DM	6/-
OC82	6/-
OC82D	6/-
OC83	6/-
OC169	5/-
OC170	7/-
OC171	8/-
OC200	7/6
SX642	3/6
XA101	3/6
XA111	3/6
XA112	4/6
XA125	5/-
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C.W.O. P. & P. 1/-. Minimum order value 5/- (Trade inquiries invited)
POTENTIOMETERS (Carbon): Long life, low noise. ½W at 70°C ±20% ≤½M, ±30% > ½M, Body dia. ¾in. Spindle 1in. × ¼in., **2/-** each. Linear: 1k, 2.5k, 5k, etc., per decade to 10M. Logarithmic: 5k, 10k, 25k, etc., per decade to 5M.
SKELETON PRE-SET POTENTIOMETERS (Carbon): Linear: 1k, 2.5k, 5k, etc., per decade to 5M. **Miniature:** 0.3W at 70°C. ±20% ≤½M, ±30% >½M. Horizontal (0.7in. × 0.4in. P.C.M.) or Vertical (0.4in. × 0.2in. P.C.M.) mounting 1/- each.
Submin. 0.1W at 70°C ±20% ≤1M, ±30% > 1M. Horizontal (0.4in. × 0.2in. P.C.M.) or Vertical (0.2in. × 0.1in. P.C.M.) mounting, **10d.** each.
RESISTORS (Carbon film): High stability, very low noise, ¼W. at 70°C. Body ⅛in. × ⅛in. Values in each decade: 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91 from 4.7Ω to 1M. ±5%, **2d.** each, 1.2M, 1.5M, 1.8M, 2.2M, 2.7M, 3.3M, 3.9M, 4.7M, 5.6M, 6.8M, 8.2M, 10M ±10%, **2d.** each.
SILICON RECTIFIERS: 0.5A at 70°C. 400 P.I.V., **2/9.** 800 P.I.V., **3/3**, 1,250 P.I.V. **3/9.** 1,500 P.I.V. **4/-.**
SEMI-CONDUCTORS (All NEW). OAR, OA81, **1/6.** OC44, OC45, **1/9.** OC71, OC72, OC73, OC81. OC81D, OC82D, OC170, OC171, **2/3.** OC140, AF115, AF116, AF117, **3/-.** SEND S.A.E. FOR FULL CATALOGUE

The " **MIRACLE** " Range of Soldering Irons fitted with the Bi-Metal, Steel held Solid Silver Bit.

8 Models—Any Voltage. Over 150 type bits.
6 v. to 240 v. 10 W. to 500 W.

LONG LIFE BITS. EASY BIT/ELEMENT INTERCHANGE. NO MAINTENANCE IN USE. PERMANENT BIT SHAPE AND SIZE.

One Customer writes: " . . . This iron has been in continuous use for about **EIGHT MONTHS** and it would appear that it now needs a new bit."

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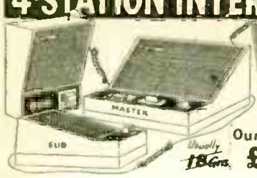
WW—131 FOR FURTHER DETAILS

4-STATION INTERCOM



Our Price Only ~~Usually 18Gns.~~ **£7/5/0**

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.

INTERCOM/BABY ALARM

Originally ~~6 gns~~ OUR PRICE ONLY **65/-**

Same as 4-Station Intercom for two-way instant conversation. Ideal as Baby Alarm and Door Phone. Complete with 66 ft. connecting wire. Battery **2/6.** P. & P. 3/6.

7-STATION INTERCOM

(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

~~Usually 6Gns.~~ OUR PRICE ONLY **59/6**

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.

WEST LONDON DIRECT SUPPLIES (W.W.), 169 Kensington High Street, London, W.8

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DISPLAYED SITUATIONS VACANT AND WANTED: £5 5s per single col. inch.
LINE advertisements (run-on): 6/- per line (approx. 7 words), minimum two lines.
Where an advertisement includes a box number (count as 2 words) there is an additional charge of 1/-.
SERIES DISCOUNT: 15% is allowed on orders for twelve monthly insertions provided a contract is placed in advance.
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 JANUARY 5 for the FEBRUARY issue, subject to space being available.

