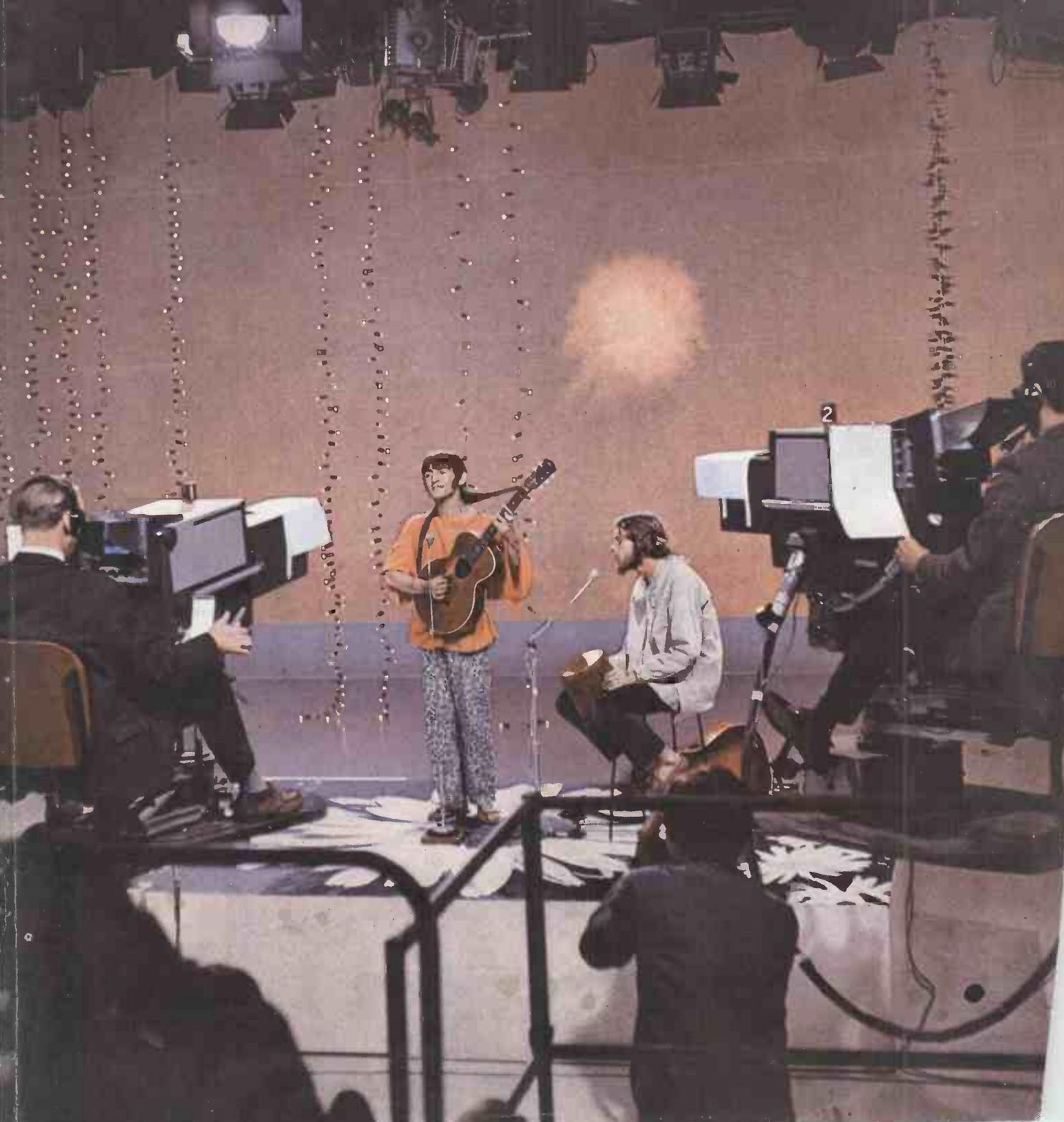


OCTOBER 1967  
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DOMESTIC RECEIVER TECHNIQUES

# Wireless World

ELECTRONICS • TELEVISION • RADIO • AUDIO



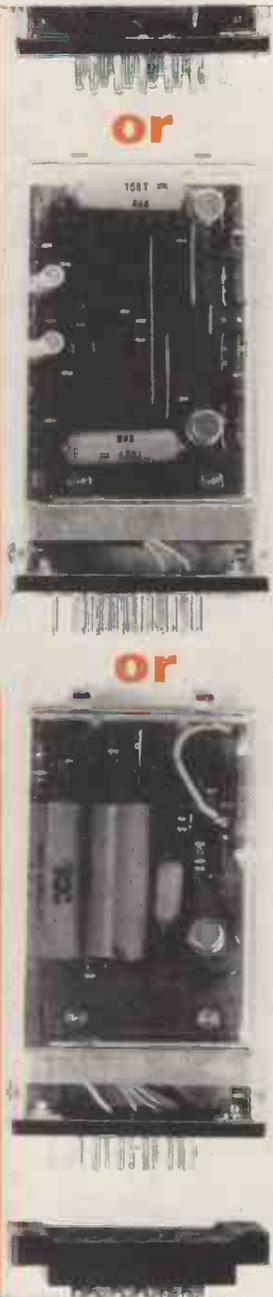


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OF PUBLICATION

ELECTRONICS, TELEVISION, RADIO, AUDIO

## OCTOBER 1967

- 463 What is the Electronics Industry?
- 464 Domestic Receiver Techniques
- 472 Stereo Signal Simulator by D. E. O'N. Waddington
- 476 Colour TV Standards Converter
- 482 Semi-stabilized D.C. Supply by G. W. Short
- 483 German Colour Television Starts
- 488 Wireless World Digital Computer—3
- 496 New Measurement Techniques
- 500 Colour TV Circuit Round-up by T. D. Towers

## SHORT ITEMS

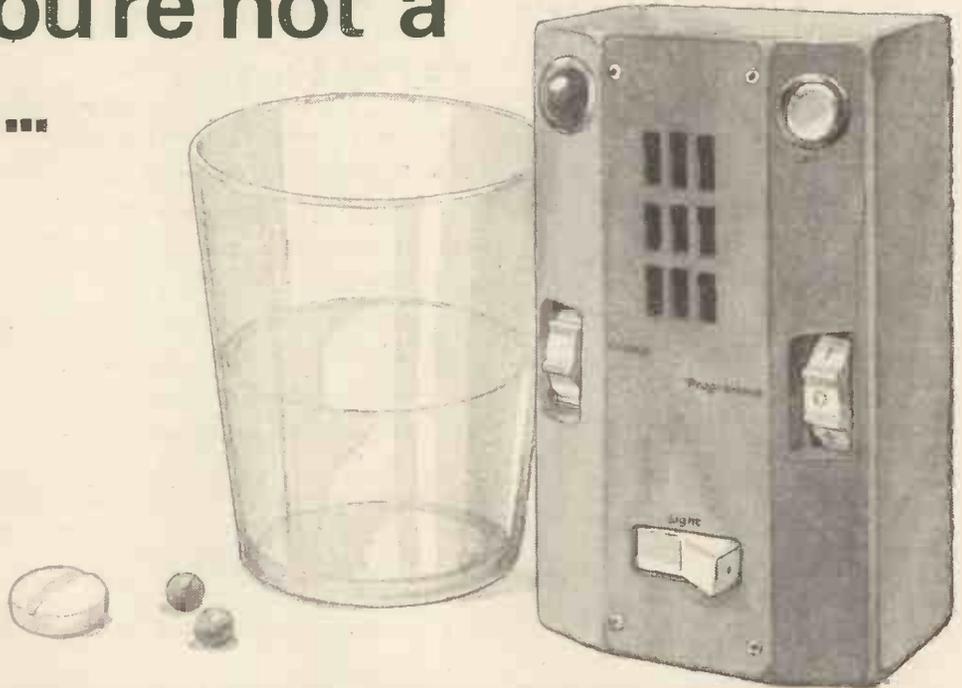
- 470 R.S.G.B. Show
- 471 BBC-2 Reception
- 471 Stroboscopic Hologram Interferometry for Transducers
- 475 Temperature Compensation Method for Oscillators
- 495 Manchester Electronics Show
- 498 Bistable Resistors
- 505 Component Specifications

## REGULAR FEATURES

- |                         |                                 |
|-------------------------|---------------------------------|
| 463 Editorial Comment   | 499 World of Amateur Radio      |
| 478 World of Wireless   | 506 Letters to the Editor       |
| 480 Personalities       | 509 News from Industry          |
| 482 Books Received      | 510 New Products                |
| 487 October Meetings    | 516 Conferences and Exhibitions |
| 494 Books Received      | 516 H.F. Predictions            |
| 495 Literature Received |                                 |

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# Wireless World

ELECTRONICS, TELEVISION, RADIO, AUDIO

## What is the Electronics Industry?

THIS, strangely enough, is the question posed by the Economic Development Committee for the Electronics Industry, in its recently issued survey of the industry's statistics. This is no new question. Indeed, on more than one occasion during the past fifteen or twenty years we have sought to define "electronics." At one time the generally accepted definition was "radio-like techniques and devices, especially valves, applied to non-communication purposes," but electronics, the child of the radio family, has now grown to maturity and the offspring's name has, by common usage, become the family name.

However, to get back to the E.D.C.'s question, the definition of an industry is essentially arbitrary. Among the criteria which can be used as the basis of a definition are "the physical nature of the product; the technology used in production; or the need which the product meets." Sometimes these criteria coincide and the defining of the industry is not difficult. However, where, as in electronics, "a technology is advancing rapidly and spreading its influence widely," giving a clear definition of the industry concerned is particularly difficult. The E.D.C. survey points out, that because some car ignition systems use semiconductors no one would suggest that this makes a car an electronic product. Similarly the electronic distributor, probably made by a motor accessory manufacturer, is unlikely to be regarded as an electronic product.

Although, so far as the Government is concerned, any definition is arbitrary, and would appear from the report to be made primarily for the purpose of statistics, "it will tend to change as technology and industrial structure change." The present "minimum list headings" (M.L.H.) of the Government's "standard industrial classification" defining the electronics industry are (a) valves, (b) consumer goods, (c) capital goods, and (d) components.\* The E.D.C. also includes telegraph and telephone apparatus in the industry.

According to the latest survey "no precise definition of the electronics industry has ever been accepted by the E.D.C." and it is now proposing a major regrouping. First there would be one M.L.H. for the components sector of the industry with three sub-divisions: active and passive components and microcircuits. It is stated that "the microcircuit sector is included in case by the time of the next census or the one after a substantial number of establishments making these circuits exist independently as off-shoots of both active and passive component (or other) firms." Secondly, there would be one M.L.H. for each of the main product sectors—capital goods, telephone equipment, and consumer goods. Lastly an M.L.H. for "the rather small but mixed sector of firms making audio products and components."

It may well be that integrated circuits (i.s.i. devices particularly, which combine active and passive component manufacture, assembly and testing) will provide a unifying influence on the whole industry. It is blatantly clear that the number of i.c. manufacturers is going to be small but their influence could be very extensive.

One other aspect of the past industrial structure has been a proliferation of trade associations, each one speaking for a particular section without an effective co-ordinating body bringing together the various sectors of the industry.

---

\* (a) valves, c.r.ts. semiconductors and electronic rectifiers; (b) radio and television receivers and sound reproducing and recording equipment including gramophones, gramophone records and tape recordings; (c) capital goods—radio and television transmitters, communication receivers, radar and electronic navigational aids, electronic computers, industrial electronic equipment, electronic medical equipment, high-frequency heating apparatus, electronic testing and measuring equipment, X-ray apparatus, etc.; and (d) components, including resistors, capacitors, inductors, circuit breakers for electronic equipment, sound reproduction components, printed circuits, etc.

# Domestic Receiver Techniques

Developments in circuitry and construction seen at recent trade shows in London

## SOUND RECEIVERS

**A**FTER looking round the trade shows at domestic radio receivers the feeling that one has seen it all before becomes very strong. The development of sound radio in Britain has to a large extent been overshadowed by that of colour television, manufacturers having concentrated the major part of their resources on this. As a result a large number of this year's models consist of last year's printed boards in new cabinets. It could be argued that there is no point in developing the domestic radio further as the public is on the whole satisfied with what it is getting and that this after all is what counts.

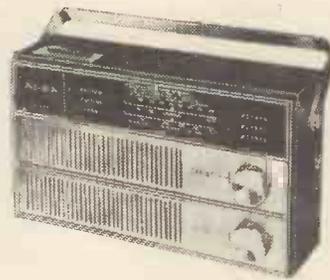
However, it is a well-known fact that modern sets last longer and because of this sales are falling as the market approaches saturation. Surely, then, it is up to set designers to produce something sufficiently tempting to encourage the public to consign that old, but still serviceable, receiver to the scrap heap in favour of a new one. People are not going to throw away a three waveband a.m./f.m. receiver for another three waveband a.m./f.m. receiver that has more plastic gold trim and sounds only marginally better. The answer probably does not lie in improved performance, the majority of purchasers caring little for improved selectivity and lower harmonic distortion. An approach should be to make the receiver perform some other useful function in addition to receiving broadcasts. Some examples of this are already to be seen, but additions should lean towards the electronic rather than the mechanical. With a little ingenuity the domestic receiver could be made to perform all manner of extra tasks—burglar alarm, baby alarms, intercom, electronic timers; if a car radio, an anti-theft device, etc.

The integrated circuit and the f.e.t. are still not to be seen in domestic receivers and most of the large manufacturers do not seem to be doing much along these lines. The general impression is that everybody is adopting a "we'll wait and see" attitude. However, varicaps are being used in increasing numbers, mostly in f.m./a.f.c. circuits.

For some time now many portable radios have included a switch to cut out the internal ferrite aerial and bring in a separate aerial coupling coil when the receiver is to be used in a car, the idea being to improve the signal/noise ratio. The Pye group have adopted a somewhat different system in one of their models (Pye 1373 Ekco PT305, Ferranti 5503), a medium- and long-wave portable. In this the ferrite rod is left in circuit but when the car aerial is plugged in a single stage wide-band r.f. amplifier is brought into play that gives about an extra 6 dB of gain. The circuit of the r.f. amplifier, shown in Fig. 1, has been designed to operate when coupled to the car aerial via a "standard" length of

coaxial cable (32 in). This set's brother (Pye 1372, Ekco PT304, Ferranti 5501) is a v.h.f., medium- and long-wave version that does not include the r.f. amplifier. The sets retail at 16gn and £20 9s, respectively.

Incorporating one of the features suggested in the introduction and looking most unlike a radio receiver is the Beolit 500 (35gn) from the Bang and Olufsen range—a continental design, of course. This is an eleven transistor v.h.f. receiver that can receive five push-button-selected stations and, if an external loudspeaker is connected, will also function as an intercom. The pre-set tuning system is interesting in that the conventional multi-gang tuning capacitor has been replaced by two



Alba 535 (£14-19-6), a three waveband seven transistor portable using modular circuit techniques.

From Japan an a.m./f.m. five waveband portable using an incandescent lamp tuning indicator, Hitachi KH-1325.



This portable from Grundig (Yacht Boy 208 33.5gn) provides 2 W output to a 5.75 x 3.75 inch loudspeaker, it has three a.m. wavebands plus v.h.f./f.m.

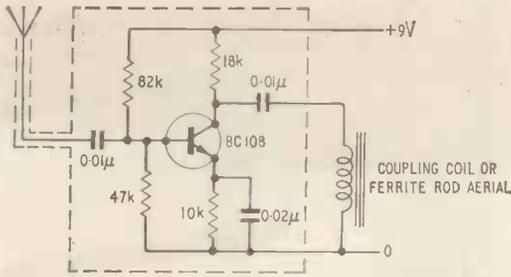


Fig. 1. The r.f. amplifier employed for car aerial coupling in some portables from the Pye Group.

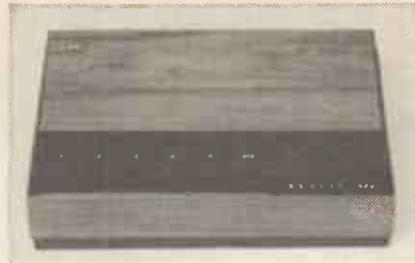
varicap diodes, the actual tuning being carried out by potentiometers (Fig. 2). Only one of the five potentiometers is shown in the drawing. The 22.5 V control voltage for these is obtained from a separate battery, thus avoiding trouble that could be caused by stray coupling with other circuits via the power supply line. It will be noticed that the collectors of both the r.f. amplifier and the oscillator are tuned; the varicaps also provide the means for applying a.f.c. B. & O. have restyled the Beomaster 1000 and the 900. They have respectively become the 1000K (84gn) and the 900K (73gn), and incorporate some improvements. It is interesting to note that these models have a fully stabilized power supply rail, the stabilizer circuits using three transistors.

Turning now to a portable from Japan at the higher end of the price range (£57 9s 8d) the FV 1700, from Sharp, has a very full specification. Significant features are f.m. with switchable a.f.c. (varicap), five a.m. wavebands (800-25 m), 17 transistors, b.f.o., fine tuning control, 1 watt output and 11 lb in weight. The tuning indicator on this model is a departure from the norm. Instead of a miniature meter two coloured incandescent bulbs are used. These are focused on a glass honeycomb panel that turns from red to green as a station is tuned in. The circuit to achieve this is shown in Fig. 3. Under no-signal conditions Tr1 is off and Tr2 is turned hard on, lighting the red bulb; Tr2 collector is close to OV so the green bulb will be extinguished. On receipt of a signal, taken from the second i.f., Tr1 turns on and the condition of the two bulbs reverse. To conserve battery energy the circuit is only operative when the dial light switch is depressed. Also in the Sharp family is the GS:5500 (£154) a 6 W/channel stereo-gram with separate loudspeaker cabinets.

While talking of sets from Japan it is refreshing to note that in spite of all the multi-transistor receivers the humble crystal set still flourishes. They are available ready built or in kit form from Eagle Electronics at about 15s each.

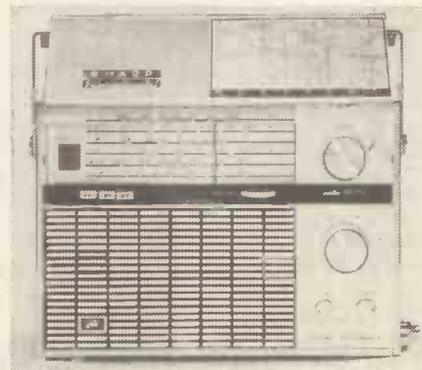
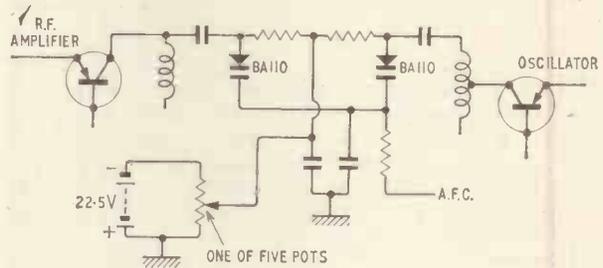
The RP36 (£33) is a new portable from Hacker Radio. It is a five waveband a.m. receiver incorporating 11 transistors and covering 1090-25 metres (152 kc/s-30.64 Mc/s) and has handsread tuning effective on all wavebands. A separate oscillator is used for each waveband, eliminating the stray capacitance associated with conventional switching and improving performance on the short-wave bands. At the a.f. end a fixed 4 dB of bass lift (at 100 c/s) is provided, the output stage delivers 750 mW at less than 1% distortion into an 8x5 in speaker.

Changes in the components being used by manufacturers are more or less as would be expected, in-



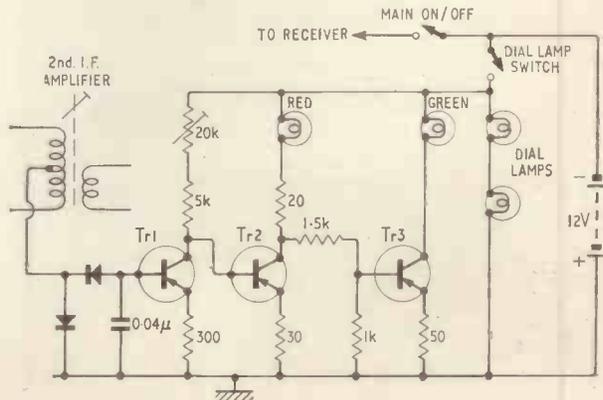
The Beolit 500 from the Bang and Olufsen range is a typical example of continental 'low-line' styling.

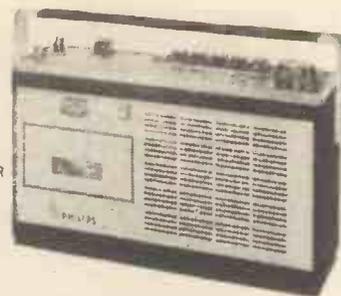
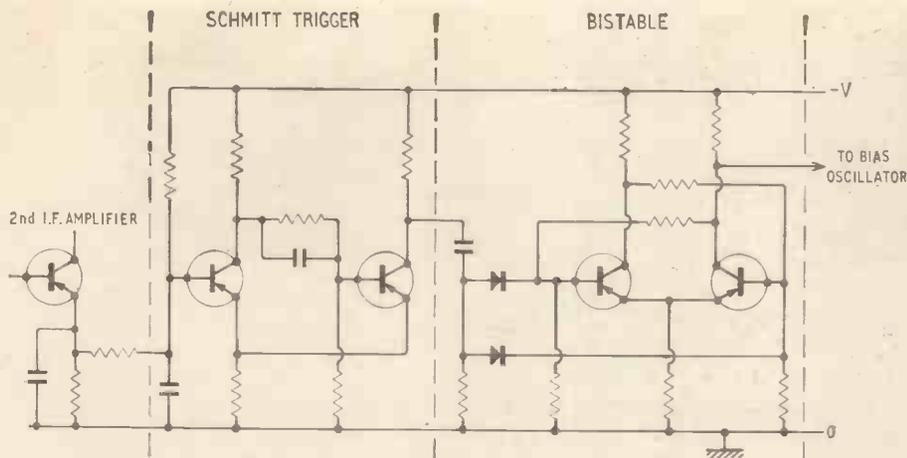
Fig. 2. The tuning and a.f.c. system used in the Beolit 500.



Sharp FV 1700, a 17 transistor multi-waveband portable from Japan.

Fig. 3. The lamp tuning Indicator from Sharp, battery power is conserved by coupling this circuit to the dial lamp switch.





The R673, a combined tape recorder/radio receiver from Philips.

Fig. 4. Bias oscillator correction circuit employed by Philips in their combined tape recorder/radio.

creasing use being made of silicon epitaxial transistors. Mullard pre-built modules are also being used to a greater extent and, as pointed out last year, there is a marked swing in favour of modular construction with its attendant advantages. It is surprising to note the preponderance of Japanese components, particularly capacitors, being used in British sets.

National have introduced a portable mains/battery tape recorder with a built-in medium-wave receiver (Model RQ120S—£30 9s). This is a twin-track machine that will accommodate 3-inch spools.

Philips have adopted a different approach in that they have built their cassette recorder into a portable radio (RL673—55 gn). The radio section covers the l.w., m.w., s.w. and v.h.f. bands. Sensitivity on v.h.f. is quoted as being  $4 \mu\text{V}$  for a 26 dB signal-to-noise ratio; non switch-switchable a.f.c. is incorporated. Facilities are available for recording direct from the radio, a microphone or a pickup, and, of course, it is possible to play back standard Musicassette tape records.

With recorder/radio combinations it is possible that

harmonics of the bias oscillator will fall in the pass-band of the receiver and cause unwanted beat notes. Philips have overcome this problem in a rather novel way. First the programme to be recorded is tuned in, then a button is fully depressed. This switches the equipment into the recording mode and switches out the ferrite aerial, disconnecting the signal source and a screened aerial coil is connected in place of the ferrite aerial. Now any signals being received will be due to harmonics of the bias oscillator. These are amplified in the i.f. strip and detected, causing a.g.c. action. Any change in a.g.c. voltage is sensed at the 2nd i.f. amplifier emitter and used to operate a Schmitt trigger which in turn complements a bistable (Fig. 4). The bistable is coupled, via a switching transistor, to the bias oscillator in such a way as to effect a change in oscillator frequency, thereby removing the spurious harmonics. When the finger is removed from the button, the ferrite rod aerial is reconnected and the control circuit is switched out, the recorder remaining in the record condition.

## TELEVISION RECEIVERS

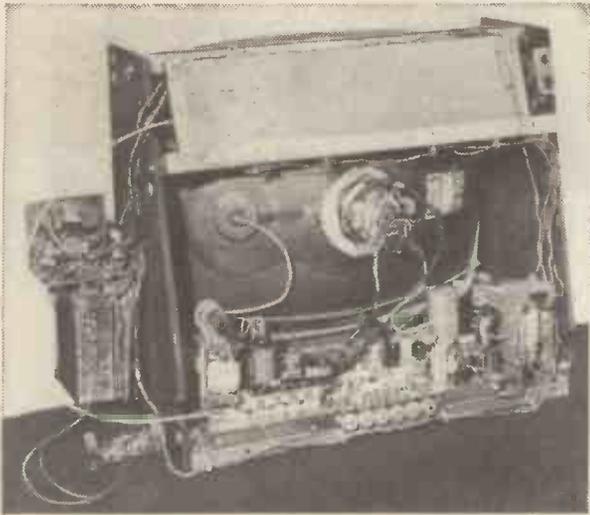
**I**N Britain television receiver design is rather in the doldrums, mainly because of the present and impending broadcasting arrangements. At the end of this decade there will be a major switch-over to a single television standard—625 lines on u.h.f.—and all the manufacturers can be expected to come out then with completely new, all-solid-state single-standard receivers. Meanwhile, with most of their development effort going into these future designs, the manufacturers are virtually marking time with the current hybrid dual-standard sets, which have not changed much since last year and are not likely to change substantially next year. This applies to both monochrome and colour receivers. In monochrome the minor developments that have taken place have been largely aimed at improving the attractiveness and maintaining the sales of black-and-white sets in the face of the coming (at least, hoped-for) colour boom. Means have been found for reducing production costs (for example, using one large printed circuit in place of several small ones) and adding small picture improving features (such as the Bush black-level correction circuit and the K-B "Deep Scene" optical filter

in front of the c.r.t.—both of which are in fact revivals of old ideas).

The trade shows did, however, provide one or two



H.M.V. 16-inch portable dual-standard monochrome set, Model 2645, with hybrid circuit on a single printed circuit board. It weighs  $27\frac{1}{2}$  lb.



Rear view of self-supporting inner cabinet of Decca "Professional" monochrome set. The circuit panel above the tube is hinged and opens out to give easy access to the components.

exceptions to this rather dull technical vista. One was the Thorn all-solid-state colour receiver, which has already been dealt with in *Wireless World*\*. The other was the first full demonstration of the Decca "Professional" receiver, a monochrome set providing superior vision and sound reproduction which was unveiled at the R.T.R.A. conference earlier this year. This 23-inch dual-standard set has been designed to make the best possible use of the signal available within the limitation of a reasonable "quality" price which discerning people can be expected to pay—actually £131 5s. It is not, of course, the ultimate in "hi-fi" television, which would cost many hundreds of pounds (starting with a special £200 c.r.t.).

On the vision side, the set offers clear resolution of 4.5 Mc/s test-pattern bars (625 lines) and 2.5 Mc/s bars (405 lines); a scanning linearity such that no two squares of Test Card D differ by more than 15%; a geometrical distortion such that opposite edges of Test Card D are parallel within  $\frac{1}{8}$  inch; interlacing not worse than 45/55 over 50% of the vertical hold range; a picture height and width held constant up to  $\pm 10$  V mains variation; elimination of "caption streaking" by d.c. coupling of the transistor video amplifier to the c.r.t. cathode; and, of course, maintenance of correct black level by the use of gated a.g.c. Cross modulation between sound and vision is reduced by using separate sound and vision i.f. amplifiers (the sound take-off being immediately after the tuner), and the noise figures of the transistor integrated tuner are 5.5 dB on Band 1, 7.5 dB on Band 3 and 13.5 dB on Bands 4 and 5.

On the sound side the set is characterized by the separate i.f. already mentioned, a transistor a.f. amplifier with push-pull output giving a maximum of 3 watts, a tone control, and a forward facing 8 in x 5 in elliptical loudspeaker. This audio section, the makers say, is the sort "normally only found in a good record player." For users who require even better sound quality there is a take-off point before the a.f. amplifier providing a connection for external high-quality sound reproducing equipment. (There is also a socket for a tape

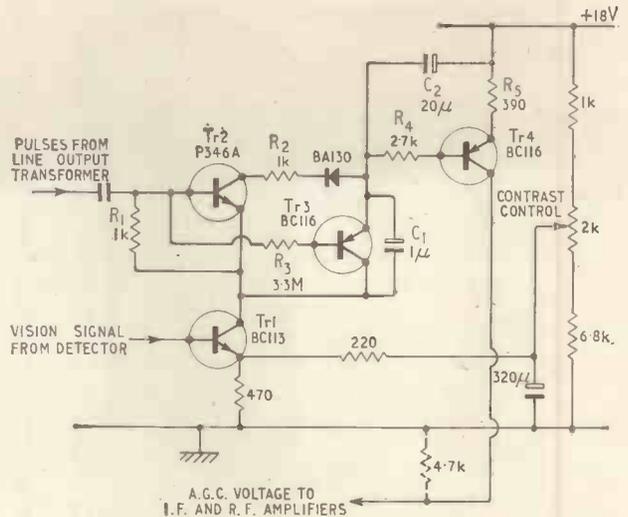


Fig. 5. Gated vision a.g.c. circuit, with anti-blocking modification, used in Decca "Professional" monochrome receiver.

recorder.) One of the inherent problems in television receiver sound channels is signal pick-up from the vision timebases, and this sets a limit to what can be achieved within the confines of the same cabinet.

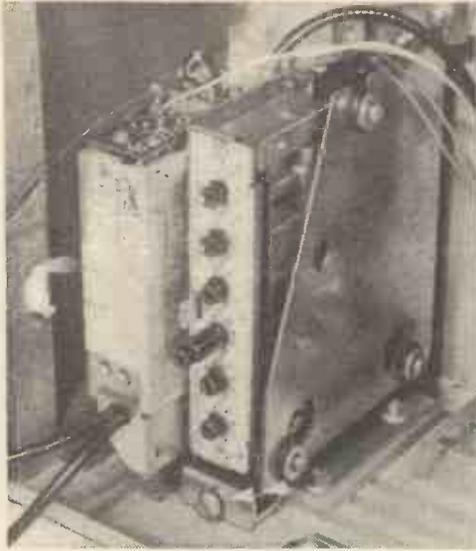
Other unusual features of the set include an electrically isolated chassis (a mains transformer and a bridge rectifier are used); a separate on-off mains switch to allow the volume control to be left set at a required level; facilities for connecting a television camera and a video tape recorder; and a self-supporting inner cabinet assembly, designed for ease of maintenance, which can be supplied as a separate unit for building-in to user's furniture.

The gated vision a.g.c. circuit is interesting because it includes a device to prevent blocking of the system when the line timebase is not working and there are consequently no gating pulses (e.g. during warm-up). Fig. 5 shows the circuit. Tr4 is biased so that it will not conduct unless a video signal is received at the base of Tr1. Transistor Tr2 is a gate which is norm-

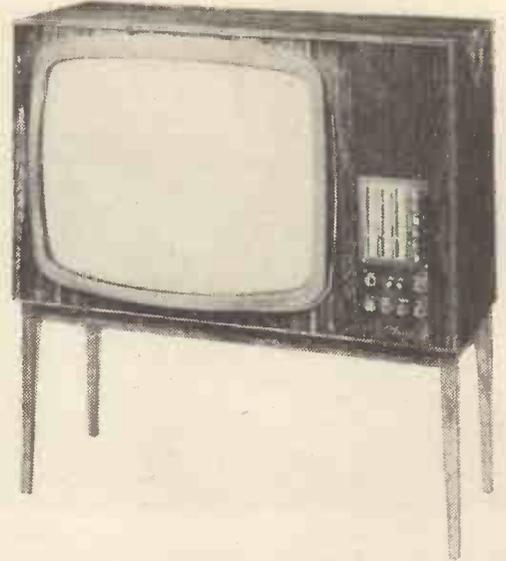


This Pye CT70 25-inch colour receiver is the first model from the re-formed company, Pye Group (Radio Television) Ltd.

\* "Transistor Line Output and E.H.T. for Colour TV," August issue, p. 396.



Rear view of Philips six-button integrated tuner. By means of the controls shown any of the six buttons can be tuned to any channel over four bands, so that when BBC-1 or ITV transfer to 625-lines/u.h.f. the viewer can use the same buttons for these programmes as at present.



The first imported colour receiver in the U.K. is this 25-inch Swedish model from Luxor Radio (available from Scandinavian Sound Corporation Ltd.). It is single-standard only (625 lines), has two loudspeakers and uses a hybrid circuit with 14 valves and 88 semi-conductor devices.

ally closed (cut-off) but, when opened by positive pulses from the line output transformer during the back porch period, allows the signal from Tr1 to have effect on Tr4. During this period, the effect of Tr1 conducting in proportion to the vision signal amplitude is to produce a negative potential at the base of Tr4 via the diode. This allows Tr4 to conduct, making its collector positive and so applying an a.g.c. voltage to the controlled stages. Capacitor  $C_2$  becomes charged and so maintains the negative base potential on Tr4, while the diode prevents any discharge. If the line timebase is not working and no gate pulses are available at Tr2, transistor Tr3 will conduct and allow a mean-level a.g.c. process to take over, but  $C_1$  prevents it from conducting

when line scanning is in operation. The contrast potentiometer supplies a positive voltage which, applied to the emitter of Tr1, backs off the effect of vision signal on the base of the transistor, thereby delaying the a.g.c.

Constant criticism about the failure of television receivers to maintain correct black level seems to be having some effect, for now another manufacturer, Rank Bush Murphy, has done something about it, this time in a normal-price domestic receiver. Misleadingly described as "black level clamp" in the publicity literature, the system is actually a form of automatic correction applied through the video amplifier to the c.r.t. cathode. In Fig. 6, a proportion of the vision signal from the video amplifier valve, tapped off at point P through  $R_2$ , has applied to it reverse-polarity sync pulses from the anode of the sync separator. The network is arranged so that the sync pulses in the vision waveform are slightly "over-cancelled," and so changed into small-amplitude reverse-polarity sync pulses. The resulting waveform, in which black level is positive-going, then measures, by its peak value, the variation of black level at the output of the video amplifier. As shown in Fig. 6 the waveform is passed through  $C_2$  to diode  $D_1$ , producing across  $R_4$  and  $C_3$  a direct voltage which is applied as a varying positive bias to the grid of the video amplifier.

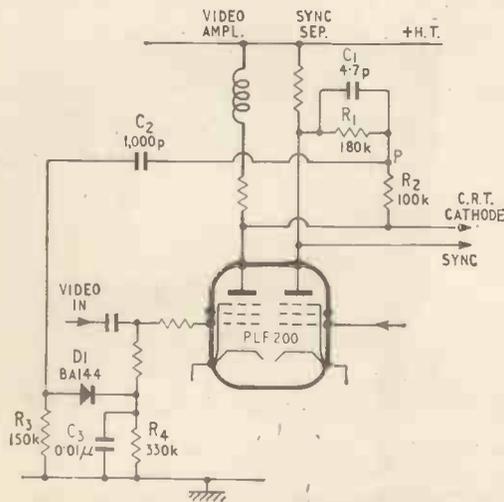
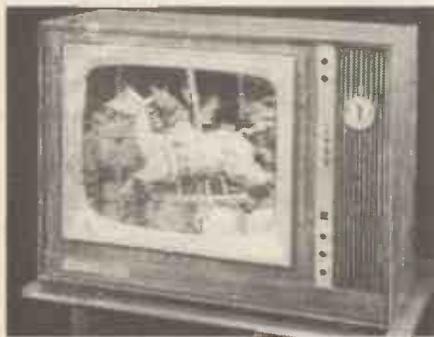


Fig. 6. Black-level correction circuit in Bush and Murphy monochrome 19-inch and 23-inch receivers.

It can be seen that this bias acts in such a direction as to offset the incorrect voltages applied to the c.r.t. cathode as a result of the a.c. coupling to the video amplifier. With an overall dark picture, for example, the c.r.t. cathode would normally be too negative on black, resulting in too much beam current and making the actual black displayed on the screen too light. Here the reduction of the "black-level" amplitude at P would lower the positive bias on the grid of the video amplifier and so drive the anode and c.r.t. cathode more positive. Thus the beam current would be reduced and the displayed "black" brought nearer to its correct value. The RBM receivers on show incorporating this circuit certainly

demonstrated a substantial improvement over uncorrected sets.

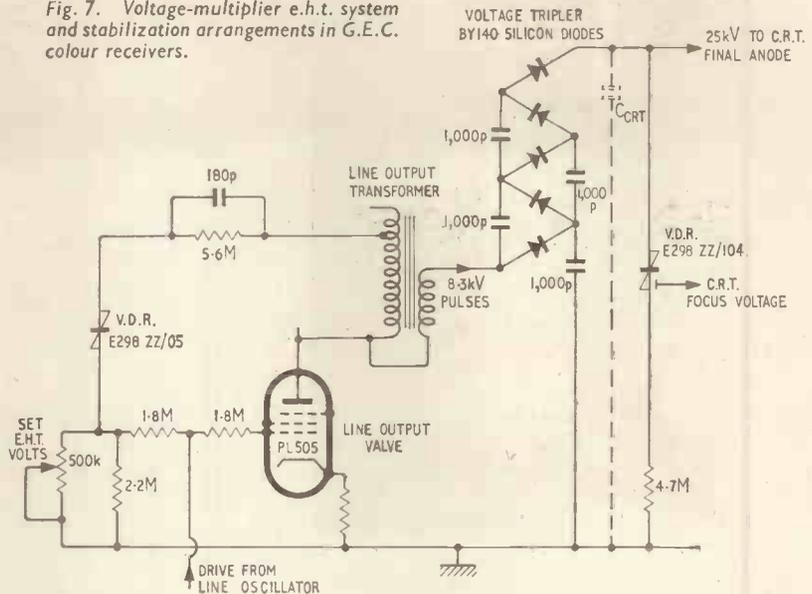
In colour television the most obvious trend this year was the appearance of 19-inch receivers. At last year's Earls Court Show everybody seemed to think that there was no future for this size of set and that the 25-inch receiver would be virtually the standard. It now seems that pressure on the manufacturers to reduce prices, plus favourable reaction from the retail trade and public, has encouraged the introduction of the smaller size. Examples were shown by G.E.C. and Sobell, Decca and K-B. This, however, does not result in any significant changes in circuit design, although the tube drive requirements are slightly smaller. In general, colour circuitry follows the techniques described by T. D. Towers in our current "Colour Receiver Techniques," series and variations tend to be small "extras" such as the Philips "Autowhite" switching system which, when the set is displaying monochrome pictures, automatically adjusts the voltages on the three guns of the tri-colour c.r.t. to give the familiar bluish-white picture of monochrome receivers. (If this monochrome "white" were used for the colour programmes the colour pictures would have an incorrect bluish tinge.) Philips, in fact, had two other "extras" in their latest sets. One is a "colour-off" button to assist the user to adjust his brightness and contrast



Colour receivers with 19-inch screens are now becoming available. This example is the G.E.C. Model 2028. It has a forward facing loudspeaker and a "colour beacon" which lights up only during transmissions in colour.

controls correctly (and, perhaps, to allow him to convince himself repeatedly that colour is worth paying all those extra pounds for!). The other is a tuning indicator which shows when the set has been correctly tuned on colour transmissions.

Fig. 7. Voltage-multiplier e.h.t. system and stabilization arrangements in G.E.C. colour receivers.



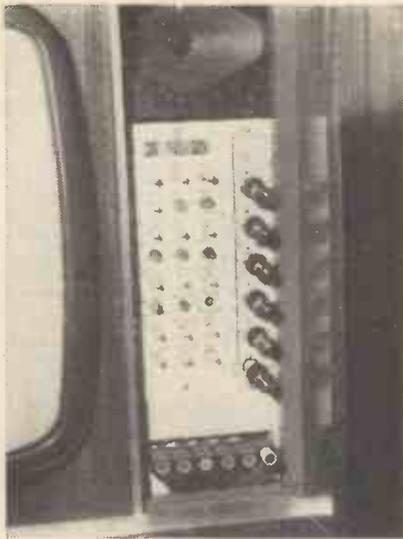
The one section of the colour receiver which does show variations in design approach is the e.h.t. generation. Some receivers (e.g. Decca, Murphy) use the conventional overwind on the line output transformer to supply the full voltage which is rectified then stabilized by a shunt regulator valve. Others are using a lower voltage winding giving pulses of 7-8 kV, plus a Cockcroft-Walton voltage multiplier to obtain the 25 kV. This technique avoids the insulation problems resulting from the use of a 25-kV overwind. Here one type of circuit has selenium stick rectifiers for the multiplier and uses a shunt regulator valve. Thorn, in their solid-state receiver, have the selenium rectifiers but dispense with the regulator valve by using a feedback arrangement for stabilization. One gets the impression, in fact, that there is now a general move to drop the regulator—understandably, since it is a large, hot valve which emits X-rays. This has become possible with the availability of high-voltage silicon diodes for the voltage multiplier, which have lower impedance than selenium rectifiers and so give better regulation.

Fig. 7 shows the e.h.t. arrangement in the latest G.E.C. and Sobell colour receivers. Regulation of the e.h.t. derives partly from the low impedance of the silicon diodes in the voltage tripler, partly from the voltage-dependent resistor connected across the 25-kV supply and partly from the v.d.r. used in the line output stage primarily to stabilize the width of the picture. In addition the e.h.t. winding on the transformer is tuned to the 5th harmonic of the output fundamental frequency, so that the waveform from the transformer is made into something more like square pulses and as a result the silicon rectifiers conduct for a longer time in each line-flyback period.

## STYLING AND MECHANICAL FEATURES

**S**IGNIFICANT mechanical developments were not in abundance at the trade shows this year. Most companies were emphasizing styling and cabinet design; for example, the cabinets of the Murphy 19in Painted Range are available in a choice of seven polyester colours, intended to blend in with contemporary colour

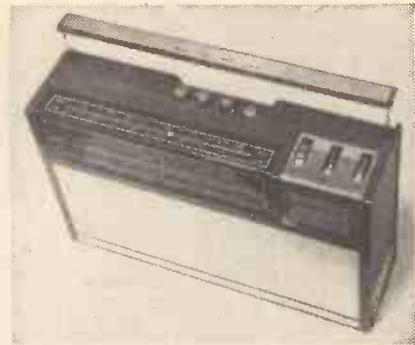
schemes within the home. Leather type finishes were shown on some of the K-B television sets at the STC show, and one set, named Deep Scene, possesses a dark tinted screen and integral front control panel which, with the set switched off, is intended to become unobtrusive in appearance. Some manufacturers, including Bosch,



Convergence controls on the Pye CT70.

STC, Rank-Bush-Murphy, and Pye have made serious attempts to improve the acoustics of radiograms by the use of properly designed loudspeaker enclosures, notwithstanding that in most cases the enclosures still remain an integral part of the cabinet work.

Switches and controls for both radio and television sets continue for the most part to remain static in design, but perhaps for colour television sets, the most interesting feature was the disposition of all the convergence controls on the Pye CT70 25 in model (applying also to the comparable Ferranti, Ekco, and Invicta sets). These controls were at the front of the set as shown in the photograph, concealed behind a removable decorative front panel and adjacent to the tuner. This has been done with the service engineer in mind, so that setting up can be carried out easily and directly. Should any of the convergence controls themselves become suspect, the whole panel as a separate unit can be detached from the set via a cable harness and 14-way plug. Although the use of solenoid switching in television chassis is not new, more manufacturers such as Baird, Pye and K-B were showing colour television chassis where solenoids were employed for switching the i.f. strips, timebases, and convergence. On the Pye (Model 60) and Ferranti (Models T1164/1165) monochrome sets, a new rotary multiband tuner employing silicon transistors—known as the Programme Master—is being used. With just this one switch, ITA or BBC 1 or 2 can be obtained without recourse to a separate tuner for BBC 2. Any six channels drawn from any of the bands can be quickly chosen in any order desired, through the six-channel selector mechanism, by pressing and rotating a memory control. Thus any channel combination can be arranged in the sequence desired by the viewer. On some of the K-B television cabinets, the circular v.h.f. and u.h.f. dials are illuminated from the rear by low-voltage torch-type bulbs, indicating which channel has been selected, controls on some of the K-B radiograms were similarly illuminated. Thumbwheel controls on portable radios exhibited by Ferranti have international symbols for tuning, volume and tone adjacent to them, while the volume and tone controls (see photograph) have a broken tapered line marked on them to indicate the relative



This Ferranti portable has International symbols by the thumbwheel controls.

position of either control. A useful mechanical feature on the Sovereign portable radio by Hacker was that of adjustable station markers providing accurate indication of the local f.m. station, a facility simplifying tuning for the general user. This set also has the new B.B.C. titles for the principal sound services, and is mounted on a small turntable permitting the set to be rotated through 360° to assist in station selection and interference reduction.

The design of the Pye 1373, Ekco PT305 and Ferranti 5503 a.m. portable radio indicates that ease of servicing has been kept well in mind. The printed circuits, tuning gang, controls and loudspeaker are mounted on a wrap round metal tray which can be completely withdrawn from the plastic moulded cabinet. Volume and tone controls are each mounted on separate brackets and can be changed without disturbing other components. Finally, in the direction of stereo signal reception, it was noted that only a few radiogram manufacturers including Bosch and K-B indicated that they were offering a plug-in modular type decoder as an optional extra on some of their sets.

## R.S.G.B. SHOW

THE International Radio Engineering and Communications Exhibition is the title of this year's R.S.G.B. show to be held at the Royal Horticultural New Hall, Westminster, London, S.W.1. The central feature will be a radio and space research display by the Science Research Council, and Dr. J. A. Saxton, director of the Radio and Space Research Station will open the exhibition at 12.00 on September 27th, and it will remain open until September 30th from 10.00 to 21.00 each day. On the *Wireless World* stand will be displayed the digital computer being described in our current series of articles; the amateur s.s.b. transmitter described by C. J. Salvage in the March and April issues, the Dinsdale stereo/mono transistor amplifier and D.E.O'N. Waddington's stereo decoder (January). Admission 3s. The exhibitors are:—

- |                                 |                                   |
|---------------------------------|-----------------------------------|
| Amateur Radio Mobile Society    | Partridge Electronics             |
| Baden-Powell House              | Peter Seymour                     |
| Scout Amateur Radio Group       | P.F. Ralfe Radio                  |
| Brit. Amateur Radio             | Philadelphian Electronics         |
| Teleprinter Group               | Practical Electronics             |
| Brit. Amateur Television Club   | Radar and Electronics Association |
| Daystrom                        | R.S.G.B.                          |
| Electroniques (STC)             | R.A.F.                            |
| Enthoven Solders                | R. Navy                           |
| G.P.O.                          | Royal Signals                     |
| Imhof                           | Science Research Council          |
| International Short Wave League | Short Wave Magazine               |
| J. Beam Engineering             | Swanco Products                   |
| K. W. Electronics               | T.W. Electronics                  |
| Low Electronics                 | Wamrac                            |
| L.S.T. Components               | Weller Electric Corporation       |
| Northern Polytechnic            | Wireless World                    |

# BBC-2 RECEPTION

## Survey in service areas of Crystal Palace, Sutton Coldfield and Winter Hill

**A**n inadequate or badly installed aerial was found to be the major cause in more than 50% of the households where reception of BBC-2 was unsatisfactory. Of the total sample of over 1,500 households within the 70 dB field strength contours of the Crystal Palace, Sutton Coldfield and Winter Hill u.h.f. transmitters 24% were using aerials which were not designed for u.h.f. reception and only 31% had outdoor aerials. Because of these and other factors, e.g. incorrectly adjusted receivers, only 64% of the householders assessed their reception as satisfactory. However, investigations proved that more than 90% of viewers in the total sample of households, and 98% in the Crystal Palace service area, would be able to receive BBC-2 satisfactorily "provided they have a properly installed [10-element] aerial of the correct type and a correctly adjusted receiver with a reasonable performance." Incidentally, the effect of an inadequate aerial was found to be much more severe on u.h.f. reception than on v.h.f.

These are some of the findings of a survey carried out by the Engineering Division of the B.B.C. in order to obtain reliable information on the standard of BBC-2 reception in viewers' homes, and where possible to compare this with the reception of BBC-1 and ITV.

Some 40 technical staff were employed in this operation; they visited and checked receiver installations at over 1,500 households. The sample of households was provided by the B.B.C.'s Audience Research Department after a preliminary investigation to find homes where there were BBC-2 receivers. They were selected from areas within the 70 dB (reference  $1 \mu\text{V}/\text{m}$ ) field-strength contours of the transmitters, avoiding known major pockets of poor reception which will be served by BBC-2 relay stations. The contour corresponding to a median

field strength of 70 dB above  $1 \mu\text{V}/\text{m}$  represents the approximate limit of the service area of a u.h.f. transmitter.

The grade of reception was assessed by the viewer as well as by the more critical B.B.C. technical staff and the results recorded on detailed questionnaires. These were overall assessments resulting from a combination of all factors which affect the quality of the picture seen on the viewer's receiver.

Unsatisfactory BBC-2 reception resulted in many instances from the failure of viewers to adjust their receivers for best results. This difficulty appeared to be mainly concerned with receivers having continuous tuning over the u.h.f. band but some receivers with push-button pre-set tuning were also giving trouble due to mechanical instability.

Where outside aerials are used BBC-2 reception was technically assessed as being as good as, or better than, BBC-1 and ITV reception at 59% and 60% respectively of the total households investigated. In a further 24% of the households BBC-2 reception was only marginally worse than BBC-1 and ITV. The fact of BBC-2 being worse than BBC-1 and ITV does not necessarily mean it was unsatisfactory. As the survey was carried out during the winter when there is no sporadic E interference from distant co-channel stations in the v.h.f. band, the immunity of u.h.f. reception from this form of interference and the advantage over v.h.f. Band I reception, which would have shown up in summer, was of course not evident.

The survey confirmed that multipath propagation causing "ghosting" which is frequently troublesome in the v.h.f. bands, is not a serious problem with BBC-2 reception on u.h.f.

## STROBOSCOPIC HOLOGRAM INTERFEROMETRY FOR TRANSDUCERS

HOLOGRAPHY has made possible the formation of interference patterns of moving objects with rough surfaces; for instance, loudspeaker diaphragms and other electro-acoustic transducers.

One method of recording an interference hologram is to expose two consecutive holograms on the same photographic plate, one before and one after the object has been displaced or distorted. Alternatively, one exposure can be taken with the object in its normal position and the plate replaced in its original position. Viewing the object through this hologram then gives an interference pattern when the object is displaced. The brightness of such fringes, incidentally, is  $I = (J_n[4\pi d/\lambda])^2$ , where  $d$  is the vibration amplitude, and the fringes are spaced at  $\lambda/2$  intervals, with nodes showing as the brightest part.) Such patterns can be used to investigate and measure small displacements and modes of vibration.

Potentially greater application is envisaged at the N.P.L. for the technique in which a hologram is recorded with a stationary object, and then the object, now moving, is viewed through the processed hologram. If the laser illumination is interrupted with the same frequency as that of the object a stroboscopic effect is obtained.

The illustration shows a time-averaged hologram reconstruction of an elliptical loudspeaker vibrating at 1 kc/s. The fringe pattern shows contours of equal vibration amplitude

spaced at half wavelength intervals on the loudspeaker cone.

Interferometry of this type is of interest because the surfaces investigated need not be smooth and regular, as required for normal interferometry, and even irregular living structures can be investigated.



# STEREO SIGNAL SIMULATOR

Silicon transistor design for setting up stereo decoders and tuners

By D. E. O'N. WADDINGTON, A.M.I.E.R.E.

IN an earlier article, the author pointed out the fact that the performance of a stereo decoder could best be optimized using a known multiplex signal. Although the B.B.C. are transmitting regular test signals, they do not provide the entire answer as it is necessary to have a "good" receiver to make use of them. True multiplex signal generators are expensive and, for the amateur, relatively hard to come by. In view of this, the author decided that there could be a use for a circuit which would generate a simulated multiplex signal, i.e. a signal which, although not true multiplex, exhibits multiplex properties.

The first step was to decide what kinds of signal would be most useful. For setting up purposes the signal should consist of an audio frequency (e.g. 1 kHz), 19 kHz pilot tone and L - R information to give either left or right hand channel simulation. In addition to setting up, a distortion check is desirable. In order to do this it is only necessary to provide a low distortion audio frequency signal and the 19 kHz pilot tone. These signals are all that are necessary to set up the decoder but if this source is to be used for setting up f.m. tuners as well, it would be useful to include a frequency modulated r.f. oscillator. From the above signal requirements it was then possible to draw out a block diagram of the complete signal simulator, see Fig. 1.