SITUATIONS VACANT

AN OVERSEAS CAREER with International Aeradio Limited.
TO meet the requirements of constant growth and expansion, we invite applications from technicians and engineers for an overseas career in North, West and East Africa, the Mediterranean area and the Arabian Gulf. If you have recently completed service in a trade such as Ground Wireless Fitter in the R.A.F., Radio Electrical Artificers in the Royal Navy or R.E.M.E., Army, or have other experience in the maintenance of H.F. and V.H.F. communications, R.T.T. and navigation aids, we should be interested to hear from you. Successful candidates would normally spend six weeks at our Radio Engineering School, Southall, Middlesex, before proceeding overseas, but in some cases staff with suitable qualifications and experience may be offered immediate posting. Overseas staff receive a tax-free salary with married and child allowances if appropriate and accommodation, bachelor or married is provided free: other benefits include generous U.K. leave and membership of an excellent pension and life assurance schemes.
WRITTEN applications, please, to Personnel Manager, International Aeradio Limited, Aeradio House, Hayes Rd., Southall, Middlesex. [19

EXPERIENCED Cinema Sound Engineer required for service and installation; good salary and conditions.—Box W.W. 1926, Wireless World.

EXPERIENCED enthusiasts required, London, W.1 for tape editing, mobile work, evenings, weekends, state experience and salary expected.—Box W.W. 1941, Wireless World.

TRAINED engineers required for interesting work on radio radar equipments at a flying unit in North Wales.—Apply: Short Bros. & Harland, Ltd., R.A.E. Llanbedr, Merioneth, N. Wales. [22

RADIO Engineer-Mechanic, first-class communications work, required by large company engineers, 12 ms. service overseas, excellent opportunity.—Write age, experience, Box W.W. 1903, "Wireless World."

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

HEARING aids (transistor) service engineer with view eventually to control small service and despatch dept., London area. Good salary and prospects for right man. Apply with details.—Box W.W./8392, "Wireless World."

TV Service Engineer and Trainee for London retail business of the highest standing; estd. over 40 years; good position and prospects for suitable applicants with high standards of service; state age and details of experience.—Box W.W. 73, Wireless World.

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

TEST Engineers, Micro Equipment. Several posts are vacant for intelligent persons in vigorous, young, expanding company. Salary range £750 to £1,200.—Full details education and experience to Research Officer, Flann Microwave Instruments Ltd., 9, Old Bridge St., Kingston-upon-Thames, Surrey. [1901

WORLD-WIDE News and Newspicture agency requires competent, versatile TELECOMMUNICATIONS ENGINEERS for extremely interesting work in London, Europe, Middle East and Africa. Applicants must have a sound knowledge of Radio/Electronics and general principles of line/radio telegraphy telephony.—Apply in writing, giving all details of past experience, present salary, languages spoken, etc., to Mr. D. Till, Director of Communications, United Press International, 8, Bouverie St., E.C.4. [1937

WEST Sussex County Education Committee. Worthing College of Further Education, Broadwater Rd., Worthing, Sussex. Applications are invited for the post of ELECTRICAL LABORATORY TECHNICIAN to maintain and construct electronic equipment. Salary Scale N.J.C. T.3.—£860-£1,020 per annum. Commencing salary according to age and experience. Additional remuneration payable in respect of certain specialist qualifications. Superannuable post.—Application form obtainable from the Principal. [1935

NORTH-EAST ESSEX TECHNICAL COLLEGE, Sheepen Rd., Colchester, Essex. Department of Electrical Engineering. An Assistant Lecturer, Grade B, in either Applied Electronics or Telecommunications is required. Applicants should have industrial and/or teaching experience, together with appropriate qualifications. Salary scale: £955-£1,625 p.a. plus degree allowance. Assistance with removal expenses may be given.—Application forms and further particulars are available from the Principal to be returned within 14 days of the appearance of this advertisement. [1934

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 1967 (extension for Forces and Overseas Civil Service).