## 19 kHz PILOT OSCILLATOR

As low cost, as well as simplicity, was considered to be an essential, the 19 kHz oscillator was designed using a simple LC circuit. Ideally, of course, a quartz crystal should be used to control the frequency. However, by using a polystyrene capacitor and a ferrite cored inductor, it is possible to produce a tuned circuit having a low temperature coefficient, of the order of 1 Hz/deg C. Although this would not be good enough for transmission

purposes, it is perfectly adequate for setting up decoders, particularly as it is possible to synchronize the frequency with that of a stereo transmission if this is felt to be essential. The oscillator was designed around the basic Colpitts configuration but, in order to ensure that the output waveform was reasonably free from distortion, a simple a.l.c. circuit was included. This was achieved by connecting a diode D1 in series with the feedback path to the emitter of Tr1. When the circuit is first switched on, this diode is forward biased with the result that oscillation starts normally. When, however, the amplitude of oscillation is such that the voltage developed across  $R_{e1}$ , due to rectification by D2 and D3, approaches the voltage at the emitter of Tr1, the diode D1 starts to turn off thus limiting the feedback and hence the oscillation amplitude. It is interesting to note that this amplitude limiting action has a further desirable effect in that it helps to ensure that the frequency of oscillation is more or less independent of supply voltage. In the prototype it was found that the frequency only varied 4 Hz for a 20% supply voltage change.

## FREQUENCY DOUBLER

The full wave rectifier (D2 and D3) which provides the a.l.c. voltage actually has a more important role to perform, namely, that of frequency doubler. The rectified wave form is taken to the base of Tr2; the collector circuit of which consists of a transformer with a tuned primary. The secondary of this transformer feeds through a phase reversing switch to the mixer. In order to prevent the operation of the switch in the secondary circuit from upsetting the tuning of the transformer and thus the phase relationship between the pilot tone and the sub-carrier, a special winding method was devised (see Fig. 2). The secondary was wound on first in two

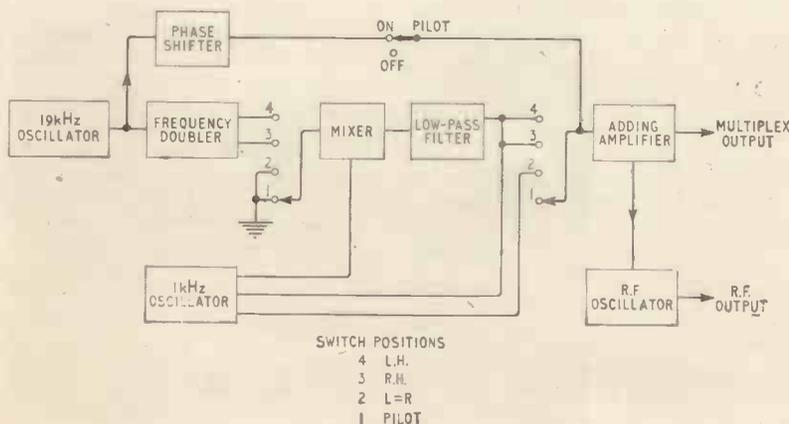
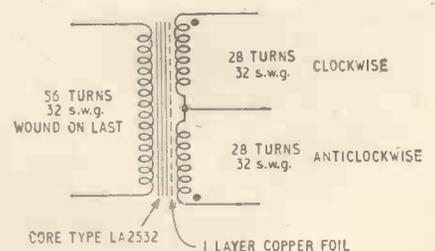


Fig. 1. Block diagram of stereo signal simulator.

Fig. 2. Winding detail for T2.



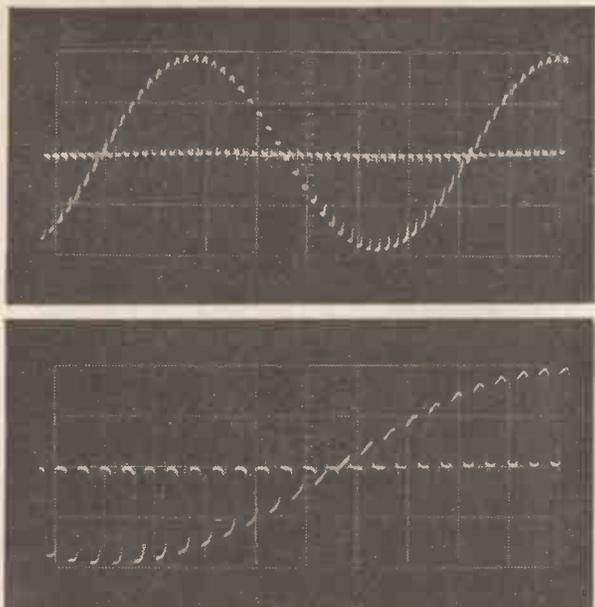


Fig. 3. Top: Waveform at Tr3 collector. Below: Expanded trace of collector waveform.

sections side by side, arranged so that the start of each winding was near the former and the finish on the outside. In order to achieve this and yet to maintain the correct phase relationship, these two halves are in fact wound in opposite directions. Between the secondary and primary is an electrostatic shield consisting of one layer of copper foil. This winding method has the effect of balancing the secondary so that the operation of the phase reversing switch no longer reflects a capacitance change into the primary and the phasing of the pilot tone and sub-carrier is maintained within reasonably close limits.

#### MIXER AND LOW-PASS FILTER

As a simple suppressed carrier mixer was required, the shunt gate was chosen, its performance being adequate. So that the loading presented to the secondary of T2 should appear more or less constant throughout the cycle the diode D4 in series with a 22 k $\Omega$  resistor was included. The output of this mixer is fed to a low pass filter, the function of which is to remove the harmonic components from the switching waveform. As the phase response of this filter is of prime importance it was decided to trade rejection against phase response and to use a slightly higher cut-off frequency than would have been expected. In order to compensate slightly for this a Papoulis class L filter<sup>2</sup> was chosen. While this configuration retains a relatively linear phase and amplitude response in the pass band, the amplitude response falls off more rapidly outside than the conventional Butterworth design. This filtering does not remove all the distortion from the output but, for all practical purposes it is good enough. When the first model was built it was found that although the signal at the shunt gate appeared to be correct (see Fig. 3) the output from the filter had poor channel separation. Naturally enough the filter was blamed, but when the relative amplitudes of the frequency components before and after the filter

were examined using a wave analyser, it was found that in point of fact the shunt gate mixer was not providing the required output. A quick examination of the arithmetic of shunt gate mixers showed that the results were as would be expected and that this effect would need to be compensated for. Fortunately no phase complications arise and all that is necessary is to add the requisite amount of unmodulated signal, in phase, to the signal at the output of the filter. This is done *via* R<sub>20</sub> and RV2.

#### ADDING AMPLIFIER

The function of this amplifier is to assemble the final output signal. It consists of a three stage amplifier with feedback from the emitter of the output stage directly to the input thus making the input a virtual earth. The interesting feature of the output stage is the level control circuit. By making the collector resistor of Tr6 a 600 $\Omega$  potentiometer with the collector connected to the wiper, it is possible to vary the output level from zero to maximum while leaving the output impedance fixed at 600 $\Omega$ . Although this circuit has the disadvantage that there can be no overall negative feedback, the performance is adequate. With an output of 2 V r.m.s. the distortion introduced is less than 0.08% second harmonic and 0.01% third.

#### PILOT TONE

The pilot tone is taken, *via* a phase shifting network, from the secondary of the 19 kHz oscillator transformer. The range of variation available from this phase shifting network is more than sufficient to compensate for any phase shift in the frequency doubler and mixer circuits. As the correct phasing is most important it should only be set after all other tuning adjustments have been made. The method of setting the phase is as follows:—

1. Set the main selector switch to L or R, disconnect one end of R<sub>17</sub> and connect the output to the x input of an oscilloscope.
2. Connect the y input of the oscilloscope, preferably *via* a high impedance probe, to point A.
3. Adjust RV1 until the waveform is as shown in Fig. 4. It may be necessary to adjust the value of R<sub>11</sub> in order to obtain the correct proportion of pilot tone. On left or right hand channel, the pk-pk value of the pilot tone should be 10% of the pk-pk value of the waveform.

#### A.F. SOURCE

This need not be included in the signal simulator as any a.f. source providing up to 0.5 V r.m.s. may be used. However, for the sake of completeness an audio oscillator circuit is included. The circuit is a fairly conventional Wien bridge oscillator. The number of phase shifts within the loop has been reduced to a minimum by permitting both a.c. and d.c. feedback through the thermistor. The d.c. component, however, is so small as to produce negligible additional heating of the thermistor so that the amplitude control characteristic is unimpaired. The frequency of oscillation is approximately 1 kHz.

#### R.F. OSCILLATOR

The circuit used is a modification of the Clapp oscillator arranged so that the output is 50 $\Omega$ , and so that the tuned circuit acts as a  $\pi$  section filter thus ensuring that the

output wave form is a reasonably good sinusoid. A feature of this design also is the method of confining the radio frequency currents so that there is no necessity for additional decoupling components. Frequency modulation is accomplished by means of a variable capacitance diode connected across the main tuning capacitors. In order that the modulation shall be reasonably linear, a fixed bias is applied to this diode in addition to the modulation voltage. The frequency deviation is set by means of RV3. The easiest way to set this is to use a

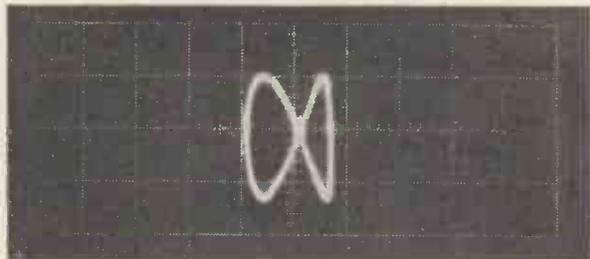


Fig. 4. Lissajous figure showing correct pilot tone phasing.

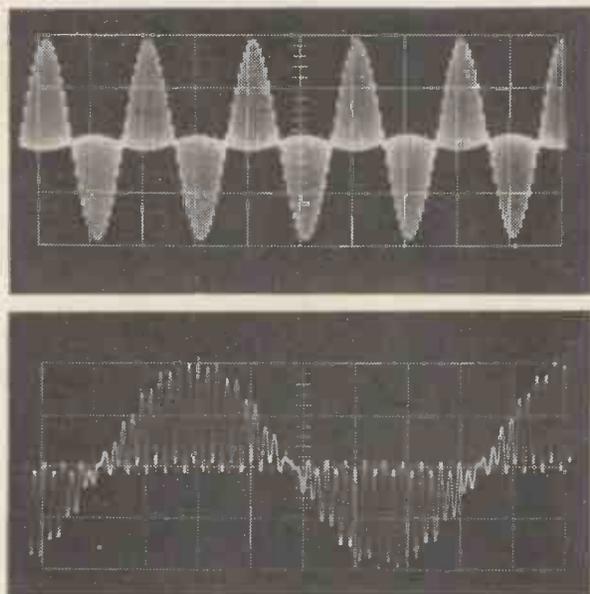


Fig. 5. Upper trace: output signal with incorrect compensation. Lower trace: output signal with correct compensation and 19 kHz pilot tone added.

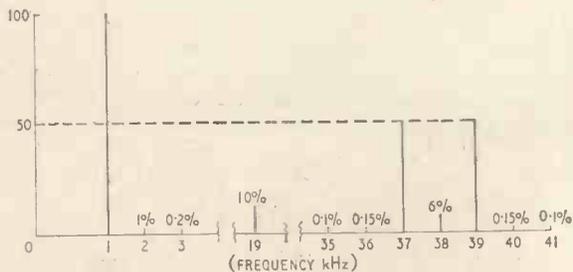


Fig. 6. Spectrum of simulator output with 1 kHz modulation of right-hand channel.

f.m. receiver with a known discriminator characteristic and to measure the pk-pk voltage output with only the pilot tone as modulation.

## SETTING UP

There are only four adjustments which need to be made: the first is to set the frequency of the 19 kHz oscillator. This should be set as exactly as possible by adjusting the core of T1. If available, a frequency counter is the ideal instrument for the job. In the absence of a counter, however, the best method is to use a Lissajous figure on an oscilloscope. The pilot tone from a stereo broadcast makes the ideal standard if this method is to be used. The next setting is the frequency doubler. The core of T2 should be adjusted to give a maximum output to the mixer.

The channel separation depends on two settings, namely, the pilot tone phasing which has already been described, and the proportions of components in the composite signal. This is set up either on the left or right hand channel with the pilot tone switched off. The method is to apply a modulation of 1 kHz and to view the overall output on an oscilloscope (see Fig. 5). RV2 is then adjusted so that the "base line" of the signal is straight. In order to obtain optimum channel separation, it is necessary to expand the picture in the y direction to judge when the best setting has been made.

## LIST OF COMPONENTS

### Signal Simulator

R <sub>1</sub>	8.2 kΩ	C <sub>1</sub>	0.1 μF Mylar
R <sub>2</sub>	18 kΩ	C <sub>2</sub>	0.01 μF ± 1% polystyrene
R <sub>3</sub>	10 kΩ	C <sub>3</sub>	2 μF 12 V
R <sub>4</sub>	4.7 kΩ	C <sub>4</sub>	150 pF polystyrene
R <sub>5</sub>	10 kΩ	C <sub>5</sub>	2 μF 12 V
R <sub>6</sub>	6.8 kΩ	C <sub>6</sub>	0.1 μF Mylar
R <sub>7</sub>	8.2 kΩ	C <sub>7</sub>	As C <sub>6</sub>
R <sub>8</sub>	68 kΩ	C <sub>8</sub>	0.1 μF Mylar
R <sub>9</sub>	15 kΩ	C <sub>9</sub>	1.6 nF ± 1% polystyrene
R <sub>10</sub>	1 kΩ	C <sub>10</sub>	860 pF ± 2% polystyrene
R <sub>11</sub>	1 MΩ	C <sub>11</sub>	500 μF 6 V
R <sub>12</sub>	10 kΩ	C <sub>12</sub>	500 μF 6 V
R <sub>13</sub>	10 kΩ	C <sub>13</sub>	330 pF ± 5% polystyrene
R <sub>14</sub>	22 kΩ	C <sub>14</sub>	10 nF
R <sub>15</sub>	10 kΩ	C <sub>15</sub>	500 μF 12 V
R <sub>16</sub>	10 kΩ	Tr1-Tr6	BC 108
R <sub>17</sub>	2.2 kΩ	D1	OA47
R <sub>18</sub>	1 kΩ	D2-D4	1s44
R <sub>19</sub>	3.3 kΩ	L1	11.1mH. 141 turns of 36 s.w.g. Core LA2532.
R <sub>20</sub>	33 kΩ	T1	Primary: 112 turns of 36 s.w.g. tapped at 56 turns. Secondary: 112 turns of 36 s.w.g. tapped at 56 turns. Core type LA 2532
R <sub>21</sub>	6.8 kΩ	T2	See Fig. 2.
R <sub>22</sub>	1 kΩ	<b>Audio Frequency Oscillator</b>	
R <sub>23</sub>	1.8 kΩ	C <sub>16</sub>	25 μF 6 V
R <sub>24</sub>	10 kΩ	C <sub>17</sub>	33 nF ± 5% polystyrene
R <sub>25</sub>	10 kΩ	C <sub>18</sub>	33 nF ± 5% polystyrene
R <sub>26</sub>	6.8 kΩ	C <sub>19</sub>	680 pF ± 10%
RV1	250 kΩ	C <sub>20</sub>	100 μF 6 V
RV2	47 kΩ	C <sub>21</sub>	100 μF 6 V
RV3	250Ω	Tr7	BC108
		Tr8	2N3702
		Tr9	BC108
		<b>Radio Frequency Oscillator</b>	
		C <sub>22</sub>	1 μF
		C <sub>23</sub>	8-20 pF
		C <sub>24</sub>	150 pF
		C <sub>25</sub>	3.3 pF
		C <sub>26</sub>	150 pF
		C <sub>27</sub>	100 pF
		Tr <sub>10</sub>	2N706
		D5	BA110
		L <sub>2</sub>	4t 22 s.w.g. enam 0.3in dia. 0.3in long
			All resistors 10% ½W types

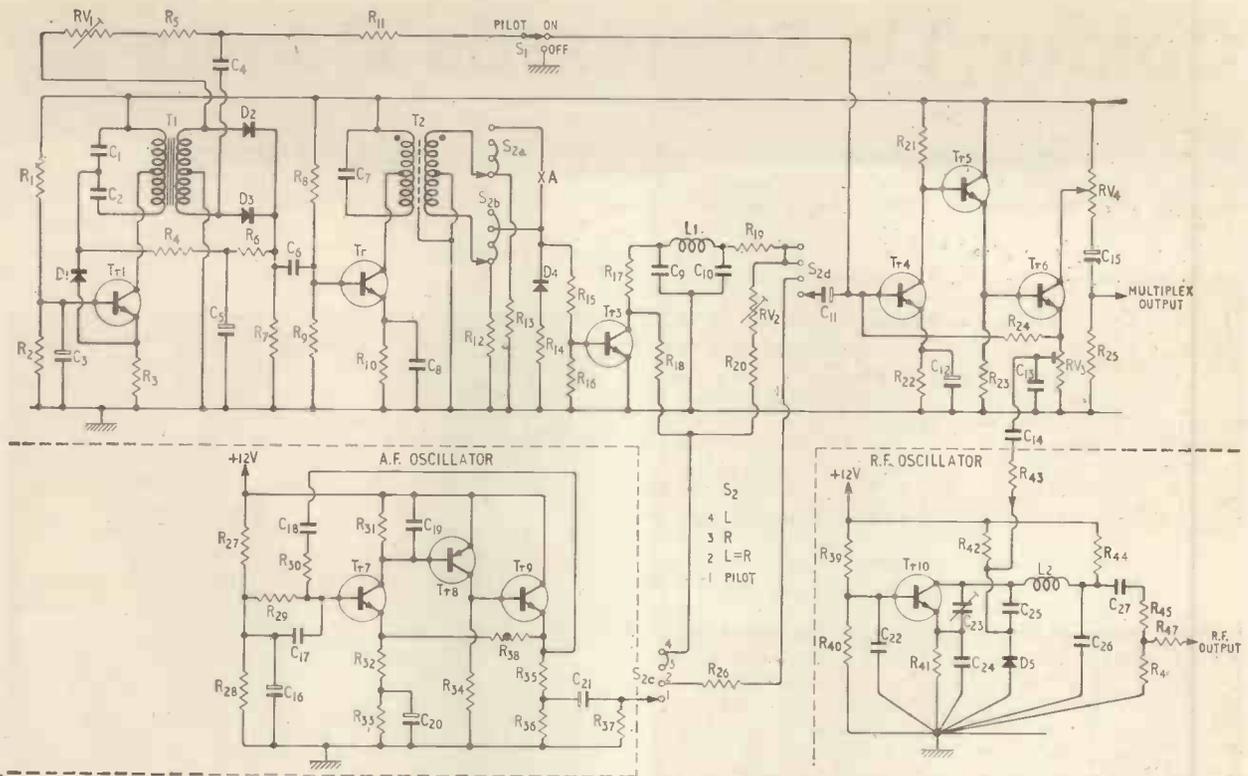


Fig. 7. Complete circuit of simulator showing a.f. and r.f. (carrier) oscillators separately

### PERFORMANCE

In the experimental model the following performance figures were measured with a modulation of 1 kHz.

1. Distortion on signal  $L=R$ : 0.1%.
2. The spectrum of the signal in the right hand channel is shown in Fig. 6.
3. The channel separation was 35 dB.
4. The output of the r.f. section was 10mV and the

channel separation had not deteriorated to any measurable extent.

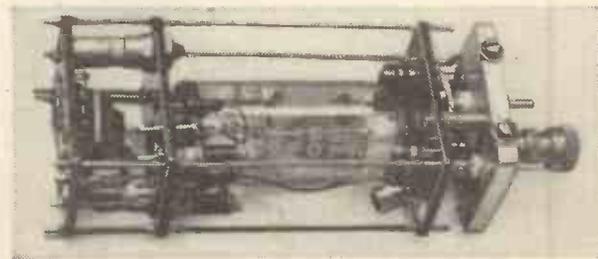
### REFERENCES

1. "A Stereo Decoder," D. E. O'N. Waddington. *Wireless World*, Jan. 1967.
2. "Comparison of Five Methods of Low-pass Filter Design," A. G. J. Holt. *Radio and Electronic Engineer*, March 1964, p. 167.

## Temperature Compensation Method for Oscillators

IN some applications frequency stability of crystal oscillators by ovens is not convenient, for instance, where short heating time is required or because of power limitations. Stability in such cases can be had by arranging for a compensating network, incorporating a temperature sensitive element, to provide a control voltage which is applied to a frequency compensating capacitance diode. This method, however, can only be used if the frequency variation is small, as in the case of selected AT-cut crystals. Since this selection is wasteful and expensive a method has been developed at the Marconi Research Laboratories which can be applied to all crystals with a parabolic frequency-temperature law. If two crystals with different turnover frequencies are connected in parallel then the temperature range over which compensation can be obtained is increased. The compensated frequency is, however, higher than the turnover frequency of the parabola.

As an example of the technique an oscillator was shown which used two 8 Mc/s crystals with turnover temperatures of  $-44$  and  $+84^{\circ}\text{C}$ . With a circuit capacitance adjusted to give maximal flatness to the  $f-T$  curve stability was  $\pm 1$  in  $10^6$  over a range  $-26$  to  $+66^{\circ}\text{C}$ .



# Colour TV Standards Converter

Electronic field rate conversion in new B.B.C. equipment for changing North American to European transmission standards

AS a result of a new development in processing complete television fields, it is now possible to convert North American 525-line, 60 fields/second, N.T.S.C. colour television pictures into European 625-line, 50 fields/second PAL colour pictures (or vice versa) by entirely electronic means. This major technical achievement in the transformation of television signal information is the work of the B.B.C. Designs Department—in particular a team led by Peter Rainger—and it makes London a world centre of expertise in the specialized technology of standards conversion. The equipment is installed in a laboratory near Broadcasting House, and at the time of going to press is scheduled to be put into operation on 10th September to convert to European standards live colour pictures relayed from the U.S.A. by the Early Bird satellite—the programme being the World Golf Series finals in Cleveland, Ohio. Meanwhile, *Wireless World* has seen a demonstration of the equipment in which live and recorded colour programme material was sent from the Canadian Broadcasting Corporation's Toronto studio centre to Broadcasting House via Early Bird. The converted colour pictures were astonishingly good, considering the enormous length of the circuit and the complexity of the equipment they had passed through. Comparison with the received 525/60 pictures also displayed during the demonstration showed that any slight defects that could be discerned were those existing in the signals before conversion.

The principal units of the conversion equipment are shown in Fig. 1. It is the first unit on the left, the "field store converter," which is the new development referred to above. This converts the 60 fields/sec incoming picture into a 50 fields/sec picture (without changing the number of lines), and its principle of operation will be described later. The resulting 525/50 signals are fed into an N.T.S.C. decoder, similar in principle to that in an American domestic colour receiver, and here the luminance and chrominance components are separated and the *I* and *Q* chrominance signals obtained by synchronous demodulation. The luminance component is passed into an electronic line store converter—a B.B.C. designed equipment of the type that has been



The complete conversion equipment in a B.B.C. laboratory near Broadcasting House, London

in operation for some years\*—which changes the black-and-white picture to the 625-line standard. A second electronic line store converter changes the *I* and *Q* chrominance signals to the 625-line standard. All three components, now on 625-line standards, are fed into a PAL colour encoder, from the output of which is obtained the European 625-line 50 fields/sec PAL colour signal. Alternatively the same three components could be encoded to provide a 625-line SECAM picture for

\* See "Electronic Standards Conversion," *Wireless World*, October, 1963, p.494.

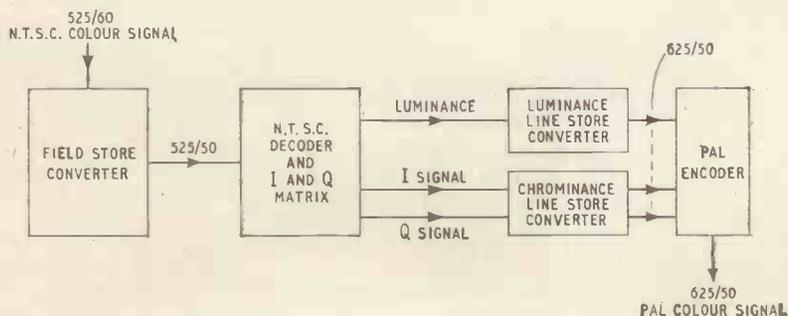


Fig. 1. Schematic of the complete conversion system. The new electronic field store converter is the first unit in the chain.

distribution to those countries requiring it. If only black-and-white signals are incoming to the equipment, the luminance line store converter alone provides the 625/50 picture.

### Redistributing fields in time

In the field conversion process the basic problem is, of course, that there are 60 American fields to every 50 European fields, or, in a 0.1 sec interval, six American to five European (see Fig. 2). A related problem is that the American field occupies less time than the European field. The field-store converter deals with this situation by redistributing the 525/60 fields in time so that they fit into the time "slots" for fields laid down by the European standard. Since the 525/60 fields are shorter, this means that they must be temporarily stored—hence the name "field store converter"—and read out from the store at the required 50 field/sec rate.

The process can be understood more precisely from Fig. 2, which shows any 0.1 second interval, encompassing six American and five European fields. If the two systems start scanning simultaneously, the first American field will have been completed slightly before the first European field. Consequently the information can be transferred directly without shifting in the time scale. The second American field, however, begins slightly before the second European field, should begin—16.6 ms after the start of the sequence as opposed to 20 ms. A delay of just over 3.3 ms is therefore introduced, as shown, so that the start of American field No. 2 is delayed until just after the correct instant for the start of European field No. 2. This process is continued, the delays increasing with successive fields, until American field No. 5 becomes European field No. 5.

In the explanation of Fig. 2 so far, American field No. 6 in the cycle has not been accounted for. If this were simply discarded the omission of one field in every six would result in a jerky picture, particularly on fast movement. To overcome this difficulty a delay of 16.6 ms is introduced to make American field No. 6 occur at the

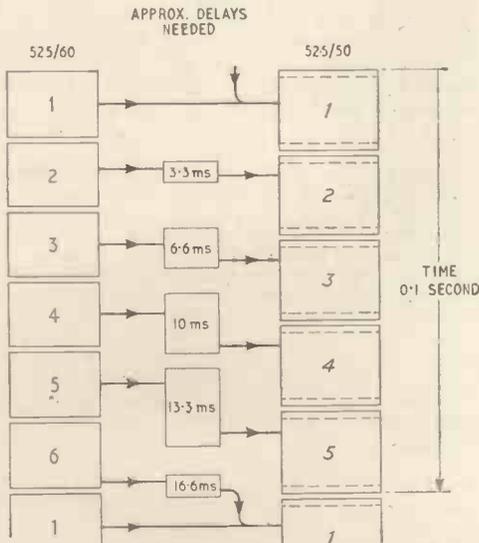


Fig. 2. The sequence of delays necessary to change the timing of the American fields to that of the European fields. (The second stage of interpolation is not shown).

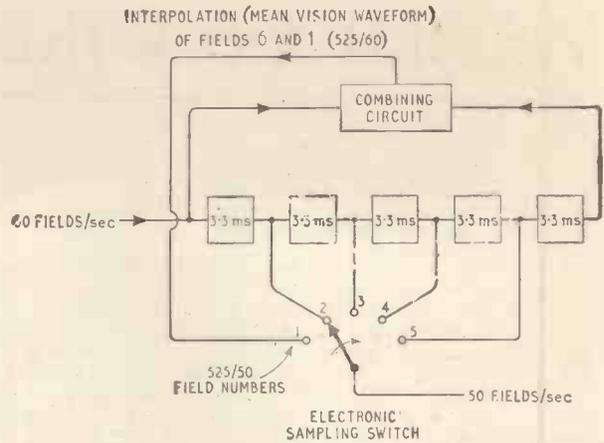


Fig. 3. Principle of the electronic system of the field store converter (not showing second stage of interpolation).

same time as American field No. 1 in the next six-field cycle, then the two fields are combined to form an "interpolated" version (the mean value of the No. 6 and No. 1 waveforms) which becomes the No. 1 field in the next European cycle. This interpolation process is repeated for European field No. 2, and as a result any jerkiness that would otherwise appear is smoothed out in the final picture.

### Reduction of picture size

As the number of lines per field is not altered by the introduction of the delays, and the 525 lines occupy less time than the 625 lines in a European field, there will be a space at the top and bottom of the outgoing 525/50 picture, as indicated by the dotted lines. Consequently the height of the outgoing picture is too small for the width, and as a result of this geometrical distortion any circular object would appear oval. This defect, however, is rectified later in the line store converters, which compress the picture in a horizontal direction. The net result, as could be seen at the demonstration, is that the picture geometry is corrected, but there is a black border all round the picture. This is a fundamental limitation of the system which must be accepted but will probably be eliminated in later, more complex, converters.

The basic principle of the electronic system of the field store converter is illustrated in Fig. 3. The incoming signal is passed through a chain of five delay lines of approximately 3.3 ms each, giving a total delay of 16.6 ms or one complete American field. Glass ultrasonic delay lines are used for the 3.3 ms units, and the 525/60 signal is passed through them as amplitude modulation on a 24 MHz carrier. An electronic switch samples the delay-line outputs in turn in such a way that the required delays shown in Fig. 2 for the successive fields are progressively built up. The intervals in which the "wiper" of the electronic switch "moves" from one "stud" to the next are the 1/5-field gaps indicated by the dotted lines in Fig. 2. When a field has passed through the chain it has been delayed by one complete field period, so American field No. 6 emerges from the line at the right time to be combined with American field No. 1 in the next cycle. The two are combined as shown and the interpolated version is picked up by the electronic switch as European field No. 1. By recirculation of the information through the delay chain, the interpolation process is repeated to form European field No. 2.

# WORLD OF WIRELESS

## Mariner V Communications

MARINER V launched 14th June from Cape Kennedy, Fla., U.S.A., is expected to pass Venus on 19th October after travelling 216 million miles. This 540-lb spacecraft will be about 2,500 miles from the planet's surface on the latter date. Two-way communication with Mariner V is accomplished with a radio link between Earth tracking stations and a dual transmitter, single receiver, radio system in the spacecraft. Communications are transmitted in binary digital form, and radio command pulses to Mariner are decoded in a command sub-system—on board—and routed to their proper destination. The spacecraft is capable of accepting 29 direct commands and a quantitative command (for mid-course trajectory manoeuvre). A 100-channel telemetry sub-system can sample 90 engineering and science measurements; the data gathered, which includes voltages, pressures, currents, temperatures and other values measured by telemetry sensors and scientific instruments, is prepared for transmission by a data encoder also aboard the spacecraft. The tape recorder uses 50 feet of magnetic tape in an endless loop, and science measurements prepared by the data automation system are recorded simultaneously on two tracks at 66½ bits per second. Playback of data will take approximately 36 hours at the rate of 8½ bits per second, playback is from one track at a time at a tape speed of 0.01 in per second. The spacecraft S-band receiver will operate continuously during the mission at 2116 Mc/s. It will receive Earth commands either through the low or high-gain aerial.

## Television Teaching Aid

AN audio-visual system called E.V.R. (electronic video recording and reproduction) is to be manufactured and marketed by Ciba Ltd., of Switzerland, Columbia Broadcasting System, Inc., of America, and Imperial Chemical Industries who have formed a partnership in the U.K. This system is so designed that television sets in homes and schools can be used to display recorded programmes from ciné film and video tape at low cost.

The E.V.R. system uses an electron beam recorder which takes off information from a television camera, magnetic tape, or cinema film, and uses this information to generate an E.V.R. master in colour or black-and-white on 8.75 mm unperforated thin film. This film will be produced by Ilford Ltd. (joint subsidiary of I.C.I. and CIBA), and it will be loaded into cartridges seven-inches in diameter and about half an inch thick. The cartridge is inserted into a player attached to the aerial terminals of a television receiver and the information displayed on the screen. The film from the cartridge is automatically threaded, played, rewound, and the cartridge then ejected from the player. The film moves at a speed of five inches per second, can be stopped at will, and a still frame held. It is stated that an E.V.R. cartridge is capable of carrying up to one hour of black-and-white programme or a half hour of colour. Original colour material is recorded in monochrome and reproduced in colour on colour television sets.

For teaching purposes particularly, it is interesting to note that one cartridge player can be used to play back information to a number of television receivers simultaneously. It is also possible to use film strips or ciné film with this machine.

Demonstrations of the system are expected next spring, and cartridges and players (prototype production types to be made by Thorn Electrical Industries) will be available in the spring of 1969.

## Colour Television Test Card (F)

FEATURES of the B.B.C. 625-line colour test card include coloured edge castellations to check colour synchronization effects and picture size; a grid with corner diagonals and centre circle enabling picture geometry to be assessed; a "letter box" pattern to test low-frequency effects, and a six-step grey scale, with frequency gratings designed to produce signals of approximately square waveform corresponding to frequencies of 1.5, 2.5, 3.5, 4.0, 4.5, and 5.25 Mc/s. A colour picture is contained in the centre circle to facilitate the assessment of overall picture quality and flesh tones.

In the information sheet 4306(1) July 1967 including a coloured facsimile of the test card (5s for six copies) received from the B.B.C. Engineering Information Dept., the following points are discussed. (1), checking decoder performance, (2) reference generator faults, (3) sync separator performance, (4) resolution, (5) convergence checking, (6) the colour picture, (7) aspect ratio, (8) picture size, (9) contrast, (10) resolution and bandwidth, (11) scanning linearity, (12) line synchronization, (13) low-frequency response, (14) reflections, and (15) uniformity of focus.

Additional comments and information on the use of the test card which may be helpful to service and installation technicians have been issued by the British Radio Equipment Manufacturers' Association, 49 Russell Sq., London, W.C.1. These comments concern colour bars, resolution, convergence, picture size, and contrast.

PAL and SECAM programmes will be interchangeable, state AEG-Telefunken, of Frankfurt, Germany, through a specially designed coder-decoder. Dr. Walter Bruch, inventor of the PAL colour system, has developed this device which will transform signals from the French SECAM system, so that they can be received by television receivers working on the PAL system. It will also be possible to exchange programmes in the reverse direction without any degradation. Although the principle of this coder-decoder has already been demonstrated, it would be some time before the unit reaches the manufacturing stage.

The programme for the fourth Ultrasonics for Industry conference and exhibition has been compiled by our associate journal *Ultrasonics* in collaboration with the Acoustics Group of the Institute of Physics and the Physical Society. The conference—to be held at St. Ermin's Hotel, London, on October 31st and November 1st—will consist of 16 thirty-minute lectures, ranging from production and industrial uses of ultrasound, through hazards of airborne ultrasound, to animal sonar and sub-bottom surveys by acoustic methods. Finally applications such as the ultrasonic interferometer, and medical diagnostic equipment will be discussed. Application forms are available from the organiser, 'Ultrasonics for Industry' Conference and Exhibition, Dorset House, Stamford Street, London, S.E.1.

A satellite earth station for Mount Margaret in Kenya is announced by the East Africa Common Services Authority. To be operational by early 1970, the construction and operation of this station will be the responsibility of the East African Telecommunication Company Ltd. Tenders are to be invited from manufacturers for equipment and installation.

Comprehensive performance data, reliably measured under real or simulated operating conditions are essential to using instruments efficiently, or promoting their use without inviting misapplication. S.I.R.A. (British Scientific Instrument Research Association) have provided such an evaluation service for several years, and in view of the internationally expanding interest in this field of applied science, are arranging for a one-day symposium in London on 10th November, the title will be **Progress in Instrument Evaluation**. Six papers will be presented in two sessions, covering topics such as specifying and proving instrument performance, and the importance of environmental testing. Further information from Head of Industrial Communications Group, SIRA, South Hill, Chislehurst, Kent.

**American f.m. Success Story.**—Statistics from the American Electronic Industries Association record that in the first six months of the year, the proportion of radio receivers in the U.S. market with f.m. facilities was 39.3%, the highest so far recorded. From 1961 (with 119,000) to 1966 (with 1.29 million), clock radios in the market with f.m. features increased by 984%. Mr. Wayman, spokesman for the E.I.A. Consumer Products Division, said that "we're heading for a 50 million radio sets year," compared with 20 million sets in 1957. He admitted that although technology and styling had a lot to do with this growth, it was also true to say that "a great influence in the return of radio had been the superior sound capabilities of f.m. and stereo transmission."

**Colour Television Engineering.**—A course of 26 lectures covering the basic engineering requirements for colour television will commence on 9th October at 18.30 at the Northern Polytechnic, Holloway Road, N.7, and on Monday evenings thereafter. Specialist lectures will be given by well-known engineers from industry and broadcasting organizations. The subject matter of these lectures will range from a resumé of black-and-white technique, through a consideration of N.T.S.C. and PAL systems, display systems, receiver design, picture originating equipment, to test equipment, aerial systems, and video-tape recording. A good fundamental knowledge of black-and-white technique is required, and minimum entry requirements are Final R.T.E.B. Certificate or Final C. & G. Telecommunications Technician's Certificate. Fee for the course is £2.

**International Conference on Colour Television.**—This conference will be held in Paris from April 1st to 5th next year in connection with the International Exhibition of Electronic Components and is sponsored by F.N.I.E. (Electronic Industries Association of France). The scientific and technical aspects of the development of colour television will be considered under three main headings: the reproduction of pictures in colour; television equipment and the exploitation of broadcasting networks; and colour television reception. Information concerning the submission of papers to this conference can be obtained from Colloque International sur la Télévision en Couleur, 16 rue des Presles, 75-Paris 15.

**Colour Television Fair.**—A two-week colour television exhibition is to be held by Mullard Ltd., at Mullard House from November 17th to December 2nd. This is primarily a show for the public, and set manufacturers will be displaying sets, many of them working in domestic settings. Both the B.B.C.—with an information stand—and the independent television companies are supporting this fair, where there will be continuous shows of colour programmes. Details of ticket distribution will be announced later.

"**Non-Destructive Testing**" was published for the first time in September, by Iliffe Science and Technology Publications Ltd., 32 High Street, Guildford, Surrey. This new quarterly journal will provide full coverage of the techniques, economics, and management of non-destructive testing. Annual subscription rates are: U.K. £6, overseas £10.



Malcolm Nisbet, compère of the B.B.C. World Service's latest programme *World Radio Club*, indicates the target area of his programme and the club card. He gives DX news as well as tips to newcomers on how to improve shortwave reception.

An exhibition of American electronic production equipment opens on November 13th at the Royal Lancaster Hotel, London. About 50 American manufacturers are expected to participate in this exhibition, which covers such items as spray etches, precision etches, screen printers, welding and encapsulating equipment, integrated circuit processing equipment, and other machinery for producing complex circuit boards, miniature transistors, diodes and packaged circuits. Open from 10.00 to 17.00 on the first day, and from 10.00 to 18.30 on November 14th to 18th. Information and tickets may be obtained from the Director, United States Trade Centre, 57 St. James Street, London, S.W.1.

A three-year research programme which will include an investigation into the fundamental physics and properties of materials which limit the performance of magnetic recording heads, is to be undertaken at the Welsh College of Advanced Technology, Cardiff. This research is being sponsored by Data Recording Instrument Co. Ltd.; manufacturers of recording heads for data processing and general industrial applications.

**Hong Kong Colour TV.** According to the July issue of *The World of Hong Kong*—the first of a series of monthly newspapers to be published by the Hong Kong Government Information Services—the Colony will be transmitting at least 40 hours of colour television programmes, weekly when a second channel starts up later this year. Of this number of hours, 32 will be filled with original programmes in Chinese.

**Redbridge Amateur Radio Society** is to be the title of a club being formed in the London borough of this name. Interested readers are invited to write to the Secretary, T. L. Stoakes, 62 Dudley Road, Ilford, Essex.

**Standard Frequency Transmission.**—We regret the misalignment, relative to the time scale, of the modulation schedules for WWV and WWVH in the diagram on p. 446 of the September issue.

An error occurred in the parts list of the article "**Low Distortion RC Oscillator**" by P. F. Ridler that appeared in the August 1967 issue. VR1 should have been described as a 50 k $\Omega$ , 2-gang, matched, curve A, potentiometer, Type CLR/192/17.

# PERSONALITIES

**W. J. Morcom, B.Sc.(Eng.), F.I.E.E.**, for the past two years Marconi's chief engineer (telecommunications) has been appointed manager of the company's Radio Communications Division. Mr.



W. J. Morcom

Morcom joined the company as a design engineer on broadcasting transmitters in 1933 after graduating from Imperial College on a Whitworth Scholarship from a Naval Dockyard. During the second world war he was concerned with radio combat and jamming techniques and in 1947 became head of Marconi's transmitter design group. From 1956-1965 he was chief transmitter engineer.

**Bernard Marsden, F.I.E.E., M.I.E.R.E.**, who has been with Associated Television Ltd. since 1955, latterly as group engineering controller, has joined London Weekend Television Ltd. as controller of operations. L.W.T. will, as its title indicates, be providing the weekend programmes for the London I.T.A. station to be relinquished by A.T.V. which will then be concentrated in the Midlands where they have so far operated only on weekdays. Mr.



B. Marsden

Marsden, who spent five years in commercial broadcasting before joining A.T.V., was previously in the domestic radio industry. From 1963 to 1967 he was technical controller of A.T.V.

**P. Scargill, A.M.I.E.R.E.**, who joined Union Carbide Ltd. a year ago as sales manager for the U.K. for capacitors and semiconductors, has been appointed general manager of the company's Electronics Division. Prior to joining Union Carbide he was with Hughes International (U.K.) Ltd. The company also announces that **Dr. J. S. Wager**, formerly general manager of the Electronics Division, has been appointed director, electronics, in Union Carbide Europe, Inc. in Switzerland.

English Electric Valve Company announces the appointment of **John Montgomery-Smith, B.Sc.**, as a sales engineer dealing chiefly with photo-



J. Montgomery-Smith

multipliers and image intensifiers. Mr. Montgomery-Smith, aged 33, graduated in physics from Manchester University in 1956 and then joined the Marconi Company where he spent some time on radar receiver development. In 1961 he went to Mullard Ltd. as a sales engineer responsible for thyristors and special industrial valves and for the past four years has been commercial product manager of the Infra-Red and Special Semiconductors Department.

"In recognition of his devoted and eminent service in the advancement of engineering in motion pictures, television and in the allied arts and sciences," the Society of Motion Picture and Television Engineers has elected **Dr. John G. Frayne**, an honorary member. Dr. Frayne, who was born in 1894 in County Wexford, Ireland, emigrated to the United States in 1914. He received his

B.A. degree from Ripon College, Wisconsin in 1917. In 1922 Dr. Frayne received his doctorate in mathematics from the University of Minnesota. He joined the American Telephone and Telegraph Company in 1919, after service in the U.S. Signal Corps. In 1929 he joined Westrex Corporation. In collaboration with Halley Wolfe of Westrex, he wrote "The Elements of Sound Recording." Dr. Frayne, in collaboration with R. R. Scoville, developed the intermodulation technique of distortion measurements.

**Arthur C. Clarke**, whose original article "Extra-terrestrial relays" outlining the principles of synchronous communication satellites was published in *Wireless World* in 1945, was presented with a certificate of honorary fellowship of the British Interplanetary Society when he addressed members on September 7th on "Voices from the sky; past, present and future of communication satellites."

**E. V. D. Glazier, Ph.D., B.Sc., F.I.E.E.**, head of the Physics & Electronics Department at the Royal Radar Establishment, Malvern, has been appointed director of the Establishment in succession to **G. G. Macfarlane, C.B., B.Sc., Dr. Ing., F.I.E.E.**, who has become controller of research. Dr. Glazier, who is 55, entered the Scientific Civil Service in 1935 serving first in the G.P.O. as an executive engineer and was transferred in 1942 to the Signals Research and Development Establishment where he took charge of the research division in 1950. He was director of scientific research (electronics and guided weapons) in the Ministry of Aviation from 1957 until 1959 when he was appointed head of the Ground Radar Department at R.R.E. where in 1963 he became head of military and civil systems.



Dr. E. V. D. Glazier

Alfred R. Laws, who has been manager of Marconi's Radio Communications Division since it was formed two years ago, has joined the board of Racal Communications Ltd. as commercial director. Mr. Laws spent six years in the Post Office Engineering Department before joining the Royal Signals in 1943.



A. R. Laws

In 1960, he retired from the Services with the rank of Major, having been responsible for the design, installation and commissioning of the Commonwealth Communications Army Network (COMCAN)—a world-wide h.f. communications system.

This year's recipient of the David Sarnoff award is Dr. James Hillier, vice-president of RCA Laboratories, for his "pioneering research on the electron microscope, including both electron optics and biological microscopy, and for his accomplishments as a research director and his inspiration to scientists young and old." The David Sarnoff Award was established in 1959 between the Radio Corporation of America and what is now the Institute of Electrical and Electronics Engineers. The award consists of a gold medal, a bronze replica of the gold medal, and \$1,000.

Captain L. S. Bennett, C.B.E., B.Sc., M.I.E.E., R.N. (Rtd.), education and training officer of the I.E.E. has retired after nine years' service on the staff of the Institution, and is succeeded by K. C. Jones, A.M.I.E.E., Grad.I.E.R.E., who has been deputy education officer for the past two years. Before joining the staff of the I.E.E., Mr. Jones spent six years in the radio and electronics industry and seven years as a lecturer in electronics and communications. He is currently engaged in part-time research on semiconductor technology at the University of Surrey.

E. R. Howlett has joined Rola Celestion Ltd., the Thames Ditton, Surrey, loudspeaker manufacturers, as sales manager. Mr. Howlett, who has been more than 20 years in the industry, was recently with R.C.A. (Great Britain) Ltd.

John R. Mills, B.Sc., has become director of the Signals Research and Development Establishment of the Ministry of Technology at Christchurch, Hants, in succession to Cedric J. Stephens who has been appointed chief scientific adviser at the Home Office. Mr. Mills, who is 51 and a graduate of King's College, London, entered the Scientific Civil Service in 1939. He was a member of the team set up at the Telecommunications Research Establishment (now R.R.E.) at Malvern to develop electronic systems for civil aviation; his particular interest being D.M.E. From 1954 to 1960 he was superintendent in the airborne radar department at R.R.E. In 1961 he became head of the Radio Department at R.A.E., Farnborough, and since 1965 has been head of the electronics branch of the Electronics and Instrumentation Division, Ministry of Technology, Headquarters.

Dennis H. Noyle, B.Sc., manufacturing manager of International Rectifier Company (G.B.) since 1964 has been appointed production manager. Mr. Noyle, who is 39, spent seven years in the field of geophysical exploration before studying at the Battersea College of Advanced Technology for his degree which he obtained (majoring in electronics) in 1960. He then joined Texas Instruments Ltd. and subsequently took charge of production of all germanium transistors. In 1963 he transferred to industrial engineering and was sent to the parent company in the U.S.A. for training. The following year he joined I.R. at Oxted.



D. H. Noyle

Charles A. Marshall, B.Sc., M.I.E.E., who for the past two years has been editor of *Systems & Communications* (which has now ceased publication) has become editor of *IEE News*. After graduating at Manchester University in 1945 he spent two years with Philips and then joined the staff of the Mullard Research Laboratories. He entered technical journalism in 1954 when he became technical editor and later editor of *British Communications & Electronics* which in 1965 was incorporated in our associate journal *Industrial Electronics*.

H. G. Foster, B.Sc., M.Sc., F.I.E.E., M.I.E.R.E., editor and latterly managing editor of *Electronic Engineering* for the past 18 years, has retired. A graduate of King's College, London, he was senior research engineer with the Dubilier Condenser Company for a short time before going to South Africa in 1936 to become lecturer in communication engineering at Cape Town Technical College. He returned to this country in 1939 to take up a similar position at



H. G. Foster

Birmingham University (from which he received his master's degree) where he stayed until joining *Electronic Engineering*. The new editor is L. G. Poole, until recently on the staff of *Control*.

D. M. B. Grubb has become assistant chief engineer, B.B.C. television developments in succession to G. D. Cook, who, as announced in the August issue, has been appointed assistant chief engineer, television operations. Mr. Grubb joined the B.B.C. in 1938 and, since December 1965, has been assistant superintendent engineer, television engineering operations.

## OBITUARY

Lt. Col. Sir Albert George Lee, O.B.E., B.Sc., F.I.E.E., who died on August 28th, aged 88, was engineer-in-chief of the British Post Office for seven years until the outbreak of the Second World War when he became director of communications (research and development) at the Air Ministry. For several years after the War Sir George, who was knighted in 1939, was a member of the Scientific Advisory Council for the Ministry of Supply and from 1946 to 1955 was a member of the Royal Commission on Awards to Inventors.

Hugo Gernsback, the well-known editor-in-chief and publisher of the American journal *Radio-Electronics*, recently died in New York, aged 83. He has been called the father of science-fiction, and for many years produced an annual supplement to the journal forecasting the applications of electronics in the next century.

# Semi-stabilized D.C. Supply

By G. W. SHORT\*

THE simple stabilizer illustrated in Fig. 1 uses positive feedback to compensate the effects of load variations. The voltage reference is zener diode D1. This is not used in the usual way to sense variations in output voltage, but merely to enable Tr1 to pass a constant current through R<sub>2</sub> and R<sub>3</sub>.

A portion of the resulting stabilized voltage across R<sub>2</sub> and R<sub>3</sub> is picked off at the slider of R<sub>2</sub> and applied to the output pair Tr2, Tr3, which form a compound emitter-follower with high input impedance and low output impedance. The regulation of this basic stabilizer is improved by increasing the reference voltage as the load current increases. The load current flows through R<sub>4</sub>, and the resulting p.d. across it is added to the zener voltage.

Setting up is very easy. First, R<sub>1</sub> is set to zero, and R<sub>2</sub> to maximum output voltage with no load. A load resistance corresponding to maximum output current is then connected and R<sub>1</sub> adjusted so that the same output voltage is again obtained. The process is then repeated.

If full output voltage is not obtained at maximum current, the explanation is probably that the unstabilized output voltage has fallen so far that there is not enough voltage left to operate the transistors. The circuit should then be set up again, starting with a lower maximum output voltage.

The final regulation curve may show a slight rise of output voltage at intermediate current levels. Resistance R<sub>6</sub> draws a few milliamps when there is no external load. This avoids an abrupt fall of voltage which may otherwise occur at the low-current end.

The lamp gives some protection against short-circuited outputs. Diode D2 is necessary to protect the output pair against excessive reverse base-emitter voltages which can occur on switch-off. The output capacitance C<sub>2</sub> was found to be necessary to suppress parasitic h.f. oscillations due to internal feedback in Tr2 and Tr3. Output ripple is very low provided that C<sub>1</sub> is adequately large. It should not be too large, or large pulses of output current may flow if the load is accidentally shorted.

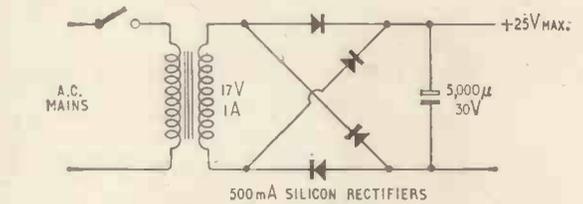


Fig. 2. Mains power unit.

The zener diode may be replaced by a battery or by a string of junction diodes operating in the forward direction. In this way a low reference voltage (say 1.5 V) may be used, to minimise the voltage wasted in operating the stabilizer. A suitable power source is shown in Fig. 2.

## Books Received

**Russian Books on Automation and Computers**, compiled by E. Gros. This publication provides a comprehensive list of Soviet books and irregular publications (symposia, conference transactions, pamphlets) on the theory and application of automation and computers. Pp. 92. Price 160s. Scientific Information Consultants Ltd., 661, Finchley Road, London, N.W.2.

**Basic Electricity for Electrical Engineers** by A. W. N. Kerkhofs. This book comes from the Philips Technical Library and is available in German, Dutch and English. It provides a simple explanation of a.c. and d.c. theory starting from fundamental principles as taught in the electrical engineering courses run by the Philips Company. Pp. 212. Price 38s. N.V. Philips Gloeilampenfabrieken, Eindhoven, The Netherlands.

**An Introduction to the Electron Theory of Solids** by John Stringer. Some fundamental knowledge is assumed in this book. This includes the properties of gases, liquids, insulators, semiconductors and metals; chemical binding; the concepts of macroscopic symmetry and the use of Miller indices and the Bragg law. The reader should also have knowledge of vector algebra, partial differential equations and real and complex variables. The subject matter includes:—the breakdown of the classical theory; atomic spectra and the old quantum theory; the uncertainty principle of Heisenberg; the foundations of quantum mechanics; some problems in wave mechanics; a wave-mechanical treatment of the simple harmonic oscillator and the hydrogen atom; assemblies of atoms; atoms in motion; statistical mechanics. Pp. 246. Price 35s. Pergamon Press Ltd., Headington Hill Hall, Oxford.

**Spread-F and its effects upon radiowave propagation and communications.** Reviewed last month. The price is 210s and incidentally AGARD was formed in 1951, not 1961 as was stated.

\*Amatronic Ltd.

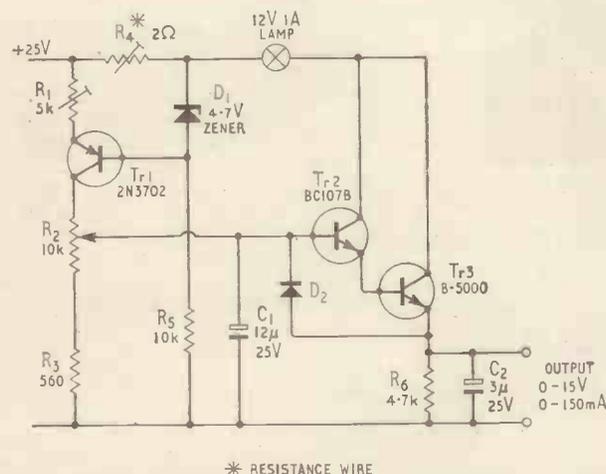


Fig. 1. Supply circuit for 0-15V, 0-150mA. The B-5000 transistor requires a heat sink of 10cm × 10cm × 2mm aluminium.