SALARY (Inner London): £1,110-£2,052 depending on age and qualifications. Good prospects of promotion.

Pensionable appointments.
(Reference S 85 ASO)

EXECUTIVE ENGINEERS
AND ASSISTANT EXECUTIVE ENGINEERS
POST OFFICE

Applications are invited for posts as EXECUTIVE ENGINEERS and ASSISTANT EXECUTIVE ENGINEERS in London and provinces for work on the development and design of communications systems and postal service equipment.

QUALIFICATIONS: **Executive Engineers:** Degree 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 Engineers: 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.

AGE: Executive Engineer: At least 21 and under 35 on 31st December 1967. Some extensions for service in H.M. Forces or Overseas Civil Service. Assistant Executive Engineer: At least 17½ and under 27 on 31st December 1967.

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.

ELECTRONIC DESIGN & DEVELOPMENT ENGINEERS (ALL GRADES) SALARIES UP TO £2,800 P.A.
ELECTRONIC TEST & SERVICE ENGINEERS (ALL GRADES) SALARIES UP TO £1,600 p.a.
TECHNICAL SALES ENGINEERS (EXPERIENCED) SALARIES UP TO £2,500 p.a.
TECHNICAL AUTHORS (ALL GRADES) SALARIES UP TO £1,800 p.a.
ALSO
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:—

ELECTRONICS APPOINTMENTS LTD.,
Norman House,
105-109, Strand, W.C.2.
TEMple Bar 5557-8.

Government of UGANDA

REQUIRES

TELECOMMUNICATIONS ENGINEERS

for the Ministry of Internal Affairs, on contract for one tour of 21-27 months in the first instance. Salary, according to age and experience in the scale £1,347-£2,205 a year. Included is an allowance, normally TAX FREE, ranging from £600-£816 a year which will be paid by the British Government direct to an officer's bank account in Uganda. Gratuity 25% of total emoluments. Educational allowances. Uniform allowance £25 a year. Liberal leave on full salary. Accommodation provided at reasonable rental or hotel allowance in lieu. Contributory pension scheme available in certain circumstances.

Candidates, who will serve as Superintendents/Assistant Superintendents of Police (Radio), must possess a City and Guilds Final Certificate Course 49 or equivalent qualification with at least 6 years practical experience including installation and maintenance of fixed and mobile V.H.F. equipment (A.M. and F.M.); H.F. medium and low power S.S.B. and D.S.B. transmitters and receivers; Radio teleprinter equipment; Small diesel and petrol electric generating plants. Duties will include the supervision and instruction of local maintenance staff under training.

Apply to CROWN AGENTS, M. Dept., 4 Millbank, London, S.W.1 for application form and further particulars, stating name, age, brief details of qualifications and experience and quoting reference M3D 62331 WF

ST. BARTHOLOMEW'S HOSPITAL, LONDON, E.C.1. An ELECTRONIC ENGINEER OR PHYSICIST is required to take charge of high voltage machines used for radiotherapy. These comprise a 15 MeV continuously evacuated electron accelerator and a 6 MeV Linear Accelerator operating basically on solid state units. For the successful applicant there will also be an opportunity to collaborate on research work. Applicants must have a degree. The salary will either be on the scale £855 to £1.658 or £1.833-£2.276 per annum according to qualifications and experience, plus £75 London Weighting.—Applications should be sent to the Clerk to the Governors quoting ref. no. ASC/1271. [1936

FIELD SERVICE ENGINEER FOR PUBLIC EQUIPMENT AND AUDIO AMPLIFICATION EQUIPMENT

Covering London and Southern Counties. Experience Essential. Good Salary. Expense Allowance. Company Vehicle or Vehicle Allowance provided.

Write:
SERVICE MANAGER, MAGNETA (B.V.C.) LTD., Parsons Green Lane, London, S.W.6.