**DEVELOPMENTS IN GERMAN  
DOMESTIC RADIO AND  
TELEVISION AS SEEN AT  
THE 25TH GERMAN RADIO  
EXHIBITION, BERLIN,  
25 AUGUST — 3 SEPTEMBER**



## GERMAN COLOUR TELEVISION STARTS

**T**HE special attraction at the 25 Grosse Deutsche Funkausstellung was, of course, colour television. Nearly 30 years after the demonstration of colour television in Berlin, the city took part in the official opening of German colour broadcasting. Herr Willy Brandt (now Federal Minister of Foreign Affairs and Vice-Chancellor, but previously Mayor of Berlin) inaugurated the service and at switch-on at least a dozen apparently black-and-white monitors (plus, as usual, a large-screen Eidophor projector) could be seen to change simultaneously to colour. A fitting tribute was paid to Dr. Walter Bruch, pioneer of the PAL system, who was present at the opening ceremony along with many dignitaries and 1,200 guests.

Initially the German colour service will be limited—420 hours in the first year from the two German television networks (about four hours each per week by ARD and ZDF), which is less than in the U.K.

### Colour receivers

Sales of colour receivers for the second half of 1967 (sets were released in July) are expected to be 80,000 and possibly greater, in 1968 to reach 200,000, in 1969 320,000 and in 1970 450,000, making a total sale of about

1 million by 1970. (It has been reported, incidentally, that one survey in Germany showed that only 8% of householders said they would buy a set for a price over 2,000 DM.) Retail prices of German colour receivers have been subject to some variation recently. They started high at 2,500 DM (£230) until mail order houses and large stores announced prices of around 2,000 DM (£180) or less. Attempts at price fixing seem to have been circumvented by exporting sets and then buying them back. Most of the large firms now offer sets at around 2,300 DM (£210). During the exhibition Grundig announced a 48 cm (19 in) receiver for 1,865 DM (about £170). Then there is the Kuba 28 cm (11 in) portable set selling at 1,500 DM, less than £140. (The design of this set does not fit into the normal pattern however—it is a simple PAL receiver, using mainly valves.)

All told there are 18 names in colour television (about the same as for black-and-white) producing nearly 50 models, though many have similar chassis of course. The principal makers are A.E.G.-Telefunken, Blaupunkt, Graetz and Schaub-Lorenz (I.T.T.), Grundig and Tonfunk, Imperial and Kuba (G-E), Körting, Loewe-Opta, Metz, Nordmende, Philips, Saba, and Siemens. Other names, involved to a lesser extent, are Braun, Emud, Kaiser and Wega.

Practically all the sets have a 63 cm (25 in) diagonal screen and are delay-line PAL receivers (rather than simple PAL sets which rely on the eye to average small phase errors on adjacent lines). Exceptions to the 63 cm screen size have 56 cm (22½ in) screens (Blaupunkt CTV 2006 and Siemens FF11), a 48 cm (19 in) screen (Grundig T800), and a 28 cm (11 in) screen (Kuba CK211P—see illustration on p. 485).

Two important decisions must be taken at the outset in colour receiver design; the question of the h.t. value and the method of picture tube drive. Since the mains supply voltage in the U.S.A. is 117 V, transformers have been used there to provide the h.t. voltage (optimum value around 400 V). But in Europe the higher voltage mains supplies led to the adoption of the transformerless technique using either a half-wave power-supply circuit, with a separate horizontal output stage and e.h.t. generator (lack of availability of valves with a high enough anode dissipation for combined output stage service has led to separate e.h.t. generator and line output stages), or a doubler circuit with electronic regulation to drop the voltage to around the 400 V mark.

Commonly with the doubler-type of circuit a shunt voltage regulator valve with 25 kV across it maintains a low internal resistance of the e.h.t. supply, but

this technique is likely to be ousted by using a v.d.r. and voltage multiplier thus avoiding any trouble due to X-rays. Most makers (e.g. Siemens, Grundig, Körting, Loewe, Saba) seem to use the half-wave system, usually with a separate 30 V winding on the c.r.t. transformer to give 36 V *via* a bridge rectifier for the transistor circuitry. (This voltage can be added to the 270 V to give over 300 V for the colour difference, deflection and video output stages.) Telefunken, Blaupunkt and Nordmende are among those using the doubler technique.

Concerning the colour tube drive, the colour difference method, in which R-Y, G-Y and B-Y are fed to in the c.r.t. grids and the luminance Y signal fed to the cathodes, effectively giving matrixing in the tube, is used on Grundig and Philips receivers, also Loewe and Metz. (This is the method used in the U.S.A.) The disadvantage of this technique is the high amplitude signals required from the difference amplifiers (around 200 V) and from the luminance amplifier (over 100 V into 25 pF with a bandwidth of over 4 Mc/s), making transistorization expensive, if not impossible. With the RGB method, however, in which the R, G, and B signals are obtained from a matrix and fed to the tube cathodes, the three colour stages need only be designed for 115 V output into 12 pF at over 4 Mc/s bandwidth, thus making transistorization easier. This method is used in Telefunken, Blaupunkt, Graetz and Schaub-Lorenz, Kuba, Nordmende and Siemens receivers. There are disadvantages though, in that beam-current limiting is more complicated and deviations of black level of 1% are noticeable. These can result in a higher number of active devices (transistors plus valves)—around 50, rather than around 40 for the difference method. It seems that the half-wave power supply (270/300 V) and the colour difference technique offer the most economical solution.

On the question of valve/transistor ratio, economics and other factors dictate the use of transistors in the tuners and sound and vision i.f. stages, and valves in the output stages. In the colour circuits, sound stages, sync-separator, etc., either can be used, and this accounts in part for the varying ratios found. Colour difference stages also vary, and can use either three valves or five transistors. Analysing receivers on this basis of valve/transistor ratio, one finds four main groups. Philips and Saba models employ 27 valves and 13 transistors, whereas the Grundig models have 19 valves and 23 transistors. Both these groups use the colour difference approach. Makers using 14 valves and 33 transistors and the RGB approach

include Telefunken, Kuba-Imperial, Körting, and Nordmende, while the 14 valve-40 transistor group take in Blaupunkt, Loewe-Opta, Schaub-Lorenz and Graetz and Siemens. The situation is thus quite different from in the U.K. where 11 valves and 33 transistors are common with the colour difference method.

An interesting and unique colour receiver which attracted a great deal of attention was the Nordmende Spectra Colour S. This set is equipped with three 15 cm (6 in) monochrome monitors which can receive different programmes simultaneously (see illustration). The large colour screen can display any of the three monitor pictures or a fourth programme. This rather expensive luxury costs nearly 5,000DM (about £450).

### Monochrome receivers

With the current interest in colour television it might be thought black and white receivers had taken a back seat. Market-wise this is in fact so—receiver sales were down 6% last year (1966) to the 1964 level. (Exports were high though, at 20% for 1966.) It is felt, though, following experience in other countries, that the sales of black-and-white receivers will not be affected by colour sales. The degree of market saturation is 60%, so to reach the 85-90% figure thought to be achievable will mean that the number of householders buying a set for the first time will be high over the next few years.

With the new introductions there are now a wide variety of screen sizes in the portable sets—28, 30/31, 36, 41, 44, 47/48 and 51 cm (11 to 20-in). The larger table models have, almost with-

out exception, 59 or 65 cm screens.

More attention seems to be given to sound quality than in the U.K., although many sets do not have negative feedback from the output transformer secondary. Many feature two or more loudspeakers, and in at least one case the maker has thoughtfully provided connections for an external amplifier to be used.

Circuit design changes of late have taken place mostly at the tuner end, notably with the increasing use of variable capacitance or tuning diodes along with a number of pre-set potentiometers for station selection. The latest developments concern the use of diodes for switching—the tuner described on p.400 of the August issue is an example of v.h.f.-u.h.f. switching. More recently Band I-III switching has been achieved, one method using Band I and III inductors in series, with a switching diode across one of the coils (BA143) and a tuning diode (BA142) across both coils. An alternative method, used by Telefunken in the MT500 tuner for both monochrome and colour receivers, is shown in Fig. 1, where the diodes function both as short circuits and variable capacitors, but not, of course, at the same time. Band IV-V switching and tuning arrangements are different, the same inductor being used for both bands. In the Telefunken design, the two diodes (BA149) are in series on Band V while on Band IV one is forward-biased, thus increasing the tuning capacitance. In the u.h.f. region, chokes rather than resistors isolate the diodes from their control circuits—small deviations in capacitance due to the voltage dropped across the resistors now becoming significant.

Two of the designs which came from the S.E.L. applications lab. some time ago were for f.m. discriminators using the diode-transistor pump type of pulse-counting detector. The circuits formed part of direct-coupled i.f. amplifiers operating with low i.f. values (200 k/cs) and without transformers or inductors. One design, for a 5.5 Mc/s inter-

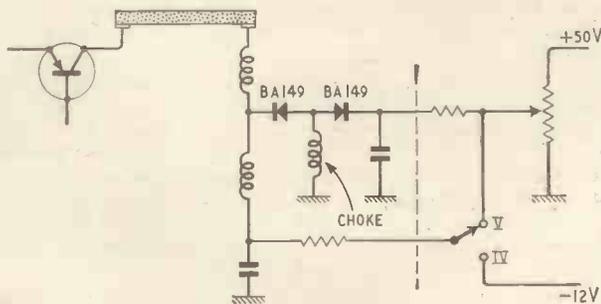
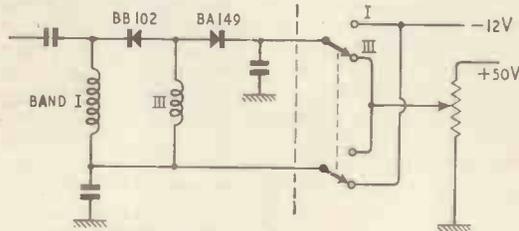
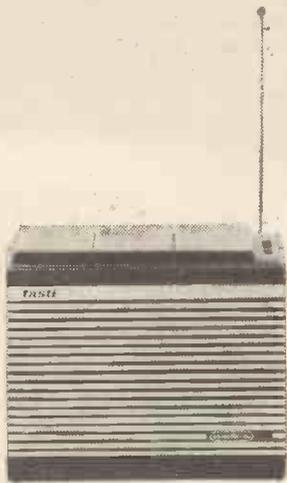


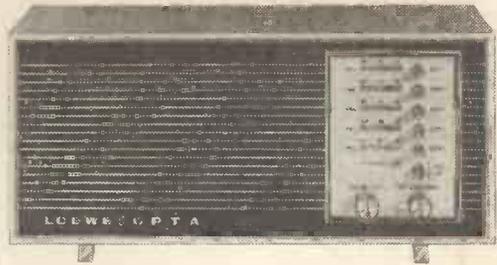
Fig. 1. Use of variable capacitance diodes for band I-III switching (upper diagram) and band IV-V switching (lower diagram) as well as tuning (Telefunken). Given adequate decoupling, controls to right of broken line can be remote from tuned circuits.



Portable v.h.f.-only receiver without tuning scale but with three pre-tuned stations. Cost about £13 (Nordmende "Tasti").



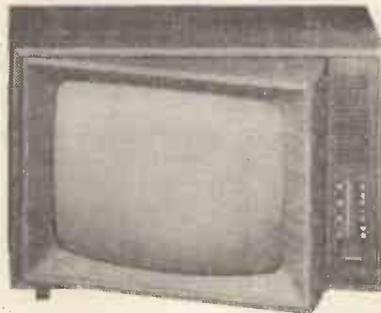
Colour receiver with three monochrome monitors which may be operated simultaneously (Nordmende).



Pre-set tuning by potentiometers and capacitance diodes on a best-selling v.h.f.-only mains receiver (Loewe-Opta "Tempo").



Combined car radio receiver (m.w. and l.w.) with tape cassette player (Philips).



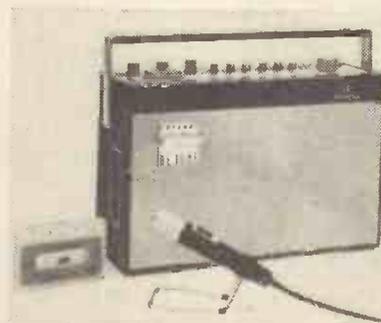
Above:- Novel colour receiver with adjustable screen viewing angle (Metz).



Latest tape recorder in "Electronic Notebook" series with playing time of 2 x 10 minutes (Grundig EN7).

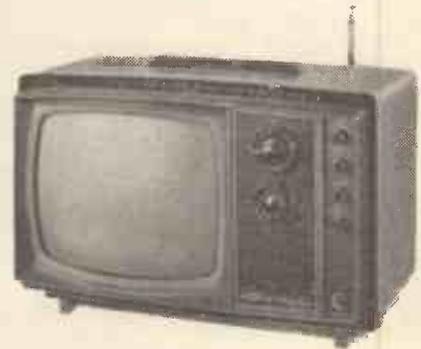
carrier sound receiver, is incorporated as part of a television receiver design using only semiconductor active devices. The design, for a 110°, 18 kV e.h.t. set, is developmental but production may be considered in 1968. The power supply circuit for the receiver is transformerless and the supply voltage is dropped, in part, by an s.c.r. (switched at the 50 c/s rate) which forms part of a voltage-stabilized supply. The horizontal timebase uses a 1,000-V thyristor in series with a BD106, permitting operation from a supply voltage of 110 V. The various supply voltages for the receiver are taken from rectified outputs of a winding on the output transformer of this stage—including the e.h.t.

Right: Colour scheme of receiver can be easily varied by changing hinged flaps—orange and red in model illustrated (Nordmende Spectra Futura).



Combined-four-band radio and tape recorder for portable or car use—a "Tonstudio im Taschenformat". When recording from radio, bias frequency is chosen to avoid beating between local and bias oscillators.

Portable colour receiver with 29 cm (11 in) tube. Set uses the simple PAL system and costs about £140 (Kuba CK211P).



### Sound receivers

Cabinet colour seems to play a larger part in the German domestic radio and

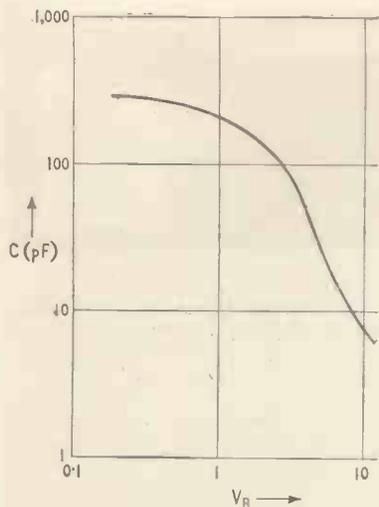


Fig. 2. Capacitance variation with reverse voltage in BA163 tuning diode.

tv market than in Britain—Nordmende, in particular, have bright single and multicoloured receivers in their range. In the Spectra Futura models (illustrated) the hinged flaps which cover the front panel are coloured orange and red, with the pvc-covered cabinet in white and loudspeaker fascia in black. The colour scheme can be altered to bright blue and dark blue simply by using different flaps. (In the stereo version, incidentally, the two loud-speaker boxes can be detached and placed apart from the receiver.) In spite of the interest in colour schemes the “technische look” still holds an important place in marketing, as exemplified by Braun equipment. The latest catchphrase is the “Metall-look,” used by Grundig to describe their aluminium-fronted tuner-amplifiers.

The trend in v.h.f. receivers toward diode-tuned front ends with pre-selected stations (usually five) is strong and appears on many tuner-amplifiers in addition to the normal continuously-variable tuning arrangement. Usually each pre-set potentiometer is accompanied by a separate scale indicating the channel or frequency selected. This technique has now found its way into some lower-priced receivers, in particular the Loewe-Opta Tempo, a v.h.f.-only mains table radio announced last year, which has turned out to be a best-seller. For the tuning-diode supply a separate transformer winding with rectifier and a 36 V Zener stabilizing diode is usual.

A more recent introduction in the v.h.f.-only class is the Nordmende Tasti, an unusual portable design in that no tuning scale is included. Large push-button switches occupying the whole set-top select one of the three pre-tuned stations (see illustration).

**Integrated circuits.** Heathkit Geräte GmbH showed an f.m. receiver, the AR-15, which uses integrated circuits in the i.f. stages. (This model was introduced in the U.S.A. early this year.) Two RCA CA3012 circuits, two crystal filters, two discrete transistors and a mixer and discriminator transformer make up the 10.7 Mc/s i.f. section. (The CA3012 i.c. is also used in two Blaupunkt black and white television receivers. It is expected that Blaupunkt will market a car radio with a European i.c.—Philips or Siemens—early in 1968.)

The first European pocket radio using integrated circuits was shown by Philips. This medium-wave only set operates from a 3.6 V Deac cell for two hours on one charge—output power is given as 50 mW. The i.f. amplifier contains one i.c. and another is used in the a.f. pre-amplifier (TAA 263). Additional discrete active devices are a BF195 and AC127/AC132 complementary output stage.

What is probably the first use of thick-film integrated circuits in domestic apparatus—in Europe at any rate—was seen at the Telefunken stand. The nine-component passive circuit with discrete tantalum capacitors and transistors (2N4062 and 2N3704) attached forms the a.f. pre-amplifier section of the Banjo a.m./f.m. portable. Telefunken

have in fact produced a range of miniature diodes and transistors, for connection on to thick-film passive circuits, which are electrically equivalent to a transistors, e.g. BA174  $\equiv$  1N4154; selected range of standard diodes and BC197  $\equiv$  BC107; AF257  $\equiv$  AF106; and BF230  $\equiv$  BF195.

One of the most interesting developments in passive components in recent times is the practicability of variable-capacitance diodes with the right impurity concentration profile for capacitance values extending up to 300 pF or so, making possible the elimination of ganged variable capacitors in m.w. receivers. Devices with capacitance ratios exceeding 20:1 (for voltage ratios of about 10:1) are possible with  $Q_s$  of over 200, examples being the Intermetall (I.T.T.) BA163 (Fig. 2) and the Siemens BB107 double diode. The two diodes in the BB107 are different, capacitances being 150 pF and 375 pF at 3 V, so that they can be used for a.m. r.f. and oscillator tuned circuits. Experimental a.m. tuners using such diodes have been built in various application laboratories—a Siemens model the writer saw occupied about half the volume of a matchbox! Fig. 3 shows a typical a.m. mixer/oscillator circuit using the BA163 diodes, and which includes potentiometers for pre-selecting a number of stations.

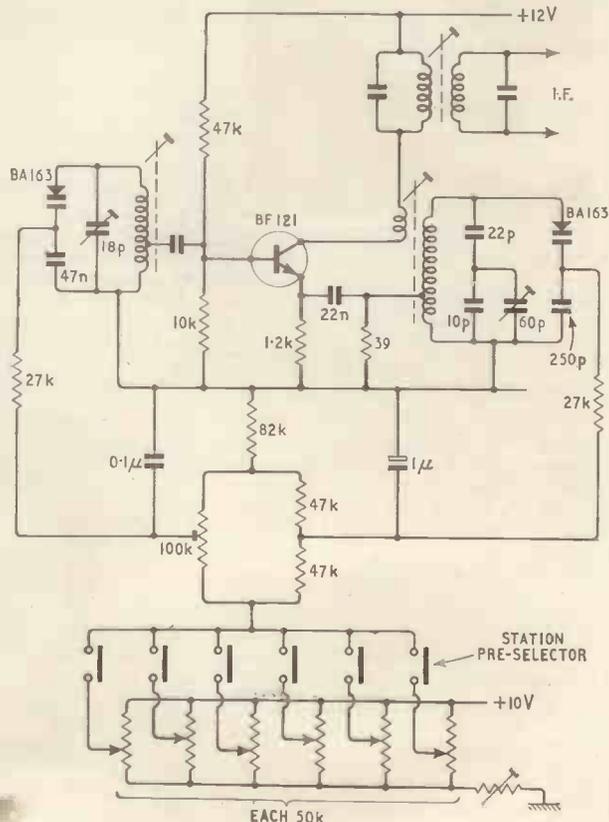


Fig. 3. Application of BA163 tuning diodes to medium wave receiver. Stations are pre-selected by potentiometers (Intermetall)

# OCTOBER MEETINGS

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

## LONDON

4th. I.E.R.E.—“Animal sonar” by Dr. D. Pye at 6.0 at the Institution, 8-9 Bedford Square, W.C.1.

4th. S.E.R.T.—“Radiophonic workshop” by F. C. Brooker at 7.0 at London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

4th. B.K.S.T.S.—“The design of linear audio-frequency amplifiers” by Dr. E. A. Faulkner at 7.30 at the Royal Overseas League, Park Pl., St. James's St., S.W.1.

10th. Soc. Relay Engineers.—“Extending a narrow-band v.h.f. system to 230 Mc/s” by L. Frankham and “U.H.F. distribution at fundamental frequencies for large communal systems” by J. Claydon at 2.30 at the I.T.A., 70 Brompton Rd., S.W.3.

11th. I.E.R.E. & I.E.E.—Symposium on “Ultrasonics and medicine” at 2.30 at Middlesex Hospital Medical School, Cleveland St., W.1.

12th. R.T.S.—“Fully transistorised colour television receiver” by J. W. Bussell, S. C. Jones and R. Gray at 7.0 at the I.T.A., 70 Brompton Rd., S.W.3.

12th. Brit. Acoustical Soc.—Symposium on “Sound propagation in anisotropic solid media” at 2.40 in the Physics Dept., Imperial College, S.W.7.

13th. I.E.R.E. & I.E.E.—Symposium on “Ariel III” at 10.30 a.m. at the Middlesex Hospital Medical School, Cleveland St., W.1.

16th. R.T.S. & I.E.E.T.E.—Lecture by G. E. Mueller, Manned Space Flight Chief of NASA at 6.0 at the I.T.A., 70 Brompton Rd., S.W.3.

17th. I.E.E.E.—“Education for the engineering mission” by Dr. W. G. Shepherd at 6.0 at I.E.E., Savoy Pl., W.C.2.

19th. I.E.R.E.—Symposium on “Management methods and media in electronic training at the School of Electronic Engineering, R.E.M.E., Arborfield” at 8-9 Bedford Sq., W.C.1.

25th. I.E.R.E. & I.E.E.—“A survey of digital data display systems” by Dr. G. Wooldridge and T. J. Stakemire at 6.0 at London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

25th. B.K.S.T.S.—“High-quality monitoring speakers” by R. E. Cooke at 7.30 at the Royal Overseas League, Park Pl., St. James's St., S.W.1.

27th. R.T.S.—“Television distribution and broadcasting from satellites” by G. K. C. Pardoe at 7.0 at the I.T.A., 70 Brompton Rd., S.W.3.

## BATH

19th.—I.E.R.E. & I.E.E.—“Ergonomics in electronic equipment and systems design” by B. Shackell at 6.0 at the Technical College, Avon St.

## BIRMINGHAM

12th. I.E.R.E.—“Sound waves in the sea” by Dr. V. G. Welsby at 7.15 at the Dept. of Electronic and Electrical Eng'g., the University.

## BRISTOL

11th.—I.E.R.E.—“Some experiments with demountable valves” by Dr. C. R. Burch at 7.0 at the Technical College, Ashley Down.

## CARDIFF

4th. R.T.S.—“Further aspects of colour television” by B. J. Rogers at 7.30 at the Angel Hotel.

6th. S.E.R.T.—“A PAL for the service man” by G. D. Barnes at 7.30 at Llandaff Technical College, Western Avenue.

11th. I.E.R.E.—“Design of low distortion transistor amplifiers for audio frequencies” by P. J. Baxandall at 6.30 at the Welsh College of Advanced Technology.

20th. S.E.R.T.—“What is programming?” by D. G. Howells at 7.30 at Llandaff Tech. College, Western Ave.

## CHELMSFORD

3rd. I.E.R.E.—“Telemetry and communication systems in the oil industry” by A. C. W. Bedwell at 6.30 at the Technical High School, Patching Hall Lane.

## CHELTENHAM

16th. I.E.R.E.—“Development in railway signalling and communication systems” by W. H. Dyer at 7.0 at the North Gloucester Technical College.

## COLCHESTER

24th. I.E.R.E.—“The future of electronic telephone exchanges” by V. E. Mann at 7.0 at the University of Essex, Wivenhoe Park.

## COVENTRY

19th. S.E.R.T.—“Thyristors” at 7.30 at the Herbert Art Gallery and Museum, Earl St.

## EDINBURGH

4th. I.E.R.E.—“An integrated circuit reliability study with special reference to plastics encapsulation” by G. R. Latham at 7.0 at the Dept. of Natural Philosophy, the University.

## GLASGOW

5th. I.E.R.E.—“An integrated circuit reliability study with special reference to plastics encapsulation” by G. R. Latham at 7.0 at the Inst. of Engineers and Shipbuilders, 39 Elmbank Cresc., C.2.

## LINCOLN

5th. I.E.R.E.—“Trends in semiconductor development” by Dr. G. D. Bergman at 6.30 at the East Midlands Electricity Board Showrooms.

## LIVERPOOL

18th. Inst. Eng'g Inspection.—Symposium on “A practical approach to reliability engineering” at 9.45 a.m. at the Royal Institution, The University.

18th. I.E.R.E.—“Computer control of air traffic” by D. Halton at 7.0 at the College of Technology, Byrom St.

## MANCHESTER

16th. Soc. of Instrument Tech.—“Analytical instruments and their application to automatic control” by G. L. Collier at 6.45 at the Literary and Philosophical Soc., 36 George St.

19th. I.E.R.E.—“Medical electronics” by H. S. Wolff at 7.15 at Renold Building, College of Science and Technology, Altrincham St.

## NEWCASTLE-UPON-TYNE

4th. S.E.R.T.—“Colour television” by D. G. Packham at 7.15 at the Charles Trevelyan Technical College, Maple Terrace.

11th. I.E.R.E.—“Domain originated functional integrated circuits” by Dr. M. B. N. Butler at 6.0 at the Inst. of Mining and Mechanical Engrs, Neville Hall, Westgate Rd.

## NEWPORT, I.o.W.

20th. I.E.R.E.—“I.L.S. integrity monitoring” by W. F. Winter at 7.0 at the Technical College.

## NORTHAMPTON

26th. S.E.R.T.—“Record playing units” by E. Mortimer at 7.0 at the College of Technology, St. George's Ave.

## NOTTINGHAM

18th. I.E.R.E. & I.P.P.S.—“Micro-circuitry” by Dr. I. C. Walker at 6.30 at the University.

## READING

10th. I.E.R.E.—“Integrated circuits” by D. H. Roberts at 7.30 at the J. J. Thomson Physical Lab., the University.

## REDRUTH

19th. Soc. of Instrument Tech.—“Computer hardware construction and operation” by W. D. Old and W. C. Hosken at 7.30 at Cornwall Technical College.

## SOUTHAMPTON

18th. Soc. of Instrument Tech.—“The design and development of industrial pressure transmitters” by E. C. Buckland and R. W. Penny at 7.30 at the University.

19th. S.E.R.T.—“Some applications of tape recorders” by G. A. Allcock at 7.30 at the College of Technology, East Park Terrace.

24th. I.E.R.E.—“Domain originated functional integrated circuits” by C. P. Sandbank at 6.30 at the Lanchester Theatre, the University.

# WIRELESS WORLD

## DIGITAL COMPUTER

3—More on system design: the order decoder and control unit: how they translate instructions given to the machine into switching signals for operating the various control gates.

**L**AST month we considered the arithmetic unit and its associated stores, and we ended with a system diagram (Fig. 25, p.422) showing the computer as so far described. The machine could in fact be used in this form if all the control gates shown in Fig. 25 were connected to switches and a means were available for generating batches of eight shift pulses and applying them to the appropriate registers. But such a system would be difficult to handle, as one would have to refer to the circuit diagram to find out which gates to open in order to carry out any particular operation. Also, it would be almost impossible to control the computer from a sequential programming device.

It is the task of the "order decoder" (see Fig. 1 schematic, August issue), on receipt of an instruction from the operator, to open the correct gates and route shift pulses to the required destinations. The shift pulses are applied to this order decoder at low level from the "control unit" (again see Fig. 1 August issue). After the destinations of the pulses have been defined the order decoder amplifies the pulses so that they are capable of driving a shift register.

To enable an operator to convey instructions to the machine a language or machine code "understandable" by both has to be used, and the order decoder is so named because it translates this code into the gate switching signals required by the computer. The basis of the code is a binary word. A five-bit word has 32 possible combinations and in fact would be sufficient to accommodate the 28 control instructions that the computer is designed to handle. The control sequence, however, would not follow any particular pattern and it would be necessary to memorize all 28 instructions, which would make operation of the machine rather difficult.

In view of this it was decided to use an eight-bit control word, split up in such a way as to make memorizing the instructions an easier task. As mentioned in Part 1, the instructions are entered by means of a set of eight switches on the front panel, and there is in fact one switch for each bit of the instruction word. Each switch has two positions, one entering a "0" and the other entering a "1".

The operations that the computer will perform can be divided into four groups: transfer to store; transfer from store; arithmetic; and miscellaneous. The first two bits of the instruction word define which group the order falls in, i.e.

- 0 0 arithmetic operation
- 0 1 transfer to store and reset
- 1 0 transfer from store
- 1 1 miscellaneous

For transfer instructions the computer is divided into two parts, "arithmetic unit" and "store", and the

registers in these parts are given "addresses" within them as follows:—

Arithmetic unit addresses		Store addresses	
Register	0 0 1	Store 1	0 0 1
Accumulator	0 1 0	Store 2	0 1 0
Counter	0 1 1	Store 3	0 1 1

During transfer instructions three switches specify the arithmetic unit address and three switches the store address, so a typical instruction would be:—

Nature of order	Arithmetic unit address	Store address
0 1	0 1 0	0 0 1

In the light of what has been said it can be seen that this encoded instruction means "transfer the contents of the accumulator to store 1". If the code pattern were altered to 1 0 0 1 0 0 0 1 then the instruction would be "transfer the contents of store 1 to the accumulator"—in other words, the nature of the instruction is different but the addressees are the same.

In order to clear a register and "lose" its contents all that is necessary is to specify a transfer either from or to that register, but not specify another address for the contents to come from or go to. For example, either 0 1 0 0 0 0 1 0 or 1 0 0 0 0 0 1 0 would clear the contents of store 2.

Arithmetic instructions (prefix 0 0) do not require that an address be specified, and it is necessary to remember which instruction does what. The left-hand digit in each of the two groups of three digits is used exclusively for arithmetic operations, namely for the formation of the ones complement of a number. The corresponding two switches always have the same effect on the computer regardless of the nature of the order (the prefix). This results in a saving of parts and makes manual operation of the computer easier.

As was mentioned in the binary arithmetic "reminder" section (August issue) the control instructions are converted to the octal number system for ease of handling. All control instructions with the octal equivalent are listed in the table on the next page, which uses the following abbreviations:

A=accumulator	St.2=store 2
R=register	St.3=store 3
Cntr.=counter	C=carry store
St.1=store 1	T=transfer

A transfer between, say, the register and Store 2 will be indicated as follows:—T. R→St.2.

It can be seen that the "complement accumulator" instruction (045<sub>(8)</sub>) is a combination of three instructions, i.e. add, inhibit carry and set 2° in register.

The logical circuit of the decoder is shown in Fig. 26. The reader is permitted to shudder at what appears at first sight a very complicated conglomeration of com-

ponents. However, things are not as bad as they may seem. The single pole switches  $S_1$  through to  $S_8$  provide the means of feeding in control instructions and the electrical signals resulting from closure of the switches are correspondingly labelled A to H. It will be noticed that instructions can be fed in from another source. Consider  $S_1$ . When this switch is open the output of NOR 15 is "up" and that of NOR 16 "down." When the switch is closed the output of NOR 15 is down and that of NOR 16 is up; therefore NOR gates 15 and 16 provide the A and  $\bar{A}$  inputs to the decoder. This double inversion is carried out for the other input switches by NOR gates 17 through to 30. The signal lettering A to H corresponds to the letters heading the columns of the instructions of the table. Care must be taken not to confuse the As and Bs of the adder/subtractor inputs with them.

During the following explanations of the decoder operation it is necessary to refer to the computer logical diagram of Fig. 25 (September issue) as well as Fig. 26. First, let us see what happens when we close switch  $S_8$ . This results in the order to add, 0 0 1<sub>(8)</sub>. The nature of the order is arithmetic, so the switches giving A and B will be open (0 0), NOR gates 15 and 17 will be "up" and 16 and 18 "down." The input to the decoder will therefore be  $\bar{A}\bar{B}$  gate AND 46 will open and provide one input for gates 47, 48, 49 and 50. As the input is  $\bar{A}\bar{B}$ , gates 51 and 52 will be closed and NOR gate 31 will be up. This opens the computer gates 13 and 15, completing the register and accumulator regenerative loops. Switch  $S_8$  is closed, so the input to the decoder, in full, is  $\bar{A}\bar{B}\bar{C}\bar{D}\bar{E}\bar{F}\bar{G}\bar{H}$ . Gate 49 will open as it already had one input up,  $\bar{A}\bar{B}$  from gate 46, and its other inputs are GH. The output of gate 49 "tells" the adder/subtractor to add. In going up, gate 49 provides an input for NOR 33 which goes down, and NOT 34 goes up, providing one of the inputs to gate 63. The other input for gate 63 is clock pulses from the control unit. The output of gate 63 goes up and down in sympathy with the clock pulses triggering flip-flops 1 and 2, providing shift pulses for the register and accumulator. In all, eight clock pulses are received from the control unit, and after the last one the contents of the register will have been added to the accumulator.

The conditions for subtracting are very similar except that switch  $S_7$  is closed and  $S_8$  open, and gate 50 opens to tell the adder/subtractor to subtract. The rest of the operation is the same as for adding, the register and accumulator receiving shift pulses.

For multiplication the switches that are closed are  $S_5$  and  $S_8$ . As  $\bar{A}\bar{B}\bar{G}\bar{H}$  is still present, the add AND gate 49 opens, with the same results as before; also gate 47 ( $\bar{A}\bar{B}\bar{D}\bar{E}$ ) opens to inform the control unit that multiplication is to take place. Division is again very similar the input being  $\bar{A}\bar{B}\bar{D}\bar{E}\bar{G}\bar{H}$ . Gate 48 opens to inform the control unit that division is to take place and gate 50 opens with the same results as before, i.e. subtract, shift pulses to R and A.

Switches  $S_3$  and  $S_6$  inhibit the carry store and set the 2<sup>o</sup> bistable in the register to form the 1s complement. These are "straight through the decoder" instructions and as such are not gated with anything else and can be ignored while considering other aspects of the decoder.

Let us open all the switches except  $S_2$ , so that the order's prefix is  $\bar{A}\bar{B}$  or 0 1, signifying that a transfer to store is required. All the arithmetic gates will remain closed as these require a  $\bar{A}\bar{B}$  input. Gate 51 will open and the output of NOR 31 will fall, closing the computer gates 13 and 15, breaking the register and the accumulator feedback loops. Gate 51 also supplies one of the inputs for gates 53 and 54. As the output of NOR 31 is now down,

the output of NOR 32 is up, providing one input to each of the shift pulse AND gates 58, 59, 60, 61 and 62.

CONTROL ORDERS TABLE										
Binary Order	A	B	C	D	E	F	G	H	Octal Equiv	Instruction
<b>Arithmetic</b>										
0 0 0 0 0 0 0 0	0	0	0	0	0	0	0	1	0 0 1	add
0 0 0 0 0 0 0 1	0	0	0	0	0	0	1	0	0 0 2	subtract
0 0 0 0 0 1 0 0	0	0	0	0	1	0	0	0	0 1 1	multiply
0 0 0 0 1 0 0 0	0	0	0	1	0	0	0	0	0 2 2	divide
0 0 0 1 0 0 0 0	0	0	1	0	0	0	0	0	0 4 0	inhibit C
0 0 0 0 0 0 1 0	0	0	0	0	0	1	0	0	0 0 4	write 1 in 2 <sup>o</sup> of R
0 0 1 0 0 0 1 0	0	1	0	0	0	1	0	0	0 4 5	complement A
<b>Transfer to store</b>										
0 1 0 0 0 1 0 0	0	1	0	0	0	1	0	0	1 1 1	T. R → St. 1
0 1 0 0 0 1 0 1	0	1	0	0	0	1	0	1	1 1 2	T. R → St. 2
0 1 0 0 0 1 1 0	0	1	0	0	0	1	1	0	1 1 3	T. R → St. 3
0 1 0 1 0 0 0 0	0	1	0	1	0	0	0	0	1 2 1	T. A → St. 1
0 1 0 1 0 0 0 1	0	1	0	1	0	0	0	1	1 2 2	T. A → St. 2
0 1 0 1 0 0 1 0	0	1	0	1	0	0	1	0	1 2 3	T. A → St. 3
0 1 0 1 0 1 0 0	0	1	0	1	1	0	0	0	1 3 1	T. Cntr → St. 1
0 1 0 1 0 1 0 1	0	1	0	1	1	0	0	1	1 3 2	T. Cntr → St. 2
0 1 0 1 0 1 1 0	0	1	0	1	1	0	1	0	1 3 3	T. Cntr → St. 3
<b>Transfer from Store</b>										
1 0 0 0 0 1 0 0	1	0	0	0	0	1	0	0	2 1 1	T. St. 1 → R.
1 0 0 0 0 1 0 1	1	0	0	0	0	1	0	1	2 1 2	T. St. 2 → R.
1 0 0 0 0 1 1 0	1	0	0	0	0	1	1	0	2 1 3	T. St. 3 → R.
1 0 0 1 0 0 0 0	1	0	0	1	0	0	0	0	2 2 1	T. St. 1 → A.
1 0 0 1 0 0 0 1	1	0	0	1	0	0	0	1	2 2 2	T. St. 2 → A.
1 0 0 1 0 0 1 0	1	0	0	1	0	0	1	0	2 2 3	T. St. 3 → A.
<b>Reset</b>										
0 1 0 0 1 0 0 0	0	1	0	0	1	0	0	0	1 1 0	Clear R.
0 1 0 1 0 0 0 0	0	1	0	1	0	0	0	0	1 2 0	Clear A.
0 1 0 0 0 0 0 1	0	1	0	0	0	0	0	1	1 0 1	Clear St. 1
0 1 0 0 0 0 1 0	0	1	0	0	0	0	1	0	1 0 2	Clear St. 2
0 1 0 0 0 0 1 1	0	1	0	0	0	0	1	1	1 0 3	Clear St. 3
<b>Miscellaneous</b>										
1 1 0 1 0 0 0 0	1	1	0	1	0	0	0	0	3 3 0	Reset Cntr.

The odd man out is the counter reset instruction. As this is not a shift register it is necessary to apply a negative voltage to its reset d.c. line, this being performed by the 11<sub>(10)</sub> instruction.

The next part of the instruction is the arithmetic unit address. At this stage we will consider only transfers from the register or accumulator and not the counter. Now the address of the register is 0 0 1 ( $\bar{C}\bar{D}\bar{E}$ ) and that of the accumulator is 0 1 0 ( $\bar{C}\bar{D}\bar{E}$ ), and, as shown in the table, if the transfer is to come from the register then switch  $S_5$  (giving E) will be closed. The input to the decoder is now 0 1 0 0 1 or  $\bar{A}\bar{B}\bar{C}\bar{D}\bar{E}$ . Gate 53 will therefore open and this in turn will open the computer gate 16, which allows the register access to the store. Also it will be noted that when clock pulses arrive, gate 58 can open and close in sympathy to trigger flip-flop 1 and provide shift pulses to the register as the output of NOR 32 is up. If the transfer had been from the accumulator the order would have been 0 1 0 1 0 or  $\bar{A}\bar{B}\bar{C}\bar{D}\bar{E}$ . In this case AND 54 would have opened to open computer gate 17, allowing the accumulator access to the store, and AND gate 59 would open on receipt of clock pulses to provide accumulator shift pulses.

All that remains to be done is to specify the address in the store. No further control gates have to be opened and all that is required is to ensure that the correct store receives shift pulses. Now the address of store 1 is 0 0 1 ( $\bar{F}\bar{G}\bar{H}$ ), that of store 2 is 0 1 0 ( $\bar{F}\bar{G}\bar{H}$ ) and that of store three is 0 1 1 ( $\bar{F}\bar{G}\bar{H}$ ), so it can be seen that on the receipt of clock pulses gate 60, 61 or 62 will open to provide the correct store with shift pulses. Note that gates 55, 56 and 57 cannot open as they have a common  $\bar{A}\bar{B}$  or 10<sub>(2)</sub> input.

For transfer from the store, the order prefix is 1 0 or  $\bar{A}\bar{B}$ . Gate 52 will open, and this will close computer gates 13 and 15 via NOR 31 and open computer gate 14 to allow the store access to the arithmetic unit. Gates 53 or 54 cannot open to open gates 16 or 17 as a common  $\bar{A}\bar{B}$  input is required for this. Also note that as the output of NOR 31 is down that of 32 will be up, so one input to the shift pulse AND gates will be up (58 to 62). The only effect of setting the arithmetic unit address will be to open

either AND 58 or AND 59 on receipt of clock pulses, to provide either the register or the accumulator with shift pulses.

Selecting the store address  $\bar{F}\bar{G}H$ ,  $\bar{F}G\bar{H}$  or  $\bar{F}GH$  will open one of the gates 60, 61 and 62 on receipt of clock pulses to provide shift pulses for the required store. Also, as gate 52 is up, gates 55, 56 and 57 have a common input line up. One of these will open, depending on the address selected, to open one of computer gates 18, 19 or 20 and therefore open the output line of the selected store.

We have not yet discussed the parallel transfer from the counter. First, this is classed as a "transfer to store" instruction with the prefix  $\bar{A}\bar{B}$ . Bearing this in mind, if we now selected the address in the store into which the counter had to be copied, shift pulses would be applied to that store. Now this is a parallel transfer, and if shift pulses were applied to the selected store the information would be destroyed; so shift pulses to the selected address must be inhibited. To transfer from the counter we first select  $\bar{A}\bar{B}$  and the counter address  $\bar{C}\bar{D}E$ . Gate AND 51

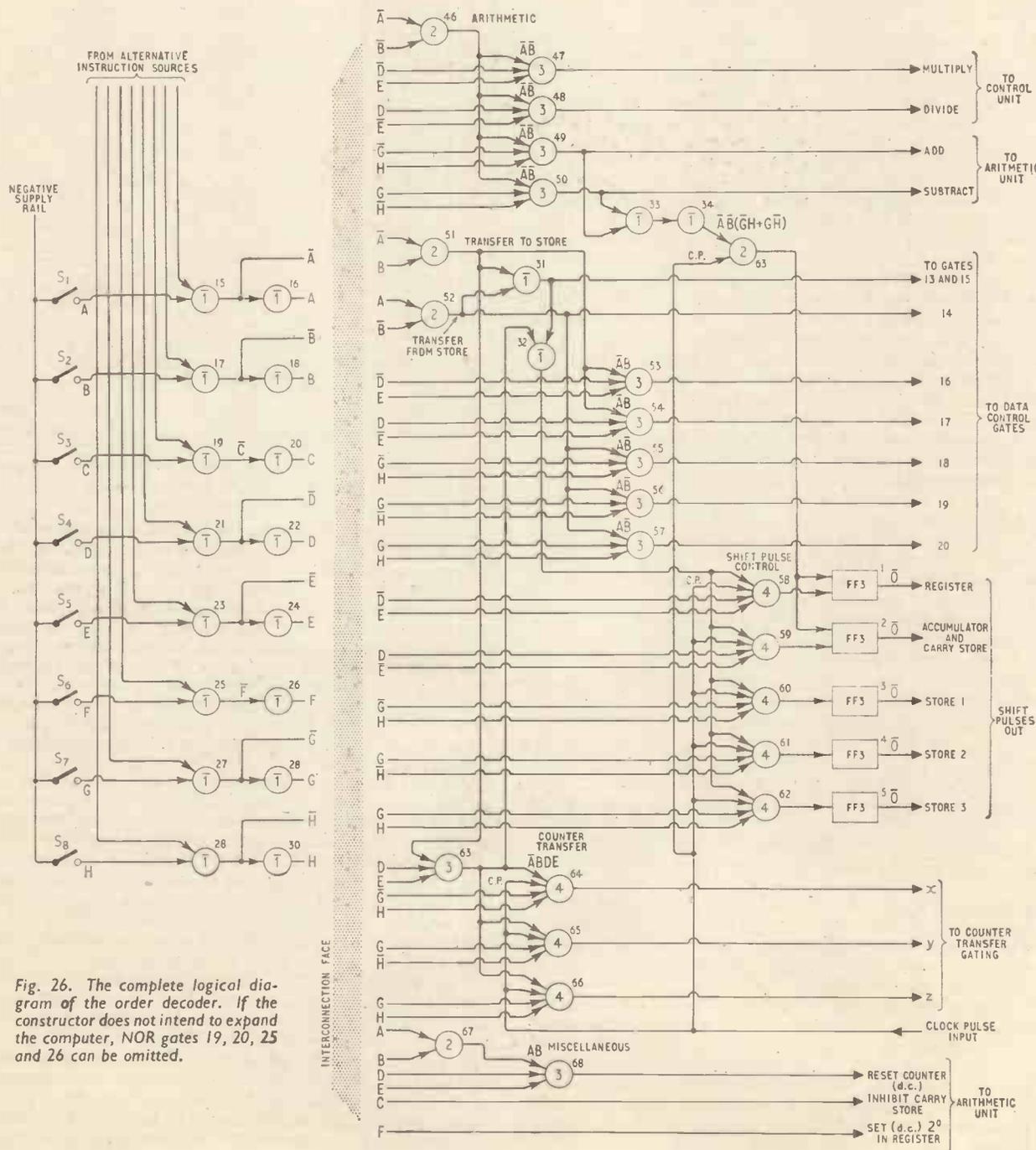
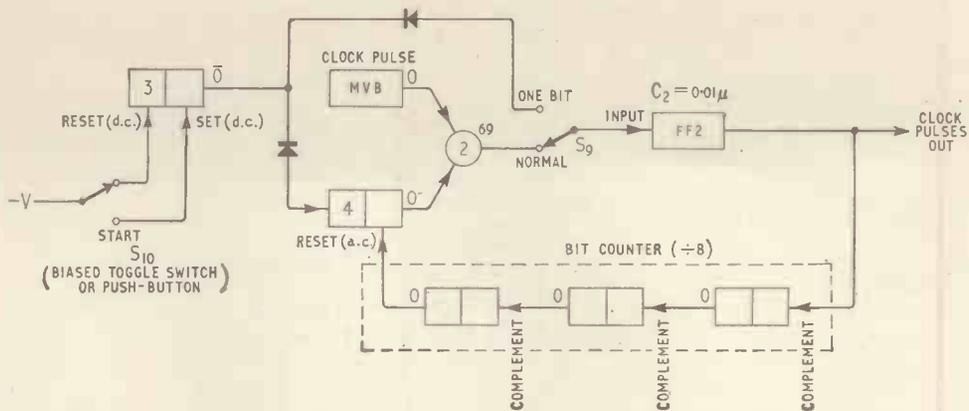


Fig. 26. The complete logical diagram of the order decoder. If the constructor does not intend to expand the computer, NOR gates 19, 20, 25 and 26 can be omitted.

Fig. 27. Simplified diagram of the control unit, illustrating the principles involved.



will open, providing one input for AND 63. The other two inputs are D and E, so AND 63 will open, and this will cause one of the inputs to NOR 32 to go up. NOR 32 output will go down, as will one of the inputs to each of the shift pulse AND gates. These cannot now open and no shift pulses can leave the decoder. In opening, gate 63 provides a common input for gates 64, 65 and 66. The store address selected ( $\overline{FGH}$ ,  $\overline{FGH}$  or  $\overline{FGH}$ ) opens one of these gates when clock pulses are applied; therefore the X, Y or Z output goes up. These, of course, communicate with the counter transfer gating. The only reason for feeding gates 64, 65 and 66 with clock pulses is to ensure that no inadvertent transfer can take place while moving the control switches until clock pulses are deliberately applied.

The only other function of the decoder is to reset the counter. The control instruction for this is 1 1 0 1 1 or AB  $\overline{CDE}$ , which opens gates 67 and 68 to drive the counter reset d.c. line up. It will be noted that the shift pulses are taken from the NOT output of the flip-flops. If this was not done the times of the positive edges would not coincide due to component tolerances.

The decoder differs from the control unit in that it does not take into account conditions that exist within the computer. In other words it receives a certain input and gives a fixed output that does not change. The control unit, on the other hand, receives instructions from the decoder and an additional order to start. The output it gives will then depend on these inputs and conditions within the computer.

It would be a good idea before starting to describe the control unit to list all the things that are required of it:—

**Add—Subtract** and transfer instructions. Deliver eight clock pulses to the decoder.

**Multiply.** Provide batches of eight clock pulses to the decoder and one pulse for each addition to the counter. When at the end of a word the contents of the counter equal the contents of store 1, no further pulses to be generated. If at the end of a word the carry store is set, indicating that the capacity of the accumulator has been exceeded, stop generating pulses regardless of the state of the counter.

**Divide.** Generate batches of eight clock pulses and a pulse to the counter for each subtraction minus one until the carry store is set at the end of a word, indicating that the accumulator has gone negative.

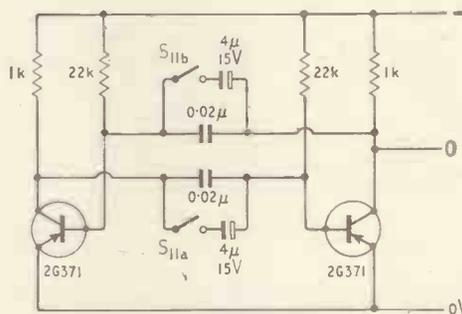


Fig. 28. Circuit of clock-pulse multivibrator. S<sub>11</sub> allows the frequency to be reduced for slow-motion demonstrations.

**General.** Provide a facility for operating the computer at slow speed for demonstration purposes. Also, for the same reason, provide a facility for carrying out operations bit by bit instead of a complete operation at a time. Provide an output for a sequential programming device to indicate that an operation is complete and that the computer is ready for a further instruction. Operation of the control switches must not result in spurious pulses being delivered to the computer.

The logical diagram that forms the basis of the control unit is shown in Fig. 27. When the "start" press-switch S<sub>10</sub> is depressed bistable 3 is set and the positive edge available at its NOT output terminal in turn sets bistable 4, driving one of the inputs to AND gate 69 "up." The other input to gate 69 is provided by the clock-pulse multivibrator, the circuit of which is shown in Fig. 28. As a result AND gate 69 opens and closes in sympathy with the multivibrator output, triggering flip-flop 2. The output of flip-flop 2 is fed to the order decoder and to a bit counter formed by three of the counter type bistables. A counter connected in this fashion will provide one output pulse for every eight input pulses, so after eight pulses have been received by the bit counter its output resets bistable 4, closing AND 69 and preventing any further output pulses. From this it can be seen that every time the "start" switch is pressed eight pulses are delivered to the order decoder. If S<sub>9</sub> is put into the "one bit" position, flip flop 2 is now triggered by bistable 3, so that one pulse will be fed to the decoder for each press of the "start" switch.

The clock pulse multivibrator (Fig. 28) is a conventional astable multivibrator, the speed of which can

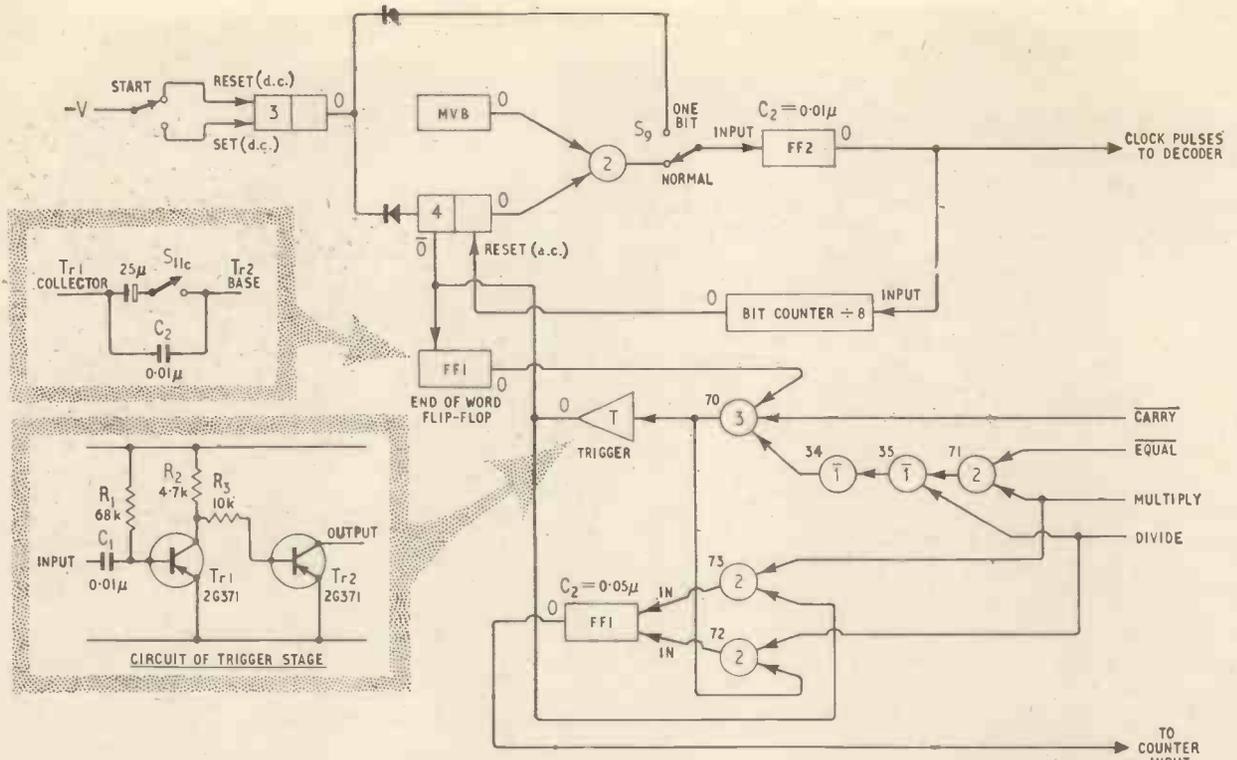


Fig. 29. The complete control unit. Note that the value of  $C_0$  in e.w.t. flip-flop can be altered by  $S_{11}$  for demonstration purposes.

be decreased for slow-motion demonstrations by switching in two extra capacitors.

The complete logical diagram of the control unit is shown in Fig. 29. Operation of the basic circuit is much the same as previously described. It will be noticed that after eight pulses have been produced, i.e. one word has been dealt with, the "end-of-word-time-flip-flop" (e.w.t.) is triggered by the negative-going edge available at the NOT output of bistable 4 as it is reset. The output of the e.w.t. flip-flop is fed to gate 70 and has no effect

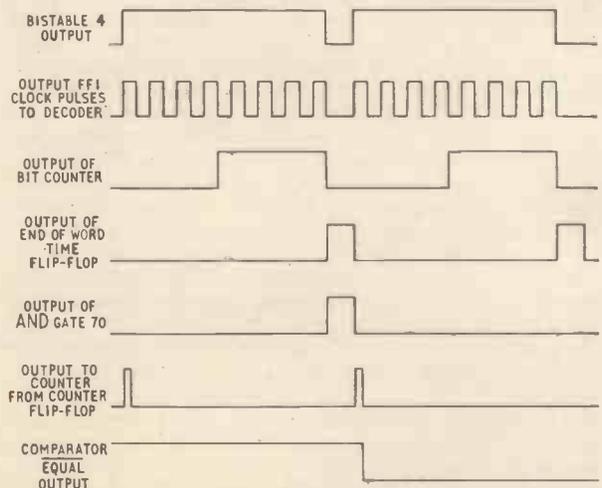
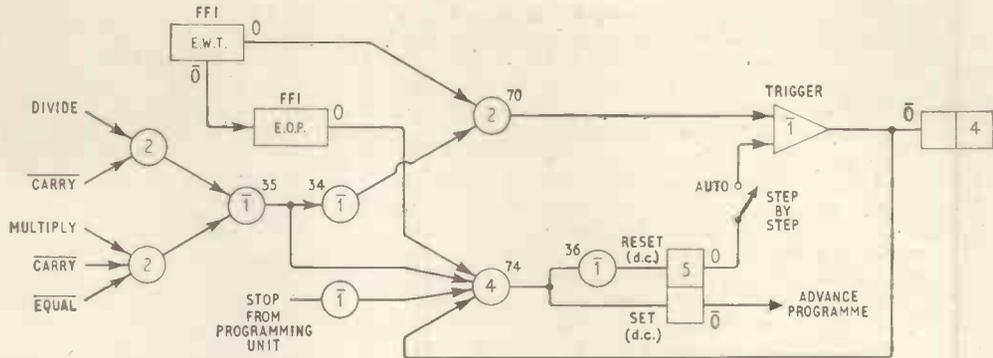


Fig. 30. Pulses present in the control unit when the computer is multiplying by two.

unless "multiply" or "divide" is selected. It will be remembered that during multiplication the multiplier is put into store 1. The computer then adds, each addition being counted until the number of additions equals the multiplier, this being detected by the comparator. When the computer is instructed to multiply, AND gate 47 in the order decoder opens to provide an "up" signal to one of the inputs of gate 71 in the control unit. As the counter is at zero at the start of the operation and as store 1 holds the multiplier, the EQUAL output of the comparator will be "up," opening gate 71, the output of NOR 35 will be "down," and that of NOT 34 "up," providing one input for gate 70. The start switch is pressed, and, as is normal, eight clock pulses are produced. At the end of the word the e.w.t. flip flop triggers to open AND gate 70 which provides an "up" input to the trigger stage (ignore the CARRY input to gate 70 at this stage).

The trigger circuit is one that has not been mentioned previously. Its output transistor collector is coupled to the collector of Tr1 in bistable 4. Under normal conditions Tr1 in the trigger stage is held in a conducting state by  $R_1$  and its collector at 0V. As a result Tr2 is turned off, having no effect on bistable 4. When the e.w.t. flip-flop triggers AND gate 70 opens and the resulting negative-going edge tries to drive Tr1 in the trigger stage further into conduction and has no effect. When  $C_2$  in the e.w.t. flip-flop discharges, the flip-flop returns to its normal condition and closes AND gate 70. A positive-going edge is now applied to the trigger stage, momentarily turning off Tr1. The collector potential of Tr1 rises to  $-V$ , turning on Tr2 and "pulling" the collector potential of Tr1 in bistable 4 to 0V, setting bistable 4, to produce another eight clock pulses. Every time

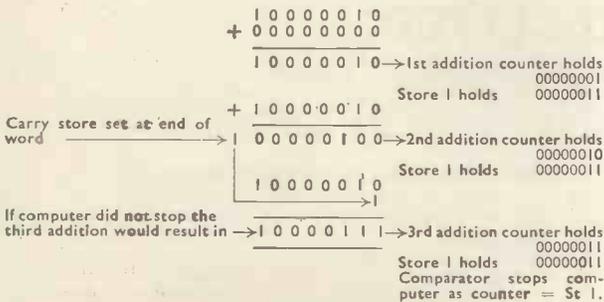
Fig. 31. Modification to the control unit that provides controlling pulses for an external programming device. The numbers of the AND gates on the left of the diagram are: upper 75, lower 71. The unmarked NOR gate is 37.



bistable 4 sets, with "multiply" selected AND gate 73 opens to trigger the counter flip-flop, providing a pulse to advance the counter one position. Sequences of eight pulses are generated, and for each batch of eight pulses a pulse is delivered to the counter until the contents of store 1 equal the contents of the counter. Then the EQUAL output of the comparator goes "down," to close AND 70, preventing any further pulses from being generated.

AND gate 70 is only "interested" in what the conditions are at the end of the word time period, so any carries that are generated during a word do not affect gate 70 as the e.w.t. flip flop is not set. However, if during a multiplication the capacity of the accumulator is exceeded the carry store will be set at the end of a word time, and this causes the CARRY input to gate 70 to go "down," preventing any further additions from taking place. If this did not happen and the computer continued with the computation, the most significant digits would be lost and an end-around-carry would take place, resulting in an incorrect answer.

For example, suppose the arithmetic operation to be carried out is  $130 \times 3$ . In binary this is equal to  $1000010 \times 0000011$ , so that  $1000010$  has to be added to itself  $0000011$  times.



From this it can be seen that if the computer did not stop when the capacity of the accumulator was exceeded the answer to  $1000010 \times 0000011$  would be given as  $10000111$  or  $130 \times 3 = 135$ , which is not a very happy state of affairs. In the completed computer the state of the comparator is indicated on the front panel, as is the state of the carry store, so if the computer halts during a multiplication with the comparator indicating "not equal" and the carry store set, the result contained in the accumulator is unreliable. The operation of the control

unit during multiplication is summarized by the waveforms in Fig. 33.

During division it is necessary to count every subtraction minus one and halt the computer when the accumulator goes negative, which is detected by the carry store being set at the end of a word. For example, we will imagine that before the last subtraction the accumulator holds  $00000101$  and that we are dividing by  $00001000$ . The last subtraction would yield

$$\begin{array}{r} 00000101 \\ - 00001000 \\ \hline 11111101 \end{array}$$

The carry store is set at the end of the word, indicating that the accumulator is negative. It may be interesting to analyse this a little further. What we have done is subtracted 8 from 5; therefore, ignoring the carry, the accumulator must hold the binary equivalent of  $-3$ , but we have already seen that  $11111101$  is equal to 153. It is clear that if some means were available for indicating the sign of a number, both positive and negative values could be represented. This is dealt with fully in a later section dealing with the operation of the computer.

When the computer is instructed to divide, AND gate 48 in the decoder opens to provide an "up" signal to gate 70 via NOR 35 and NOT 34. Continuous subtractions will now take place as for multiplication, the difference being that the comparator has no effect on the sequence of operations as AND 71 is closed, the condition of the carry store at the end of word time being the sole controlling factor. The counter flip-flop now receives its trigger pulses from AND 70 via AND 72, so now the counter advances one position at the end of the word time period, not at the beginning of a word as with multiplication. Because AND 70 is closed by the carry store at the end of the last subtraction, the last subtraction is not counted, fulfilling the requirement of counting all the subtractions minus one during division. During addition and subtraction the counter is unaffected as AND gates 72 and 73 cannot open. This means that when only addition and subtraction are to take place the counter can be used as a store—but more about this later. The e.w.t. flip-flop time-constant is increased during demonstration functions by a section of switch  $S_{115}$  the switch that controls the clock generator speed, so that the end of each word can be clearly seen as indicated by the long pause.

**Modification to allow use of programming facility.**—It was mentioned in Part I that a stored-programme facility would be a feasible addition to the computer. This could take the form of the matrix programming board already mentioned or could be a uni-selector or stepping drum. At each position of such a

programme store a particular instruction would be fed to the order decoder, and a complete sequence of instructions would cause the computer to perform a required arithmetical process. If such a device is to be added the computer must be arranged to provide an output pulse to advance the programme one position at the end of each operation.

The additional logic required for such a system is shown in Fig. 31. It provides two possible modes of operation. First, at the end of an operation a pulse is fed to the programming unit which selects the new instruction, then the computer automatically re-starts and goes through the complete programme until a "stop" instruction is received. Second, the "end-of-operation" pulse will advance the programme but will not restart the computer. This means that the "start" switch has to be pressed for each operation but the following instruction is pre-selected. This should be of value when demonstrating the unit to a group of students.

Modifications required to the control unit consist of disconnecting the "divide" control signal from NOR 35 and providing it with an AND gate of its own (75). The CARRY input is disconnected from AND 70 and re-connected to AND 75 and AND 71. The input components to the trigger stage are duplicated and fed from some additional logic. A moment's thought will show that now, when multiplication or division is taking place the output of NOR 35 will be "down" for the duration of the operation and at the completion of the operation the output of NOR 35 will be "up." So at the end of a word when NOR 35 is "up" the programme unit must receive an advance pulse.

At the end of every word the e.w.t. flip-flop triggers as before. If the output of NOR 35 is "down" the computer is restarted in the normal way. Each time the e.w.t. flip-flop resets the end-of-operation (e.o.p.) flip-flop triggers. If NOR 35 is "up," indicating the end of an operation, and if bistable 4 is reset, as it will be at the end-of-word time, AND 74 opens. This sets bistable 5, providing a positive edge to advance the programme. When the e.o.p. flip-flop resets, bistable 5 resets, providing a positive edge for the trigger stage and restarting

LIST OF PARTS			
<b>Switches</b>			
8	Single-pole on/off	SM259/DB	} A. F. Bulgin & Co. Ltd., Bye Pass Road Barking, Essex Home Radio (Mit- cham) Ltd., 187 London Rd., Mitcham Surrey
11	Single-pole push-to-make	MP7	
1	Single-pole c/o, biased	SM273/DB	
1	Single-pole c/o	SM265/DB	
1	4-pole 2-way	WS 24	
<b>Neon Lamps</b>			
48	Clear neon lamps	D795/clear	} A. F. Bulgin
5	Red neon lamps	D795/red	
<b>Resistors and semiconductors</b>			
LST Components, 23 New Road, Brentwood, Essex			
<b>Capacitors</b>			
See text, page 367, August issue			
<b>Case (used in prototype)</b>			
Type 1100A. Alfred Imhof Ltd., Ashley Works, Cowley Mill Road, Uxbridge, Middx.			

the computer. This procedure will continue until a "stop" instruction from the programme unit drives the input to NOR 37 "up," preventing AND 74 opening and inhibiting any further restart and advance pulses. The switch in the restart line from bistable 5 enables the programme to be carried out automatically or step-by-step for demonstration purposes. The input to AND 74 from bistable 4 prevents the programme from being advanced in the middle of a word as would happen under certain conditions.

This concludes the description of the functioning of the computer. Readers who have been able to stay with the series thus far can now start to order parts and reach for their soldering irons with confidence.

(Next month: constructional hints.)

**Corrections.** (1) Fig. 2. OR gate, first element of the combined NOR/NOT version should have 1 and not 4 as shown. (2) Equation 3, page 416, should read  $ABC + \bar{A}BC + \bar{A}\bar{B}C + ABC = \text{SUM}$ . (3) Page 422, L.H. column, line 13, change EQUAL to EQUAL. (4) Page 423, L.H. column, line 8, change 20 to 18.

**Note:** The computer will be on show at the R.S.G.B. exhibition, see page 487.

## BOOKS RECEIVED

**Basic Algol** by W. R. Broderick and P. S. Barker. The material presented in this book first appeared as a series of thirty articles in *Computer Weekly*. Its aim is to provide a means whereby the non-mathematical and the mathematical readers can achieve an understanding as to what Algol is and how it is used. The book starts by outlining the basic principles of computers and binary arithmetic leading up to a description of basic Algol. As each Algol expression is introduced it is included in a programme to illustrate its use and effect. The book includes a question and answer section to enable the reader to try his hand at using his new-found knowledge and ends with a revised report on Algol 60. Pp. 121. Price 15s. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

**Instruments Electronics Automation** (Third edition) 1967 year book and buyers' guide. This reference work is divided into five sections. The first section contains a Who's Who, Who Buys (a guide to people responsible for the procurement of supplies for Public Services in the U.K.), and British Standard and Defence Specifications. Section two contains manufacturers' addresses, etc. Section three is devoted to an alphabetical buyers' guide; information being presented under more than 4,600 product headings to which section four is an illustrated adjunct. Section five consists of a

number of equipment surveys. The book is a mine of information for all who are associated with electronics and automation. Pp. 729. Price 60s. Morgan Brothers (Publishers) Ltd., 28 Essex Street, London, W.C.2.

**Computer Technology**, proceedings of the conference held in Manchester during July 1967 by the I.E.E. This book presents the papers given at the above conference and covers the latest development in many branches of computer technology. It includes descriptions of sub-systems and complete experimental computers. A number of papers are devoted to storage systems, the plated wire type predominating, although a high-speed read-only store using ferrite rods is described. This store has a capacity of 2,048 words of 50 bits and a random access cycle time of 80 nanoseconds. A paper by members of the Advance Research and Development Department of I.C.T. describes a method of interconnecting unencapsulated integrated circuits on a multi-layer thin film conductor structure mounted on a ceramic substrate. Access to the lower conductor layers is made via small windows; interlayer interconnection is carried by the deposition of bridging links. In all, 28 papers are included in this book which should prove to be a valuable acquisition to anyone involved with computers. Pp. 277 (8.25 x 11.75 inches). Price 75s. I.E.E., Savoy Place, London, W.C.2.

# LITERATURE RECEIVED

**Electrolube Application Guide** has two of its 28 pages devoted to recommended applications within audio and electronics fields. The lubrication of contacts and moving parts are listed under the following headings: tape and disc recorders, radio and television, record players, audio amplifiers, electronic organs/key boards, transmitters, transmitter receivers and radio controlled models. **Electrolube Ltd., Slough, Bucks.**  
WW 337 for further details

English editions of the **Agfa-Gevaert Magnetron Magazine** are to be distributed at least once a year. The current edition is available free of charge from radio/photographic dealers or directly from Agfa-Gevaert Ltd., Great West Road, Brentford, Middlesex.  
WW 338 for further details

Low inertia motors, tachogenerators and integrators are described in the seven-page catalogue (publication G65) from **Ether Ltd., General Products Division, Caxton Way, Stevenage, Herts.**  
WW 339 for further details

Received from **SGS-Fairchild Ltd., Planar House, Walton Street, Aylesbury, Bucks,** is the eight-page **Industrial Planar Selector.** Silicon planar devices, such as switching and amplifier transistors, phototransistors, dual transistors, number tube drivers, Zener diodes and s.c.r.s, are listed, with primary and secondary selection characteristics.  
WW 340 for further details

**Quick reference guides 1967/8** for (a) industrial valves and tubes, (b) industrial semiconductors, and (c) industrial components by **Mullard Ltd.** contain abbreviated product information for performance comparisons. The guides also contain volume numbers of the **Mullard Handbook** service so that subscribers can obtain detailed data on the products listed. Copies of the three guides can be obtained on application to **Mullard Ltd., Industrial Markets Division, Mullard House, Torrington Place, London, W.C.1.**  
WW 341 for further details

There are 38 pages in the **Hird Brown Ltd. brochure J135 Photo-Electric Cell Operated Relays.** Full information on the 1967 range of photo-electric equipment is given. Diagrams and photographs of ten photo-relays and a selection of time-delay relays. Over 40 types of photo-electric projectors and receivers are described, and an alignment meter for setting up photo-cell beam sources.  
WW 342 for further details

A new edition of "**Ignitrons**" by **English Electric Valve Co. Ltd., Chelmsford, Essex,** is now available. This 114-page publication contains full data on all EEV Ignitrons, an equivalents index, theoretical and practical information for designers and users, quick-reference selection chart of tabulated data, and a list of U.K. stockists and overseas agents.  
WW 343 for further details

Three solid-state power amplifiers are briefly described in a leaflet from **Derritron Electronic Vibrators Ltd., 24, Upper Brook Street, Mayfair, London, W.1.** The 25WT, 100WT, and 300WT, produce 25, 100, and 300W respectively to drive small electro-mechanical vibrators.  
WW 344 for further details

**Radio Frequency Cables** is the title of a 43-page B.I.C.C. publication (533). Section one provides physical and electrical characteristics of coaxial cables with polythene and polypropylene insulation. Section two describes Uniring and Hyring insulated and non-insulated terminations for coaxial cables, multiway connectors and installation tools. **British Insulated Callender's Cables Ltd., 21, Bloomsbury Street, London, W.C.1.**  
WW 345 for further details

Shortform catalogue (4 pages) "**Instruments for Industry and Research**" published by **Farnell Instruments Ltd., Sandbeck Way, Wetherby, Yorks,** describes bench power supply units, sub-unit supplies, sine/square wave oscillators, a solid-state millivoltmeter, and an educational digital logic system.  
WW 346 for further details

## Manchester Electronics Show

THIS year's Institution of Electronics exhibition to be held in Manchester from September 26th-29th, will be the largest of the series of 22. In all 125 manufacturers are exhibiting—over 50 of them for the first time.

The show, the official title of which is the **Electronics, Instruments, Controls and Components Exhibition and Convention,** will be held in the Exhibition Halls, Belle Vue Gardens and will open each day at 10.00 and close at 18.00 on the 26th and 28th and at 21.30 on the 27th and 29th. Admission is by complimentary ticket obtainable from exhibitors or the Institution, 78 Shaw Road, Rochdale, Lancs., from which a catalogue of the exhibits (price 5s 6d) is available.

The exhibitors are:—

A.E.P. International  
A.P.T. Electronic Industries  
Advance Controls  
Alma Components  
Analog Devices  
Arrow Electric Switches  
AEL-Thorn Semiconductors  
Associated Engineering  
Aveley Electric  
Avo  
Beckman Instruments  
Belling & Lee  
Benson-Lehner  
Bourns (Trimplot)  
Bradley, G. & E.  
British Electric Resistance Co.  
Cambion Electronic Products  
Cannon Electric (G.B.)  
Cedenco (C. Denis & Co.)  
Celdis  
C. P. Clare International N.V.

Coutant  
Crouzet England  
Croydon Precision Instrument Co.  
Dana Laboratories U.K.  
Data Acquisition  
Datum Metal Products  
Dawe Instruments  
Diamond H. Controls  
Digital Equipment Corp.  
E.M.I.  
Educational Systems  
Electrical Apparatus Co.  
Electro Automat  
Electro Mechanisms  
Electrothermal Engineering  
Elliott Automation  
Ether Engineering  
Ether  
Ever Ready Co.  
Evershed & Vignoles  
Farnell, A. C.  
Farnell Instruments

Fenlow Electronics  
Flight Refuelling  
Foster Instrument Co.  
Fylde Electronic Laboratories  
G.E. Electronics (London)  
Greenpar Engineering  
Hallam, Sleigh & Cheston  
Hardman & Co.  
Hatfield Instruments  
Heathkit/Daystrom  
Hedin Furnaces  
Hellermann Electric  
Highland Electronics  
Hird-Brown  
Holiday Bros.  
Honeywell Controls  
Howells Radio  
Imhof  
Insuloid Manufacturing Co.  
Intersonde  
K.G.M. Electronics  
K. & N. Electronics  
K.S.M. Electronics  
Kent Industrial Instruments  
Klippon Electricals  
Koletric  
Lambda Electronics  
Lectropon  
Leeds & Northrup  
Lock, A. M. & Co.  
Lucas, Joseph (Electrical)  
Lyons, Claude  
M.E.L. Equipment Co.  
Magnetic Devices  
Martin-Ivo  
Meterflow  
Milton Ross Co.  
Miniature Electronic Components  
Morecambe Electrical Equipmt. Co.  
Morgan Brothers (Publishers)  
Mullard

Newmarket Transistors  
Norma  
Painton & Co.  
Peto Scott  
Polaron Equipment  
Precision Instruments (U.K.)  
Pye, W. G.  
Pye-Ling  
RCA Great Britain  
Racal Instruments  
Redifon-Astrodata  
Reliance Controls  
Research Electronics  
Roband Electronics  
Royal Navy  
S.E. Laboratories (Engineering)  
Salford Electrical Instruments  
Sasco  
Smiths Industries  
Staveley-Smith Controls  
Stow Electronic  
Superior Electric Nederland N V  
Symonds, R. H.  
Taylor Electrical Instruments  
Tectonic  
Teddington Aircraft Controls  
Telephone Manufacturing Co.  
Telford Products  
Telonic Industries U.K.  
Texas Instruments  
Thermionic Products  
Thomas & Betts Co. Inc.  
Tinsley, H., & Co.  
Transradio  
Veeco Instruments  
Vero Electronics  
Watford Electric & Mfg. Co.  
Waycom  
Westinghouse Brake & Signal Co.  
Whiteley Electrical Radio Co.  
Zenith Electric Co.

# New Measurement Techniques

From the Fourth International Measurement Congress, IMEKO IV, Warsaw

AS was mentioned in our Editorial Comment last month, the Fourth International Measurement Congress at Warsaw encompassed an extremely wide range of engineering techniques.\* Electronic methods, however, figured very prominently, because of their ability to provide high sensitivity, accuracy and flexibility in obtaining measurement information, and it is from these that the following examples have been selected. All the papers, with excerpts in three languages and discussion reports, are due to be published in *Acta Imeko* 1967 which will be available from the Imeko Secretariat, P.O.B. 457, Budapest 5, Hungary.

**Impulse testing of concert hall acoustics** by correlation measurements was a technique suggested by B. P. Veltman of the Technical University of Delft, Netherlands. M. R. Schroeder has proposed a new method of measuring reverberation time which involves calculating the decay in the squared value of the impulse response of the hall, but it is difficult to check this performance

\* "Is Measurement a Science?" September issue, p. 415.  
 † See "Random Signal Testing for Evaluating System Dynamics" by W. D. T. Davies, *Wireless World*, August 1966.

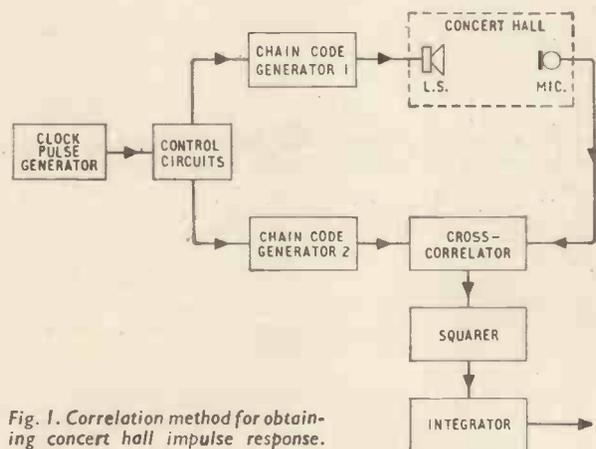


Fig. 1. Correlation method for obtaining concert hall impulse response.

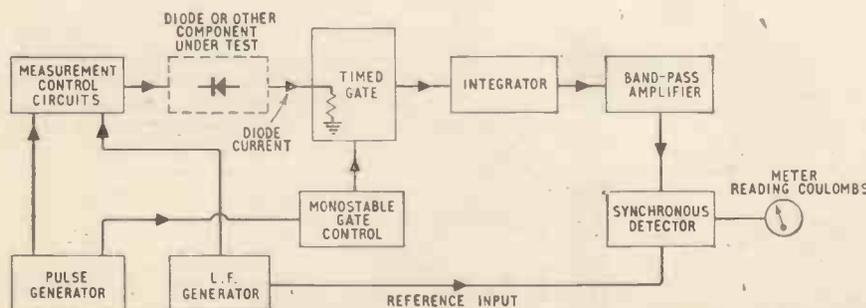


Fig. 2. Schematic of apparatus for measuring stored charges in semiconductor devices.

criterion for a sufficiently large number of halls because of the complicated procedures necessary with conventional recording techniques. Veltman's solution, in which the impulse response is obtained by cross-correlation between excitation and response, with random signal excitation, is claimed to be relatively simple. This is because his correlation equipment itself is a simple, compact digital system working on signals quantized into two-state form and because it allows the use of "on-off" pseudo-random binary sequences,† known as chain codes, for the acoustic excitation. The testing system is shown in Fig. 1. There are two chain code generators, giving sequences of long repetition period, actuated by a common source of clock pulses. Cross-correlation coefficients between the microphone signal and the loudspeaker signal, which is shifted in time to give a series of delays, are automatically calculated to give the cross-correlation function. This is an amplitude/time curve which is in fact the impulse response, and is obtained in 100 such time-delay points. In the correlator, the different delays between the two signals are obtained by passing the two-state loudspeaker signal through a shift register, and the frequency of the shift pulses applied to this determines the time interval between successive points in the cross-correlation function. Finally, as can be seen from Fig. 1, the successive values representing the impulse response are squared and then integrated to give the required reverberation time curve.

**Measuring stored charges in diodes and other semiconductor devices** during their recovery periods was the subject of a paper by A. Marek of the Research Institute of Mathematical Machines, Prague, Czechoslovakia. The interest here lies in the ability to measure extremely small charges, of the order of  $10^{-13}$  coulomb, in extremely short intervals of  $10^{-9}$  sec to  $10^{-11}$  sec, during transient conditions after diode activation. In practice the major difficulty is in separating the wanted part of the diode signal (stored charge vs. time) for observation from the activation part necessary to produce it. Passive methods of gating (using the signal itself to actuate circuits) were found unsatisfactory because of non-linearity and bandwidth problems, and finally it was decided not to attempt to observe the waveform of the transient quantity (diode current) but merely to obtain its integral over a known time interval. This necessitated the use of an externally timed gate synchronized with the activation system.

A schematic of the measuring apparatus is shown in Fig. 2. The pulse generator determines the instants that the diode activation charge is applied and removed by the measurement control circuits, while the monostable triggered by it determines the precise start and finish of the integrating

period. Current through the diode resulting from the activation and subsequent carrier storage is passed through a resistor; and the voltage developed across this is gated during the selected integrating period and passed to the integrator (a low-pass filter circuit). The low-frequency generator, band-pass amplifier and synchronous detector arrangement allow the system to be modulated in order to overcome the zero drift of the timed gate. They also improve the overall sensitivity and allow different activation transients to be applied to the diode under test. In the synchronous detector the integrated signal is converted down to d.c. and this is then displayed on a meter calibrated in coulombs. Dr. Marek reported successful use of the apparatus on point-contact diodes, on bonded, alloyed, diffused, planar epitaxial gold-killed junction diodes and on Schottky-barrier silicon and gallium arsenide diodes.

**Calibrating inductive voltage dividers by an apparatus giving extremely high accuracy** was described by a speaker from the Laboratory of Electricity and Magnetism, Chinese Institute of Metrology, Peking. The calibration errors at 1,000 c/s were stated to be a voltage ratio error of less than  $3 \times 10^{-9}$  and a phase angle error of less than  $3 \times 10^{-8}$  radian (referred to the voltage divider input signal). The calibration technique is based on the use of a reference voltage and is shown in principle in Fig. 3. The reference voltage is obtained from the secondary of a transformer whose primary is fed from the same a.c. source that energizes the inductive voltage divider. Thus any variations in the energizing source affect the divider voltages and the reference voltage equally, and this effect is cancelled out. Voltages from the various tappings on the divider are balanced against the reference voltage by a compensating circuit to give a null indication on the detector. This compensation is actually provided by a controllable proportion of the signal voltage from the energizing source, obtained through an auxiliary i.v.d. and a transformer. The high accuracy is the result of various precautions for maintaining constant the voltage ratio of the reference transformer. This transformer is constructed in two sections, is extensively screened to reduce magnetic leakage to a minimum, and, during calibration, the transformer screen is maintained at the same potential as the secondary winding. As a result of these measures the relative stability of the reference voltage is said to be better than 1 part in  $10^{-9}$  per hour.

**Magnetic-scale displacement measurement system, using a periodic remanence pattern recorded on a coated glass**

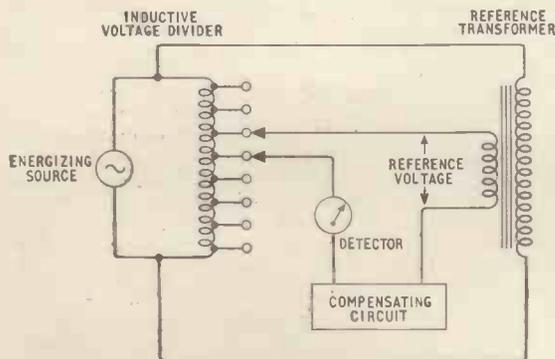


Fig. 3. Reference voltage method for calibrating an inductive voltage divider.

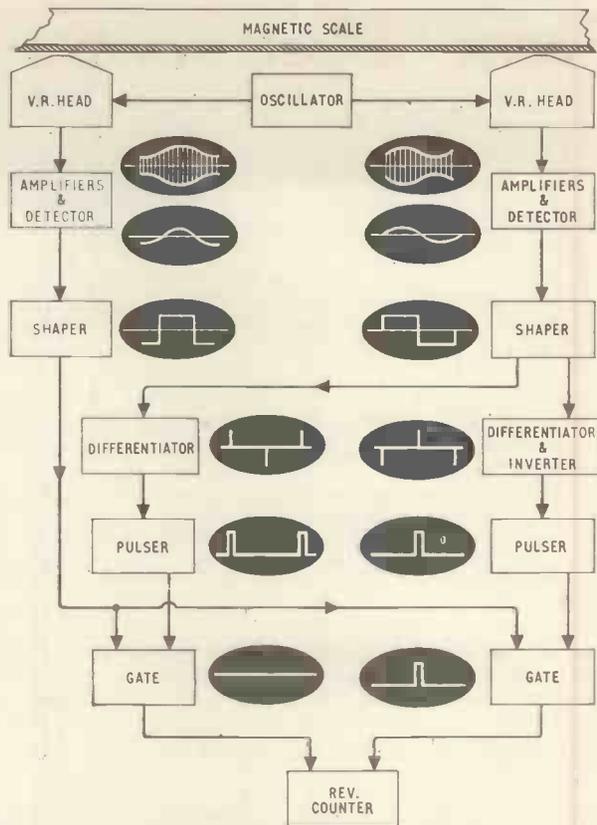


Fig. 4. Simplified schematic of scheme for displacement measurement using a magnetic scale.

rod as a scale, was the subject of a paper by M. Morimura (Japan). The periodic pattern is recorded by moving the 40-cm magnetically-coated square glass rod at a constant speed past a recording head to which an a.c. signal of constant frequency is applied. This scale is attached to the moving part of the machine in which displacement is to be measured, and a variable-reluctance (flux-sensitive) magnetic pick-up head is attached to the fixed part. At a given phase point in each cycle of the head signal a pulse is generated, and the total displacement of the scale relative to the head is measured by counting the number of pulses produced during movement.

The electronic system shown in Fig. 4 is for accommodating two directions of movement—pulses being added to a total count for one direction and subtracted from the count for the other direction. In the right-hand channel pulses are emitted either when the head waveform is rising or when it is falling. The left-hand channel produces a signal which gates the pulses in such a way that one direction of motion results in pulses from one gate and movement in the other direction results in pulses from the other gate. These pulses are then counted in a reversible counter on the principle explained above. Actually the system uses two magnetic scales with their patterns displaced a quarter of a wavelength relative to each other. The purpose of this is to prevent erroneous counts and to provide interpolation to give higher resolution (four pulses now being emitted in a displacement equal to one wavelength). For this interpolation system a more complex logic arrangement than that shown is used, in which each signal channel

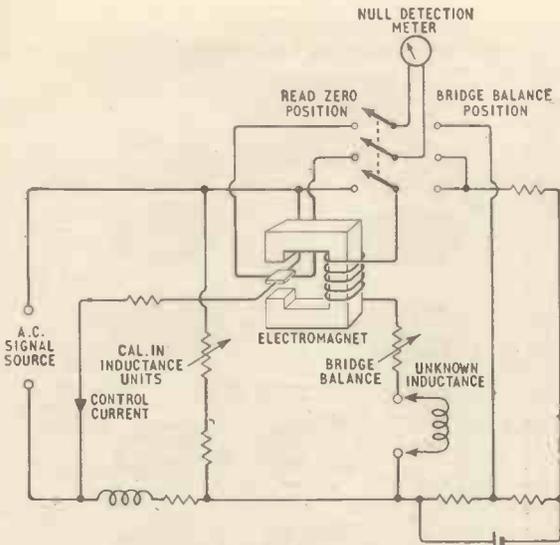


Fig. 5. Hall-effect inductance meter combined with resistance bridge.

controls a gate through which pulses produced by the other channel are transmitted. Measurement of displacement of up to 40-cm in units of  $10\mu$  (scale wavelength =  $40\mu\text{m}$ ) has been achieved, and the accuracy of the unit of measurement has been estimated to be of the order of  $0.1\mu\text{m}$ .

**Hall-effect inductance meter**, using a Hall element to detect the phase difference between the element control current and the magnetic flux density of the applied field, was described by M. Nalecz, Z. Dunajski, W. Torbicz and H. Ziomecki of the Institute of Automatic Control, Polish Academy of Sciences, Warsaw. In Fig. 5 the energization voltage from the a.c. signal source (which can be 50 c/s mains) is applied across the Hall element, producing a control current in phase with it, and also across a reactive circuit, including the electromagnet and unknown inductance, in which there is a phase difference between the current and the energization voltage. The electromagnet applies a magnetic field to the Hall element which is placed in its air gap. When the unknown  $L$  is zero (short circuited terminals), by a suitable choice of circuit components the phase difference between the control current  $I_c$  and the magnetic flux density  $B$  is arranged to be  $90^\circ$ . When an inductance is connected to the terminals the phase shift will differ from  $90^\circ$  causing the Hall element to give a voltage, the d.c. component of which is

$$V_H = \gamma I_c B \cos \phi$$

where  $\gamma$  is the sensitivity of the Hall element and  $\phi$  is the phase angle between  $B$  and  $I_c$ . Since the phase angle  $\phi$  depends on the value of the unknown inductance and its associated resistance, the Hall element voltage is a function of the inductance and can be measured as such.

Actually, the arrangement in Fig. 5 provides for measurement of the inductor's resistance and for a null-balance measurement of inductance giving greater accuracy and independence of signal source variations. When the switch is thrown to the "bridge balance" position the inductor's resistance can be measured on the resulting d.c. Wheatstone bridge by adjustment of the calibrated "bridge balance" variable resistor. When

the switch is thrown to the "read zero" position, the left-hand variable resistor is adjusted until the null detection meter reads zero, and in this condition the unknown inductance and other component values are such that  $\phi = 90^\circ$ . The authors show that the  $R$  of the left-hand variable resistor is a linear function of the measured inductance and so this variable control can be directly calibrated in inductance units.

**Acknowledgements to the Chairman.**—A well-known feature of life in China is that all achievements are attributed to the inspiration of Mao Tse-tung, particularly as received through his "Thoughts." At Warsaw it was interesting to see this influence in the Chinese contribution mentioned above, which began:—

"Under the leadership of the Chinese Communist Party and the brilliant illumination of Chairman Mao Tse-tung's thought, our national metrological enterprise, just like our other departments, has got a rapid development. Therefore, there is a higher demand in the measurement of a.c. voltage ratio. By promoting the revolutionary spirit of relying on ourselves and to work vigorously, we have carried out our scientific research with the dialectical materialistic point of view and methods explained in 'On Contradiction' and 'On Practice.' We have overcome a series of difficulties with the work-style of 'daring to think and daring to act.' Eventually a method of precise measurement of complex-voltage ratio of i.v.d. at audio frequency has been developed within a short period."

and ended:—

"That the research can be accomplished within such a short period is the result of the concern of our Party and Government, and also of the constant studying and applying of Chairman Mao Tse-tung's works in a creative way by our comrades in class struggle and the struggle for production and scientific experiment."

Another Chinese paper from the same Institute, on a bridge for measuring the time constant of resistors, contained similar references to and quotations from Mao's philosophical writings.

## BISTABLE RESISTORS

THE fact that vanadium oxide ( $\text{VO}_2$ ) exhibits a large discontinuity in resistivity at a temperature of  $68^\circ\text{C}$  has been known for some time, but it is only recently that this effect has been utilised to form a bistable element—which may have application as a storage device. The discontinuity is closely associated with a phase transition which occurs at  $68^\circ\text{C}$ . Above this temperature  $\text{VO}_2$  has a low "metallic" resistivity, while below it, the material is a semiconductor with a resistivity of the order of  $10^3$  times higher.

To form a bistable element a bias voltage is applied through a series resistor across a  $\text{VO}_2$  crystal  $100\mu\text{m}$  thick. If the energy dissipation below the transition temperature is less than that required to maintain the crystal at  $68^\circ\text{C}$  and if the dissipation above the critical temperature is greater than this, then the device will show the bistable property. A positive pulse applied to the device (superimposed on the bias voltage) with sufficient duration to supply energy to raise the temperature above  $68^\circ\text{C}$  (or, conversely, a negative pulse to allow temperature to fall below critical) will switch the element from one state to the other. Typical magnitudes of the quantities involved are: bias voltage 17 V, pulse height 16.5 V, duration  $10^{-4}$  s, mean dissipation 150 mW, resistances of  $1500\Omega$  and  $100\Omega$  for the two states, switching time  $100\mu\text{s}$ . (The switching time of such a device is limited, of course, by the rate of heat transfer.) This work was reported in *Philips Res. Reports*, 21, 5, p. 387.

# WORLD OF AMATEUR RADIO

## Growth of the Club Movement

GROWING interest in amateur radio is evident from the fact that during the past 12 months the number of radio clubs and societies affiliated to the R.S.G.B. has increased from 270 to 320—an all-time record. The largest sectional increase has been in the number of clubs and societies associated with seats of learning, which now total 55, compared with 42 a year earlier. Universities account for 25, colleges of further education for 11 and schools of all types for 19. Service establishments, headed by the Royal Air Force with clubs at 17 centres at home and abroad, provide another important section of interest, and more than 20 clubs are associated with commercial concerns of all kinds. Just how many individuals are members of the 320 clubs is not known, but if an average of 30 per club is accepted as reasonable the total is approaching 10,000.

## British Success in VHF/UHF Contests

AGAINST strong competition from European contestants Jim Foster (G2JF), of Wye College, Kent, took first place in the 1966 I.A.R.U. Region I v.h.f./u.h.f. contest for fixed stations operating on 144 Mc/s, the results of which have just been announced by the organizing society, *Reseau des Emetteurs Français*. Mr. Foster scored 50,116 points in a field of 375 competitors drawn from 19 countries, with Czechoslovakia, Germany (East and West combined) and Italy providing the highest number of entrants. Second place was taken by a Swedish station (SM7BZX) with 46,059 points, followed by the West German station DLØZW (44,360 points). British stations were also placed first in the contests for fixed stations operating on 1,296 Mc/s and for mobile or portable stations working on the same band, the winners being, respectively, W. R. Hawthorne (G3MCS), of Aylesbury, Bucks., and P. V. Dutfield (G3OBD/P), of Poole, Dorset.

The I.A.R.U. Region I v.h.f./u.h.f. contests take place annually in September and are organized on a rota basis by I.A.R.U. Region I member societies. This year's event, which took place on September 2nd/3rd, was organized by the Danish Amateur Radio Society.

Mr. Foster's success in the 1966 contest followed earlier successes in the 1962 and 1963 events. An idea of the intensity of his activities on 144 Mc/s can be judged from the fact that he has contacted more than 3,200 different stations in 24 European countries. Mr. Foster's station is located 600 ft above sea level, which means that it virtually overlooks the English Channel and has falling countryside in other directions—an ideal site for v.h.f. operation.

**December R.A.E.**—The winter Radio Amateurs' Examination, organized by the City and Guilds of London Institute, will be held on Tuesday, December 5th, at 18.30 at the College of Preceptors, Bloomsbury Way, London, W.C.1. Applications to sit the examination must reach the Radio Society of Great Britain, 28, Little Russell Street, London, W.C.1, not later than October 31st, accompanied by an entry fee of £2 5s in the case of non-members. The December examination is arranged primarily for the benefit of candidates who fail to pass the examination held during the previous May.

**EXPO '67.**—Among the thousands of exhibits at EXPO '67, the Canadian Centennial Exhibition in Montreal, is an amateur radio station VE2XPO. Situated on La Ronde, a small island in the centre of the Exhibition the station can be heard most days on 21.3 Mc/s between 14.00 and 15.00 G.M.T. and most evenings on 14.15 Mc/s at about 22.00.

**National Field Day Winners.**—One of the oldest established radio clubs in the British Isles—the Surrey Radio Contact Club centred on Croydon—was winner for the first time of the National Field Day Shield, most coveted of all the trophies available for competition in R.S.G.B. circles. There were 42 entries. With a score of 2,061 points it was closely followed by the South Birmingham Radio Society (2,032 points) and the Cannock Chase Amateur Radio Society (2,029 points). In the single station section, with 74 entries, Norfolk Amateur Radio Club led the field with a score of 1,208 followed by the Great Yarmouth & District Group (1,023) and Basildon & District Amateur Radio Society (997). National Field Day first took place in 1933 and, except for the war years, has been an annual event since. It is estimated that at least 2,000 people play some part in every N.F.D. This year's event was held on June 3rd/4th.

**Beacon News.**—Reports on beacon transmitters now operating from Gibraltar and St. Helena will be appreciated by the Scientific Studies Committee of the R.S.G.B., c/o 28 Little Russell Street, London, W.C.1. The Gibraltar station (ZB2VHF) recently provided 64 contacts in two days with 49 different stations in 14 countries on 4 metres with D. Carden (G3RIK) of Rochdale, Lancs., claiming the honour of the first UK-ZB2 contact followed two minutes later by C. Miles (G3TOT), of Knebworth, Herts. The St. Helena station (ZD7WR) is operating in the 2-metre band for the purpose of investigating trans-equatorial scatter on paths to Gibraltar and the United Kingdom, and in view of recent long distance results on this band there seems to be a reasonable chance of contacts being established with stations in the British Isles.

**Britain's Lady Radio Amateurs.**—Three of Britain's lady amateurs have qualified for the exclusive DX-YL Certificate awarded to licensed lady operators who have made contact with 25 or more other YL operators in distant countries. Introduced nine years ago by the Young Ladies' Relay League, the first certificate went to Molly Henderson, ZE1JE, of Salisbury, Rhodesia. Since then 30 of the 8,000 ladies throughout the world that hold a licence, have qualified for the certificate. The United Kingdom holders, all of whom have been licensed for more than 30 years, are Nell Corry (G2YL), of Tadworth, Surrey, Barbara Dunn (G6YL), of Darleston, Cumberland, and Constance Hall (G8LY), of Lee-on-Solent, Hampshire. Although the number of lady operators continues to grow each year the 50 mark has yet to be reached in the United Kingdom.

**Amateur Radio on the "Hope."**—The hospital ship *Hope*, which is at present in Cartagena, Colombia, as part of the "People to People" programme, will be stationed there until the end of the year when she returns to the United States for refitting prior to leaving for Ceylon for her next mission of mercy. This is the sixth year the ship has carried its programme of teaching service to areas of the world requiring her help. Amateur radio, according to Dr. Harold Morgan, KØTP writing in *QST*, is usually the only means of maintaining contact between those on board the ship and their relations at home. Telephone contacts are expensive and not too dependable from many parts of the world visited by the ship. Crew pay is low and the medical staff (doctors and dentists) donate their services. Mr. Don MacLean, VE3BFA, of Sudbury, Ontario, Canada, is the full-time operator of the amateur radio station on board the ship which is currently operating under the call sign HK1AFG. The station equipment was donated and is maintained by Hallicrafters and a three-element beam is mounted on the starboard mast. Dr. Morgan recently spent two months on board the *Hope* as a radiologist during which time he frequently operated the amateur radio station.

JOHN CLARRICOTS, G6CL

# Circuit Round-Up

A look at colour television receiver sections which in the main use techniques common to colour and black-and-white practice

By T. D. TOWERS,\* M.B.E.

**I**N articles in this series so far, we have concentrated on the sections of the colour television receiver with features special to colour practice. To complete the picture to some extent, this article surveys most of the remaining sections, including the vision i.f. amplifier, the sound i.f. amplifier, the luminance amplifier, the a.g.c. control section, and the timebases. In addition, we take a brief look at the technique of automatic "degaussing," as colour receiver designs now often include this.

At present colour receivers in this country are dual-standard, but, since colour is on 625 lines only, the circuits used here have been simplified to show only the 625-line portions of them, eliminating the separately switched 405-line portions. Illustrations are from a modern colour receiver design by Mullard Ltd.

### VISION I.F. AMPLIFIER STRIP

Fig. 1 shows the circuit of a three-stage vision i.f. amplifier and detector for a 625-line colour television receiver, with a 5 Mc/s 6 dB-bandwidth centred on a 37 Mc/s midband frequency. Bandpass coupling is used on the input from the tuner, but interstage and detector

couplings are by single-tuned circuits, stagger tuned. Higher gain could have been achieved by bandpass interstage coupling. However, the extra gain was not necessary in the design and the use of single-tuned circuits led to better production reproducibility.

The i.f. amplifier uses BF167 and BF173 n-p-n silicon v.h.f. transistors which have exceptionally low collector-base feedback capacitance (of the order of a few tenths of a picofarad) making it possible to use them unneutralised, as here.

Some designs use separate detectors for luminance-chrominance and inter-carrier f.m. to reduce intermodulation beat between the chrominance and sound signals. The design of Fig. 1, however, uses a single detector, and avoids beats by attenuating the sound carrier about 36 dB down on the chrominance carrier in a trap circuit in the front end of the i.f. amplifier.

The amplifier has a total voltage gain of some 70 dB. A 37 Mc/s mid-band signal of about 150  $\mu$ V at the base of the first transistor produces 1 mV at the base of the second and about 20 mV at the base of the third to give finally 2 V d.c. from the detector (corresponding to 1 V d.c. at the 39.5 Mc/s vision i.f. frequency). These figures imply stage gains of 14 dB, 26 dB and 30 dB approximately.

\*Newmarket Transistors Ltd.

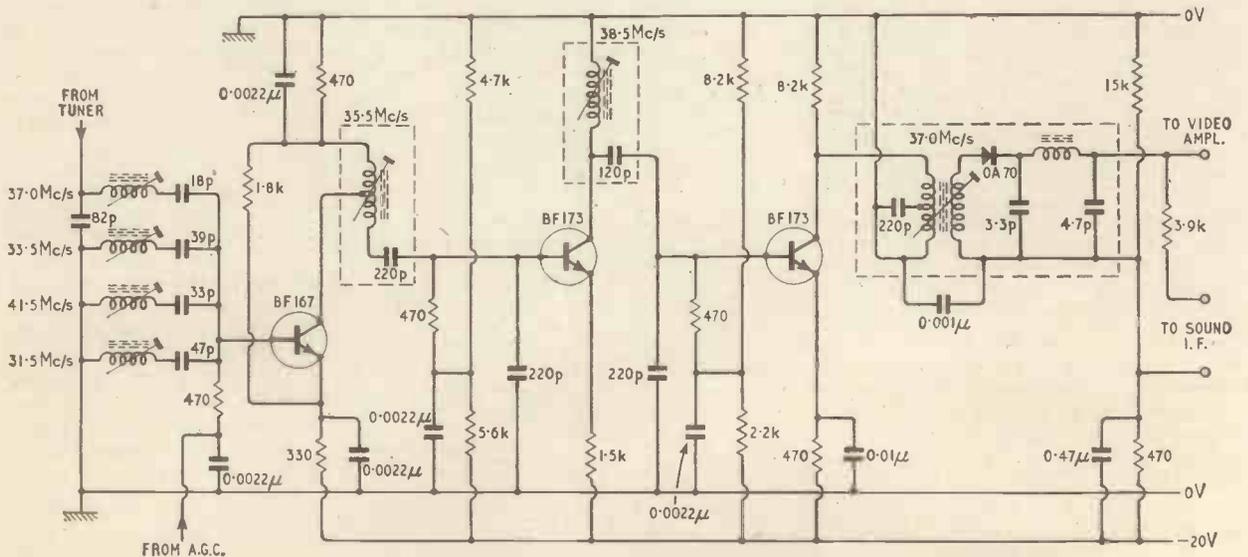


Fig. 1. Vision i.f. strip up to video detector stage.

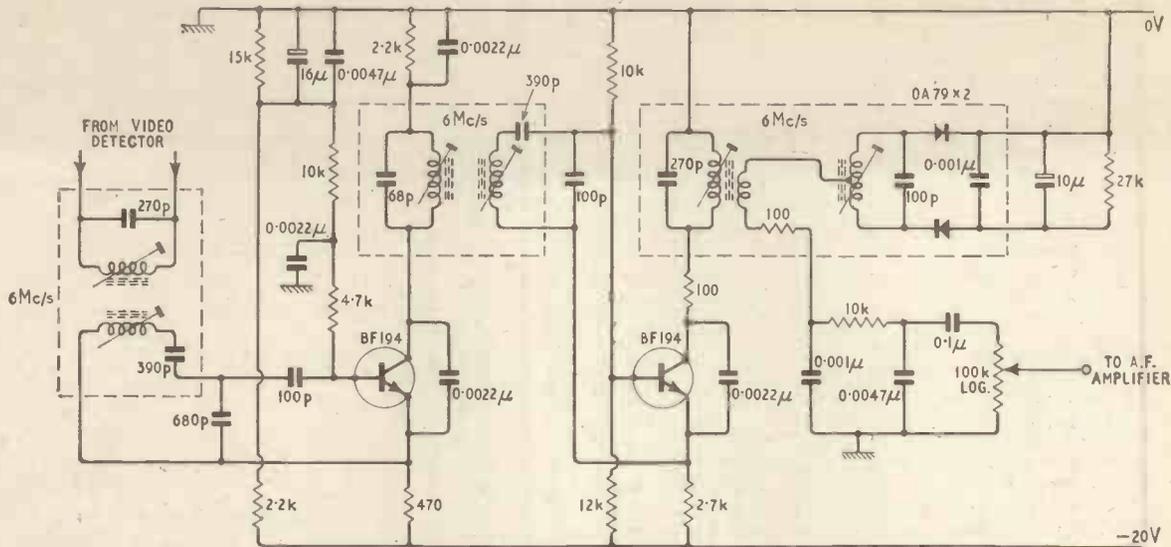


Fig. 2. 6 Mc/s intercarrier sound i.f. strip.

A broadband, bottom-capacitance-coupled transformer feeds the tuner output to the input of the i.f. amplifier, the transformer primary being in the tuner itself (not shown). The secondary appears in Fig. 1, with capacitance-tapping into the base of the first-stage transistor to reduce the effects of the variation in the input impedance of the first transistor as its bias conditions are varied by the a.g.c. control voltage. The input stage is shunted by three separate acceptor traps: 33.5 Mc/s sound-carrier attenuation, 31.5 Mc/s adjacent-channel vision, and 41.5 Mc/s adjacent-channel sound.

The first-stage BF167 is a special transistor with a forward-gain-control characteristic. Its gain is maximum at about 4 mA collector current, and reduces by 40 dB at 13 mA. The a.g.c. control signal is derived from a separate section, to be described below, and is applied to the base of the first transistor through a 470-ohm isolating resistor decoupled by a 0.0022 μF capacitor. The collector of the transistor is tapped down into the tuned load circuit, so that changes in its output impedance with varying a.g.c. affect the tuned circuit to a minor extent only. The collector circuit is tuned 1.5 Mc/s off the 37 Mc/s midband frequency to 35.5 Mc/s, and has a working Q of about 20. Capacitive-tapping is used here, too, for coupling into the input of the second stage.

The second stage (not a.g.c. controlled) has its collector tuned circuit stagger-tuned 1.5 Mc/s on the other side of 37 Mc/s mid-band to 38.5 Mc/s. It also has an operating Q of about 20 and is capacitively-tapped into the third stage.