NEWCASTLE GENERAL HOSPITAL (1.060 beds). 2 Medical Physics Technicians Grade III (specialising in electronics) required for the Regional Neurological Centre to work in electronics laboratory on design and development of apparatus concerned with neurology and neurosurgery. There is considerable scope for initiative and the successful candidates will be expected to hold H.N.C. qualification, although consideration will be given to those with O.N.C. and experience in a similar field. Whitley Council conditions of service. Salary scale £980-£1.300.—Applications, with names and addresses of two referees, to Hospital Secretary, Newcastle General Hospital, Newcastle upon Tyne NE4 6BE, within two weeks. [1933

A NEW YEAR WITH NEW OPPORTUNITIES

MICROWAVE ASSOCIATES LIMITED

We are a young expanding Company in the field of Microwave generation, detection and control. During the last twelve months work has been carried out on many interesting projects in the radar and communications field including the development of all solid state microwave television links and of solid state switches for use in aircraft systems as well as much progress work on microwave sources.

Our Company continues to grow and if you are interested in joining a progressive team, we have the following vacancies:

COMMUNICATION ENGINEERS **MICROWAVE SYSTEMS ENGINEERS** **TEST ENGINEERS**

TECHNICIANS **TECHNICAL ASSISTANTS**

If you are interested in these vacancies or would like to join us in a capacity not mentioned please apply in writing, stating name, experience, qualifications, age and current salary, quoting reference A26 to:

R. R. Williams, Personnel Manager,
Microwave Associates Limited,
Cradock Road, Luton, Beds.

All applications treated in strictest confidence.

ELECTRONIC MAINTENANCE ENGINEERS

There are excellent opportunities in the Installation and Maintenance Division of E.M.I. Electronics Ltd., for engineers to carry out maintenance work on a wide variety of electronic equipment, including laboratory test gear, tape recorders, broadcast and studio T.V. equipment, and electronic automation equipment.

Candidates should be between 21 and 45, have had at least three years' experience of this type of work, and be willing to travel.

Good commencing salaries will be paid, and staff conditions include a contributory pension scheme and free life assurance. Grants towards re-location expenses will be made in suitable cases.

EMI CAREERS

EMI

Applications, giving concise personal/career details to:
P. JONES · GROUP PERSONNEL DEPARTMENT · E.M.I. LTD
BLYTH RD · HAYES · MIDDLESEX · TEL: 01-573-3888 · EXT: 411

GATESHEAD & DISTRICT
HOSPITAL MANAGEMENT
COMMITTEE

SENIOR ELECTRONIC TECHNICIAN

Applications are invited for the above post, to carry out duties in the Gateshead district, N.W. Durham, Hexham district and Prudhoe groups of hospitals. Qualifications should preferably include the H.N.C. (Electronics or Light Current Electrical Engineering) or City & Guilds Telecommunications Engineering Certificate, or of similar academic level. The person to be appointed should have wide experience in the electronic field including telecommunication radio frequency transmission and reception, audio frequency systems, domestic and public entertainment, pulse generation, automatic control systems and electro-medical apparatus. Hospital experience would be an advantage.

The Technician will be based at Gateshead and be responsible to the Group Engineer, Gateshead & District H.M.C. for organising a system of routine maintenance covering a wide variety of electronic equipment. National Health Service conditions of service. Salary within the scale £980-£1,300 p.a.

Applications, giving full details of age, education, experience, qualifications and present salary, together with names and addresses of three referees, should be sent to the Group Secretary, Gateshead & District Hospital Management Committee, Queen Elizabeth Hospital, Sheriff Hill, Gateshead, Co. Durham. NE9 6SU.

THE Royal Free Hospital requires an Electronics Engineer. The successful candidate will be part of a team of electronics engineers but will have special responsibility for the maintenance and modification of electronic diagnostic apparatus including electrophysiological and data processing equipment in the Department of Psychological Medicine at the Lawn Road Branch, where there are first-class computing facilities including a small on-line installation. Experience with either biological or pulse techniques would be an advantage but is not essential and the Department is prepared to consider a recent graduate or someone of comparable ability still in training and interested in the fields of medical automation, computer programming or electrophysiology. Detailed applications stating age, qualifications and experience to the Administrator, The Royal Free Hospital, Gray's Inn Rd., London. W.C.1. [1932

World wide News and News Picture Agency requires competent versatile

TELECOMMUNICATIONS ENGINEERS

for extremely interesting work in London, Europe, Middle East and Africa.

Applicants must have a sound knowledge of Radio/Electronics and general principles of Line/Radio Telegraphy/Telephony.

Apply in writing giving all details of past experience, present salary, languages spoken, etc., to:

Mr. D. Till,
Director of Communications,
UNITED PRESS INTERNATIONAL,
8 Bouverie Street, E.C.4.

UNIVERSITY OF LONDON Goldsmiths' College, New Cross, London, S.E.14. Applications are invited for the post of Technician in Audio-visual Aids. The work will be with an expanding unit and opportunities will exist for an interesting and progressive career. Applicants must be suitably qualified with experience in radio and tape-recorder servicing. Experience in CCTV and Film Projection equipment an advantage. Salary range: £715-£1,215 p.a. according to age and ability.—For further particulars write to the Registrar. [1951

SIGNALS Command Air Radio Laboratories, Ministry of Defence (Air), R.A.F. Watton, Thetford, Norfolk. Telecommunications Engineers (2 posts graded S.S.O./S.O.) to work on the design and development of aerials, receiving and analysis equipment for the V.H.F., U.H.F., and S.H.F. frequency bands used in aircraft. Involves original laboratory work and some supervision of development contracts. A knowledge of solid state techniques an advantage. Qualifications: 1st or 2nd class honours degree or equivalent or higher qualification in appropriate subject and, for S.S.O., at least 3 years' post-gradute experience. Salary: S.O. £926-£1,574. S.S.O. (minimum age 26) £1,744-£2,155. Prospects of permanent pensionable appointments.—Application forms from Ministry of Defence, CE2 (Air), Sentinel House, Southampton Row, London, W.C.1. [1930

SITUATIONS WANTED

MERCHANT NAVY Radio Officer seeks shore employment as Service Engineer, willing to train for new position.—Please write Box W.W. 71, Wireless World.

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

OUTSTANDING OPPORTUNITIES FOR ABOVE AVERAGE DESIGN AND DEVELOPMENT ENGINEERS

To earn not less than £2,500 p.a.

Qualified Engineers are urgently required to work on advanced engineering contracts in the Home Counties and Provinces, with experience in one or more of the following fields:—

(1) Analogue and Digital Equipments
(2) Microwave and Communications
(3) Radar and Navigational Aids
(4) Instrumentation

This is a first-class opportunity to work on exciting projects at exceptional salary levels.

STC

STRAND TECHNICAL CONTRACTORS LIMITED
NORMAN HOUSE, 105-109 STRAND, LONDON, W.C.2
01-836 5557 Please quote: EWI

UNIVERSITY OF NEWCASTLE UPON TYNE

A technician is required for closed circuit television maintenance work in this expanding service. The duties will include routine servicing of a variety of television cameras, monitors and associated equipment, and service with a small mobile unit. Some new construction will be involved. Applicants must have a thorough knowledge of basic electronics; an understanding of optics and audio equipment will be an advantage.

The commencing salary will, for an appointee with appropriate qualifications, be at a suitable point on the University's full scale for Technicians (£683-£968 p.a.) and a supplementary allowance of £50 per annum will be paid to the holder of approved higher qualifications.

Applications, giving full details of age, education, qualifications, and experience, should be sent as soon as possible to the Director, **Department of Photography, The University, Newcastle upon Tyne, 1.**

Applicants should state when they will be available for interview.

BECKMAN MODEL J. Continuous Instrument Potentiometer 2" dia. 10K, 35/- Brand new Res, Tol +5% Lin Tol +0.15%.