In the third stage, the coupling between the transistor and the diode detector is a low-Q, broadband, single-tuned circuit, in which the inductance is tuned by the transistor output capacitance to a midband frequency of approximately 37 Mc/s. The tuned circuit is coupled to the diode detector by a secondary overwind, bifilar wound with the primary. This provides d.c. isolation for the diode and its loads. A pi-type h.f. filter is used after the detector to allow a relatively small filter input capacitance to be used so that changes in reflected tuning capacitance are kept low and phase modulation reduced.

From the detector stage, two outputs are taken off; one carrying luminance, chrominance, and sync to the luminance amplifier, and the other 6 Mc/s inter-carrier sound to the sound i.f. amplifier. You will be able to follow these into the circuit diagrams of the relative sections below.

#### SOUND I.F. AMPLIFIER

Fig. 2 shows a transistorised 6 Mc/s two-stage sound f.m. i.f. amplifier. It has the input from the video detector fed in through a 6 Mc/s bandpass circuit, capacitively-tapped into the base of the first transistor. A 6 Mc/s bandpass coupling is used also between the first and second stages. In the collector circuit of the second transistor, the 6 Mc/s tuned output circuit is transformer-coupled to a conventional f.m. ratio detector. The detector output is fed into the top end of a 100 kΩ logarithmic volume control, from which the audio signal is led off to a conventional audio amplifier (not shown) employing a PCL86 triode-pentode valve.

It will be noted that no a.g.c. is applied to the inter-carrier sound i.f. strip. The amplifier operates at maximum gain, and has a limiting action on the 6 Mc/s sound signals.

#### LUMINANCE AMPLIFIER

Fig. 3 gives the circuit of a luminance amplifier design for colour television. The basic function of the amplifier is to amplify the video signal from the detector sufficiently to drive the red, green and blue cathodes of the picture tube. The voltage gain of the amplifier overall is approximately 35 times to allow the full tube cathode drive of 100 V black-white with a 3 dB bandwidth of about 5 Mc/s to be obtained from a 3 V black-white detector output.

Besides amplifying this luminance signal, the amplifier also provides drives from separate take-off points to the chrominance amplifier, the a.g.c. control, the sync separator circuit and the saturation preset circuit in the chrominance amplifier.

The BF194 first stage transistor in Fig. 3 acts as a phase splitter. The luminance signals are derived from its collector and the chrominance and a.g.c. drives from its

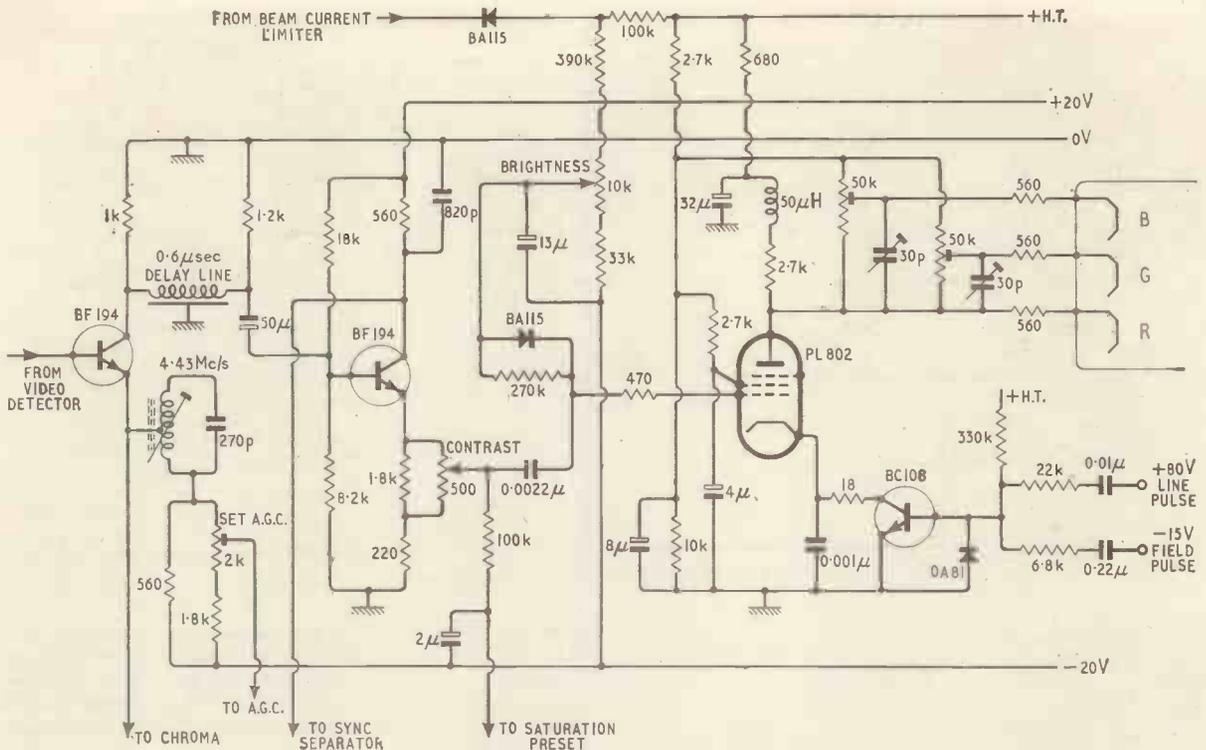


Fig. 3. Luminance (video) amplifier.

emitter. The resistances in the emitter circuit give the stage a high input impedance, designed to provide a light loading on the detector circuit. The emitter circuit includes a rejector trap tuned to the 4.43 Mc/s colour subcarrier frequency. The negative feedback caused by this emitter trap reduces the amplitude of the luminance signal output at the collector by about 3-4dB at the subcarrier frequency. This reduction of the luminance amplifier response at 4.43 Mc/s reduces the radiation of subcarrier from the amplifier and the visibility of the subcarrier pattern on the picture.

Drive from the first to second stages of the luminance amplifier is via a 0.6 μs delay line, for delay equalization of the picture tube drive signals. It will no doubt be remembered that the signals through the luminance amplifier have to be delayed with reference to the signals through the chrominance amplifier because of the narrower bandwidth of the latter. This ensures that the chrominance and luminance signals arrive together at the picture tube. Various forms of delay lines can be used but this design uses an air-cored, distributed-element unit, which is now being commonly adopted because it is cheap and gives a good performance over the required video bandwidth. Such a delay line has an average insertion loss of only about 1.5dB.

The second BF194 transistor in Fig. 3 also operates as a phase splitter, with the luminance signal taken from its emitter and the sync separator pulse drive from its collector. The 500-ohm potentiometer in the emitter circuit provides manual control of the overall gain of the amplifier and thus control of contrast.

From the slider of this potentiometer a signal proportional to the contrast level is taken off by a smoothing, 100kΩ-2μF, filter network as a d.c. saturation tracking control voltage for the chrominance amplifier. This con-

trol voltage is applied to the junction of the two current-biased diodes used in the manual gain ("saturation") control of the chrominance amplifier. (This was shown in detail in Fig. 8 of the article in this series in the July, 1967, *Wireless World*.) This arrangement of coupling the luminance contrast control electrically with the chrominance saturation control ensures that the colour saturation tracks automatically with variations in contrast. This means that, once the saturation level has been manually set in the chrominance amplifier, you can operate the manual contrast control on its own without having to constantly adjust the saturation control in step with it.

The luminance output from the contrast control is capacitance-coupled to the grid of the PL802 luminance output pentode valve, via a 470-ohm grid-stopper resistor. The d.c. bias on the grid of the PL802 is varied by a manual 10 kΩ potentiometer "brightness" control across the h.t. rail. The BA115 diode between the control slider and the valve grid acts as a d.c. restoration diode operating on sync pulse tips.

In the cathode circuit of the PL802, in Fig. 3, you will note a BC108 transistor used for blanking insertion. This transistor is normally bottomed by the current through the 330 kΩ resistor from +h.t. into its base. In the bottomed condition, its collector-emitter provides an effective short circuit, and the PL802 cathode sees only the 18-ohm cathode resistor with a 0.001 μF capacitor shunting it for h.f. compensation. On line and field fly-back, negative pulses are fed in to the BC108 base to cut off the transistor, and thus provide line and field blanking by inserting an effective high resistance in the PL802 cathode circuit. The OA81 diode is included to protect the emitter junction of the BC108 from high voltage reverse spikes which might lead to its breakdown.

In the anode circuit of the PL802, a 2.7 kΩ load resistor

with an associated  $50\ \mu\text{H}$  peaking coil provides direct drive via a 560-ohm stopper resistor to the red cathode of the picture tube. Appropriately scaled down drives are provided to the green and blue cathodes by  $50\ \text{k}\Omega$  preset potentiometers with smaller trimmer capacitors connected across them to compensate for the loss of drive at the higher luminance frequencies.

The BA115 diode at the top of Fig. 3 is connected to the control grid circuit of the e.h.t. shunt stabiliser triode valve. (Shunt stabilised e.h.t. circuits were discussed in the July, 1967, article in this series.) If the picture tube beam current increases excessively, as for example by someone turning up the brightness unduly, the shunt stabiliser cuts off and its control goes negative, causing the BA115 diode to conduct. This causes the d.c. voltage at the top of the brightness control  $10\ \text{k}\Omega$  potentiometer to fall. This in turn reduces the picture tube brightness and the arrangement thus limits the mean current of the picture tube to a safe value.

### A.G.C. CONTROL CIRCUITS

In colour television receivers, a.g.c. is conventionally applied both to the tuner and to the first vision i.f. transistor. The a.g.c. control voltages are produced in some circuit such as Fig. 4. The input to this circuit is derived from the emitter circuit of the first luminance stage, as shown in Fig. 3 above. The input level is set by a preset potentiometer take-off in the luminance amplifier. Thus a preset-adjustable proportion of the video signal is fed into the base of the first transistor in Fig. 4. The  $5.6\ \text{k}\Omega$ ,  $1\ \text{k}\Omega$  potentiometer network across the supply applies a reference bias voltage to the emitter of the first transistor. When the input from luminance amplifier exceeds this bias by the  $0.6\ \text{V}$  base-emitter threshold, control begins and the transistor draws pulses of current proportional to the height of the sync. pulse peaks above the threshold voltage. These current pulses are smoothed and fed to the second BC108 transistor via a voltage-dependent-resistor.

When the signal level is low, the first BC108 transistor is cut off and the second one bottomed, so that the junction of the  $910\text{-}\Omega$  and  $180\text{-}\Omega$  resistors in its collector circuit is at a substantial negative voltage. As signals increase and the a.g.c. comes into operation, the current

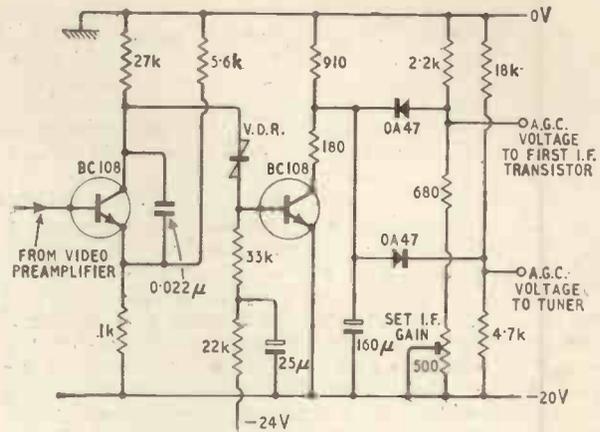


Fig. 4. A.g.c. control circuit.

in the second BC108 begins to fall and the voltage in the collector circuit rises towards zero volts. This voltage is connected as a control to the bias circuits of the first vision i.f. transistor and the tuner r.f. transistor through the OA47 "delay" diodes. As the voltage on the left of the diode rises towards zero with increasing signals, first of all the top diode conducts and forward biases the first i.f. transistor to reduce its gain as explained earlier. When the i.f. gain has been reduced as far as possible, the lower diode comes into operation and applies progressive gain reduction to the tuner transistor.

As the a.g.c. action is controlled by the sync. pulse peaks, it is independent of the vision modulation on the received signal.

### SYNC PULSE SEPARATION

In a colour receiver, the sync pulse separator circuits are very similar to those of a black-and-white one. Fig. 5 shows a typical circuit using a single-transistor pulse separator controlling a line timebase oscillator via a double-diode phase detector and providing a separate field sync pulse drive to the field timebase.

Sync pulse signals (derived from the collector circuit of the second stage of the luminance amplifier in Fig. 3.)

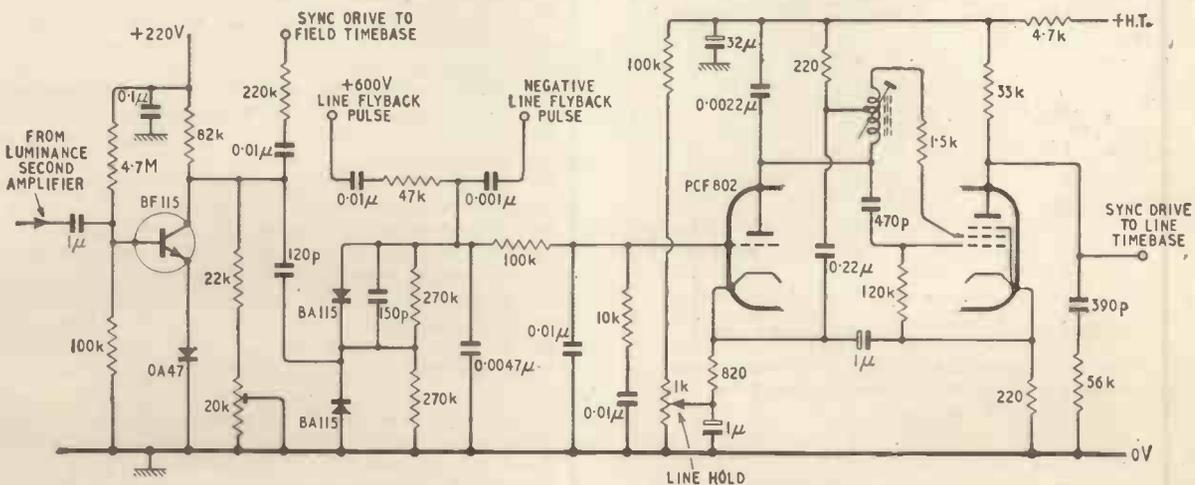


Fig. 5. Sync pulse separator (and line timebase oscillator) circuit.

are fed via a long time-constant  $1\ \mu\text{F}$ - $100\ \text{k}\Omega$  to the base of the sync pulse separator transistor BF115 in Fig. 5. The 4.7-megohm resistor associated with this network ensures that the sync separator transistor bottoms satisfactorily during sync pulse tips, even with low-average video signals. The OA47 diode in the emitter circuit is a protection against the breakdown of the emitter junction of the BF115.

The collector output of the BF115 is fed via a  $120\text{-pF}$  capacitor to the double-diode phase detector using a pair of B115 diodes. The sawtooth phase-reference waveform for the detector is derived from a positive, 600 V, line-flyback pulse, integrated by a  $0.01\ \mu\text{F}$ - $47\ \text{k}\Omega$  network. A correcting, negative, line flyback pulse is also applied through a  $0.001\ \mu\text{F}$  capacitor to enable the phase detector to operate with an output potential of nominal zero volts at phase centre. A small  $150\ \text{pF}$  capacitor across the upper diode is included to keep the "pull-in" symmetrical about the centre frequency.

The PCF802 triode-pentode valve serves two purposes. Its pentode section operates as a screen-coupled Hartley oscillator with the line drive developed at its anode. Its triode section functions as a variable reactance valve controlling the frequency of the pentode output oscillator by means of the d.c. output from the phase detector circuit. Manual line hold control is effected by varying

the cathode voltage of the triode by a  $1\ \text{k}\Omega$  potentiometer fed through  $100\ \text{k}\Omega$  from the h.t. rail.

The output from the pentode line drive valve is fed off to the grid of the line output valve, the circuitry of which will be found displayed in Fig. 3(b) of the April, 1967, article in this series. The field sync output from the collector of the BF115 in Fig. 5 is taken off to control the field timebase, whose circuit was given in Fig. 4 of the same article.

Typical performance figures for the 15,625 c/s line timebase oscillator, controlled by the sync separator as in Fig. 5, are: oscillator control sensitivity 400 c/s per V, pull-in range 800 c/s and mains stability  $\pm 5\ \text{c/s}$  for  $\pm 10\%$  mains voltage variation.

## AUTOMATIC DEGAUSSING ARRANGEMENTS

Automatic "degaussing" is becoming standard in colour television receivers. In this arrangement, the colour tube and related magnetic components are demagnetized automatically each time the receiver is switched on. This ensures consistent colour purity, and eliminates the problems of picture tube beam misregistration that may be caused by changes in the position of the receiver or by accidental magnetization.

A number of methods have been used from time to time for automatic demagnetization. The present trend appears to be to use two coils sited symmetrically around the picture tube and, by means of control circuits, to feed these from 50 c/s mains in such a way that on receiver switch-on a very high a.c. current is passed through the coils initially. The control circuit then reduces the coil current steadily to negligible proportions.

The ferrous components which require demagnetizing are mainly the tube shadow mask, the "trim" band round the screen and the magnetic shield round the cone. For effective degaussing, the magnetic field applied by the coils must initially be large enough to produce saturation of the ferrous material. A field of the order of 500 At is normally sufficient.

Fig. 6 (a) shows diagrammatically a pair of degaussing coils located on either side of the picture tube. In practice these are shaped to fit partly inside and partly outside the magnetic screening shield round the cone as shown in Fig. 6 (b). Because they are in contact with the shield, the coils are insulated sufficiently for operation from the mains with the shield earthed.

The coil specifications depend a great deal on the control circuit used to feed them with gradually reducing current from the 50 c/s mains. Apart from the initial 500 At field required to saturate the ferrous components, it has been established that the residual field should not exceed about 0.3 At, if no measurable effects on beam registration are to be observed.

As to the control circuit for the degaussing coils, British practice seems to be tending towards the use of a p.t.c. (positive-temperature coefficient) thermistor in series with the coils across the mains, the coils being connected series-aiding to produce the required magnetic field around the tube and ferrous components. This is shown in basic form in Fig. 6 (c). The p.t.c. thermistor starts with a very low resistance, so that the current through the coil is high on switch-on. As the thermistor heats up with the current passing through it, its resistance rises rapidly and in a very short time the total current through the thermistor and the degaussing coils reduces to a low value.

In this simple form the residual coil current (and thus magnetic field) may be unacceptably high. One way of

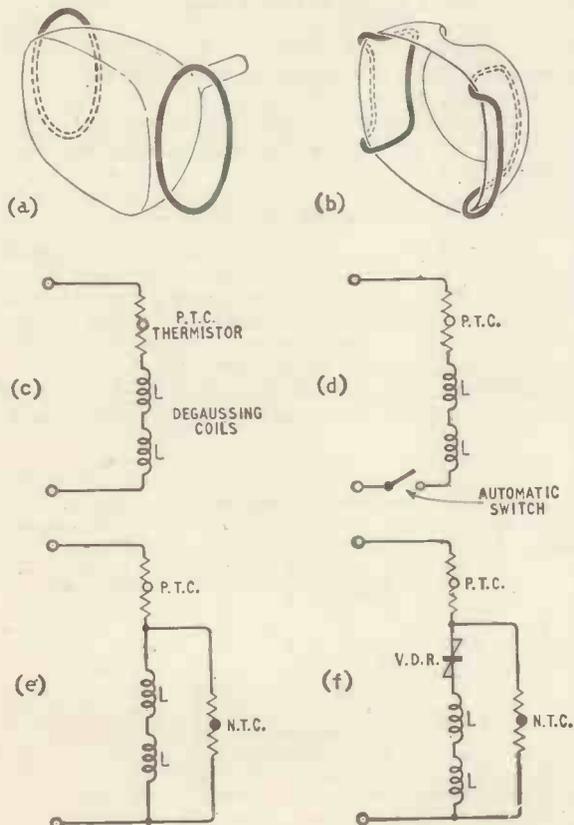


Fig. 6. Automatic degaussing arrangements: (a) location of degaussing coils relative to picture tube; (b) practical dressing of coils inside tube shield; (c) use of p.t.c. thermistor to reduce coil current to negligible proportions after initial high current surge; (d) automatic switch-off after initial degaussing; (e) shunt n.t.c. thermistor used with series p.t.c. one to reduce residual current in coil; (f) voltage-dependent-resistor in series with coil to further reduce residual current of (e).

eliminating this is to include an automatic switch as in Fig. 6 (d). This switch closes when the receiver is switched on and automatically opens itself after a short period. It may be either a special arrangement on the mains on/off switch or it may be controlled by a bi-metal strip.

An alternative arrangement to minimize the residual current through the degaussing coils is shown in Fig. 6 (e) which uses an additional n.t.c. (negative-temperature-coefficient) thermistor shunting the degaussing coils. The p.t.c. thermistor operates as before. The added n.t.c. thermistor, with an originally high resistance, bleeds off only a small portion of the initial high surge current through the coils, but, as it heats up, its resistance falls and progressively shunts the coils. This finally reduces the residual current in them to an acceptably low level.

A refinement of the combination of p.t.c. and n.t.c. thermistors that has been tried is shown in Fig. 6 (f) where a voltage dependent resistor, v.d.r., is placed in series with the degaussing coils. Initially, when the p.t.c. thermistor has a low resistance, and the n.t.c. a high resistance, the voltage drop across the v.d.r. is low.

As the voltage across the coils falls with the rise in resistance of the p.t.c. and the fall in resistance of the n.t.c. thermistors, the resistance of the v.d.r. rises sharply and reduces to a very low level the residual current in the degaussing coils.

The use of a voltage dependent resistor can introduce harmonics of the 50 c/s mains frequency, and, in more refined versions of the automatic degaussing circuit, you may find various arrangements to cancel excessive residual current in the coils by means of anti-phase 50 c/s transformer-driven circuits.

## CONCLUSION

In this article we have covered all the sections of the colour television receiver not dealt with in previous articles, except for the tuner, which is a highly specialized part of the receiver. At present only dual-standard 625/405 line u.h.f./v.h.f. tuners are fitted to British colour receivers. The circuit complexity of such dual-standard tuners rules out their discussion in an article of this length.

# COMPONENT SPECIFICATIONS

## Prague Meeting of the International Electrotechnical Commission

MORE than a thousand delegates from 31 countries were present at the 32nd general meeting of the International Electrotechnical Commission recently held in Prague.

The technical committee (TC 40) concerned with capacitors and resistors continued its trend in reshaping the basic specifications. It is hoped that by the next meeting, probably in 1968, the test and terminology documents for fixed capacitors, potentiometers and fixed resistors will have successfully completed their voting stages and may even be ready for publication. The way is now clear for the preparation of detail specifications and it was agreed that proposals should be examined by the national committees prior to the next meeting. The specification structure proposed is:—

- (a) Test and terminology
- (b) Standard values and procedures
- (c) Detail specifications.

Another step forward by TC40 was the decision to circulate the proposals of its working group on acceptance and assurance testing. Acceptance testing, being carried out on a lot-by-lot basis, would be divided into two groups. *Group A* includes those tests after which the specimens may be returned to bulk supply, e.g., visual examination and measurement of primary characteristics. *Group B* includes those tests after which the specimens must be discarded, e.g., solderability, robustness of terminations, and short-term humidity tests.

Assurance testing will be carried out at less frequent intervals and TC40 have suggested three months and one year as being appropriate intervals. The tests to be performed at three-monthly intervals are: long-term damp heat, electrical endurance at rating conditions, and reliability assessment. Annual tests are of a design proving nature, e.g., resistance to mould growth, flammability, and electrical endurance at extreme ambient conditions.

The committee also continued its efforts to rationalize the sizes of capacitors and resistors. The first steps were taken some time ago to produce overall sizes acceptable to the majority of countries and attempts are now being made to produce more practical sizes so that for example, the long thin resistor can be identified separately from a short fat

one having the same rated dissipation. Agreement was also reached that the draft giving definitions, test methods and requirements for thermistors with negative temperature coefficients should be circulated for approval by individual countries. The draft covers thermistors having power ratings from 50 microwatts to 2.5 watts and capable of use in a wide range of applications such as medical electronics television receivers and industrial process control equipment.

The sub-committee (SC 40A) concerned with variable capacitors is circulating for approval documents on air dielectric rotary variable capacitors and a guide on the use and testing of variable capacitors. It is also preparing a general document on terms and methods of test for variable capacitors.

The intention of the United Kingdom to "go metric" was apparent during a discussion on the dimensions of spindles and bushes by members of sub-committee SC 48C (switches) when the delegation stated that they would no longer be putting forward proposals for inch sizes. The discussion revealed that there was little disagreement on basic dimensions (eg., 4, 6 and 10mm diameter spindles) and a Working Group has been set up to make proposals for the shapes of spindle ends with their dimensions and associated tolerances. The sub-committee also agreed that in future its specifications should cover three applications, special purpose, general and commercial, in a manner similar to that used in the United Kingdom Common Standards.

Technical committee 56 (reliability) made some progress in extending the lists of terms and definitions, presentation of reliability data and collection of data from the field. However, an impasse was reached on the inclusion of reliability requirements into specifications. Agreement could not be obtained on the alternative U.K. and U.S.A. approaches. It was therefore agreed that a working group be set up to examine the differing views and to try and reach a solution acceptable to the committee. A report was received from the working group which had been studying acceptance and assurance testing. The report is being circulated to National Committees and it will be noted that the principles evolved by the U.K. Committee of Common Standards for Electronic Parts would need little modification to fit the proposals being put forward.

# LETTERS TO THE EDITOR

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

## Electronics and Vehicle Automatic Control

MAY I congratulate "Vector" on his "Thoughts from a Lay-by" in your September issue, in which he pointed out the deficiencies of the human being as a vehicle control system and suggested that electronics should be used instead.

Considerable work has, in fact, been done on automatic cars both in this country and abroad, e.g., America and Japan. As "Vector" said, the feasibility of using buried cable for vehicle guidance was demonstrated several years ago, for instance during the Road Research Laboratory's Open Days in 1961. However, as far as we know accurate high-speed vehicle guidance has only been achieved using cars fitted with very expensive electro-hydraulic steering systems. It is now necessary to develop a steering actuator which can be mass produced cheaply enough for public acceptance.

Cost is also the chief problem with anti-collision systems. Various technically feasible proposals have been made, such as use of inductive loop vehicle detectors buried every few feet along the road, or fitting all vehicles with radar sets and perhaps transponders. However, consideration of present car insurance premiums suggests

that the maximum price worth paying for an anti-collision system is about £10 per year per vehicle, and it has not yet been possible to make an effective system as cheaply as this. We hope that advances in solid-state microwave sources and microcircuits will overcome this problem in a few years time, but until then vehicle anti-collision systems seem likely to be restricted to applications where higher costs are acceptable, for example buses using reserved tracks.

The choice of a country's automated road transport system will be as important and as difficult as selecting its railway gauge or television standard, since it will be extremely expensive to change to a different system later. Thus it is essential for all possible systems to be considered and thoroughly assessed before a choice is made. We therefore welcome discussion of the subject and look with interest at new ideas.

S. PENOYRE

Road User Section,  
Road Research Laboratory,  
Crowthorne,  
Berks.

## Noise Figure Measurement

A SIMPLE method of measuring noise figure using a c.w. source was outlined by Mr. C. N. G. Matthews in the August issue. The writers wonder whether the claim that the inaccuracies are not glaring is not justified by the results he quotes. He does not mention that the noise figure is dependent upon source impedance and his method implies using an attenuator whose characteristic resistance equals the required source impedance. An accurate measurement of noise figure using a c.w. method can be made but requires a knowledge of the integrated bandwidth of the measuring system (not just the 3 dB bandwidth). This may be obtained by direct measurement or by measuring the frequency response and integrating graphically.

The noise level with S1 closed (Fig. 1) is noted, the attenuator is then set to 3 dB, S1 opened, the c.w. source increased to give the same reading on the volt-

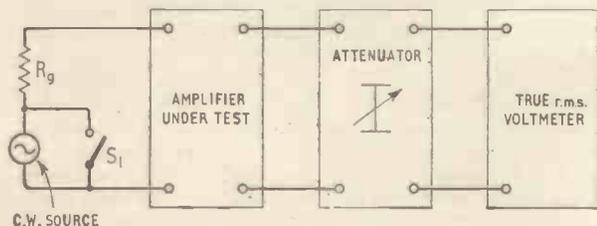


Fig. 1.

meter and the r.m.s. source voltage is noted. The attenuator is then set to 4.8 dB and the c.w. source voltage further increased to give the original reading once more. This process may be repeated for attenuator settings of 6, 7, 7.8, 8.5 dB, etc., corresponding to an output power multiplication of two, three, four, five, six and seven times the original output noise power.

All measurements may be referred to the amplifier

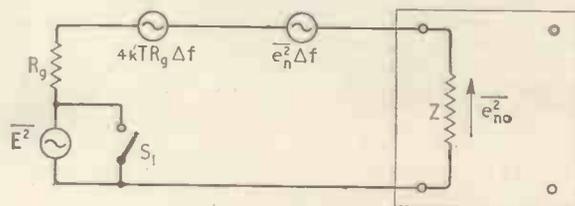


Fig. 2.

input terminals merely by dividing by the system power gain. This has been done in Fig. 2.

- $\Delta f$  is the system integrated bandwidth in hertz.
- $k$  is Boltzmann's constant =  $1.38 \times 10^{-23}$  joule/°K.
- $T$  is the temperature °K.
- $Z$  is the amplifier input impedance.
- $e_n^2$  is the mean-square noise voltage per unit

bandwidth, produced within the amplifier and referred to its input.

$$\overline{e^2}_{no} = (4kTR_g \Delta f + \overline{e^2}_n \Delta f) \frac{Z^2}{(R_g + Z)^2} \quad (1)$$

With S1 open, let  $\overline{E^2}$  be the mean-square c.w. voltage to increase the amplifier input power  $n$  times

$$n\overline{e^2}_{no} = (4kTR_g \Delta f + \overline{e^2}_n \Delta f + \overline{E^2}) \frac{Z^2}{(R_g + Z)^2}$$

Subtract (1) from (2)

$$(n-1)\overline{e^2}_{no} = \overline{E^2} \frac{Z^2}{(R_g + Z)^2} \quad (3)$$

Noise Factor =  $\frac{\text{Total noise at the output}}{\text{Noise at output due to } R_g \text{ alone}}$   
(which amounts to the same as Mr. Matthews' definition) giving:

$$F = \frac{\overline{e^2}_{no} \cdot (Z + R_g)^2}{4kTR_g \Delta f \cdot Z^2} = \frac{\overline{E^2}}{(n-1)4kTR_g \Delta f} \text{ subst. for } \overline{e^2}_{no} \text{ from (3)}$$

$\therefore \overline{E^2} = (n \cdot 4kTR_g \Delta f \cdot F) - (4kTR_g \Delta f \cdot F)$   
Hence a plot of  $\overline{E^2}$  versus  $n$  yields a straight line of slope  $4kTR_g \Delta f \cdot F$  and an intercept on the negative  $\overline{E^2}$  axis of  $4kTR_g \Delta f \cdot F$ . At room temperature  $17^\circ\text{C}$ ,  $4kT = 1.61 \times 10^{-19}$  joule.

Noise figure is  $10 \log_{10} F$ .

The measurement of noise factor is much simplified if a simple diode noise generator is constructed using a diode such as the G.E.C. A2087. This eliminates the necessity of knowing the system bandwidth and the requirement for a true r.m.s. meter.

R. M. ALLEN & J. MAVOR

Woolwich Polytechnic,  
London, S.E.18.

WE would like to take up Mr. Matthews on his reply in the September issue (p. 451) to our criticisms of his original article ("Noise Figure Measurement," August). We assert that the method is fallacious, and to support this contention we present two out of several possible arguments:—

(1) It is true that the noise figure can be defined as the ratio of input to output signal-to-noise ratios, and Mr. Matthews' proposed technique seems to be an attempt to measure this quantity as the difference between two attenuator settings. He presents an argument to justify his conclusion that the difference in attenuator settings (in dB) is

equal, or approximately equal, to the noise figure. For reasons which we explained in detail in our earlier letter we think that this argument contains an important oversight, which nullifies the conclusion. Mr. Matthews has so far not answered these detailed criticisms.

(2) As a matter of principle, all methods of noise figure measurement require a noise (or signal) source of calibrated strength. The source is used to add noise (or signal) power to the device until the output meter indication (which initially registers the noise power generated by the device alone) is exactly doubled. The added noise is then equated with the internally generated noise. This technique, with variations, is the basis of all accepted methods. It is not true, as Mr. Matthews asserts, that "all we need is the dB change in noise input to the device under test." What we need is the value of the actual noise power added by the source. Mr. Matthews' attempt to avoid the need for a calibrated source is attractive, but cannot work in principle.

F. V. BALE & M. J. S. QUIGLEY

Radio & Space Research Station,  
Slough, Bucks.

The author replies:—

I of course agree with Messrs. Allen and Mavor that a signal generator and attenuator will not give a precision noise figure measurement. It is not intended to. It does however give a reasonable indication. Its usefulness is that it requires no specialized equipment.

Without quarrelling with either of the other suggestions I should perhaps mention that for practical purposes we define noise figure as the deterioration in signal-to-noise figure from input to output, normally making the measurement as I described it but using a gas tube or temperature limited diode noise source. Bandwidth does not come into the calculation because we are not concerned with noise in microvolts per root cycle as we would be with, say transistor noise figure measurement. A true r.m.s. meter or a square law detector is as necessary with a noise source as it is with a signal generator.

Turning now to Messrs. Bale & Quigley I would very much like to know who supplies a noise source of "calibrated strength." The gas tube and the temperature limited diode do *not* provide noise of known absolute value, but the excess of "hot" over "cold" noise is accurately known when the source is used under controlled conditions. The value of the noise power added, expressed in dB over cold noise, is the dB change in noise input to the device under test. Are we really at odds?

C. N. G. MATTHEWS

Feltham, Middx.

## Using Integrated Circuits—Cost and Performance

THE cost of a piece of equipment may be a minor point to Mr. McEvoy ("Letters," September, p. 453), but I doubt whether most readers will see it that way. Since making my original cost comparison I find that the retail price of good silicon a.f. transistors ( $h_{fe}=250$ , N.F.=2 dB) has fallen to 2s 6d, and that good resistors can be had for 3d each. This brings the price of my suggested circuit down to 21s 6d, which is less than half the price of the integrated circuit. Adding half a dozen emitter resistors to increase the input impedance if required does not radically change the picture.

It was not my original intention, in making a comparison between the discrete-component and integrated-

circuit versions of the stereo mixer unit, to go into the finer points of circuitry. However, since sweeping claims have been made for the i.c. version it is now perhaps in order to look more closely at its circuitry and likely performance. This cannot be done quantitatively from the information in the article, since, apart from figures for gain and bandwidth, no performance data are given, nor are the parameters of the transistors in the i.c., or even the resistance values. Nevertheless, consideration of the circuitry reveals one feature which is likely to produce a poor performance, and perhaps render the circuit unsuitable for use as a stereo mixer. This is the use of a common load resistance for all

the emitters of the input transistors. The results of this arrangement are:—

- 1, reduction of input impedance;
- 2, deterioration of signal-to-noise ratio;
- 3, increased distortion; and
- 4, interaction between volume controls.

The mechanism which produces these defects is quite simple. Consider one of the three emitter-followers at the input as the active input transistor and the other two as passive. The 'gain' of the active emitter-follower can be anything between 0 and 1, depending on its load. In the present case the load is not just the physical load resistance but this resistance shunted by the output impedances of the two passive emitter followers. This is what causes the trouble. If all three transistors are identical, and the bases of the passive transistors are earthed to a.c., then the gain of the active transistor cannot exceed 0.33. This is because the active transistor, in looking into the outputs of the two passive ones, sees a load equal to half its own output impedance.

The immediate result of this low gain is that the input impedance of the active transistor is much lower than might be expected. Again assuming identical transistors, it is only 1.5 times the input impedance of the same transistor in the common-emitter connection.

An indirect effect of the low gain of the input stages is a deterioration of the overall signal-to-noise ratio. The input signal suffers an attenuation of 9.5 dB before it is applied to the gain-producing part of the amplifier. Thus the S/N ratio at the input to the gain-producing part is degraded. The "heavy negative feedback" referred to in Mr. McEvoy's letter does nothing to alter this, since it reduces signal and noise equally.

Another indirect effect is increased distortion. Under the conditions described above, the load of the active emitter-follower is, as we have seen, the impedance looking into the emitters of the other two input transistors. This load is non-linear, and the non-linearity is in the direction which produces distortion. The half-cycle of input signal which makes the active transistor take more current makes the passive transistors take less. This increases their impedance and raises the gain. On the other half cycle the reverse occurs. Thus one half cycle is peaked and the other flattened.

Now consider what happens if the bases of the passive transistors are not earthed to a.c., but returned to earth through a finite impedance. In practice, this impedance is the source impedance of the input signal, as seen from the base of the passive transistors. Call it  $r_s$ . The effect of  $r_s$  is to add to the output impedance of the passive transistors a resistance  $r_s/h_{fe}$ . Thus, as  $r_s$  is increased, the gain of the active transistor moves nearer to 1. In the i.c. mixer circuit, the largest increase in gain occurs when the active transistor is the one with the 5-k $\Omega$  volume control VR<sub>1</sub>, and when the other two inputs are either driven from high impedance sources and volume control VR<sub>1</sub> turned right up and VR<sub>2</sub> right down. As the volume control at any one input is varied, so the gain experienced by a signal applied to another input also varies. The theoretical maximum variation, with infinite source resistance, is 9.5 dB. A stereo mixer with anything approaching this degree of interaction between volume controls would be very difficult to use. The effect is worst when  $h_{fe}$  is low, and the values of base bias resistances specified in the i.c. circuit suggest that the transistors in it do have low  $h_{fe}$ .

There is also a crosstalk effect, some of the input signal at one input terminal appearing at the other two.

This could make monitoring of the unmixed inputs difficult.

None of the ill-effects mentioned above occurs in the discrete-component circuit. Of course, the relative importance of the various defects in practice will depend on what precisely is inside the i.c. and also on the nature of the signal sources. What is now required is information, in the form of actual measurements of interaction, signal-to-noise ratio, and distortion of the i.c. mixer. One would then be in a position to say whether the millennium has really arrived.

G. W. SHORT

Croydon.

## Binary Arithmetic

A CONVERSION from decimal to binary is given in the August issue, page 367. There is a very easy method which can be done mentally. It is to divide the decimal by 2, or halve it, and record the remainders from right to left which will then give the binary. To convert decimal 163 to binary:—

163 ÷ 2 = 81	R.1	1
81 ÷ 2 = 40	R.1	11
40 ÷ 2 = 20	R.0	011
20 ÷ 2 = 10	R.0	0011
10 ÷ 2 = 5	R.0	00011
5 ÷ 2 = 2	R.1	100011
2 ÷ 2 = 1	R.0	0100011
1 ÷ 2 = 0	R.1	10100011

As the conversion is done mentally, the binary figure is written direct, without any workings shown, being built up from right to left, so—

$$1023 = 1111111111; 682 = 1010101010$$

E. L. JENKINS

Cheltenham, Glos.

## Manx Radio

IN reference to the note on Manx Radio in the September issue of *Wireless World* (page 428), I feel that I should point out that the Isle of Man is *not* part of the United Kingdom.

As far as I know it is a condition of Manx Radio's licence that it should not transmit to the U.K. (this fact has figured in the recent radio controversy in the Isle of Man).

Thus it is hardly correct to state that "Manx Radio is the only local commercial radio station in the United Kingdom."

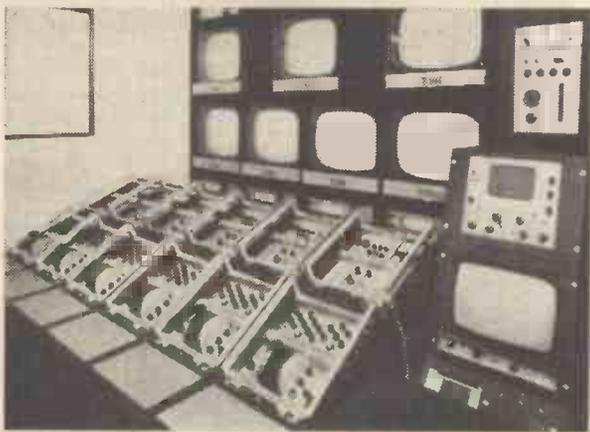
J. F. CRAINE

Ramsey,  
Isle of Man.

### OUR COVER

The main theme of this issue—television and sound broadcasting—is typified by our cover illustration specially photographed for us in the latest of the studios at the B.B.C. Television Centre to be equipped for colour. The cameras shown are the Marconi Mk VII which employs a fourth Plumbicon tube to provide a separate luminance signal.

# NEWS FROM INDUSTRY



Our photograph shows the camera control position as fitted in outside broadcast vehicles supplied by Pye TVT Ltd. The equipment is from the new system 70 range recently shown at the Design Centre.

Pye TVT Ltd. have won a contract whereby they will supply 50 television transmitters, worth over £2M, to the Independent Television Authority to implement the Authority's forthcoming duplicated 625-line u.h.f. service. The transmitters will be fully automatically controlled and will be unmanned. They will be installed in pairs connected in parallel, at 25 separate sites. Power

output varies from 6.25 kW to 25 kW depending upon the site. The first three stations will start monochrome transmissions in the late summer of 1969, going over to colour as soon as possible. The remaining 22 stations will be brought into service successively up to the end of 1971. Incidentally, the I.T.A. colour service is planned to commence in early 1970.

Yorkshire Television Ltd., one of the new programme contractors created in the Independent Television Authority's reshuffle earlier this year, have awarded Marconi a £650,000 contract for the supply of colour television cameras, telecine equipment and outside broadcasting units. Deliveries of the equipment will start in February and the bulk of the order will have been completed in the summer when this new contractor is due to go on the air from a new studio centre at Kirkstall Rd., Leeds.

The Integrated Electronics Division of Standard Telephones and Cables Ltd. have received an order worth over £250,000 for modulator and demodulator equipment to be used on the new G.P.O. DATEL service to be inaugurated next year. The equipment is designed to meet a G.P.O. specification enabling data to be transmitted at 2,400 bits/sec over private circuits with standby facilities for alternative transmission over the public network at 1,200 or 600 bits/sec. An optional supervisory return channel with a speed of 75 bits/sec is also available.

Dynamco Ltd., Chertsey, have been appointed exclusive agents in the U.K., West Germany and Eastern Europe for the Systron-Donner Corp., California. Systron-Donner's range of products includes digital counters, analogue computers, pulse generators and transducers.

Decca Ltd. have received a £350,000 contract from the Inner London Education Authority for television receivers for use in schools. The receivers are to be used with a new distribution system devised for schools in conjunction with the G.P.O. which allows flexibility in teaching. The programme can be obtained from a centrally owned studio or from the broadcasting networks.

The Component Marketing Division of Standard Telephones and Cables Ltd. have been appointed sole representatives in the U.K. for the full range of vacuum electronic components produced by ITT Jennings of San Jose, California. The range of products include passive devices, capacitors, switches and relays that achieve compactness by virtue of the vacuum in which they operate. The components are suitable for use in extreme environmental conditions.

The Scientific Instrument Control Department of Ferranti has been purchased, together with relevant patents, equipment, stock and work in progress, by Hilger and Watts. The Scientific Instrument Control Department, which has been concerned with the automation of scientific measurements and positional control, has worked closely for a number of years with Hilger and Watts on the control of X-ray diffractometers.

U.K. exports of electronic equipment for the first six months of this year were worth £51.3M compared to £43.9M for the same period last year, according to the figures given by B.E.A.M.A. The increases in the various categories are computers—£2.4M; electronic control equipment—£1.6M; nav. aids and radio communications—over £2M; and telegraph and telephone equipment—£1.3M.

The recent merger between English Electric and Elliott Automation brings into being one of the largest computer and electronic concerns in Europe, with an annual turnover of approximately £150M. The share capital of English Electric has been increased from £65M to £100M, as agreed by shareholders at the annual general meeting, to enable the merger to proceed. The takeover means that electronics will account for about 40% of the English Electric's turnover.

A contract of some £250,000 has been awarded to Marconi Ltd. by Cable and Wireless (West Indies) Ltd. to provide a 900-Mc/s tropospheric scatter link between Guyana and Trinidad, a distance of some 350 miles. Initially 32 voice channels will be accommodated with the facilities to extend this to 48 4-kc/s or 64 3-kc/s channels to C.C.I.R. standards. This new route will improve communications in the area in which Cable and Wireless has recently spent about £5M on radio and telephone cable systems. The two aerials, 60-ft diameter dishes, will be erected at Thomas Lands (Guyana) and Morne Bleu (Trinidad).

Amphenol Ltd have announced price cuts of between 25% and 50% on their 990GB range of trimmer potentiometers.

Ferranti-designed audio equipment, as shown at the Audio Fair, is now available in kit form as pre-assembled modules from Welbrook Engineering and Electronics Ltd., Brooks Street, Stockport, Cheshire.

B.E.A. are to equip their fleet of BAC one-eleven aircraft, due to come into service in August, 1968, with the Decca Navigator equipment. The order is worth in the region of £300,000.

Price reductions of up to 50% for Standard Telephones and Cables' range of flatpack d.t.l. integrated logic circuits have come into operation. For example, an MIC 946 Quad 2-input gate which was 37s (100 up quantities) is now 15s 9d, representing a price of less than 4s a gate.

B & K Laboratories Ltd have transferred their sales and service facilities from their headquarters at Tilney St., Park Lane, London, W.1, to new premises at Cross Lances Road, Hounslow, Middlesex. (01-570 7774).

# NEW PRODUCTS

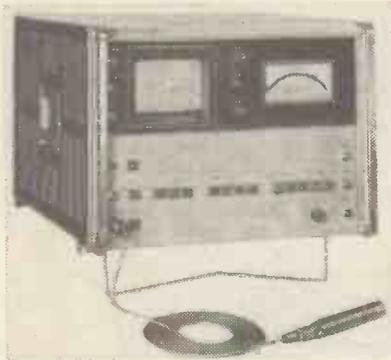
equipment systems components

## LOUDNESS ANALYSER

AN instrument giving an instantaneous indication of loudness which corresponds to subjective loudness without bandwidth and time duration restrictions has been developed by the German Hewlett-Packard company. The analyser makes a 1/3 octave noise

age multivibrators is sequentially sampled (at the 40 c/s rate) and displayed on the c.r.t. For the total loudness indicator the resulting pulse sequence is integrated, giving an indication equal of the area under the loudness spectrum curve but expressed in sones.

\*Sone: unit of loudness on a scale designed to give scale numbers proportional to loudness. WW 301 for further details



analysis which is repeated at the rate of 40 c/s and presented on a c.r.t. screen. Total loudness, evaluated by the Zwicker method, is presented on a moving coil meter in sones\*. The instantaneous or maximum value of a transient can be stored on the c.r.t. for several minutes to permit the spectrum to be photographed. [Conventional sound level meters measure sound pressure level and not loudness. The indicated value corresponds to subjective loudness only over a narrow bandwidth, and for large bandwidth or impulsive noise the meter readings can be up to a factor of 4 lower than the subjective loudness.] The sound spectrum for 45 c/s to 14 kc/s is split into 20 channels, each containing 3rd-order active bandpass filters allowing ear's frequency characteristic to be simulated either in a diffuse or directional sound field. D.C. signals proportional to the r.m.s. value of the filter outputs are then obtained for shape factors of up to 7 and over a 60 dB dynamic range. Non-linear amplifiers then convert the signals to loudness values from sound pressure values and the outputs are fed to storage circuits. Each of the 20 stor-

## OPTICAL SHAFT ENCODERS

ROTARY and linear motion encoders in the Optisyn range from Walmore Electronics Ltd., are intended to meet requirements in high grade industrial, military, and aerospace position and rate digitizing applications. Model 29 encoder offers a resolution of up to 6000 counts/rev; accuracy of  $\pm 1.8$  arc minutes; low starting torque 1.0 oz. in and high pulse rates up to 160 kc/s. Signal levels can be 200 mV peak sinusoidal outputs or 6 V pulses. The diameter of this model is 2.8 in and it has an aluminium alloy case which permits operation in environments where vibration, shock, oil spray and dust are prevalent. A shaft seal can be fitted if required. Walmore Electronics Ltd., 11-15 Betterton Street, Drury Lane, London, W.C.2.

WW 302 for further details

## Rescue Beacon

A SPECIAL feature of the Sarbe Compact 355 air/sea rescue beacon is the fact that its transmitted distress signals can be received by aircraft. Operating on 121.5 Mc/s, the international aviation distress frequency for civil aircraft, the survivor's call for help can be picked up 45 miles away by an aircraft flying at 10,000ft and 100 miles away by an aircraft at 30,000ft. It is intended for use by private and business flyers and

for yachtsmen. Completely waterproof, and small enough to be carried in a life-jacket pocket, the Compact automatically switches on when the aerial is extended. The beacon will sell for £45 and is battery operated continuously for either 30 hours or 48 hours, dependent upon the type of battery employed. Burndept Electronics, St. Fidelis Road, Erith, Kent.

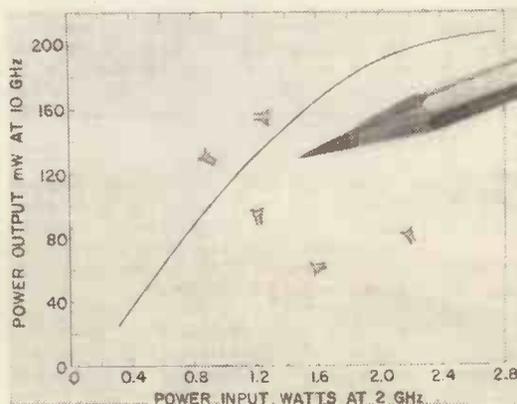
WW 303 for further details

## Step Recovery Diode

THE HPA 0320 step recovery diode is an epitaxial surface-passivated silicon device from Hewlett-Packard Ltd., 224

Bath Road, Slough, Bucks. For use as a high-order multiplier at microwave frequencies, this device when driven at 2 Gc/s with 2 W of power in a single stage X5 multiplier will yield a minimum of 150 mW at 10 Gc/s. Minimum minority carrier lifetime is 10 ns ensuring sufficient charge storage for high power output. The single stud ceramic package has low inductance with a reverse bias capacitance of only 0.7 to 1.3 pF. Reverse current in these diodes ceases abruptly, generating sharp transients, rich in harmonics, used for frequency multiplication.

WW 304 for further details



## Sound Level Meter

TYPE 1400G portable sound level meter from Dawe Instruments Ltd., is intended for measuring levels from 24 to 140 dB (up to 200 dB with special microphone) over the range 31.5 c/s to 8 kc/s. As well as incorporating A, B, and C weighting networks which correspond closely to the 40, 70 and 100 phon equal loudness contours, the circuitry of this instrument complies with "Recommendations for Sound Level Meters" IEC publication 123, and "Specification for

Sound Level Meters" BS 3489. The ceramic microphone is non-directional and can be used up to 20 feet away from the instrument; it does not require a polarizing voltage. Jacks permit a.f. analysers, variable or octave-band filters and statistical analysers to be used with the meter.

WW 305 for further details



## TAPPED DELAY LINES

SILVER Star tapped delay lines by Johnson Matthey Metals Ltd. are for use in computer circuits and other electronic applications. They are lumped constant L-C delay line units constructed from a number of interconnected delay lines. A typical unit has an overall delay time of 100 ns having ten equal taps yielding incremental delay times of  $10 \text{ ns} \pm 3 \text{ ns}$ . Overall rise time is less than 20 ns. The maximum working voltage is 125 V d.c. Characteristic impedances are  $100 \Omega \pm 5\%$  or  $500 \Omega \pm 5\%$ .

WW 306 for further details

## Transducer Amplifier

AS an aid in the measurement of load, displacement, torque, pressure and vibration, Vibro-Meter SA, of Switzerland, have produced an 8 kc/s carrier frequency amplifier 8-CFA-1/A. Wire, foil, and semiconductor strain gauges, resistive and inductive transducers may be used with this amplifier. The amplification factor is 8000 and the sensitivity is 0.1% f.s.d. per day.

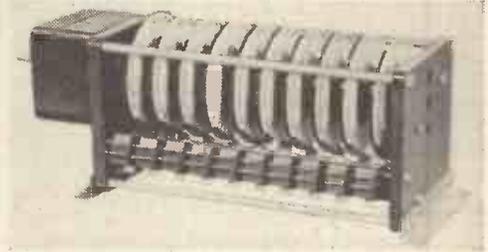
WW 307 for further details

## Cam Timers

EACH of the cam timers in the ACT series by Crater Controls Ltd. is driven by a synchronous motor and gear box. Over 420 timings are available, from 1 r.p.m. to 1 r.p. week (168 hours) and this standard range includes shaft speeds from 1 r.p.m. to 1 r.p.h. Each cam consists of two halves, one half keyed to the shaft and the second half rotatable relative to the first half through  $180^\circ$ . The complete cam unit can be adjusted on the shaft, thus permitting settings through  $360^\circ$ . Fixed cam profiles can be provided to specification. One to fifteen complete cam units can be supplied on varying frame lengths according to the number required. Switching is by

micro-switches, each of which is a single pole changeover unit operated (through a lever arm) by the cam profile. The standard rating is 250/440 V, 50 c/s, 15 A. Ratings up to 30 A can be supplied. Crater Controls Ltd., Lower Guildford Road, Knaphill, Surrey.