BECKMAN MODEL A. 10 Turn Precision Wirewound Potentiometer available in the following values:—100 Ohms, 10K, 100K. Offered at 50/-, well below list price.

BECKMAN MODEL 7216. 10 Turn Precision Potentiometer ⅞ dia., 60/-.

MATCHING DUODIALS. Type 2606 up to 15 Turn, ⅞ Dial, 45/- only, nearly half list price.

SINE/COSINE POTENTIOMETER by Kelvin & Hughes, SCP4 33K, offered at a sixth of manufacturer's price, £12/10/-.

SCOOP INDUSTRIAL BUYERS OC25, £17/10/- per 100. Mullard OC81D £7/10 per 100.

VEEDER ROOT SIX DIGIT IMPULSE COUNTER with manual reset, 230 Volts A.C. 55/-. 110 volts D.C., 35/-. Finished in two-tone grey shrivel.

SUDECO PRECISION FOUR DIGIT IMPULSE COUNTER, with pre-selection for counting back to zero as soon as the pre-set number of impulses have been received, 24 V. D.C., 185 m/A, £5/5/-, black finish.

"MINICUBE" BLOWER Sub-miniature, only 1" square, operates on 26V-400 c.p.s. input power, 1 or 2 pH. Output 2.2 CFM at free air Wt. 1½ oz. Brand new, made by Saunders Associates, offered at third of manufacturer's price, £19/10/-.

DUAL SPEED VERNIER DRIVE, completely enclosed for panel mounting, accurate to 0.05 degree Input to Output ratio 36 : 1. Universal coupling to allow for misalignment of shafts. Size 2.2"×2.2" sq. by 3" dia. White on black engraved dial. Made by Acton Laboratories to the highest Ministry specification. Offered at a fraction of manufacturer's original cost, £12/10/-.

SPERRY PRECISION DC TACHOGENERATOR, Type LS26. Brand new, in manufacturer's original packing. 5V/1,000 r.p.m. Size 11, Mod. 2. £12/10/-.

G-V controls. Hermetically sealed thermal timing relays available in the following:—7.5 seconds at 28 V., 20 sec. at 6.3 V., 30 sec. at 28 V., 120 sec. at 28 V., 180 sec. at 28 V. All £1 each.

LEACH. Balanced Armature Relays, 3 Pole. D.T.—10 amp 24/28V D.C., 25/-.

CHOPPERS. S.P.D.T. 6 volt 400 cycles, octal base 7/6.

DELAY RELAY. Hermetically Sealed Thermostatic Delay Impervious to Atmospheric conditions and altitudes S.P.S.T. Normally open with a 30 second delay, 7/6.

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have vacancies for the following skilled personnel:

ELECTRONICS ENGINEER conversant with solid state audio amplifier and logic circuit design to co-ordinate development including construction and testing of prototypes.

TESTER/INSPECTORS for audio frequency type of work for Q.R. & C. Department.

ELECTRO MECHANICAL TESTER/INSPECTORS of teleprinters and high speed tape punches for Q.R. & C. Department. We also require applications of same calibre for field maintenance and installation work; vacancies exist in many major towns.

Please apply in writing stating the vacancy which interests you, giving full details of experience and career to date, to :

Secretary, Westrex Co., Ltd.,
152 Coles Green Road,
London, N.W.2.

TAPE RECORDING ETC.

SAVE on cost of Hi-Fi. See Audio Supply notice (advert No. 1943 Services Offered column). [1944

TAPE to disc transfer. using latest feedback disc cutters; EPs from 21/-; s.a.e. leaflet.—Deroy, High Bank, Hawk St., Carnforth, Lancs. [70

TAPE/Disc/Tape transfer editing, duplicating. If quality and durability matter (especially with LPs from your previous tapes), consult Britain's oldest transfer service. Fund raising records published for schools musical societies (tax free).—Sound News Productions, 10, Clifford St., London, W.1. Reg. 2745. [1945

Television

We are expanding our activities in the field of television-by-wire, and need an experienced development engineer who can undertake important work on both immediate and long-term projects, involving both transmitting and receiving systems and equipment.