WW 308 for further details



## DECADE COUNTER

DECADE counter 550 is a ten-position unidirectional ring counter with n-p-n and p-n-p bistable transistor pairs driving an integral neon number tube. Produced by Weir Electronics Ltd., Durban Road, Bognor Regis, Sussex, it is intended for use where high-speed numerical readout is required. It will operate at frequencies up to 10 kc/s at an amplitude of +2V to +5V. The rise time of the trigger pulse is less than half a

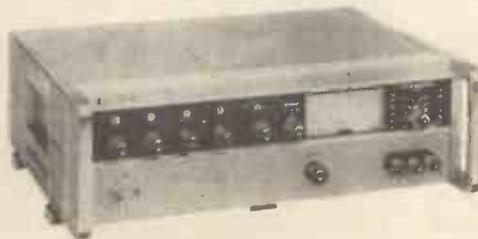
microsecond. Using a Hivac number tube XN3, or equivalent, this decade counter can be used independently or in cascade. The power requirements for this plug-in printed circuit board are +257V  $\pm 10\%$ , -12%, +75V  $\pm 7\%$ , +4.7V  $\pm 5\%$ , or -4.7V  $\pm 5\%$ . At these voltages the current requirements will be 2 mA, 2 mA, 10 mA and 6 mA respectively.

WW 309 for further details

## 4-Digit Oscillator

FREQUENCIES between 10 c/s and 1 Mc/s can be selected with four-place digital resolution on the Hewlett-Packard oscillator 4204A. Overall frequency accuracy is 0.2% and this combined with the four-place readout means that in many instances, an electronic counter will no longer be needed. Since the oscillator also has a built-in wide-range voltmeter, the amplitude of the oscillator's output can also be de-

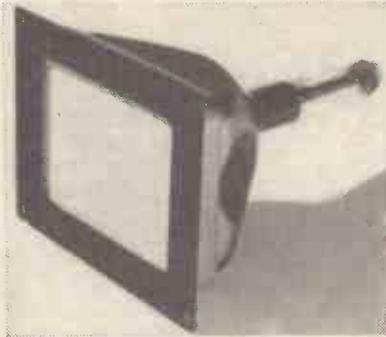
termined. Distortion for this solid-state instrument is said to be less than 0.3% from 30 to 100 c/s, and less than 1% down to 10 c/s and up to 1 Mc/s. Hum and noise content is less than 0.05% of output. The oscillator supplies up to 10 V into 600 ohms, and 20 V into an open circuit. The output attenuator has an 80 dB range in 10 dB steps with less than  $\pm 0.5 \text{ dB}$  error; a vernier control provides 20 dB of continuously variable attenuation. Oscillator stability is presented at less than a  $\pm 0.01\%$  change in output frequency for a  $\pm 10\%$  variation in line voltage. The price is £264. Hewlett-Packard Ltd., 224 Bath Road, Slough, Bucks.



WW 310 for further details

## CAMERA VIEWFINDER

THE Brimar M17-15W is a seven-inch flat-faced rectangular tube, for small monitor and viewfinder applications. This tube has a 70° deflection angle, electrostatic focus and magnetic deflection. A clear glass face is employed and the aluminized screen yields the high brightness of 850 cd/m<sup>2</sup> for a final anode voltage of 14 kV at 170 μA. The standard phosphor is white W(T4) but others can be supplied. Implosion and flashover protection are provided, and tracking is minimized by the use of moisture repellent lacquer round the e.h.t. contact on the tube cone. A metal mounting frame is associated with the bonded faceplate assembly of this tube. Thorn-AEI Radio

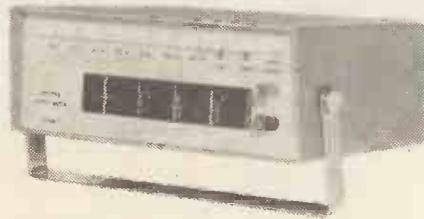


Valves and Tubes Ltd., 7 Soho Square, London, W.1.

WW 311 for further details

## Digital Multimeter

WITH four-digit readout the digital multimeter DMM-1 measures from 1.999 to 1999 mA a.c. and d.c.; 1.999 to 1000 V a.c. and d.c., and resistance from 1.999 to 1999 kΩ. Manufactured by Microwave and Electronic Systems Ltd., Lochend Industrial Estate, Newbridge,



Midlothian, Scotland, it is provided with an accuracy on all d.c. ranges of 0.1% of reading ±1 bit. On a.c. ranges accuracy is determined by the frequency at which the readings are made up to 10 kc/s. On all d.c. functions polarity of input is indicated and on a.c. ranges an a.c. sign is provided. Ni-Cd batteries are built-in with charger for true portability. Calibration is effected by use of an internal reference Zener diode and range selection is by push buttons. This instrument is of solid state construction and includes i.c.s.

WW 312 for further details

## TRANSVERTERS

SPECIFICALLY designed for waveform and frequency sensitive equipment such as video-tape recorders, and sound recorders, the series "B" sine wave transverters are manufactured by Valradio Ltd., Browells Lane, Feltham, Middlesex. An RC type oscillator with temperature stable components drives heavy duty transistors; the resultant output is fed to a ferro-resonant type of transformer which produces a sine wave

output. A high degree of voltage regulation against changes of input voltage and load is also maintained by this transformer. Frequency output is 50 c/s ±0.25 c/s, or better than 0.005% when using a "resonator" frequency synthesizer. Two outputs are provided 115 V and 230 V. The 12V unit will operate over 11 to 15 V and the 24 V unit will operate over 22 to 30 V.

WW 313 for further details

## Schmitt Trigger

THE range of discrete component, germanium, digital modules (series 40) manufactured by S.T.C. now includes a Schmitt trigger type 443E. As with the other members of this family the fan-out capability is three when used with other 40 series modules. Backlash

is 0.05 V, the upper and lower trigger levels being 0.4 V and 0.35 V respectively. The device will convert a slowly changing voltage into two-state form with short rise and fall times. S.T.C. Comp. Group, Footscray, Sidcup, Kent.

WW 331 for further details

## Capacitance Diode

THE high-capacitance change ratio (5:1) of the PHV series Varicap permits a greater than normal tuning range. Manufactured by TRW Semiconductors Inc., Laundale, California, U.S.A., this device is offered initially in 3 pF and 20 pF values at typical operating voltages of 2 to 15 V.  $V_{BR}$  (breakdown voltage) at 100 μA is 25 V minimum. It has been designed for wideband tuning applications requiring maximum capacitance/voltage change ratios and is encased in a low inductance DO-19 package. Marketed in the U.K. by M.C.P. Electronics, Ltd., Station Wharf Works, Alperton, Wembley, Middlesex.

WW 314 for further details

## HIGH FREQUENCY FET

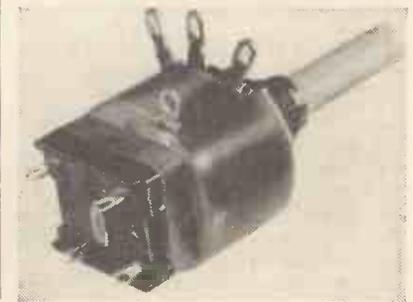
A HIGH frequency 'N' channel f.e.t. by Amelco Semiconductors has a typical power gain of 16dB at 400 Mc/s with a noise figure of 4dB. It also has a 30 V breakdown voltage and a  $G_m$  of 4.5 to 10 mA/V at 1 kc/s and 3.5 mA/V at 200 Mc/s. Agents:—Lectrotron Ltd., Kinbex House, Wellington Street, Slough, Bucks.

WW 315 for further details

## MOULDED TRACK POTENTIOMETER

INTENDED for high surge current application, including transistor television equipment, the type 51 moulded track potentiometer by Davall Electronics Ltd., Rothersthorpe Avenue, Northampton, is fitted with a double-pole switch. A screening plate can also be fitted between track and switch if required for mains applications. Resistance range available is 50Ω to 2 MΩ (linear) and 1 kΩ to 1 MΩ (non-linear) with a tolerance of ±20%. The power ratings at 70°C are 1 W and 0.5 W respectively. Insulation resistance is greater than 5000 MΩ at the maximum working voltage of 500 V d.c. Switch actions available are off-on, on-off and change-over.

WW 316 for further details



## E.H.T. UNIT

A ready-to-use, compact ( $6\frac{1}{2} \times 4\frac{1}{4} \times 2\frac{1}{2}$  in) unit, providing up to 17.5 kV for television and radar supplies is available from the Marconi Specialized Components Division. An input supply of 15.5 V drives a push-pull sine-wave oscillator, whose output frequency in

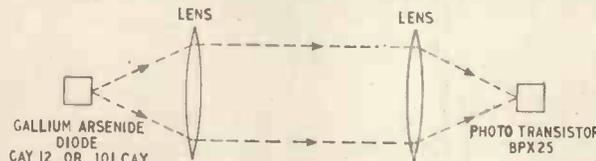


excess of 20 kc/s is fed to a Cockcroft-Walton type silicon diode multiplier stack. An external corona stabilizer is employed at the output to provide a constant voltage over a wide current range up to 200  $\mu$ A. Adjustment of output terminals across the multiplier stack provides various e.h.t. voltages of either polarity. Short circuits of the output, lasting for a few seconds will not damage the circuit provided the input current is limited to 0.7 A. It is stated that this e.h.t. unit conforms to all relevant military, air and ground specifications and will operate in a dry heat of +55°C and in damp heat at +40°C at 95% relative humidity. It will withstand vibrations of 63 to 150 c/s at 10g. The Marconi Company Ltd., Chelmsford, Essex.

WW 317 for further details

## Ga As DIODES

A SIMPLE, compact communications system is one of the suggested applications for the Mullard gallium arsenide diodes CAY12 and 101CAY. When subjected to a voltage of about 1.5 V, both diodes emit coherent radiation at about 0.9  $\mu$ m. Since this wavelength is close to the peak of the response curve of photo transistor BPX25, a diode and photo transistor could be employed to transmit information as shown. Radiation from the diodes is



modulated by the diode current. High-frequency performance and high switching speeds permit these diodes to be used in a.m. or pulsed communica-

tion links. Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.

WW 318 for further details

## Semiconductor Tester

PRODUCTION quality control and other departments concerned with the rapid and accurate assessment of semiconductor parameters will be interested in the Semcon semi-automatic transistor/diode tester SP11. This instrument is described as a "go/no go" tester which has plug-in modules for automatic set-up of conditions required for test. One test button is used for the complete sequence of operation. Test potential available is 300 V 100 mA and tests can be programmed for pulse durations of 50 ms and 200  $\mu$ s. Eight

pulsed d.c. tests are carried out in two seconds and "pass" or "fail" are indicated by lamps. Production Techniques Ltd., Cores End Road, Bourne End, Bucks.

WW 319 for further details

## Miniature Neon Indicator

AVAILABLE for 250 or 110 V operation, the miniature neon indicator by Oxley Developments Co. Ltd., Priory Park, Ulverston, North Lancs, has an overall diameter of 0.35 in. Its height above panel is 0.5 in. The recommended panel thickness is 10/16 s.w.g.

WW 320 for further details

## COUNT RATE METER

FOR use with a batch counter, the Kappa FK22 count rate meter provides an immediate and continuous indication of the count rate (objects per minute). Count-pulses generated by a batch counter are fed into a time integrating circuit (within the count rate meter), and the resultant output displayed on a large panel meter, which is calibrated to objects per minute or per hour. When count rate only is required, a self-contained version, the FK20, can be used. Kappa Electronics Ltd., 159 Hammer-smith Road, London, W.6.

WW 321 for further details

## P-N-P POWER TRANSISTORS

AMONG the applications for the Motorola p-n-p silicon power transistors 2N4398-9 are employment in high output audio or servo amplifiers where current demand is high. With an  $I_C$  of 10 A and a  $V_{CC}$  of 30 V the delay and rise time for these two devices is only 400 ns. Marketed in a low silhouette, copper-base TO-3 package the 2N4398 costs £3 8s and the 2N4399 £4 1s 6d. Motorola Semiconductor Products Inc., York House, Empire Way, Wembley, Middlesex.

WW 322 for further details

## Operational Amplifier

AN exceptionally low drift rate of 3  $\mu$ V/°C maximum is claimed for the Burr-Brown operational amplifier 3003/15. It also has a 0.3 nA/°C maximum bias current drift. Both of these characteristics apply over the temperature range -25°C to +85°C. The noise content of this unit is 3  $\mu$ V r.m.s. from a.c. to 10 kc/s and the low quiescent power supply drain is 5 mA maximum. The output is a conservative rating of  $\pm 10$  V  $\pm 20$  mA. Intended applications include stable amplification of low level signals, linear current source, and current-to-voltage conversion. General Test Instruments Ltd., Gloucester Trading Estate, Hucclecote, Glos.

WW 323 for further details

## Subminiature Connectors

THE SREC series of sub-miniature removable, crimped contact connectors have been introduced by Ether Ltd., Caxton Way, Stevenage, Herts. These connectors have 0.030 in diameter crimp (4 indents) type removable contacts with 0.094 in centre-to-centre spacing. The crimped contacts accommodate 7/00076 in. to 7/0048 in wire sizes, and are precision machined to assure solid pin and socket reliability. They are self aligning and polarized.

WW 324 for further details

# VIDEODISC RECORDER

MAGNETIC videodisc recorders by the MVR Corporation, U.S.A., are available in the U.K. through The Crow Co., P.O. Box 36, Reading, Berks. Although the limited storage capacity of a magnetic disc prevents it from supplanting the videotape recorder, it is claimed that greater flexibility of operation makes it a useful addition to existing television systems. The recording medium is a  $\frac{3}{8}$  in thick, 12 in diameter aluminium disc with a magnetically sensitive surface coating. Thousands of hours of repetitive use with little or no damage to the surface or degradation of the signal are claimed for this disc. Up to 500 tracks of video or analogue in-

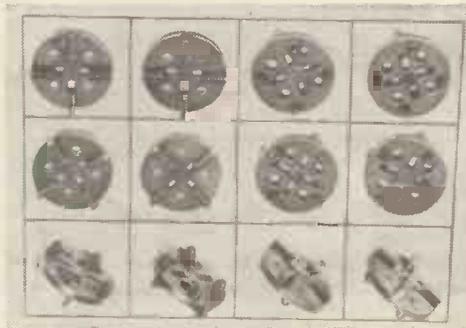
formation may be stored on a 12 in disc, which rotates at 1500 r.p.m. at the 25 frames per second rate, thus each revolution represents one television picture frame. The total time is 40 ms per revolution. The same size disc will also permits 20 s of real time continuous information to be recorded in a spiral manner. Flexibility of operation throughout the range of nine basic models includes non-destructive playback of single-frame images, slow-motion presentation. The range available includes single-channel, single head; two channel, two head; and a three-head system for recording fast moving objects.

WW 325 for further details

# Universal Transistor Pad

ONE side of the universal transistor pad T0518-001 accepts T05 transistor leads on an 0.2 in matrix for either straight-through mounting or conversion to 0.2 in T05 configuration. This pad is said to be useful where frequent changes are made from T018 to T05 on the same printed circuit boards. It is moulded in nylon A100 (melting point greater than 200°C). Jermyn Industries, Vestry Estate, Sevenoaks, Kent.

WW 326 for further details



# R.M.S. Voltmeter

BALLANTINE Laboratories, of Boonton, New Jersey, U.S.A., have introduced a new r.m.s. voltmeter that will operate between 10 c/s and 20 Mc/s and can be powered either from the mains or from rechargeable batteries. The voltmeter, designated Model 323, operates on the square law response of silicon diodes to measure the true r.m.s. value of distorted sine waves, square waves, random signal or pulse

waveforms with duty cycles as low as 0.04. The instrument has a crest factor 5 at f.s.d. increasing to 15 down scale. Twelve voltage ranges are incorporated being 300V to 330 $\mu$ V, input impedance is 2 M $\Omega$  shunted by 15 pF on all but the 1 to 30 mV ranges where the shunt capacity is 25 pF. In its null detection mode the instrument has a sensitivity of 70  $\mu$ V.

WW 327 for further details

# New Triac Range

MOTOROLA have introduced a range of three 8-amp triacs (MAC 1-2-3). The devices feature a new chip design, with a built-in copper lug for added protection, facilitating current spreading, while allowing a high surge current rating, typically 100 A. Significant figures from the specification are—r.m.s. conduction current 8 A max, gate trigger current 30 mA, holding current 30 mA, gate trigger voltage 2 V and peak

blocking voltage (1) 50 V, (2) 200 V and (3) 400 V. The devices, which cost between 15s and 36s 6d for 100 up quantities, are available in three different packages. MAC 1 is of the lug terminal type, MAC 2 is a  $\frac{1}{8}$  inch stud package and the MAC 3 is a three lead package for printed circuit mounting. Celdis Ltd., Milford Road, Reading, Bucks, are the U.K. agents.

WW 328 for further details

# Versatile X-Y Recorder

EITHER X or Y axes may be geared to time function in the X-Y recorder "function/riter" (trade mark) by Texas Instruments Inc. Plug-in function modules available, are a single range signal input module and a multirange attenuator module. Either vertical or horizontal mounting is possible, and the recording surface may be angled to 45° or 90° from horizontal when the recorder is used as a tabletop unit to allow visibility of recording when the operator is seated. Vacuum hold-down of charts is quiet, and chart sizes of 8 $\frac{1}{2}$  × 11 in and 11 × 17 in can be used. Inking is carried out through disposable plug-in ink cartridges. Solid-state servo systems are employed, and enclosed infinite-resolution slide wires are used instead of helical-wound resistance elements to ensure high precision. Texas Instruments Incorporated, 3609 Buffalo Speedway, Houston, Texas, U.S.A.

WW 329 for further details

# Multiple-function Test Unit

BOTH a.c. (r.m.s.) and d.c. voltages can be measured up to 1100 V in four ranges by the Model 1002 multimeter by Honeywell Controls Ltd., Brentford, Middlesex. The a.c. frequency range extends from 20 c/s to 20 kc/s. The three basic elements constituting this unit are a Zener-regulated  $\pm 11$  V reference supply, an electronic null detector, and a six-decade Kelvin-Varley voltage divider with numerical readout. The other functions of this unit are (a) voltage reference source, for precision calibration of potentiometric instruments—voltage levels of 6 digit resolution are available, accurate to  $\pm 0.0025\%$  and varying from 0 to 11 V; (b) null detection, to provide highly sensitive indications of input changes as small as 100 nV or input currents of  $10^{-13}$  A; (c) decade voltage divider—accurate voltage level divisions to  $\pm 0.001\%$  using a 6-decade Kelvin-Varley divider network; and (d) ratiometer, for precise d.c. ratio measurements in full scale voltage ranges of 1:1, 10:1, and 100:1, with  $\pm 0.001\%$  accuracy. The 1002 multimeter has a common mode rejection of 120 dB: an input resistance potentiometric to 11 V is 10 M $\Omega$ . The reference polarity is reversible at the front panel and the Kelvin-Varley divider output is at the rear panel.

WW 330 for further details

## Dynamic Microphone

WEIGHING 6 oz, the Reslo EC.1 cardioid dynamic microphone has a miniature insert having a directional sound pick-up field. Designed for speech, solo voice or solo instrument work, it is also supplied with an acoustic resistance cap (wind shield) for use outdoors. The frequency response over the range 100 c/s to 17 kc/s is -10 dB at 100 c/s, and -2 dB at 12 kc/s, referred to the level at 1 kc/s. Polar response is strongly directional, and partially suppressed at the rear where the pick-up is -10 to 20 dB over 150 c/s to 15 kc/s. Model L has an impedance value of 30-50Ω; Model M a dual impedance 250 or 600Ω; and Model H a dual impedance 40kΩ or 30 to 50Ω. Models M & H include miniature line transformers. Connections are from a Reslo 3-contact socket at end of case: low impedance floating from earth and phased; high impedance, single ended and phased. Reslosound Ltd., Spring Gardens, London Road, Romford, Essex.

WW 335 for further details

## UNIPHASE GAS LASER

DEVELOPED by Scientifica and Cook Electronics Ltd., the high-power uniphase gas laser B18 produces a high output (8 mW) at 6328Å, although outputs in the infra-red region are obtainable by the use of suitable mirrors. It can also be supplied for operation at 11,523Å or 33,912Å. Beam diameter is approximately 2 mm at exit aperture. The tube has silica Brewster windows with single isotope filling and the mirrors are hard coated and finished to 1/20th wavelength. The B18 can be mounted on a table or optical bench. Scientifica and Cook Electronics Ltd., 148 St. Dunstan's Avenue, Acton, London, W.3.

WW 336 for further details

### INFORMATION SERVICE FOR PROFESSIONAL READERS

To expedite requests for further information on products appearing in the editorial and advertisement pages of *Wireless World* each month, a sheet of reader service cards is included in this issue. The cards will be found between advertisement pages 16 and 19.

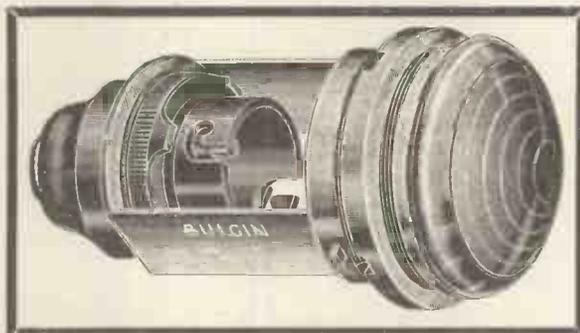
We invite professional readers to make use of these cards for all inquiries dealing with specific products. Many editorial items and all advertisements are coded with a number, prefixed by WW, and it is then necessary only to enter the numbers on the card.

Postage is free in the U.K. but cards must be stamped if posted overseas. This service will enable professional readers to obtain the additional information they require quickly and easily.



THE HOUSE OF BULGIN  
AT YOUR SERVICE

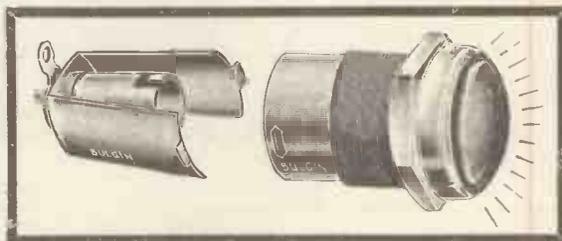
## SIGNAL LAMPS FOR EVERY USE



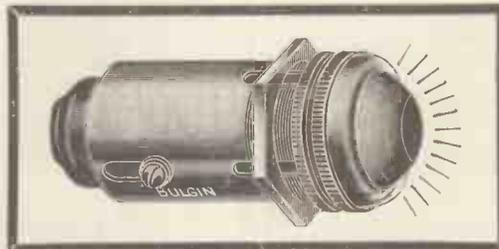
List No. D.810/G/Col.

A heavy duty open frame Signal Lamp designed primarily for **Machine Tool and Industrial Plant** uses. The moulded Lamp holder accepts B.C. mains Lamps, will work at 170°C and withstands 2.5kv. Test. The transparent glass lens is available, in Red, Yellow, Green, Blue and Clear.

List No. D.790/Col.  
Lens unit accepting clip - in lampholders SA.Z146 (M.B.C.) illustrated.



This fitting accepts various clip-in lampholders, (M.E.S., M.B.C., S.E.S., S.B.C., S.C.C., C.E.S.) and has a pilfer proof lens that cannot be removed from front of panel, therefore ideally suited to **Vending Machine and similar** uses. Lens colours are as D.810 above in both transparent and translucent finishes.



List No. D.666/G/S.B.C./Col. Also available in /C.E.S. and /M.B.C. versions.

Very popular **general purpose** model suitable for a wide range of uses, as it is available fitted with three different lampholders enabling use on mains or low voltage. Metal bezels and glass lenses are standard and there is a choice of five transparent or translucent lens colours.

All fully described in our latest catalogue No. 205/C

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Bye Pass Rd., Barking, Essex.  
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MANUFACTURERS AND SUPPLIERS OF RADIO AND ELECTRONIC COMPONENTS TO

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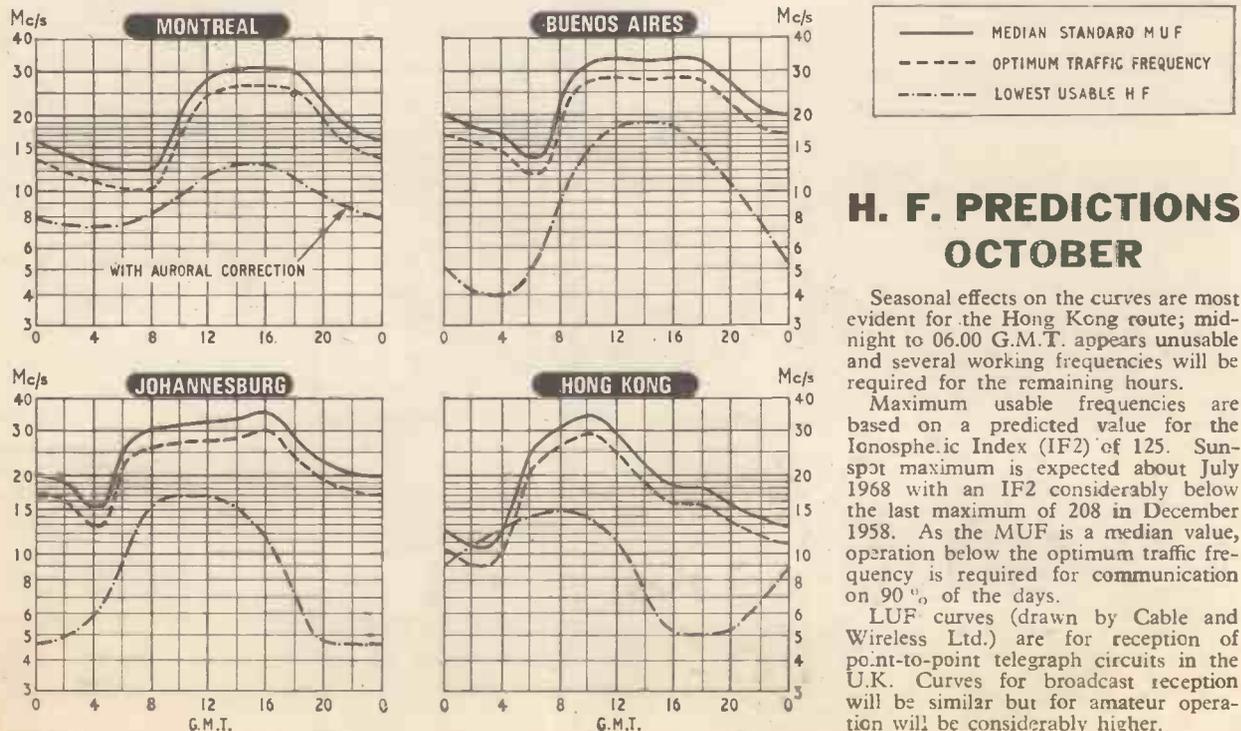
WW-115 FOR FURTHER DETAILS

# OCTOBER CONFERENCES & EXHIBITIONS

Further details can be obtained from the addresses in parentheses

<b>LONDON</b>			
Oct. 2-11	Olympia	Oct. 12-15	Genoa
<b>Business Efficiency Exhibition</b> (Business Equipment Trade Assoc., 109 Kingsway, W.C.2)		<b>International Communications Congress</b> (Istituto Internazionale delle Comunicazioni, Viale Brigate Partigione 18, Genoa)	
Oct. 31-Nov. 1	St. Ermin's Hotel	Oct. 12-22	Genoa
<b>Ultrasonics for Industry Conference and Exhibition</b> (Ultrasonics Conference and Exhibition, Dorset House, Stamford St., S.E.1)		<b>Fair of Communications</b> (Fiera Internazionale, Genoa)	
<b>BUXTON</b>		Oct. 16-18	Washington
Oct. 19	Palace Hotel	<b>EASTCON—Electronics &amp; Aerospace Systems Technical Convention</b> (Mrs. H. Manley, Westinghouse Electric Corp., 1625 K.St., N.W., Washington, D.C. 20006)	
<b>Printed Circuits Symposium &amp; Exhibition</b> (Inst. of Metal Finishing, 178 Goswell Rd., London, E.C.1)		Oct. 16-20	New York
<b>EDINBURGH</b>		<b>Audio Engineering Convention</b> (Audio Engineering Soc., 60 E.42nd St., New York, N.Y. 10017)	
Oct. 17-19	Napier Tech. Col.	Oct. 17-19	Michigan
<b>Electronics in Action Exhibition</b> (P. M. Elliott, 21 Craigmount Loan, Corstorphine, Edinburgh, 12)		<b>Antennas &amp; Propagation Symposium</b> (Dr. T. B. A. Senior, Radiation Lab., University of Michigan, Ann Arbor, Mich. 48108)	
<b>OVERSEAS</b>		Oct. 18-20	Washington
Oct. 2-5	Pittsburgh	<b>Electron Devices</b> (I.E.E.E., 345 E.47th St., New York, N.Y. 10017)	
<b>Power Semiconductors</b> (I.E.E.E., 345 E.47th St., New York, N.Y. 10017)		Oct. 18-20	Austin
Oct. 4-6	Vancouver	<b>Symposium on Switching and Automata Theory</b> (Prof. C. L. Coates, Engineering Science Building, University of Texas, Austin, Texas 78712)	
<b>Ultrasonics Symposium</b> (R. W. Moss, Imperial College, South Kensington, London, S.W.7)		Oct. 23-25	Chicago
Oct. 4-6	Monticello, Ill.	<b>National Electronics Conference</b> (I.E.E., 345 E.48th St., New York, N.Y. 10017)	
<b>Circuit and System Theory</b> (I.E.E.E., 345 E.47th St., New York, N.Y. 10017)		Oct. 19-28	Sydney
Oct. 10-15	Ljubljana	<b>International Trade Fair</b> (Industrial & Trade Fairs Ltd., Commonwealth House, New Oxford St., London, W.C.1)	
<b>Modern Electronics Exhibition</b> (Ljubljana Fair, Post Box 413-VIII, Ljubljana, Yugoslavia)			
Oct. 10-19	Utrecht		
<b>Scientific &amp; Industrial Instruments Show</b> (Royal Netherlands Industries Fair, Vrendenburg)			

## H. F. PREDICTIONS — OCTOBER



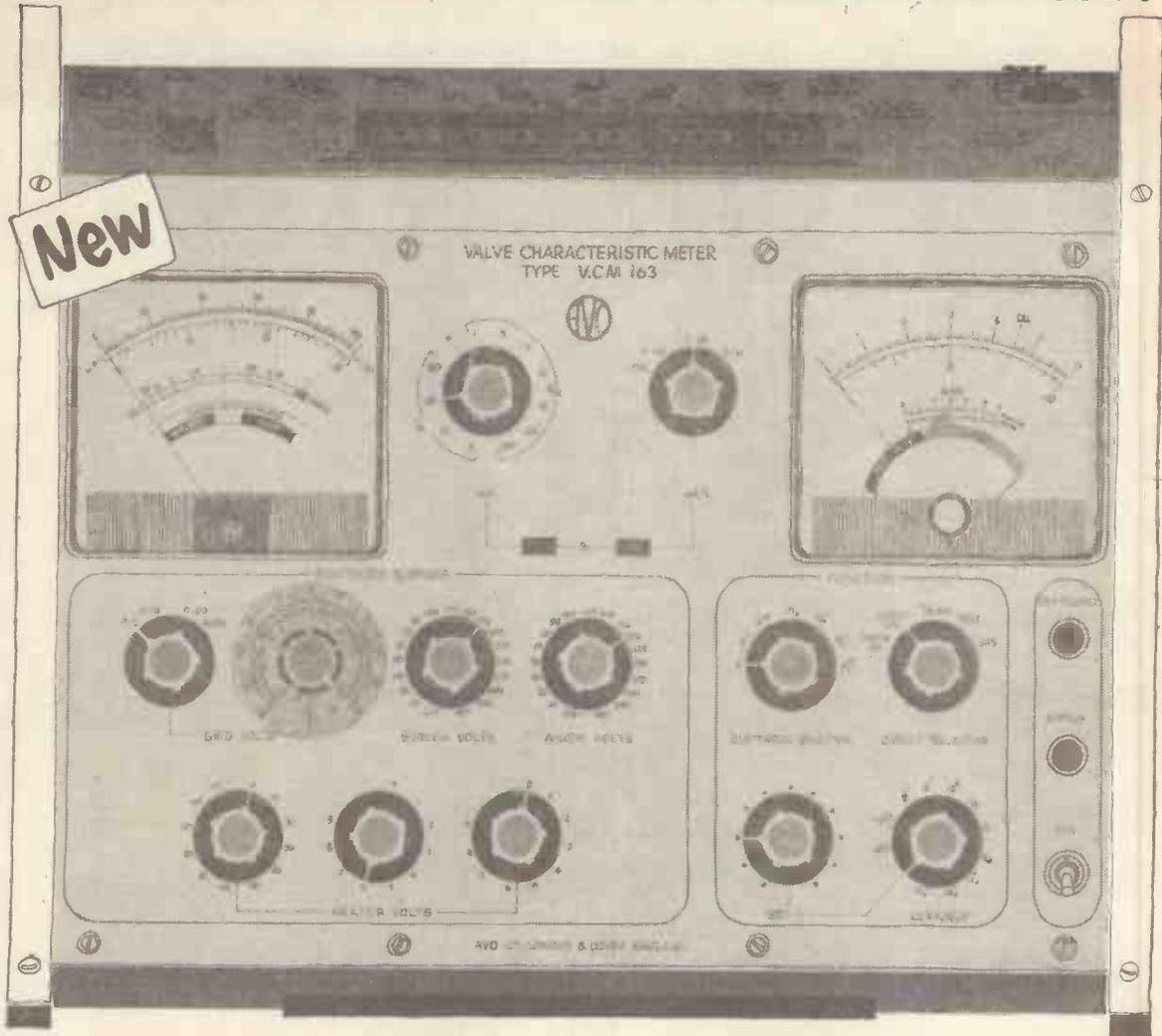
## H. F. PREDICTIONS OCTOBER

Seasonal effects on the curves are most evident for the Hong Kong route; midnight to 06.00 G.M.T. appears unusable and several working frequencies will be required for the remaining hours.

Maximum usable frequencies are based on a predicted value for the Ionospheric Index (IF2) of 125. Sunspot maximum is expected about July 1968 with an IF2 considerably below the last maximum of 208 in December 1958. As the MUF is a median value, operation below the optimum traffic frequency is required for communication on 90% of the days.

LUF curves (drawn by Cable and Wireless Ltd.) are for reception of point-to-point telegraph circuits in the U.K. Curves for broadcast reception will be similar but for amateur operation will be considerably higher.

# When is an Avo meter not an Avometer?



## When it tests nuvistors, compactrons & 13-pin valves

The new Avo VCM163 Valve Characteristic Meter is one of the most versatile valve testers ever developed. With facilities for testing valves with as many as 13 pin connections (and 2 top caps), plus recently introduced types such as nuvistors and compactrons, the VCM163 provides both rapid fault diagnosis and comprehensive static/dynamic characteristics data. Nevertheless, it is even simpler to use than previous models - no backing-off is required. A separate meter displays mutual conductance values continuously during testing, and there is pushbutton monitoring of screen parameters. The full range of h.t. voltage - 12.6V to 400V - can be applied to anode and screen, heater voltage is adjustable in 0.1V steps from 0 to 119.9 and grid voltage may be varied continuously from 0 to 100V (calibrated). Get complete information about the VCM163 from your local dealer or Avo Ltd, Avocet House, Dover, Kent. Telephone Dover 2626. Telex 96283.



M  
GROUP

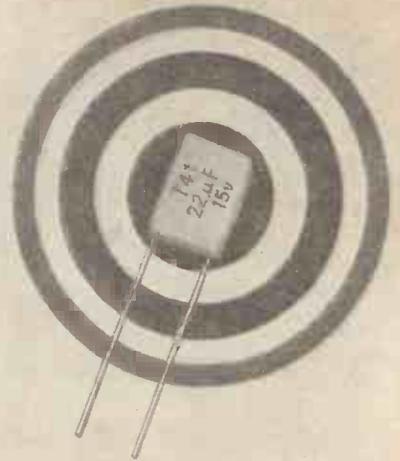
AVΩ MEANS BASIC MEASUREMENTS ALL OVER THE WORLD

WW-007 FOR FURTHER DETAILS

B.I.  
A

## Vibration-Proof Hunts T41

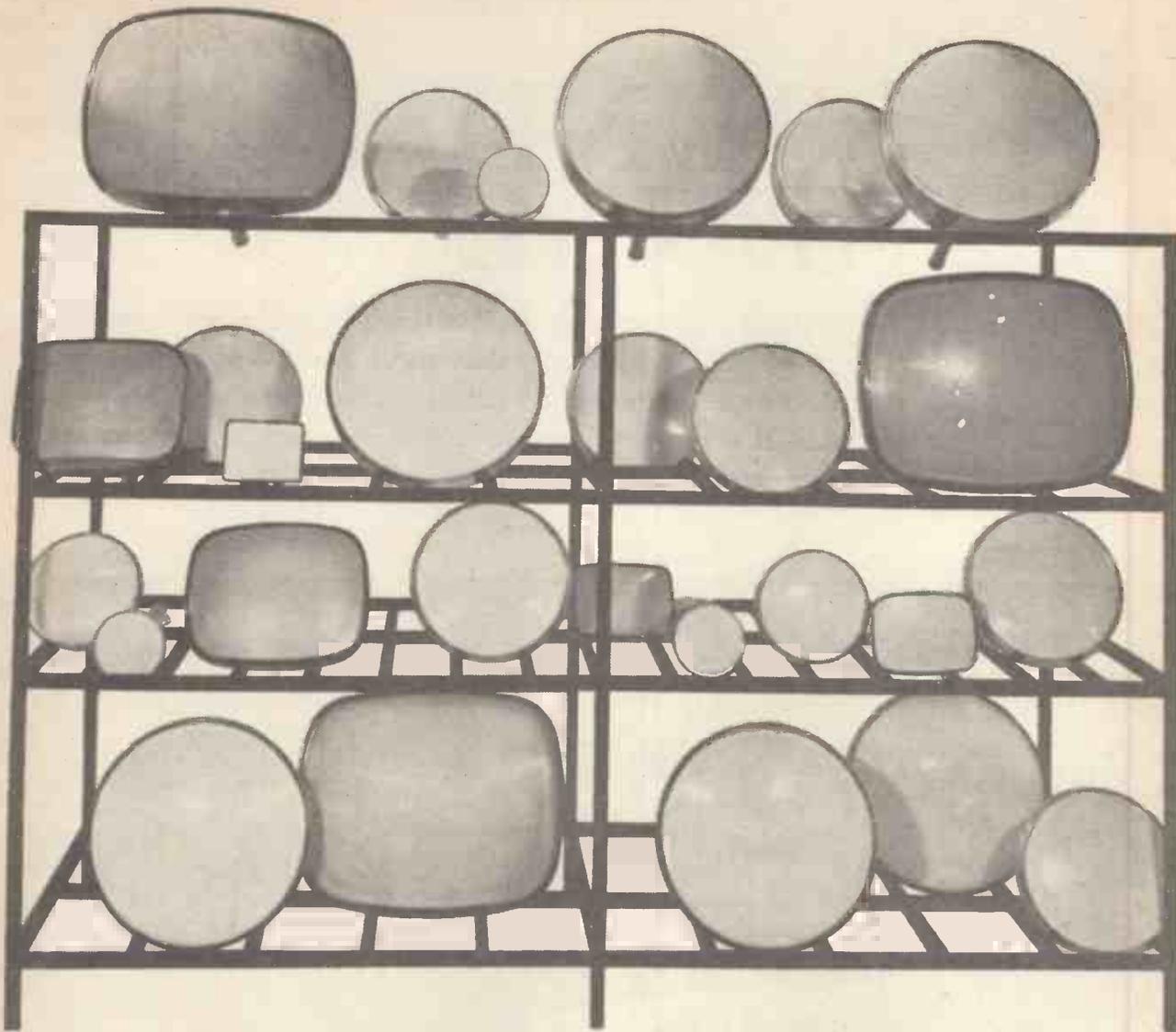
Every Hunts T41 tantalum capacitor has more than one string to its bow. In addition to the supreme advantages of a solid tantalum construction, the T41 is proof against vibration and acceleration. It also has a moisture-proof nylon cladding in a flat rectangular package form for high component density.



Hunts T41 solid tantalum capacitors are **RIGHT ON TARGET** for performance under arduous conditions.



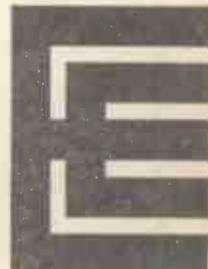
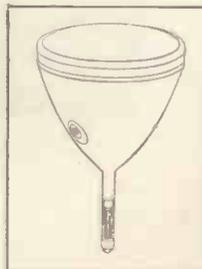
Full details freely available on request from  
**A. H. Hunt (Capacitors) Limited**  
 Bendon Valley, Garratt Lane, London S.W.18  
 Telephone: 01-874 6454 Telex: 25640  
 Factories also in Surrey and North Wales.



## CRTs off the shelf

(Specials take a little longer)

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WW-009 FOR FURTHER DETAILS

# SOUND SENSE

Broadcasting and recording studios throughout the world know that their efforts will be judged by millions of listeners and they take care that their own monitoring and listening rooms use the best equipment available. It is not surprising that the more discerning listeners use the same equipment in their own homes.



*The new Listening and Demonstration Room of the BBC Transcription Service, fitted with QUAD 22 control unit, QUAD II power amplifiers and QUAD electrostatic loudspeakers.*



for the closest approach to the original sound.

For full details of the QUAD range of units, send a postcard to:  
Ref: WW . The Acoustical Manufacturing Co. Ltd. Huntingdon. Tel: 0480 2561/2



**If you can't find the  
 Vacuum Capacitor  
 you need in here**

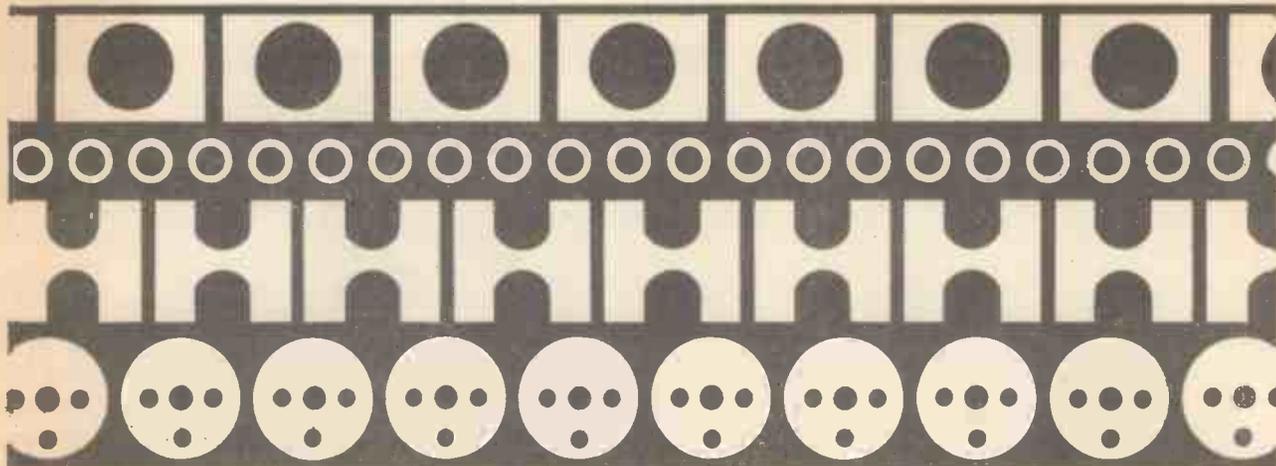
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We make glass high vacuum variable capacitors from 30 to 3000pF, glass fixed from 6 to 900pF, ceramic variable from 250 to 2300pF and ceramic fixed from 6 to 100pF, at voltage ratings from 3 to 30kV. If this isn't enough for your purposes, get in touch with us and we will make what you want, if it's technically and commercially feasible to do so.

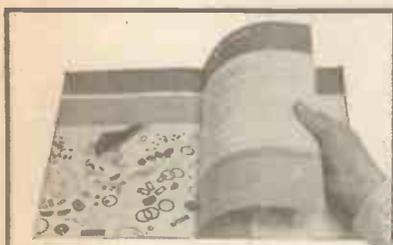


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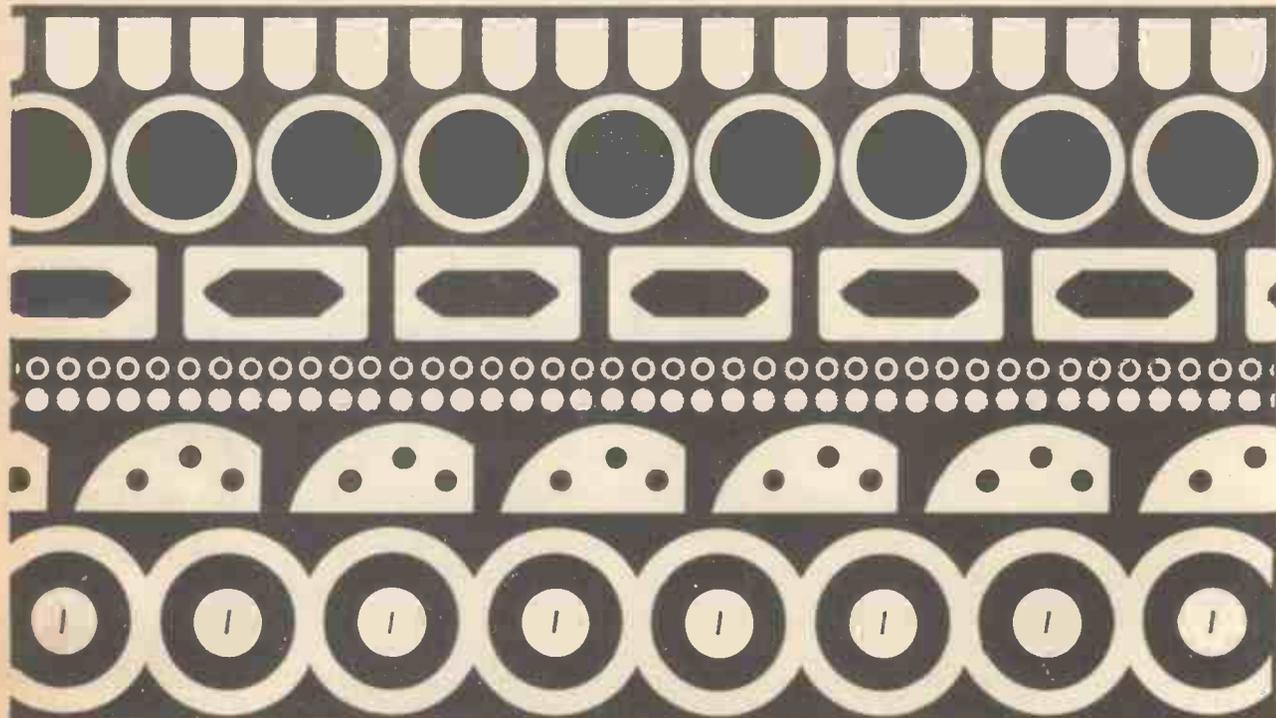
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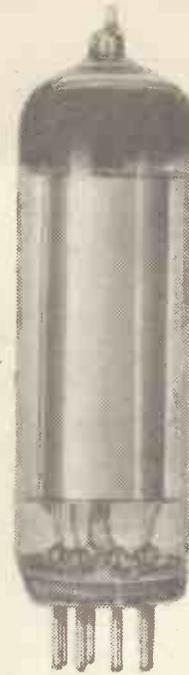


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Sales Office and Head Office  
Dominion Building, South Place, London, E.C.2  
Telephone: 01-628 8030



## Voltage Stabilisers



### DATA

Type	Service type	Operating voltage approx. (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)

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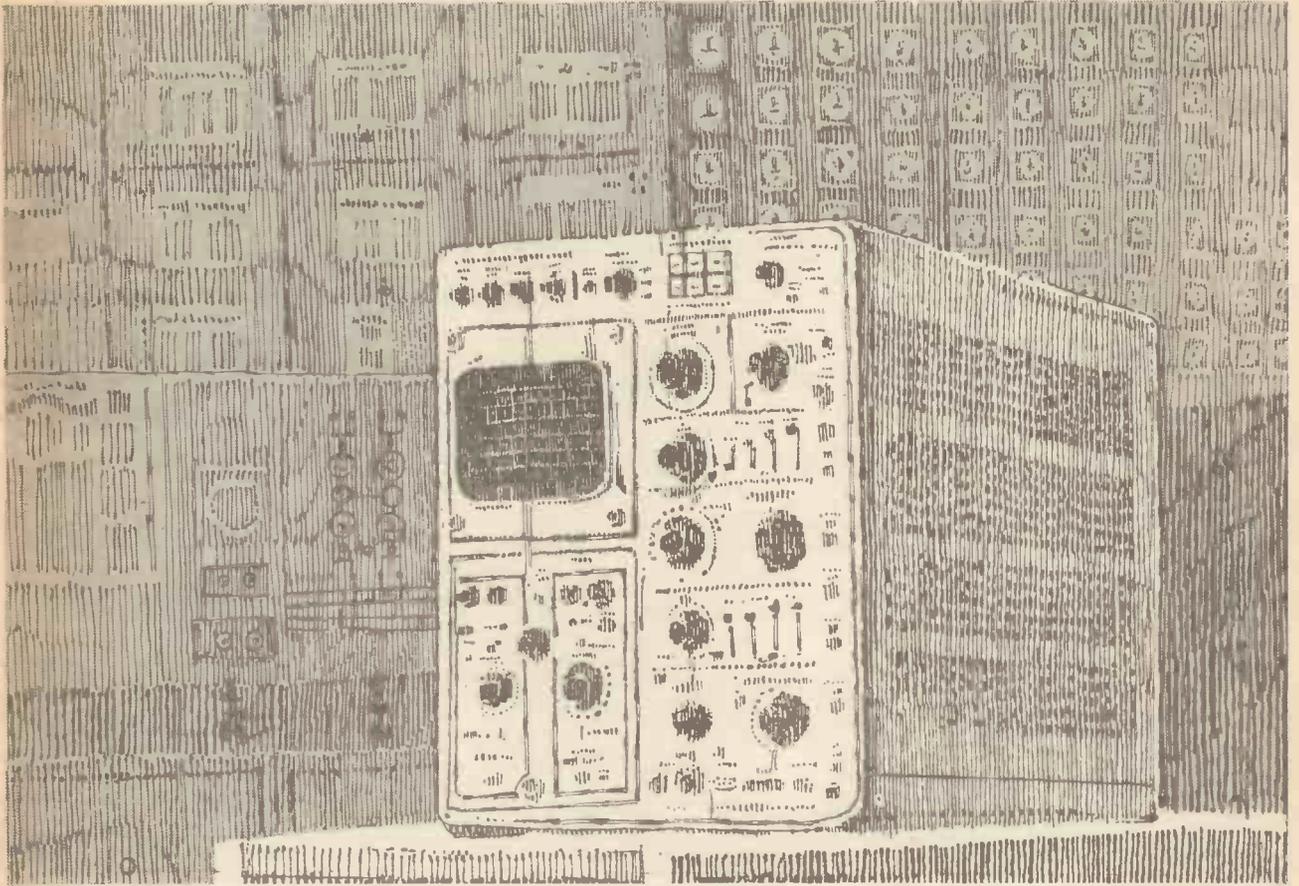
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Tel: New Cross 9731

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Wirelect House, St. Thomas Street, Bristol 1  
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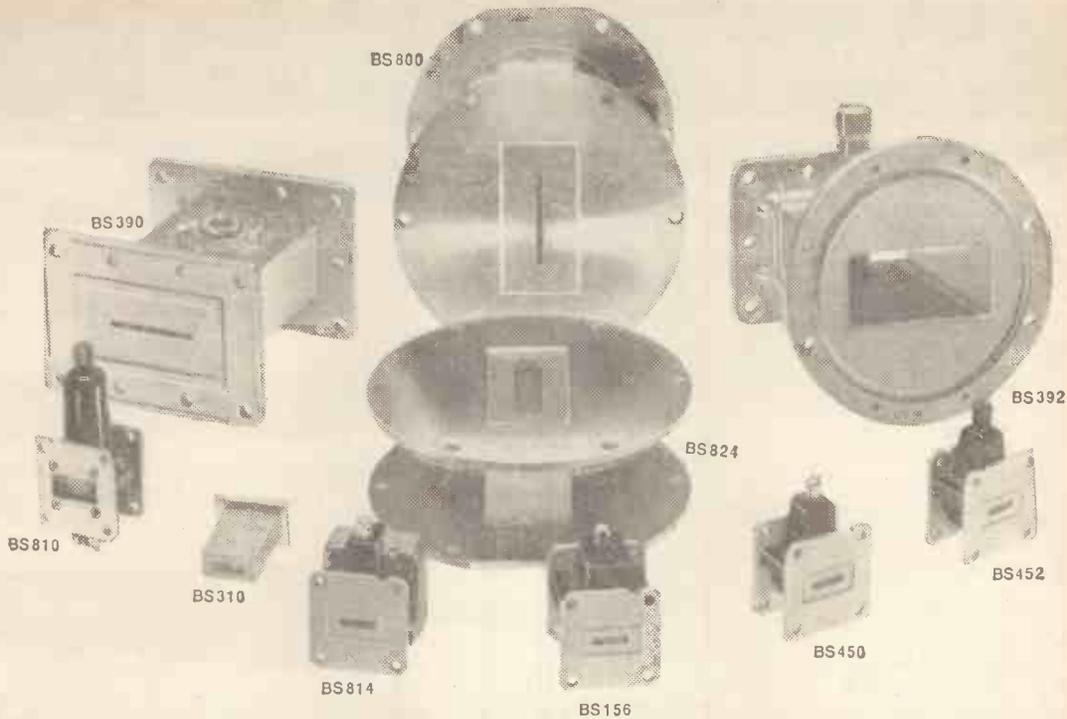
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### TR CELLS

TYPE NO.	SERVICE TYPE	BAND	FREQUENCY RANGE (MHz)	PEAK POWER (kW)	MAXIMUM V.S.W.R.	MAXIMUM INSERTION LOSS (db)	MAXIMUM RECOVERY TIME TO 6db ( $\mu$ s)
BS390	CV9442	S	2925-3075	1250	1.33	1.0	15
BS800	—	S	2840-3100	1250	1.2	0.8	15
BS824*	—	S	2700-3100	250	1.25	0.4	15 to 3db
BS156	CV2306	X	9000-9600	200	1.2	0.8	4.0
BS450	—	X	9300-9500	50	1.2	0.7	4.0
BS452	—	X	9310-9510	100	1.3	0.8	4.0
BS810	—	X	9250-9550	75	1.4	0.8	4.0

tunable

\* For protection of travelling wave tube amplifiers

### TB CELLS

TYPE NO.	SERVICE TYPE	BAND	RESONANT FREQUENCY (MHz)	OPERATING POWER (kW)	MAXIMUM LOADED Q	MAXIMUM V.S.W.R.
BS310	CV6070	X	9375	5-200	6.5	1.1

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TYPE NO.	BAND	FREQUENCY RANGE (MHz)	BAND WIDTH (MHz)	ATTENUATION AT CENTRE FREQUENCY (db)	MAXIMUM PEAK PULSED LINE POWER (kW)	TYPICAL OPERATING VOLTAGE (V)	MAXIMUM OPERATING CURRENT (mA)
BS392	S	2925-3075	150	0.25-25.0	0.5	0.85	30
BS460	X	8500 to 12000*	100	1.0-25.0	0.5	0.85	30

\* Set to customers' requirements within this range

### TR LIMITER CELL

TYPE NO.	SERVICE TYPE	BAND	FREQUENCY RANGE (MHz)	PEAK POWER (kW)	MAXIMUM V.S.W.R.	MAXIMUM INSERTION LOSS (db)	MAXIMUM RECOVERY TIME TO 3db ( $\mu$ s)	MAXIMUM LEAKAGE HIGH POWER SPIKE (erg/pulse)
BS814	CV6192	X	9000-9700	200	1.3	0.8	3.0	0.02

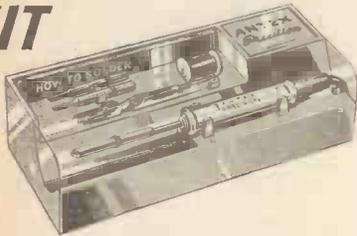
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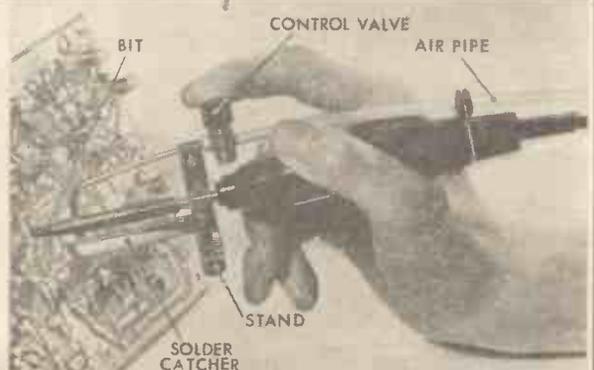
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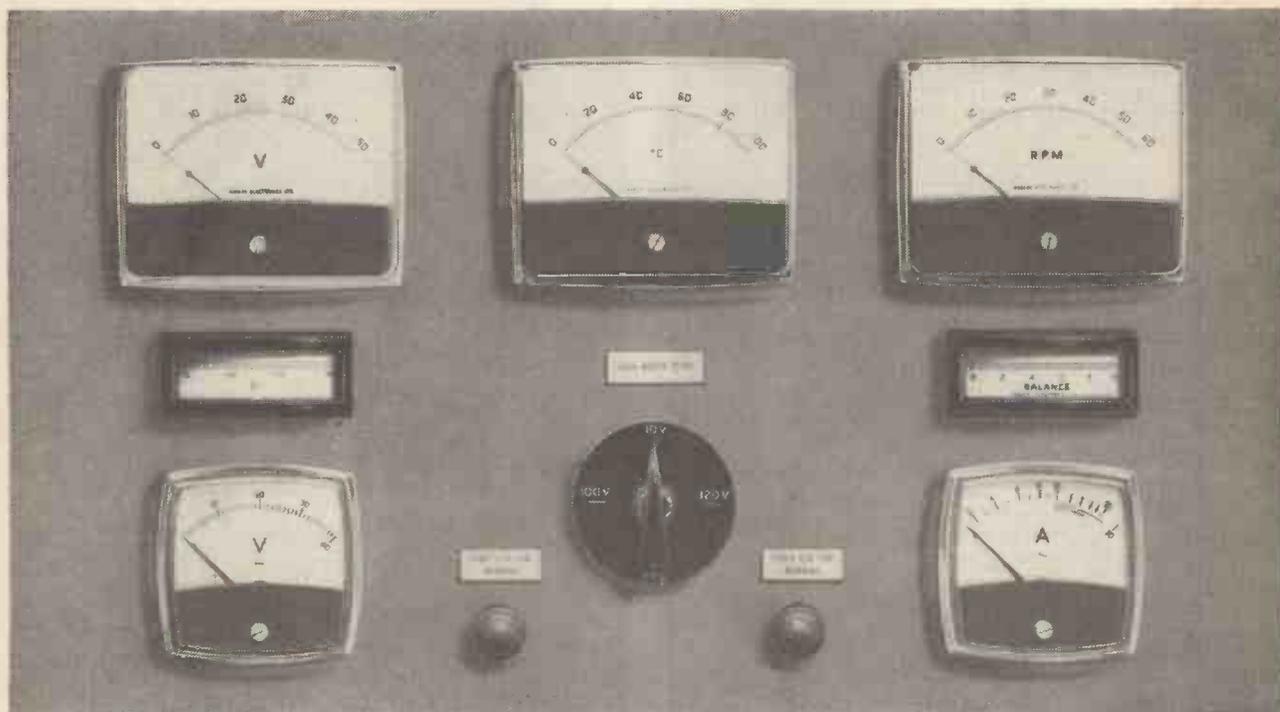
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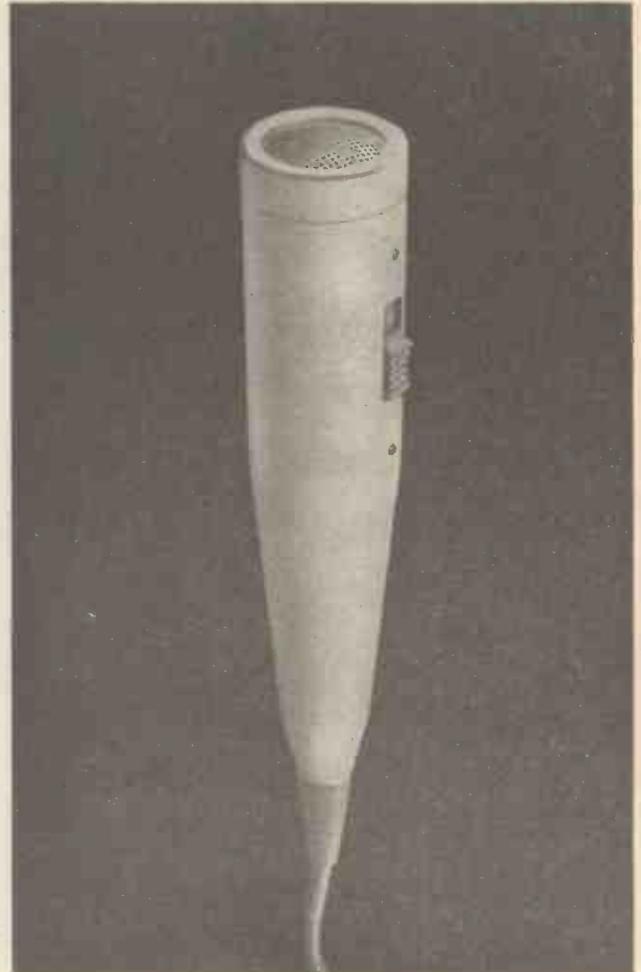
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# The Marine etc Broadcasting (Offences) Act 1967



## How it may affect you

Pirate Radio Stations operating off our coasts may, of course, be said to broadcast the type of entertainment enjoyed by a large number of listeners.

On the other hand, they can, and do, cause serious interference with stations already operating on internationally agreed wavelengths, not only in this country but abroad. Protests have come from all over Europe. They may also jam ship's radio and interfere with distress signals, shipping forecasts, gale warnings and other essential messages.

### Action by Parliament

To deal with this situation Parliament passed the Marine etc Broadcasting (Offences) Act, which came into force on August 15, 1967. The full provisions of the Act may be studied by applying for further information at Her Majesty's Stationery Office. The following is a condensation.

### The Act

It is an offence under the Act to participate in any way in the activities of pirate radio stations or ships. Briefly:

**Apparatus:** (1) operating or assisting in the operation of the broadcast apparatus (2) carrying or agreeing to carry the broadcast apparatus in a ship, or (3) supplying, maintaining, installing or repairing the apparatus.

**Supplying:** Carrying people or goods to and from such stations or ships, provisioning (food, etc.), delivering any other item required or the engaging of crew.

**Broadcasts:** Taking part in any broadcast from pirate radio stations as an announcer or performer; or in any other capacity.

**Advertising:** Finally, it is illegal to *advertise by means of broadcasting from these stations, to create or supply any material (including scripts, tapes or other recordings) for such broadcasts; or to invite anyone else to do so.*

### The Penalties

The maximum penalties for all these offences are the same: TWO YEARS imprisonment or a fine to be determined by the Court, or both.

### The Popular Music Programme

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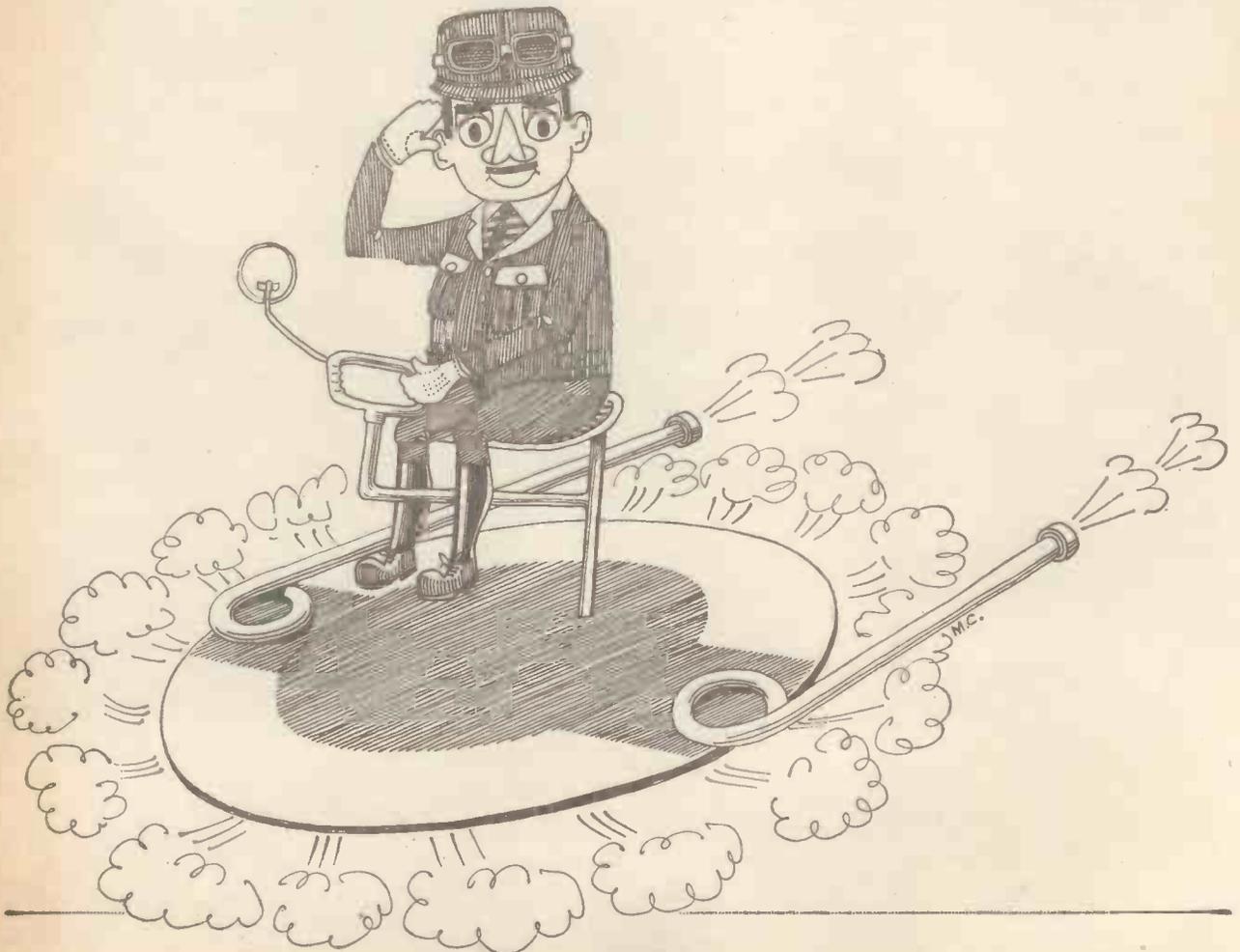
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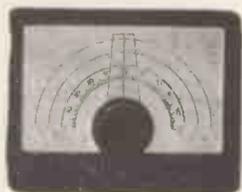
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## Wireless World

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recommended  
by all  
leading T.V.  
manufacturers



An extremely robust unit incorporating standard components for easy service and maintenance.

It is an undisputed fact that without means of checking colour convergence you are *just not in* Colour TV!! Another fact: the Antiferrence Crosshatch and Dot Generator is the most complete and inexpensive unit for colour convergence checking! It enables any TV field engineer to install colour TV without fuss, in the shortest possible time, and independent of a colour Test Card signal. Avoid colour TV installation problems from the start by using the Antiferrence Crosshatch and Dot Generator.

625 and 405 line generation  
V.H.F. output channels 6 to 13  
U.H.F. output channels 29 to 43  
Crosshatch adjustable from 5 to 25 lines vertical and horizontal.

WEIGHT 9 lbs.  
DIMENSIONS 12in. x 7in. x 5in.  
POWER CONSUMPTION 30W (220/250v. A.C.)  
Patents pending.

**EVERY FIELD ENGINEER NEEDS ONE—ORDER YOURS NOW!**

Available from all ANTIFERRENCE Distributors—Made by Video Circuits, Barnet, Herts.



**ANTIFERRENCE LIMITED | AYLESBURY | BUCKS**

WW—023 FOR FURTHER DETAILS

# TIMERS

# MICRO SWITCHES IMMEDIATE DESPATCH

## PROCESS TIMERS

### 611-T Delay Relay



approx. 40/- each, dependent on quantity.

- ★ 2, 5, 15 & 25 secs. Delay.
- ★ 15 amp. c/o micro-switch fitted
- ★ LARGE RANGE OF A.C. & D.C. COILS.

LATEST ADDITION

### SYS MINI-TIMER SYNCHRONOUS MOTOR & CLUTCH



approx. £9.15.0 dependent on quantity.

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

### 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 2 HOUR.
- MAINS OPERATION
- approx. £5.0.0 each.



### 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.

### PROXIMITY SWITCH—YL 2 GPA



- REQUIRES NO POWER PACK
- ★ 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

OPERATES DIRECT FROM MAINS SUPPLY. approx. £11.0.0 dependent on quantity.

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.



### 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.



- ### C-5G3
- LOW TORQUE PRECISION ROTARY COIN-OP. SWITCH
  - ★ 10 MILLION OPS
  - ★ AMP TAGS.

8/8 each per 1,000  
3in. wires available 6d.



### VV-15-1A

- ★ 15/10 AMPS. c/o
- ★ 100,000 ops.
- 1/8 each per 1,000

Single Throw 1/6 each

### LIMIT SWITCH

#### WL 10 FNJ

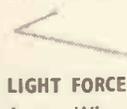
- ★ 10 AMP 2 CIRCUIT
- ★ 5 INCH FLEXIBLE ACTUATOR
- AS ILLUSTRATED FIVE OTHER STANDARD TYPES AVAILABLE AS LOW AS 44/- EACH.



### 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

U.L. APPROVED (Appr. No. 32667)

U.S. MIL. SPEC.

ALWAYS AVAILABLE FROM STOCK

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313 Edgware Road, London, W.2

## OMRON PRECISION CONTROLS

Tel.: Paddington 2370

# 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 8½ x 14 x 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-



### 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 x 12½ x 4½in. 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

### 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. x 7½in. h. x 12in. deep. Weight: 9½lb.

Kit £23.18.0 Assembled £31.18.0



### 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 x 6½in. high x 5in. deep.

Kit £13.18.0 Assembled £20.8.0

FM STEREO GENERATOR, IG-112E (not illustrated)

Kit £42.0.0. Assembled £54.0.0.



See these and other Heathkit models in the FREE catalogue



### 4½in. MULTIMETER MM-1U

- Sensitive, high quality 50µA 4½in. meter ● 22 voltage, current and resistance ranges ● Ranges A.C. and D.C. Volts 1.5, 5, 15, 50, 150, 500 and 1500, full scale. D.C. current, 150 microamperes, 15, 150, 500 milliamperes, 15 Amps ● Resistance 0.2 to 20 M/ohms in three ranges ● All 1% precision multiplier resistors for high accuracy ● 20,000 ohm/volt D.C. and 5,000 ohm/v. A.C. sensitivities ● Polarity reversing switch—eliminates transferring test leads. Dimensions: 7½in. high x 4½in. wide x 4½in. deep. Batteries 1½ v. and 9v. (not supplied).

Kit £12.18.0 Assembled £18.11.6

Complete with test leads.

### 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. x 5in. speakers ● Controls: Volume, Balance and Tone. Dimensions: overall 27in. wide x 14½in. high x 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. £113.6 inc. P.T. IF/AF amplifier kit £113.6.

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, MV 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.



Total price kit £14.18.0 inc. P.T.

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

## DAYSTROM LTD.

DEPT. WW.10, GLOUCESTER, ENGLAND

Member of the Schlumberger Group including the Heath Company

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

WW-025 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, streamline styling ● Measures 3½in. high x 13in. wide x 8in. deep ● Beautiful walnut veneered cabinet (optional extra) ● Attractive Perspex front panel.

**KIT £17.15.0 (less cabinet)**

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 ● 3½in. totally enclosed treble unit ● Speakers rigidly mounted to ½in. 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: 7½in. wide x 13½in. high x 8½in. 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.**

## NEW! TRANSISTOR AM-FM STEREO TUNER, AFM-1A



● 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 ● Pre-assembled 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-1A 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

## 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 selectivity ● Filtered outputs for direct "bea-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-1S RF Tuning Heart Kit, £5/16/- incl. P.T., TFMA-1M (Mono) IF Amplifier, Power supply £19/2/- Kit, £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 7½in. 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 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)**

## 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: 13½in. wide x 6in. high x 9in. deep.

**KIT £19.19.0 Assembled £24.19.0**

## 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 transformers 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. WW10 Gloucester

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Enclosed is £..... post paid U.K. only.

Please send model(s).....

Please send me FREE Heathkit Catalogue.

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Prices and specifications subject to change without notice.

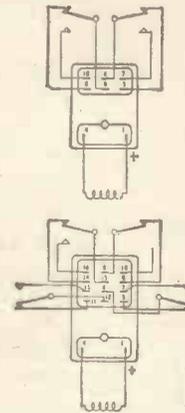


MH2P/MH4P

SPECIFICATION

KEYSWITCH RELAYS

RELAY TYPE	Coil Resistance (Ω)	Nominal Rating		Circuit Application		Special Application	Minimum Operation		Release Min. V d.c.	Hold Min. V d.c.	Non-Operate Max. V d.c.
		Voltage (V)	Current (mA)	Min. V d.c.	Max. V d.c.		Max. V d.c.	Current (mA)			
MH2P	185	6	33.0	5.0	16.0	—	4.8	26.0	0.5	2.5	2.9
	700	12	17.0	11.0	31.0	—	9.5	13.5	0.9	5.5	5.7
	1250	18	14.4	15.0	40.0	24V d.c. FAST OPERATE	14.5	11.5	1.3	7.5	8.7
	2500	24	9.6	21.0	56.0	—	19.0	7.5	1.7	10.5	11.4
MH201P	58	6	104.0	4.8	11.5	—	4.2	73.0	0.5	2.4	2.9
	325	12	37.0	11.0	24.0	—	10.0	30.0	0.9	5.5	5.7
	690	24	27.0	19.0	40.0	—	17.0	19.0	1.7	9.5	11.0
	3200	50	16.0	40.0	75.0	—	35.0	11.0	3.5	20.0	24.0
MH4P	90	6	67.0	5.5	11.0	—	4.8	53.0	0.5	2.8	2.9
	430	12	28.0	12.0	24.0	—	9.5	22.0	0.9	6.0	5.7
	1250	24	19.0	22.0	40.0	—	19.0	15.2	1.7	11.0	11.4
	2500	36	14.4	31.0	56.0	50V d.c. FAST OPERATE	28.0	11.2	2.5	15.5	16.8
MH401P	28	6	215.0	5.5	7.2	—	4.6	178.0	0.5	2.8	2.9
	110	12	110.0	10.0	14.0	—	8.9	81.0	0.9	5.0	5.5
	530	24	45.0	22.0	31.0	—	20.0	38.0	1.7	11.0	11.4
	1700	50	29.0	45.0	54.0	—	40.0	23.5	4.0	23.0	24.0



WEIGHT: MH2P/MH201P, 0.85 oz (24g) MH4P/MH401P, 1.1 oz (30g)  
 INSULATION: 500V ac TIMINGS: Operate, 10ms Release, 6ms  
 MECH. LIFE: Up to 100,000,000 operations  
 ENVIRONMENT: Up to 80% relative humidity

**CONTACTS:** 250V a.c. or 230V d.c.  
 (MH2P/MH4P are 3-micron-gold-plated silver)  
 Maximum Voltage  
 Maximum load, per contact 1A or 30W (Resistive a.c.).

For additional information, please see the Keyswitch Catalogue.  
 KEYSWITCH RELAYS LTD., 120 Cricklewood Lane, London N.W.2. Telephone: 01-452 3344. Telex: 262754

# the great relay muddle is over!

Anybody who ever needed a relay is only too familiar with The Great Relay Muddle. Finding the right relay has usually been strictly *needle-in-haystack*. There are so many different parameters involved in even the simplest type, you hardly knew where to start looking or when to stop.

Now The Great Relay Muddle is over. Finished. Simply because the boys at Keyswitch tripp putting themselves in your shoes, and got corns. So they stopped developing the best relays in the business, just long enough to develop the remarkable new Keyswitch Magic RelayFinder.

The Keyswitch Magic RelayFinder solves the needle-in-haystack problem by letting you put the needle in the haystack yourself—provided it's the Keyswitch Magic Haystack (an edge-punched data-card set).

Each of these unique new cards carries the basic printed matter you'd find on the product data-sheet for a different Keyswitch relay model, *plus* information-retrieval coding that gives you quick access to over a million different relay configurations. A few jabs of the needle into the holes corresponding to whichever parameters concern you most, and up come just the specs, price, delivery and other data you need.

**FREE**  
 A Keyswitch Magic RelayFinder is yours free on request—including data-cards, needle, handy wallet and the automatic service that up-dates your data-cards as new and advanced Keyswitch relays are introduced. So ask for yours today, and put The Great Relay Muddle out of your life forever.

**Keyswitch Magic RelayFinder**  
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Keyswitch Relays Ltd • 120 Cricklewood Lane • London NW2  
 Telephone: 01-452 3344 • Telex: 262754

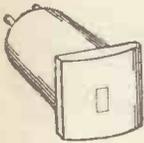
# MAGNETIC RECORDING

## TYPE "A"



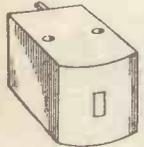
Standard 1/2 track, Record/Playback and Erase. Many special versions can be made to customers' requirements such as narrow track—raised head—or cut-away for cine use. Ideal head for dictating machines, etc. Size  $\frac{3}{16}$  in. dia. by  $\frac{1}{2}$  in. long. The round body makes for easy azimuth adjustment and takes up a minimum of space. Head has internal screen and fly leads for easy wiring.

## TYPE "R"



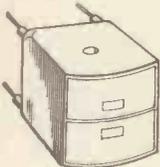
Size is  $\frac{7}{16}$  in. square at the front with body  $\frac{1}{2}$  in. dia. by  $\frac{1}{2}$  in. long. Curved front  $\frac{1}{4}$  in. radius. This head is available in a wide range of Record/Playback impedances. Also available as Erase. This novel design possesses many advantages over comparable types—higher output—lower losses—extremely good H.F. response—very low noise pick up—has internal mumetal screen. Round body aids mounting arrangements—easy azimuth alignment.

## TYPE "DR"



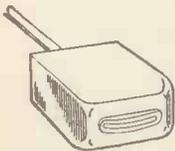
Exactly as Type R except body is  $\frac{7}{16}$  in. square along its length providing simple mounting arrangements. The Erase versions of R and DR types are double field heads. These are not just double gaps but two Erase heads in one, giving better than 60dB erasure of a saturation (+6dB on full record level), 1 k/c recording at  $3\frac{1}{2}$  i.p.s.

## TYPE "X"



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

## TYPE "T"

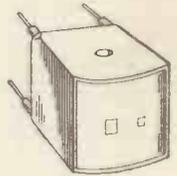


Built into a deep drawn mumetal case ensures complete shielding. Type T is the protruding pole type with special narrow track (as narrow as .002 in.) and can be made as a Record/Playback or Erase Head, or combined Record / Playback / Erase Head, or even Record/Playback and self-oscillatory Erase Head.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

# H E A D S

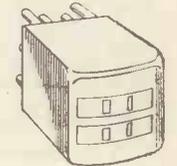
## SINGLE TRACK COMBO TYPE "X"

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



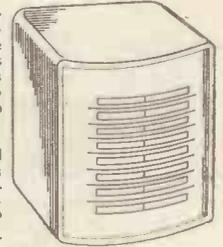
## TYPE "Z"

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



## MULTITRACK

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



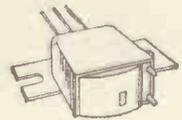
## TYPE "W" ERASE

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



## TYPE "W" R/P.

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



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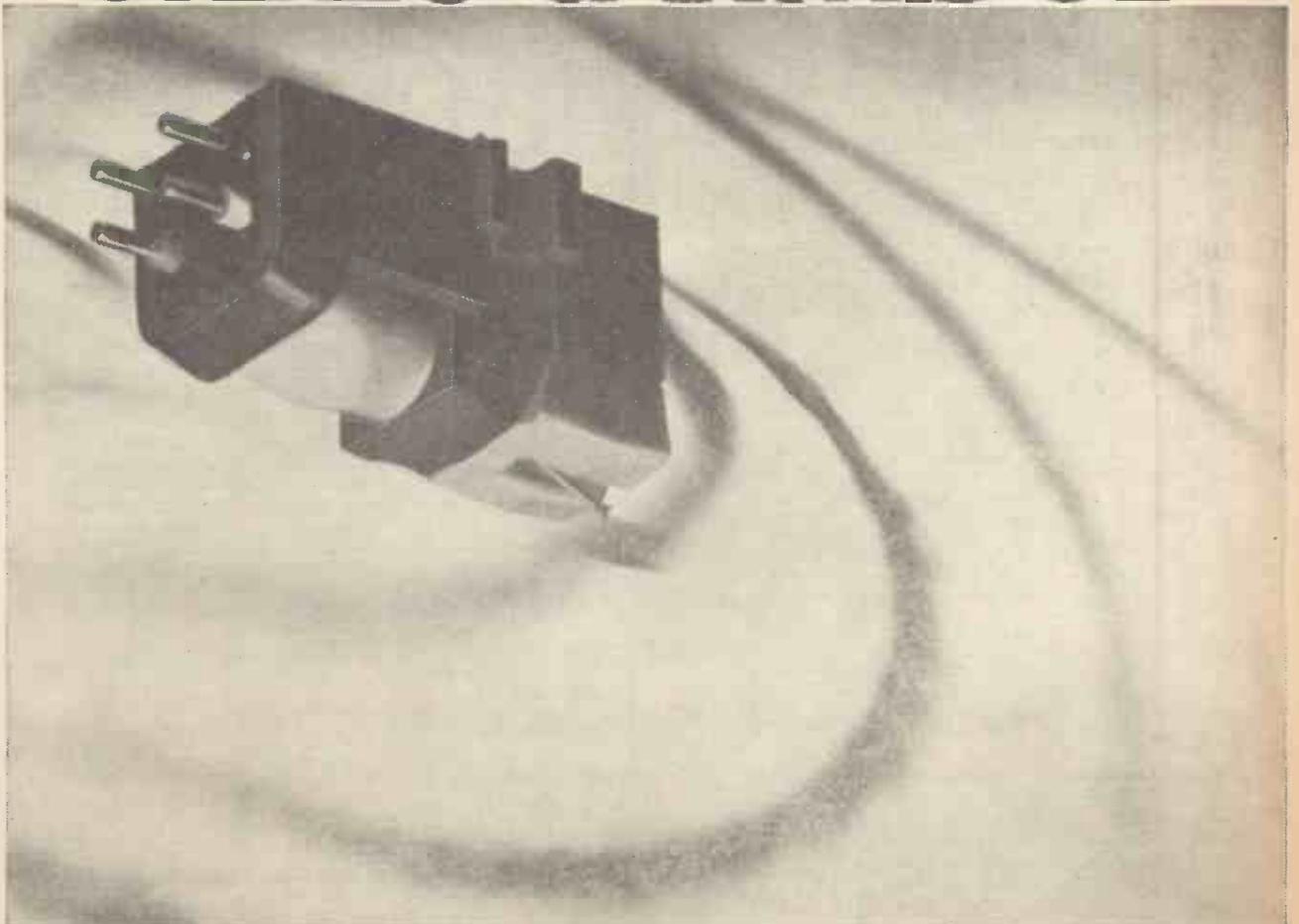
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Sensitivity	1 mv. per cm/sec.
Separation	25dB at 1kHz and nowhere less than 15dB
Load	100k—47k/ohms
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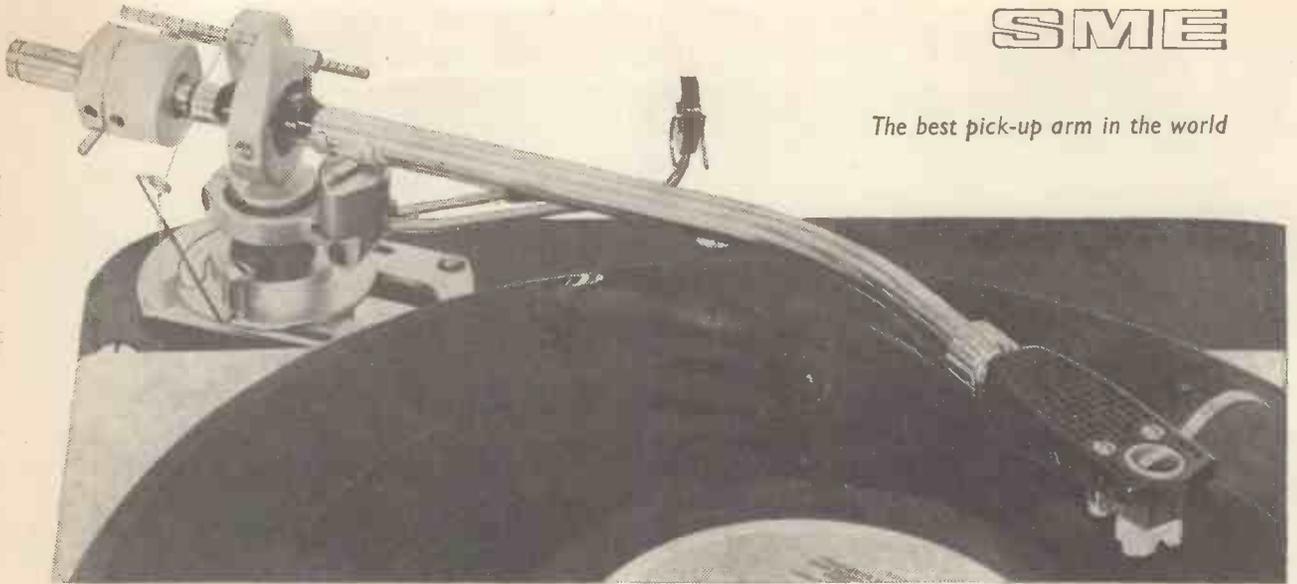
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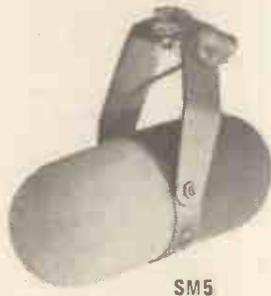
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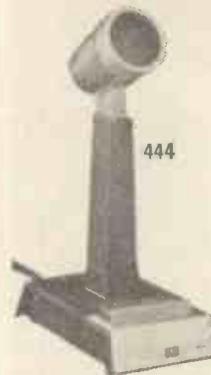
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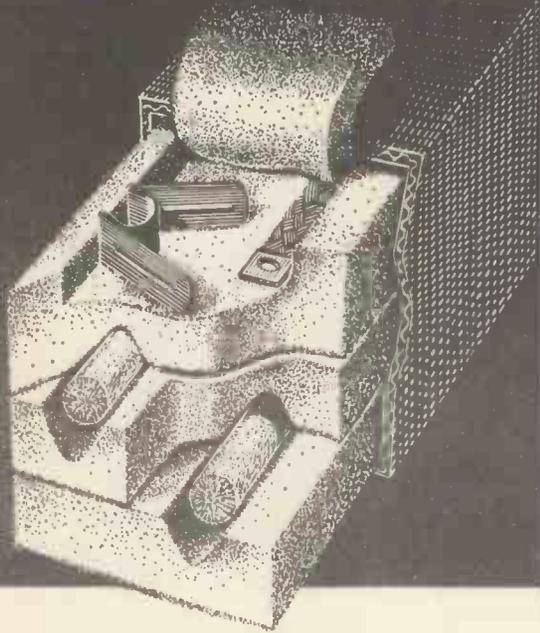


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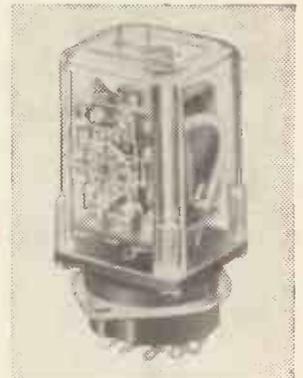
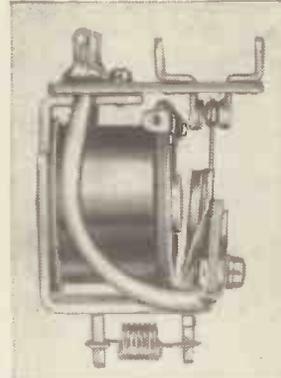
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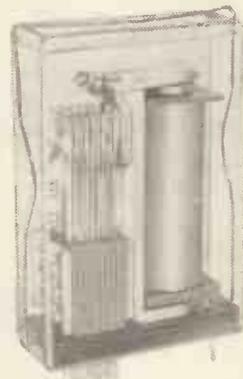


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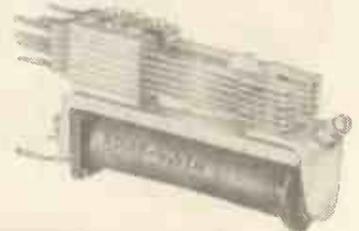
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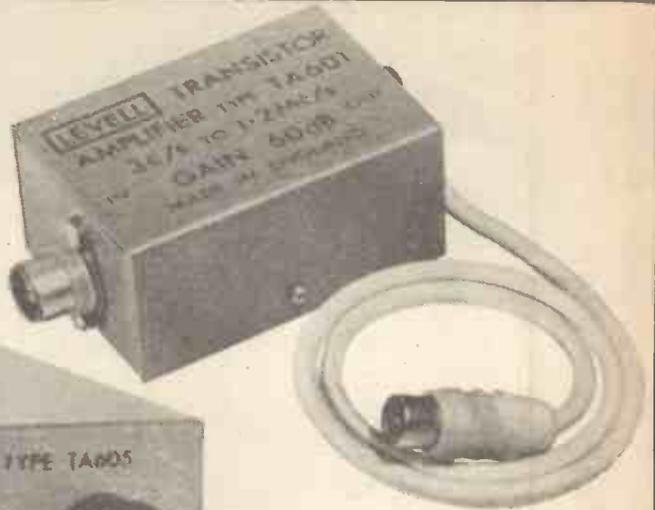
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ACTUAL  
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<b>BANDWIDTH ±3dB</b>	1Hz-3MHz	3Hz-1.2MHz	20-40dB, 1Hz-3MHz; 50dB, 2Hz-2MHz; 60dB, 4Hz-1.5MHz
<b>BANDWIDTH ±0.3dB</b>	4Hz-1MHz	10Hz-300kHz	20-40dB, 4Hz-1MHz; 60dB, 10Hz-300kHz
<b>INPUT IMPEDANCE</b>	>5MΩ, <40pF from 100Hz to 1MHz	>1MΩ, <50pF from 100Hz to 300kHz	>5MΩ, <40pF from 100Hz to 300kHz
<b>INPUT NOISE</b>	<15μV, zero source <50μV, 100kΩ source	<15μV, zero source <40μV, 100kΩ source	As TA401 and TA601 at 40dB and 60dB
<b>POWER SUPPLY</b>	PP3 battery, life 100 hours		PP9 battery, life 1,000 hours, or A.C. Power Unit
<b>AVAILABLE OUTPUT</b>	1V up to 1MHz, 300mV at 3MHz, into load of 100kΩ & 50pF		1.5V up to 2MHz 1V at 3MHz, into 100kΩ and 50pF
<b>OUTPUT IMPEDANCE</b>	100Ω in series with 6.4μF		
<b>SIZE &amp; WEIGHT</b>	3in. × 1 3/4in. × 1 1/2in. 7 oz.		2 1/2in. × 4in. × 5 1/2in. 2 1/2lb.
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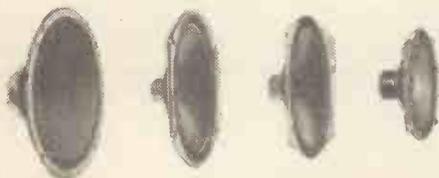
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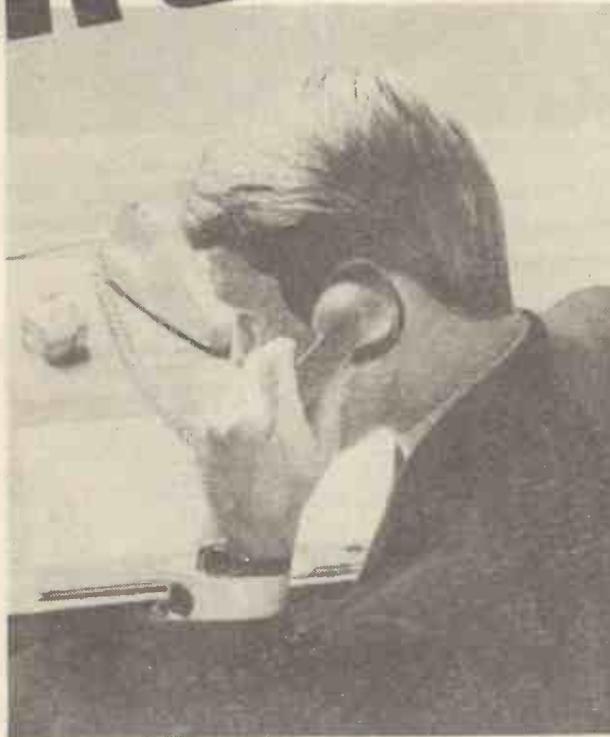
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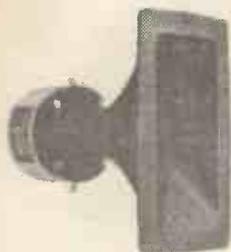
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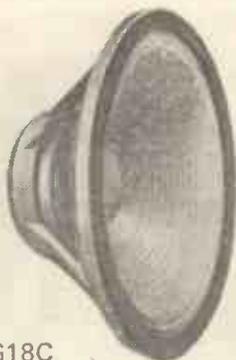


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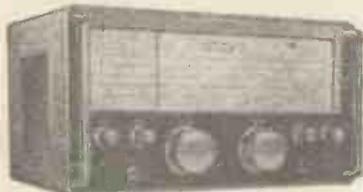
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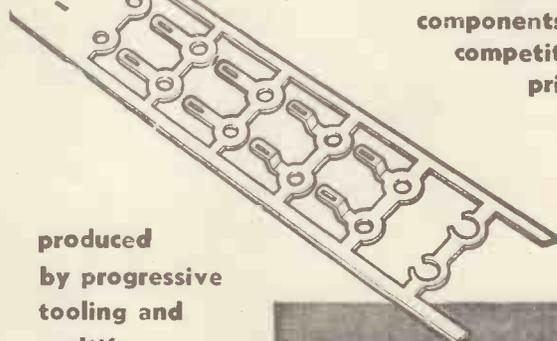
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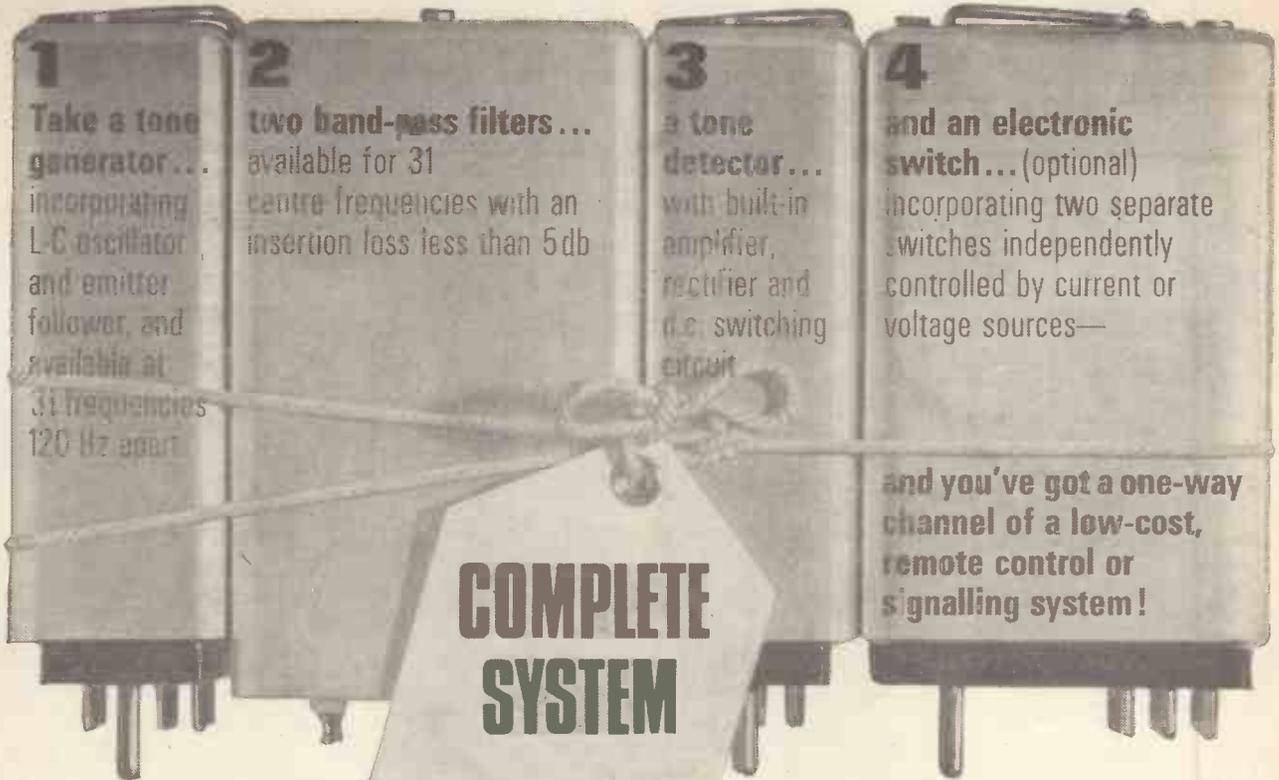
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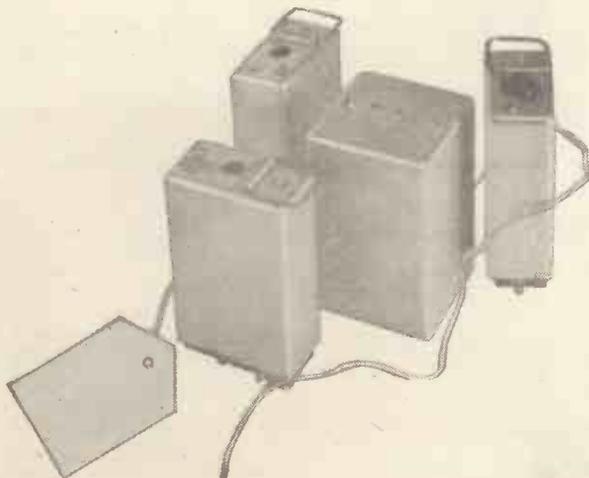
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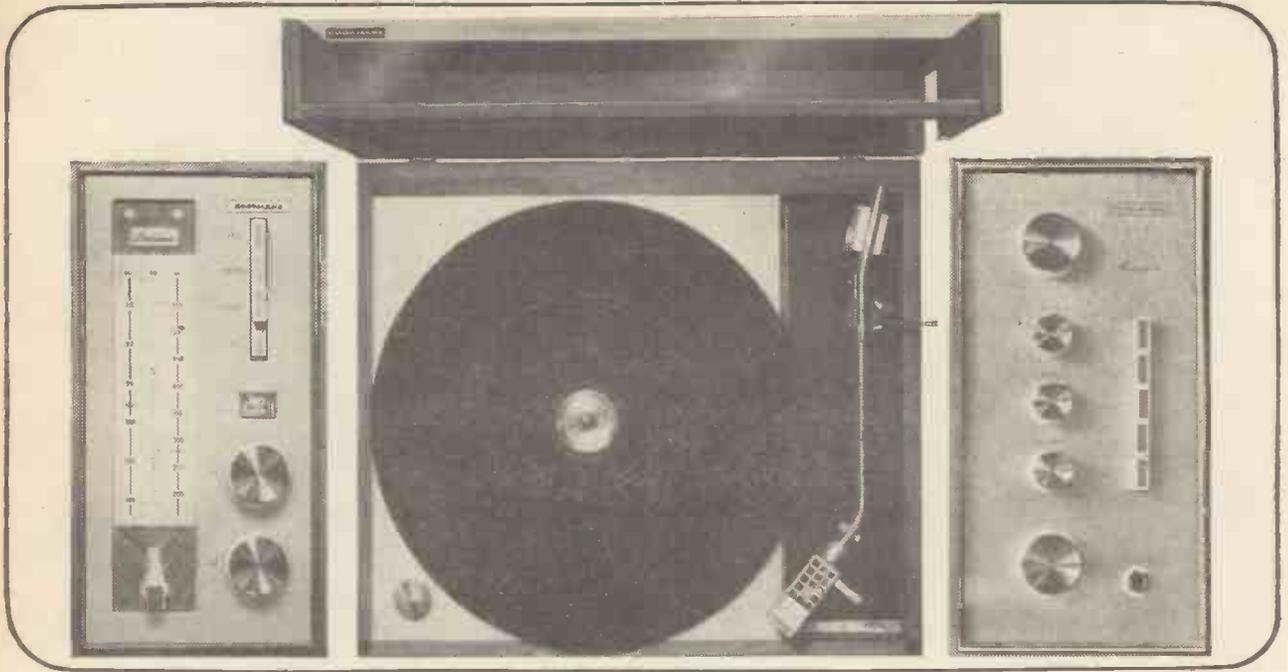
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PE(RT)6A  
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# 20,000 $\Omega$ Under DC

## Taylormeter 127A Puts High Sensitivity and 26 Ranges in Your Pocket

The Taylormeter 127A is the first pocket-sized British multimeter to bring you 20,000 ohms per volt on d.c. ranges (1000  $\Omega$ /V a.c.), plus resistance measurements up to 20 M $\Omega$  on internal batteries. Look at what else you get in this single compact ( $5\frac{3}{4} \times 3\frac{3}{4} \times 1\frac{3}{4}$ ) instrument, housed in a rugged shockproof bakelite moulding that makes it ideally suitable for bench and field work:

Easy-to-read 2-colour scale, full  $3\frac{1}{4}$  in: long  4 d.c. current ranges from 50 $\mu$ A to 100mA full-scale (to 10A with plug-in shunts) (100 $\mu$ A a.c. adaptor also available)  8 d.c. voltage ranges from 150mV to 1kV full-scale (to 25kV

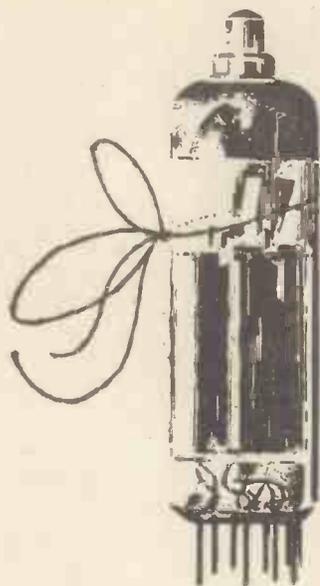
with plug-in probe)  5 a.c. voltage ranges from 10V to 1kV full-scale  3 resistance ranges from 2k $\Omega$  to 20M $\Omega$  full-scale  5 output ranges via external capacitor  Decibel scale from -10 to +62 dB (0 dB = 1mW into 600 $\Omega$ )

Although the 127A weighs only 1 lb, it gives you 3% f.s.d. accuracies for d.c. measurements, and 4% for a.c. Get complete technical and price information on this versatile

multimeter—it's even capable of withstanding momentary overloads of up to 10,000%—from your local supplier today, or direct from Taylor Electrical Instruments Ltd., Montrose Ave., Slough, Bucks., telephone SLough 21381, or telex 84429.

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# Garrard

## just for the record!

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

A single record-playing unit designed to give exceptional performance at moderate cost. The SP 25 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.

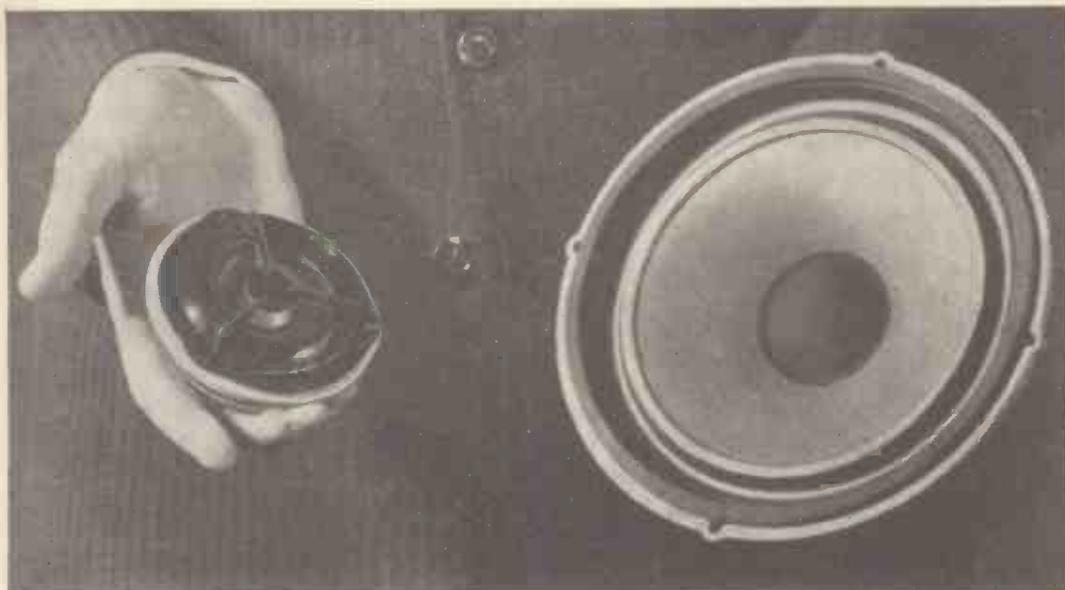
Garrard Engineering Limited, Newcastle Street, Swindon, Wiltshire. Telephone: Swindon 5381

# Garrard

looks after your records

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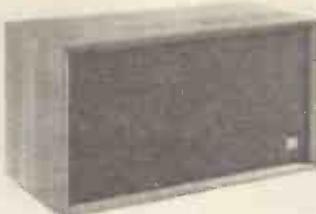


**These two units give a new dimension to small space stereo.**

Wharfedale have solved the problem of small enclosures with a new pressure unit and new 8" bass units. The small pressure unit uses the very latest in materials and approach to achieve a smoother, cleaner treble response. The excellent design of the new 8" bass units gives each system a greater apparent volume and a wider range.