Good Laboratory experience and proven ability are the main requirements for the appointment, which offers very good security and opportunities for promotion to an engineer of the right calibre. All enquiries will be treated in strict confidence, and should be addressed to

The General Manager, British Relay (Electronics) Ltd.,
1-7 Croft Street, Deptford, London, S.E.8.

THE MOTOR INDUSTRY RESEARCH ASSOCIATION

Electronic Instrument Engineer

An immediate vacancy exists for an experienced engineer capable of leading a small team engaged on the maintenance, calibration and installation of a wide range of electronic equipment.

In addition to having experience in the maintenance of normal test equipment (e.g., oscilloscopes, signal generators, etc.), the successful candidate will be expected rapidly to familiarise himself with the maintenance of analogue computers, multi-channel F.M. tape-recorders, gas analysis equipment, radio telephone and doppler radar equipment, and a wide range of specialised apparatus constructed in the Association's Laboratories.

This is a new post which calls for a man with both practical and organising ability. Salary will be commensurate with experience and qualifications.

Electronic Maintenance Technicians

Vacancies also exist for technicians familiar with practical maintenance work on complex electronic apparatus, particularly analogue computers and their peripheral apparatus.

Appointments will be made within the grades Technician II-IV at wages ranging from £16 10s. to £22 10s. per week.

Applications in writing to the Secretary, Motor Industry Research Association, Lindley, Near Nuneaton, Warwickshire.

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in
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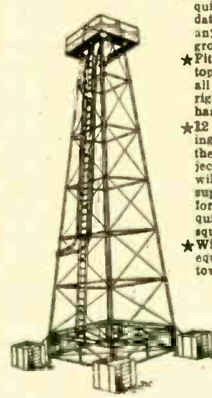

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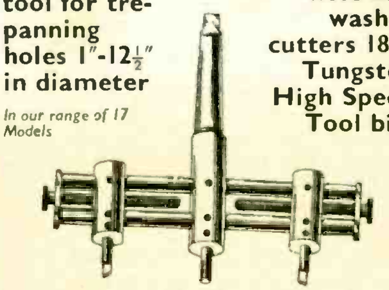

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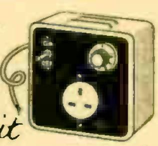

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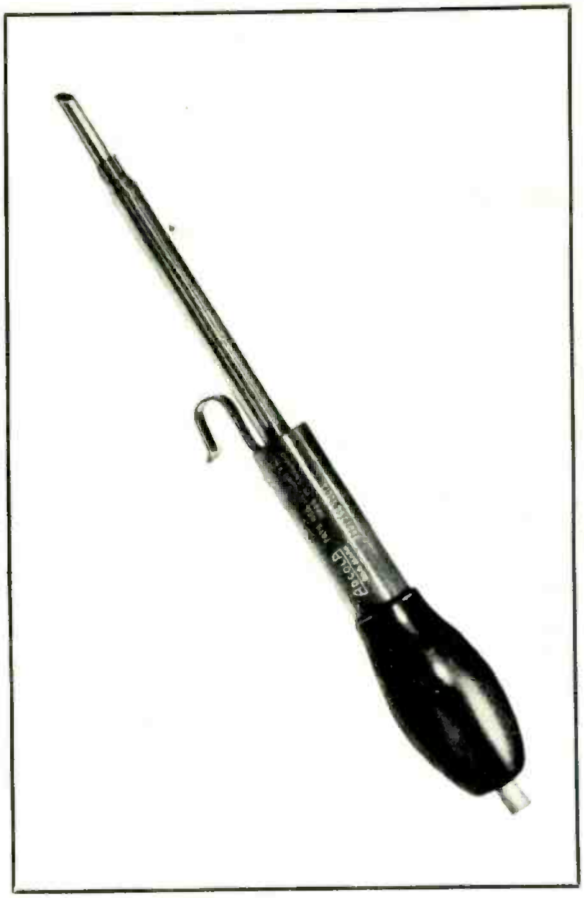

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