The New 'Denton'



The New 'Super Linton'

**THE NEW 'DENTON'.**

This compact stereo system measures only 14"x9½"x8½". It is one of the smallest true hi-fi enclosures you can offer. The 'Denton' is small enough for a bookshelf and, because of the two new units, it has a performance big enough to satisfy the most critical enthusiast. The wide frequency range will amaze you. Consider—65 Hz to 17,000 Hz from a model this size. Impedance 8 ohms. In matched stereo pairs at £31.10.0d. per pair.

**THE NEW 'SUPER LINTON'.**

A completely new system incorporating the new pressure unit and a more powerful 8" bass. It gives an excellent performance over a frequency range of 40 Hz to 17,000 Hz. Impedance is 8 ohms. It is even better than the earlier 'Linton' and comes in a cabinet 19"x10"x10". £19.19.0d. each. Send this coupon for full details and specification.

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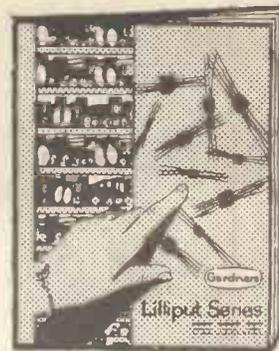


# The Lilliput Series



ULTRA MINIATURE, INVERTER, WIDE BAND, CARRIER MATCHING, DRIVER AND PULSE TRANSFORMERS, A.F. AND SMOOTHING INDUCTORS

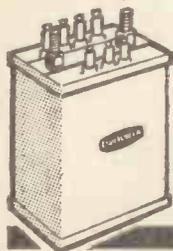
Gardners Lilliput series of Ultra Miniature transformers has been specifically developed for compatibility with other wired-in modules used on printed circuit boards. Exceptional performance has been achieved by a unique form of construction incorporating extremely thin (down to 3:2 microns) high permeability core materials and a very short length of coil turn. Transformers in this new series are particularly suitable for pulse and switching circuits with rise times of 10 nanoseconds or less



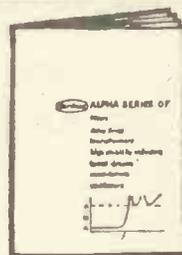
**GT 12A.** Describes the Lilliput series of Ultra Miniature transformers and gives useful information and data on their application in transistor converter/inverter, wide band communication and high speed pulse circuits.

# The Alpha Series

FILTERS, DELAY LINES, TRANSFORMERS, MODULATORS, HIGH STABILITY INDUCTORS, TUNED CIRCUITS, OSCILLATORS

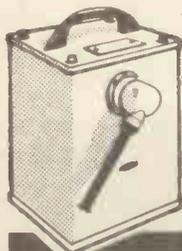


A range of custom built components from simple or hybrid transformers and modulators to highly complex multi-section filters or complete active networks of exceptional stability hermetically sealed to DEF. 5214 Humidity Class H1.

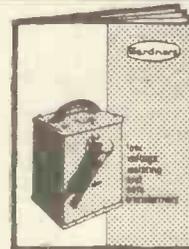


**GT 16.** Gives a general description of the Alpha series assemblies and describes their suitability for wound components where a high degree of stability is required.

# Low Voltage Isolating and Auto Transformers



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



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

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Gardners Transformers Ltd., Christchurch, Hampshire  
Telephone: Christchurch 1734 Telex 41276

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Designation .....	
Company .....	
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It will be the **LARGEST PROVINCIAL ELECTRONICS EXHIBITION** held in Britain and will include displays of Electronic Devices, Instruments, Controls and Components, of over 400 British and Overseas manufactures, that will be of interest to members of all branches of Science and Industry.

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for equipment  
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Designed to accept standard 19 inch panels the LEKTROKIT RACK SYSTEM consists of simple and inexpensive parts which allow for almost unlimited expansion — both laterally and vertically. Illustrated are two assemblies obtainable either in kit form or in separate parts.

Send for full information on the Rack System and the companion Chassis System.

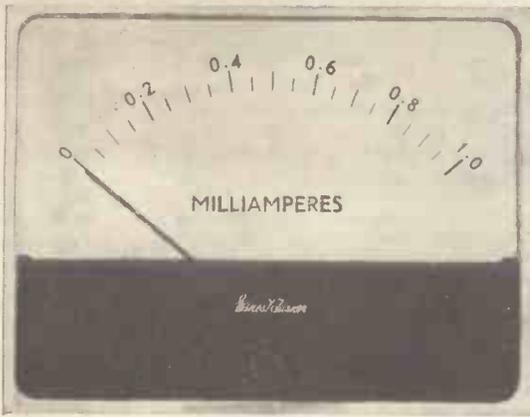


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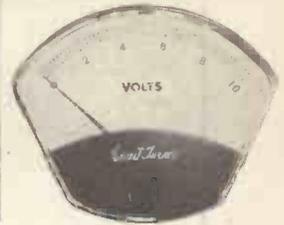
Mobile Rack £9.17.0d. \*Scope Trolley £7.15.0d.



MODEL 645



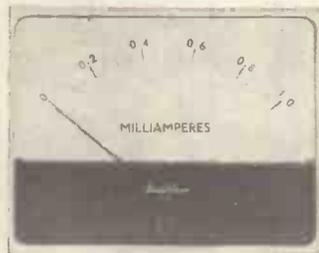
MODEL 644



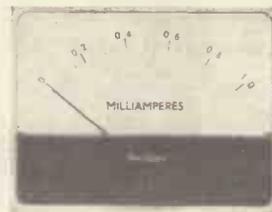
MODEL 403



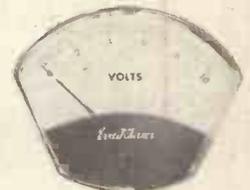
MODEL 643



MODEL 6425



MODEL 647



MODEL 402



MODEL 641



MODEL 640

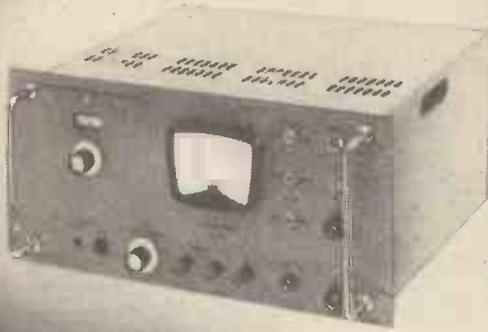
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. . . Ernest Turner. We have pleasure in announcing the addition of two new models to our clear-front range. They are Models 6425 and 644. The complete range is illustrated, approximately half-size, above. It was designed to meet the demand for a transparent-cased meter, based on our moulded rectangular series. It has the advantage of a shadow-less dial which is admirably suited to multiple and other special scaling. For full details apply for catalogue 86/25.

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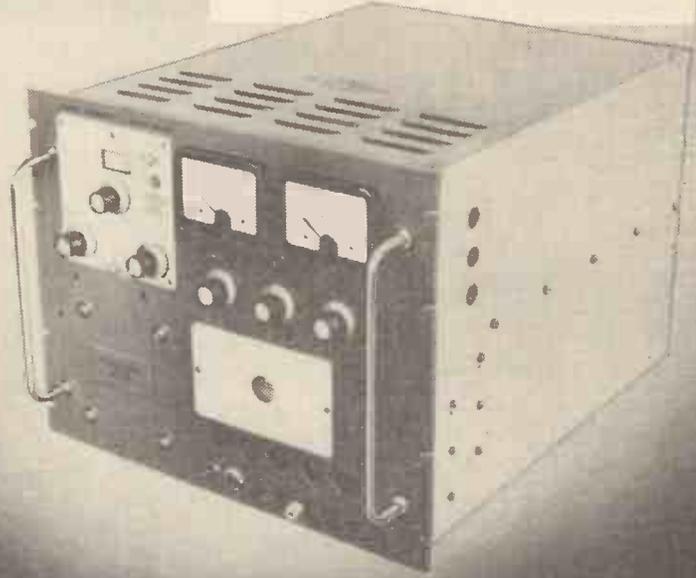
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# HATFIELD



## A.C. Power Units...

The use of high frequency power supplies for airborne equipment has created a demand for suitable power sources for ground testing. This has generally been met by small rotary inverters, or motor alternators. However, the frequency instability, bad waveform and poor regulation of these machines make them inconvenient to use, particularly for driving gyros, magnetic amplifiers and other critical devices. Indeed, for the more accurate gyros, the use of such power sources is scarcely practicable.

Electronic generation of A.C. power in Hatfield A.C. Power Units not only allows the waveform, regulation, voltage and frequency stability to be made as good as may be required but also permits complete independence of frequency and voltage controls. Another great advantage of electronic generation is that the output can be rendered completely independent of mains variation and/or mains borne interference.

The standard Hatfield types described in this advertisement can in most cases be varied to suit individual requirements, if required, in such features as frequency and output voltage.

There are many applications for this equipment in the fields of control and instrumentation, aircraft and power distribution simulators and nuclear physics. Our Technical Representative will be pleased to call and discuss your application. Ask for detailed literature.

Model	Type	Output Voltage Range	Freq. Range	V/A (Total)	Overall Size
593	SINGLE $\phi$	0-35 0-70 0-140	25c/s-5kc/s	100	19" x 9" x 17" (48cm x 23cm x 43cm)
593A	SINGLE $\phi$	0-35 0-70 0-140	10c/s 3kc/s	100	19" x 9" x 17" (48cm x 23cm x 43cm)
594	SINGLE $\phi$	0-35 0-70 0-140	340c/s-460c/s	100	19" x 9" x 17" (48cm x 23cm x 43cm)
595	THREE $\phi$	0-120* 0-240*	340c/s-460c/s	300	19" x 16" x 23" (48cm x 41cm x 58cm)
596	THREE $\phi$	0-120* 0-240*	25c/s-5kc/s	300	19" x 16" x 23" (48cm x 41cm x 58cm)
596A	THREE $\phi$	0-120* 0-240*	10c/s-3kc/s	300	19" x 16" x 23" (48cm x 41cm x 58cm)

\* Line to Line Voltage.

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BURRINGTON WAY, PLYMOUTH, DEVON.

Telephone: Plymouth (0752) 72773/4

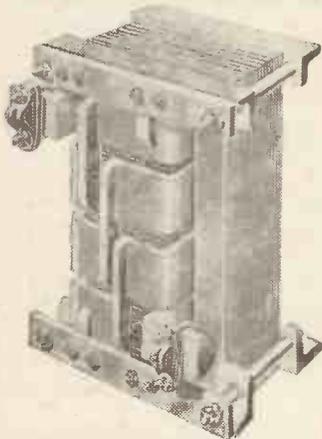
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## Transformers



### Low Voltage High Current Transformers



### DC Power Supplies



### Voltmobiles



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## Transformers

0.25 KVA to 300 KVA  
1 phase and 3 phase.

### Low Voltage High Current Transformers

with output currents of hundreds, thousands and tens of thousands of Amps.

## DC Power Supplies

For Magnets, Accelerators, Plating, Anodising, Spectroscopy, Plasma Arcs, Toronto Arcs, Electron Beams, Electrolysis Welding, Quartz Lamps, Mercury Vapour Lamps.

## Voltmobiles

64 step on load switching Auto-Transformers, 1 phase and 3 phase models with output currents from 20 Amps to 400 Amps. Output Volts from zero to 100% or 125% of Input Volts.

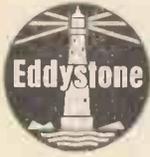
VOLTMOBILES are low-cost controllers for furnaces, rectifier sets and other loads.

**Harmsworth, Townley & Co.**

**2, Harehill, TODMORDEN, Lancs.**

Phone: Todmorden 2601. Technical enquiries & Sales: Ext. 3.

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# Eddystone EA 12

## Amateur communication receiver



An amateur bands double-conversion superheterodyne receiver, for a.m, c.w, and s.s.b reception. For all amateur channels between 1.8 MHz and 30 MHz in nine 600 kHz bands with 28 MHz to 30 MHz in four bands.

**Primary features.** Crystal controlled 1st oscillator, 2nd oscillator with continuously variable selectivity to 50 Hz, muting switched or by external relay, twin noise limiters, for a.m/c.w, and s.s.b, short-term drift better than 20 Hz and less than 100 Hz in any one hour, 'S' meter calibrated in nine levels of 6 dB and dB levels beyond 'S9,' two a.g.c time constants, deep slot filter, independent r.f, i.f, and audio gain controls with outputs for f.s.k and panoramic adaptor. £185.

### OTHER RECEIVERS IN THE FAMOUS EDDYSTONE RANGE



#### EC10 communications receiver

The fully transistorized EC10 communications receiver, supreme in its class, covers both medium wave broadcasting and all shortwave service to 30 MHz. Incorporating the famous Eddystone tuning drive, with logging scale and auxiliary vernier, shortwave reception is particularly simple. Battery operated or from optional a.c mains unit. £53.



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An 8-valve receiver with gap free coverage from 600 to 10 metres providing excellent reception of broadcast programmes and all major s.w channels including marine and international distress frequencies. The famous Eddystone extended band spread and logging scale is an essential feature. Suitable for a wide range of a.c and d.c voltages. Fully tropicalized. £66.



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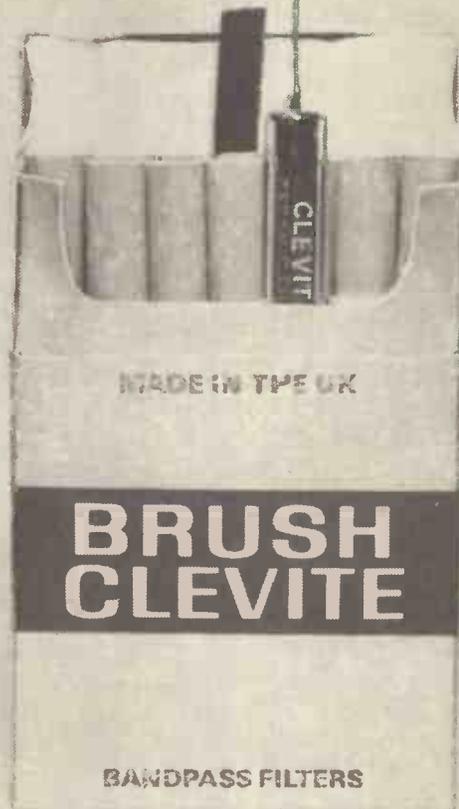
A superb high performance receiver incorporating two r.f and two i.f stages, push-pull output and silicon diode noise limiter circuit. Gap free coverage from 480 kHz and suitable for reception of c.w, a.m, and s.s.b modes. Exceptional sensitivity and stability. Built to professional standards for the serious listener. £133.

Comprehensive information from your Eddystone distributor or from: Eddystone Radio Limited, Eddystone Works, Alvechurch Road, Birmingham 31. Telephone Priory 2231. Telex 33708

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They make them in U.K. *and* they are down in price. There are major reasons why Clevite's growing family of ceramic filters are replacing LC, quartz and mechanical filters in a broad range of military and commercial equipment. Check these plus points for a start. Small. Lightweight. Rugged. Large range of band widths. Non-microphonic. Permanently tuned. Immune to magnetic fields. High stop band rejection and clean response. Highly stable with both temperature and time. There is a Clevite filter for almost every application. Take our tip. Write for up-to-date Bulletin Sheets TODAY.



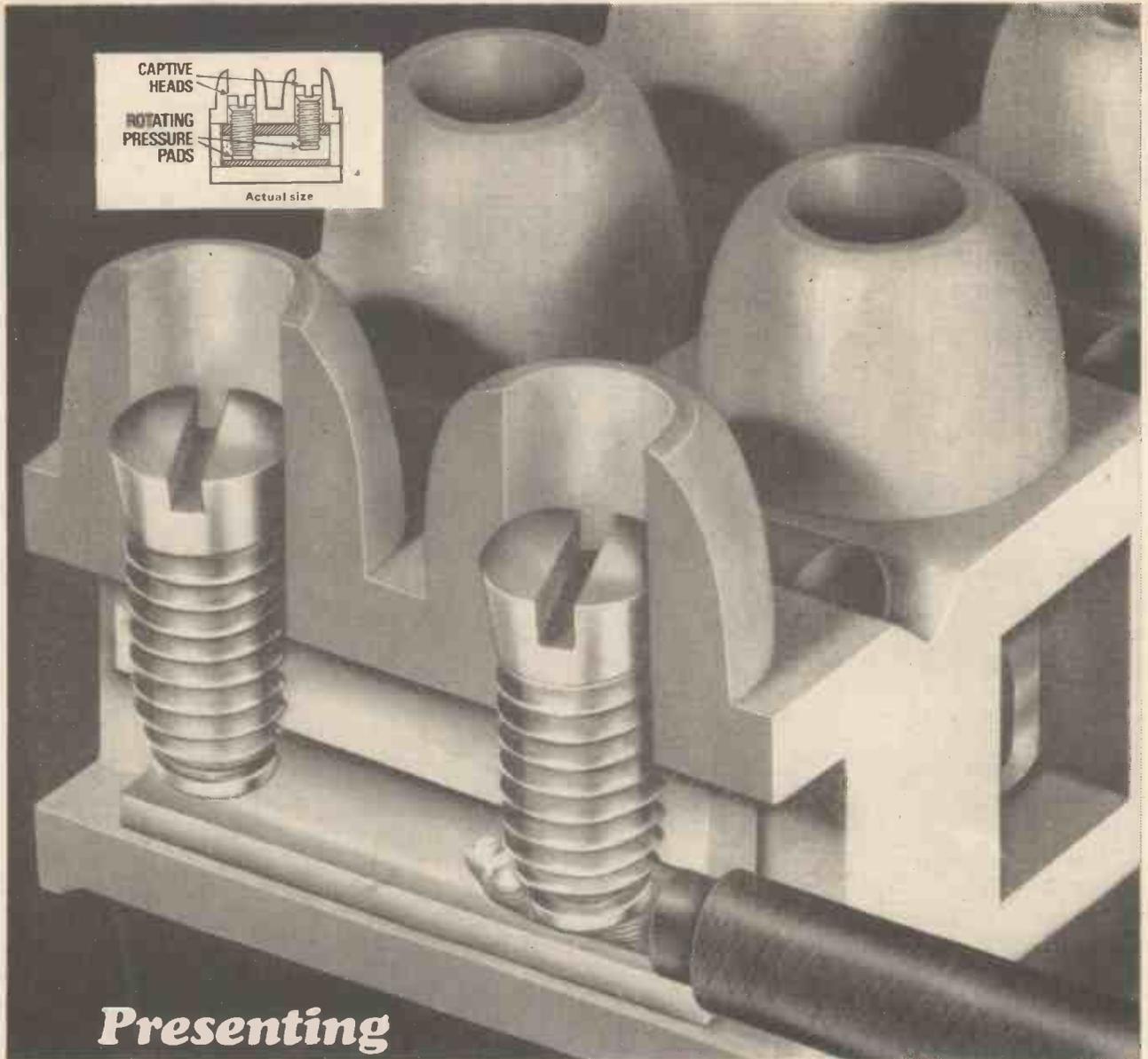
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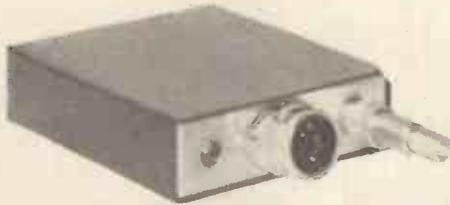
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# Reslo radio microphone

OPERATING ON 174.8 Mc/s



Dynamic Microphone, Type M.M.D1  
U.K. Retail Price £10/10/-



Transmitter Type R.M.18  
U.K. Retail Price £40/-

#### DIMENSIONS

MICROPHONE 3½" × ½" dia.  
TRANSMITTER 3½" × 2½" wide × ½" deep.  
RECEIVER 10" × 6" deep × 3½" high.



Receiver Type R.M.19  
U.K. Retail Price £77/10/-

A complete radio microphone system consisting of a microphone (usually of the lavalier neck suspension type allowing unrestricted movement), a low power pocket transmitter for carrying on the person, and a sensitive high performance receiver, providing the audio signal for the associated amplifier and loudspeaker sound system, the purpose being to provide a high quality but wire-free link between the microphone user and the sound reinforcement installation.

**APPLICATIONS.** Stage and cabaret performances of all kinds by solo artistes, including ice skating and outdoor moving acts, public meetings, radio and T/V programmes, film making, band groups and vocalists, lecturers and instructors who must be mobile for experimental demonstrations, guides, building site communication, public utilities maintenance team communication, etc., etc.

**FEATURES.** Transmitter and receiver fully transistorised · Operation from self-contained dry batteries · Frequency modulated micro-wave propagation · Crystal controlled oscillators in both transmitter and receiver for stable, no tuning operation · Wide band high quality reproduction of speech and music · Receiver incorporates a "squelch" circuit to prevent noise from the sound system should the transmitter be turned off · Battery switching by micro-phone plug · Type approved by the Post Office.

For Sales or Service write or 'phone

## Reslosound Limited

Reslo Works, Spring Gardens, London Road, Romford, Essex.

Telephone: Romford 61926 (3lines)

Telegrams & Cables: Reslosound, Romford. Telex: 25356

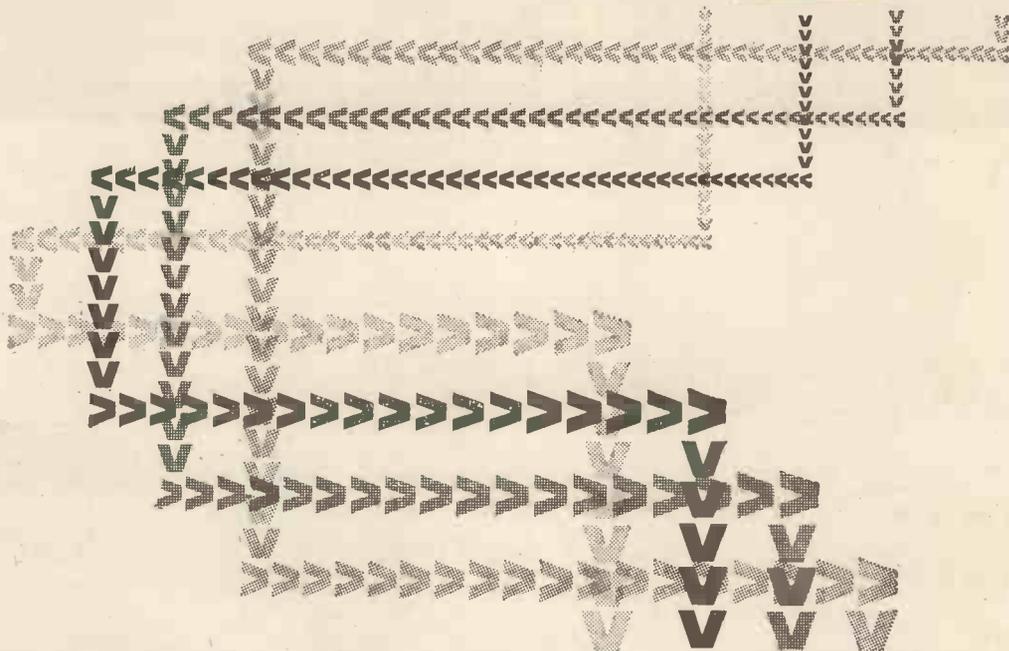


Member of the Derritron Group

WW-061 FOR FURTHER DETAILS

Ad. C

turn volts into digits with **ADVANCE**



## AC/DC Digital Voltmeter DVM1

The DVM1 gives you

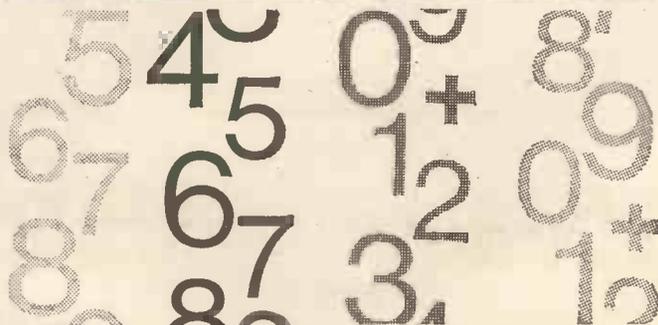
- AC as well as DC measurement
- Accuracy 0.1% DC, 0.2% AC
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Nett price in U.K. **£210**

You will wish to know more about this digital voltmeter from Advance. Write now for full specification and/or a demonstration.

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These potentiometers have the superior quality and reliability that components for space age electronic equipment must have.

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ADDRESS.....

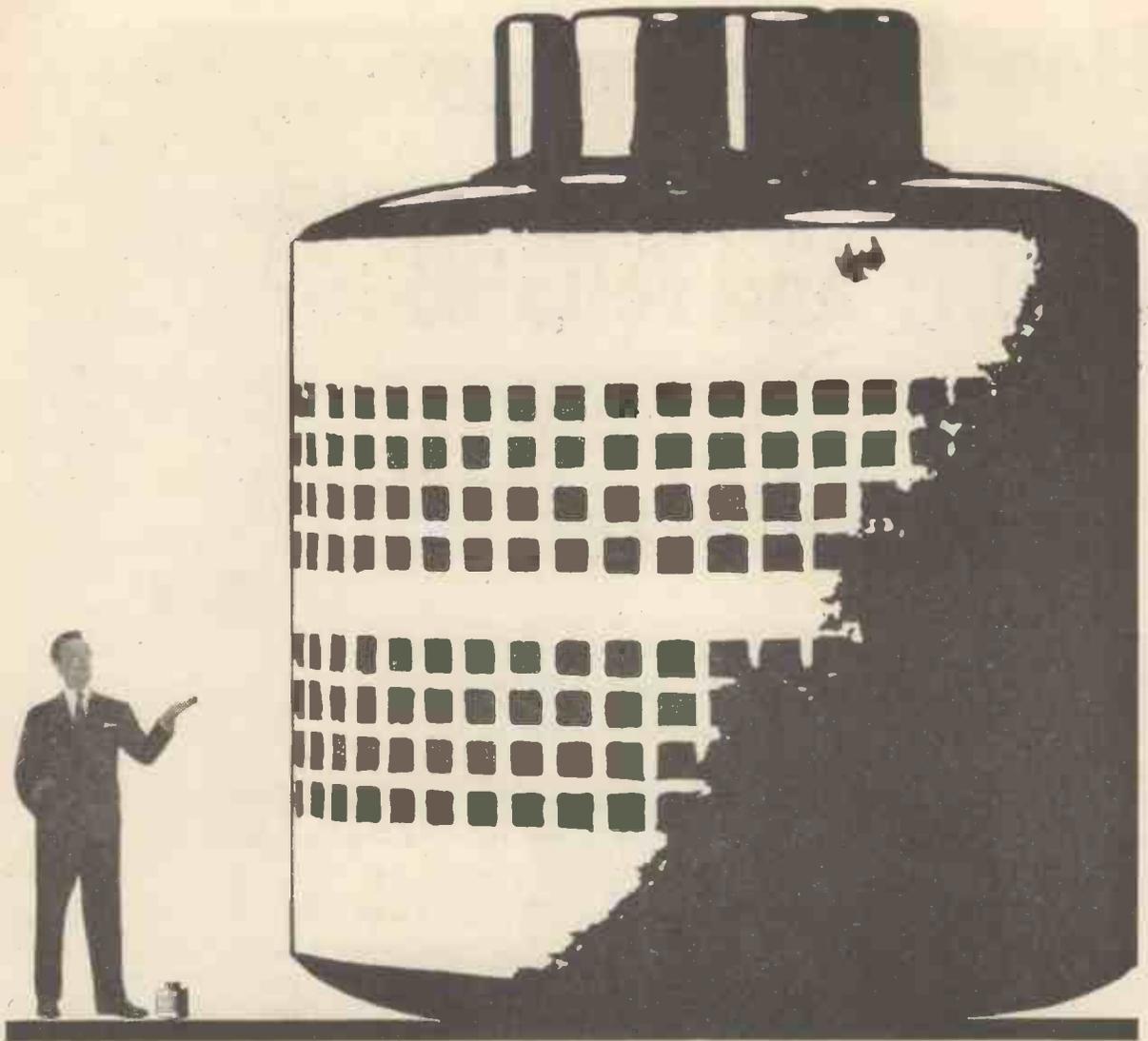
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Bede Trading Estate, Jarrow, Co. Durham. Tel: Jarrow (ONE-2) 897771. Telex: 53353



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Variacs are made in England by The Zenith Electric Co. Ltd. London, and exclusively distributed in the U.K. Eire and British Colonies by Claude Lyons Ltd.

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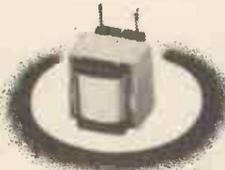
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# Belclere TRANSFORMERS

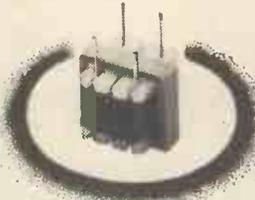
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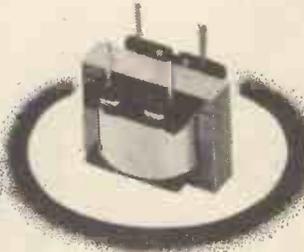
PULSE WDG.



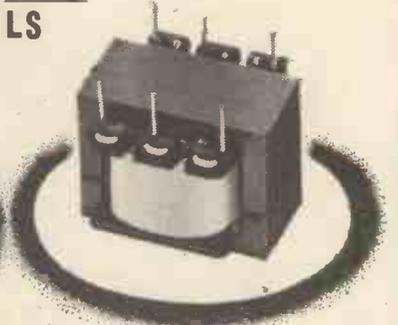
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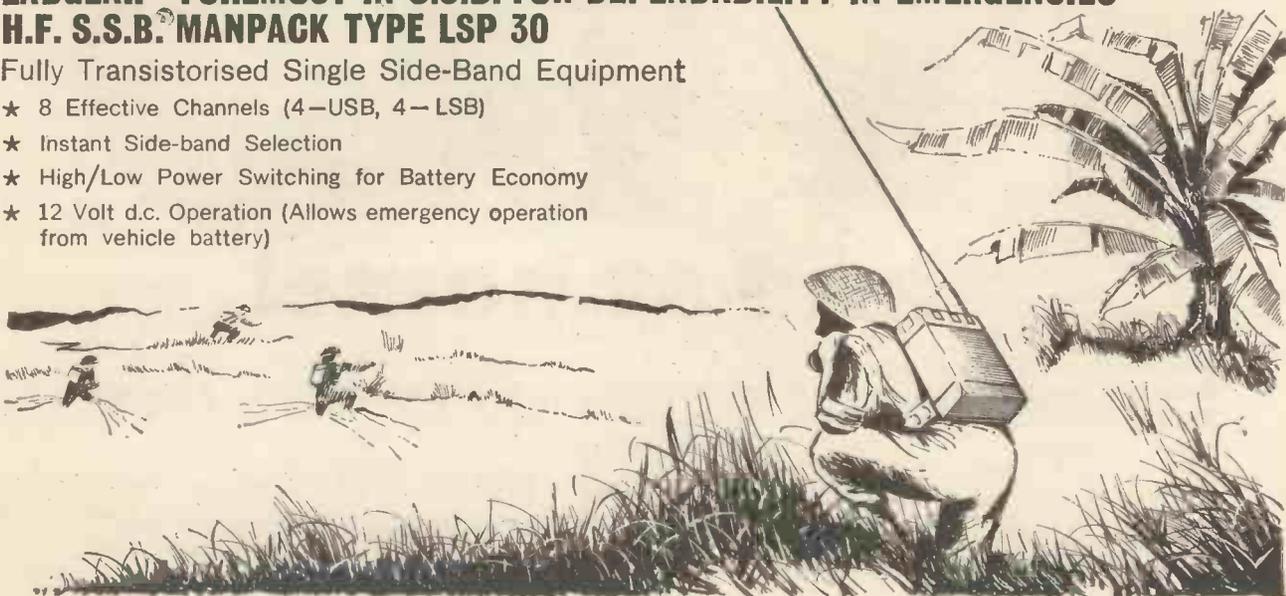
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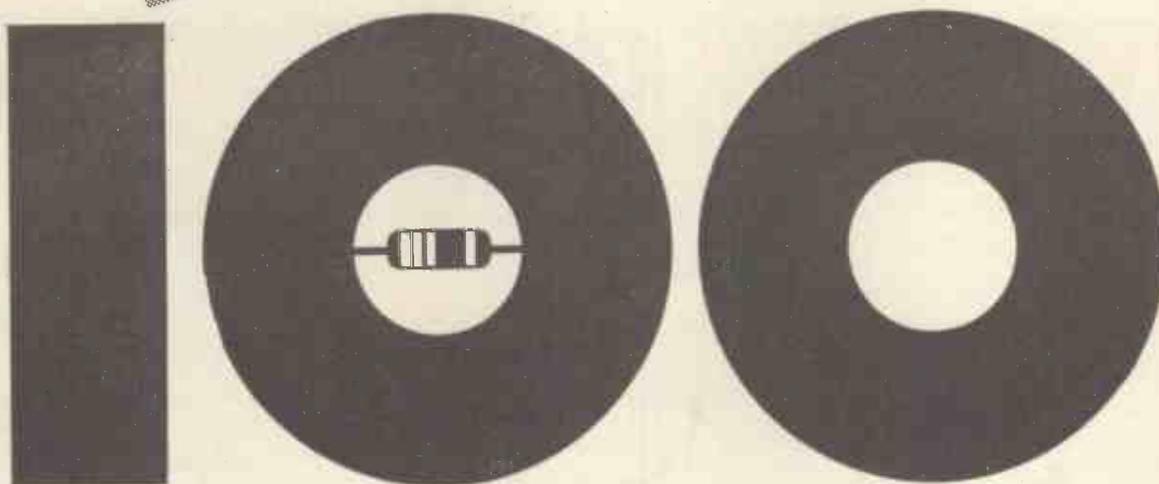
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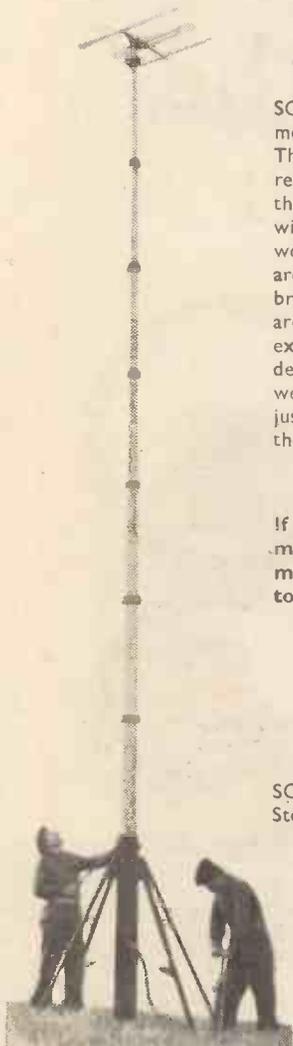


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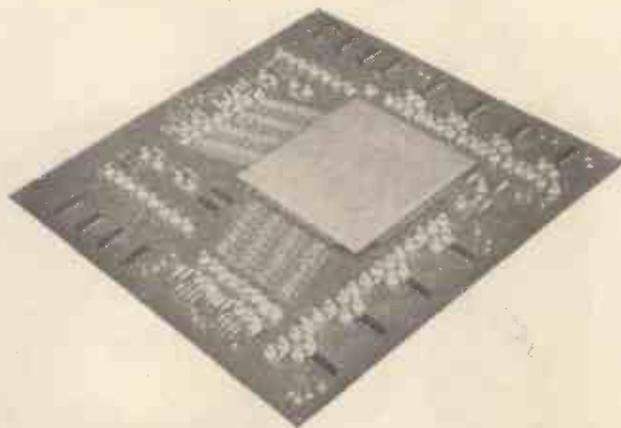
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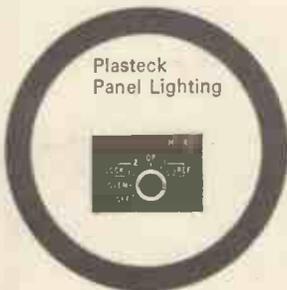
Thorn Special Products Ltd — among the leading manufacturers and suppliers of high quality components for the professional, electrical, electronic and aircraft industries — offer the widest range of products plus a complete service in instrument panel lighting. Technical literature is freely available.



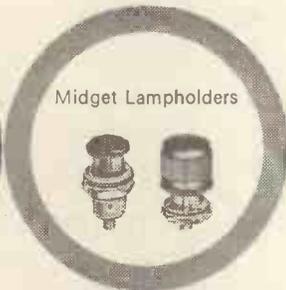
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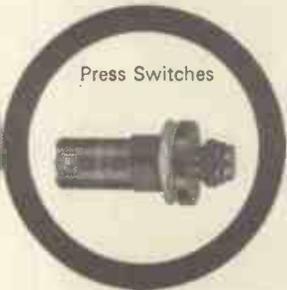
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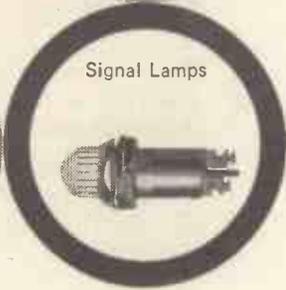
Press Switches



Digital Indicators



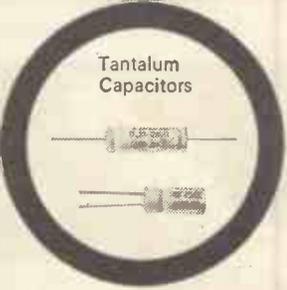
Subminiature Lamps  
and Lampholders



Signal Lamps

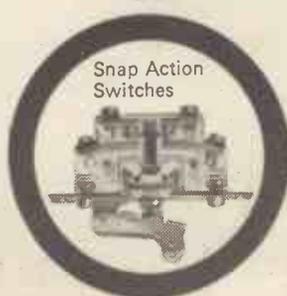


Connectors

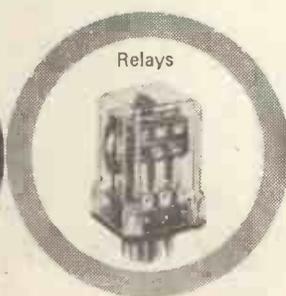


Tantalum  
Capacitors

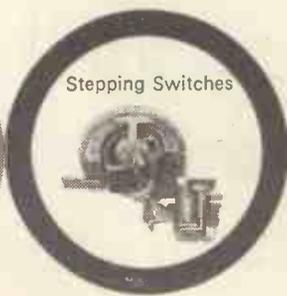
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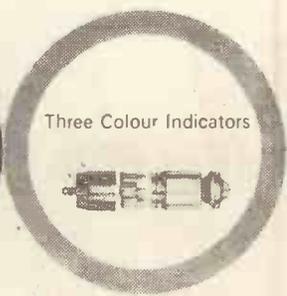
Snap Action  
Switches



Relays



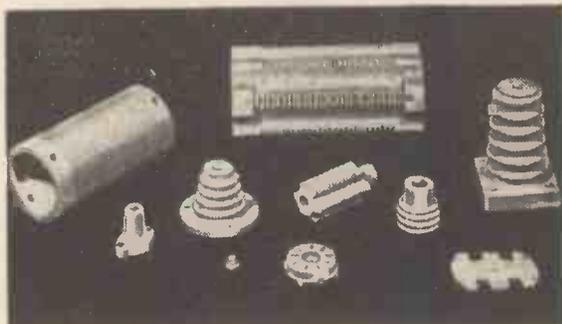
Stepping Switches



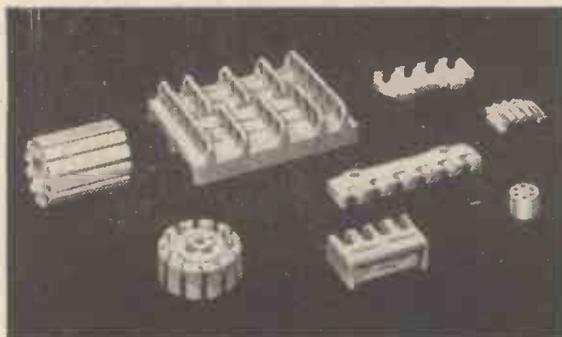
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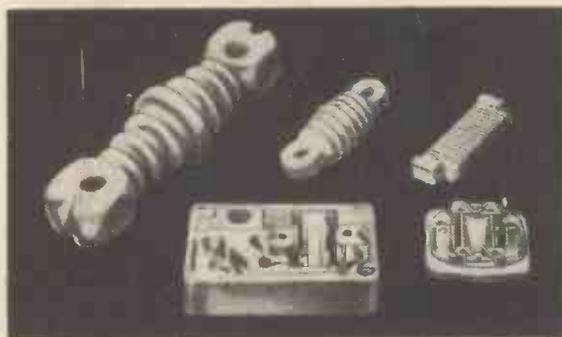
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WW—072 FOR FURTHER DETAILS

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Range of 8 interchangeable bits, from  $\frac{3}{64}$  in. (.047 in.) to  $\frac{3}{16}$  in., including new non-wearing PERMATIPS.
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The ADAMIN range includes five other models (5, 8, 12, 18 and 24 watts), Thermal Strippers (PVC and PTFE) and a De-Soldering Tool. Please ask for colour catalogue A/5.



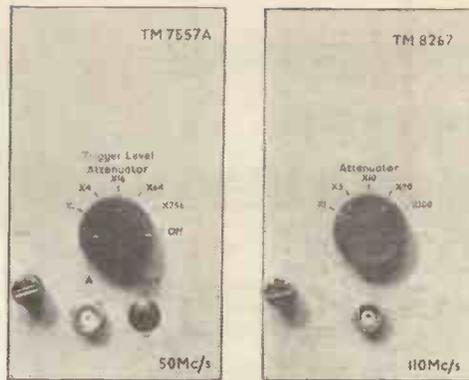
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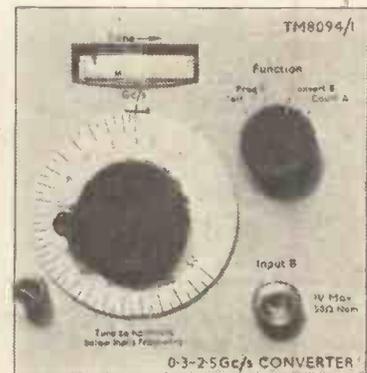
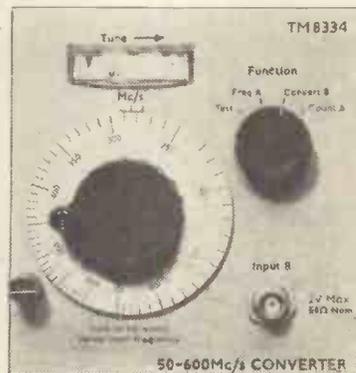
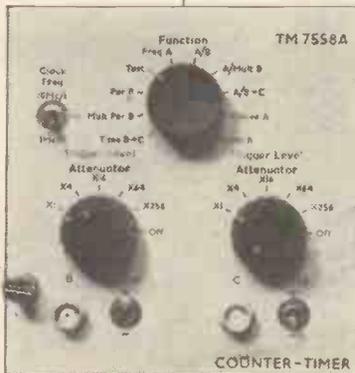
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*you don't have to buy a new counter every time the frequency goes up*



*just plug in the appropriate heterodyne converter!*



Now measuring up to 2.5 GHz The introduction of two new plug-in units for 600 MHz and 2.5 GHz extends still further the enormous versatility of the Marconi TF2401A Counter. By inserting the appropriate module, you can not only select the direct reading frequency range, but also the function.

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The plug-in modules include two alternative frequency range units giving maximum counting speeds of 50 MHz and 110 MHz respectively, function units for full counter/timer facilities or simple frequency/period measurement, and plug-in heterodyne converters covering 10 to 600 MHz in 10 MHz steps, 0.3 to 2.5 GHz in 50 MHz steps, or 0.3 to 3.4 GHz in 100 MHz steps.



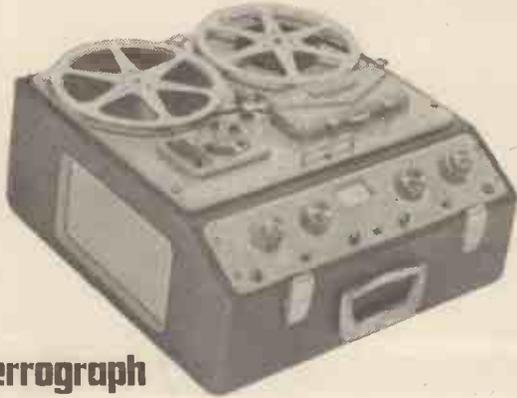
Full technical information from:

**MARCONI INSTRUMENTS LIMITED**

Longacres • St. Albans • Herts • Telephone: St. Albans 59292 • Telex: 23350

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Ferrographs are unique in their combination of reliability, rugged construction and *fidelity of recording*... not for the first exciting months of ownership, but for year after year of faultless performance. Even so, we do not claim perfection, although we do believe that we have come nearest of all to the ideal. And the vast majority of Ferrograph users agree.

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WW15

# Ferrograph

THE INCOMPARABLE TAPE RECORDER  
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Sealed construction, proof against humidity, vibration, shock, altitude and acceleration to meet Def 5011 severities. Prices from 28/- depending on quantity.

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The smallest  
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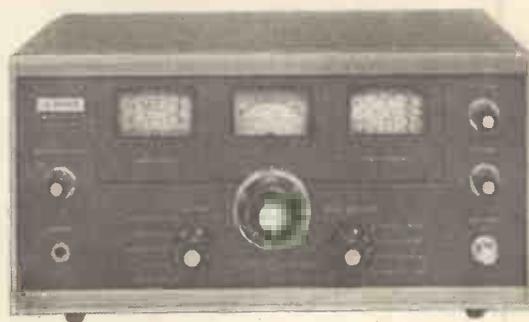
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# \* Technically Proven For Exacting Performance



**Model JR-500SE**  
**CRYSTAL CONTROL TYPE DOUBLE CONVERSION**  
**COMMUNICATION RECEIVER**

- \* Superior stability performance is obtained by the use of a crystal controlled first local oscillator and also, a VFO type 2nd oscillator.
- \* Frequency Range: 3.5 MHz—29.7 MHz (7 Bands)
- \* Hi-Sensitivity: 1.5 $\mu$ V for 10 dB S/N Ratio (at 14 MHz)
- \* Hi-Selectivity:  $\pm 2$  KHz at  $-6$  dB  $\pm 6$  KHz at  $-60$  dB
- \* Dimensions: Width 13", Height 7", Depth 10".



**Model 9R-59DE**  
**BUILT IN MECHANICAL FILTER 8 TUBES**  
**COMMUNICATION RECEIVER**

- \* Continuous coverage from 550 KHz to 30 MHz and direct reading dial on amateur bands.
- \* A mechanical filter enabling superb selectivity with ordinary (F transformers).
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- \* Sensitivity: 2 $\mu$ V for 10 dB S/N Ratio (at 10 MHz)
- \* Selectivity:  $\pm 5$  KHz at  $-60$  dB ( $\pm 1.3$  KHz at  $-6$  dB) When use the Mechanical Filter
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*superb styling throughout the range*

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## MODEL 3000 Solid-State AM/FM Multiplex Stereo Tuner Amplifier

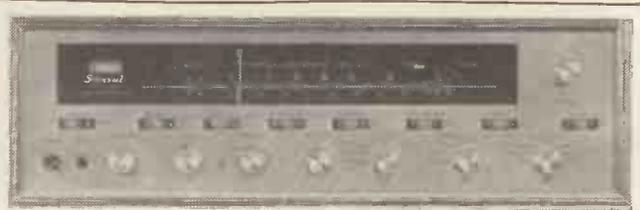
Special component selection, sophisticated engineering and precision fabrication combine to put this all-transistorised unit in a class by itself. Ample power reserves to reproduce the complete orchestra faithfully.

84 transistors.

RMS power: 45/45 W  $\pm$  1 dB.  
Music power: 110 W  $\pm$  1 dB (IHFM).  
Harmonic distortion: 0.8% at 1000 Hz RMS rated output.  
Frequency response: 20-20,000 Hz  $\pm$  1.5 dB at normal

listening level.

Usable FM sensitivity: 1.8  $\mu$ V  $\pm$  3 dB (IHFM).  
Automatic FM switching—Mono-Stereo and Stereo/Mono.  
162 gns.



## MODEL 1000A AM/FM Multiplex Stereo Tuner Amplifier

A high-quality tubed unit that uses the latest Nuvistor devices and power tubes.

RMS power: 40/40 W.

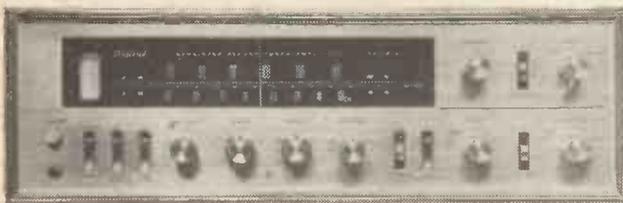
Music power: 100 W (IHFM).

Harmonic distortion: 1.0% at 1000 Hz RMS rated power output.

Overall frequency response: 20-20,000 Hz  $\pm$  1 dB.

FM sensitivity: 1.8  $\mu$ V (IHFM).

130 gns.



## MODEL TR-707A — Solid-State AM/FM Multiplex Stereo Tuner Amplifier

The same superb styling and specification as higher-priced Sansui units, but with a lower power output.

RMS power: 23/23 W.

Music power: 50 W total (IHFM).

Harmonic distortion: 1.0% at 1000 Hz RMS rated power output.

Frequency response: 20-20,000 Hz  $\pm$  1.0 dB at normal listening level.

FM sensitivity: 2.5  $\mu$ V  $\pm$  3 dB (IHFM).

130 gns.



## MODEL 500A — AM/FM Multiplex Stereo Tuner Amplifier

A tubed unit with a similar performance to the TR-707A.

RMS power: 23/23 W.

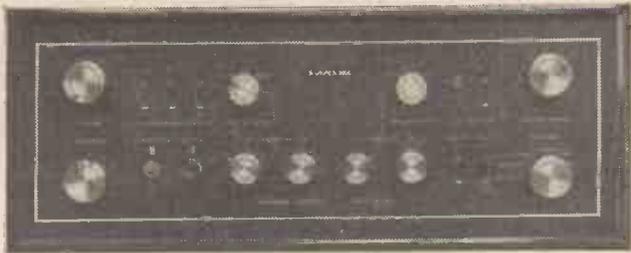
Music power: 50 W (IHFM).

Harmonic distortion: 1.0% at 1000 Hz RMS rated power output.

Frequency response: 20-20,000 Hz  $\pm$  1.5 dB at normal listening level.

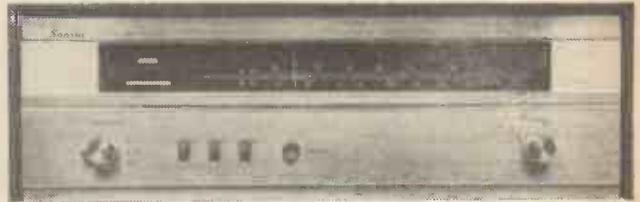
FM sensitivity: 2.0  $\mu$ V  $\pm$  3 dB (IHFM).

115 gns.



**MODEL AU-111 —  
Stereo Control Amplifier**

A high-quality tubed unit with only 0.3% distortion even at 40 W on each channel. Same aesthetic styling as on more expensive models.  
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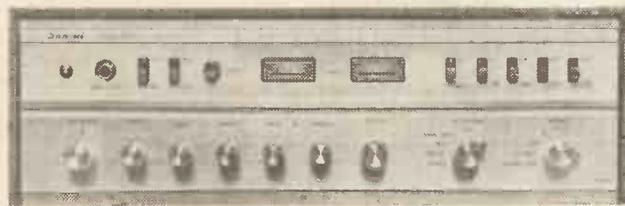


**MODEL TU-70 —  
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A compact self-contained unit with built-in power supply. Complete functional front-panel switching for AM, FM, Multiplex, noise filter, muting, FM AFC, power.

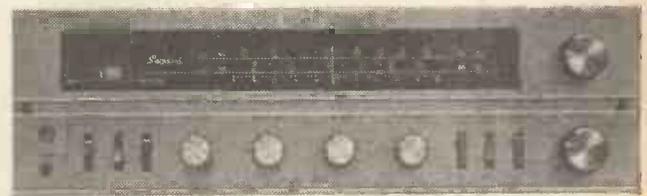
**FM Tuner**  
 Frequency range: 88 to 108 MHz.  
 Sensitivity: 1.1 μV (IHFM).  
 S/N ratio: 30 dB at 100% modulation at 75 ohms.  
 Frequency response: 30—15,000 Hz ± 2dB.

**AM Tuner**  
 Frequency range: 535 kHz to 1605 kHz.  
 Sensitivity: 6.0 μV (IHFM).  
 S/N ratio: 20 dB at 30% modulation.  
 72 gns.



**MODEL AU-70 —  
Stereo Control Amplifier**

A deluxe 50 W valve unit, with distortion limited to 0.15% at 20 W 1,000 Hz. Hum is completely eliminated by Sansui's transistor head amplifier.  
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 Harmonic distortion: 0.15% at 20 W 1000 Hz.  
 Frequency response: 10—80,000 Hz ± 1dB at normal listening level.  
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 AM sensitivity: 30 μV (IHFM).  
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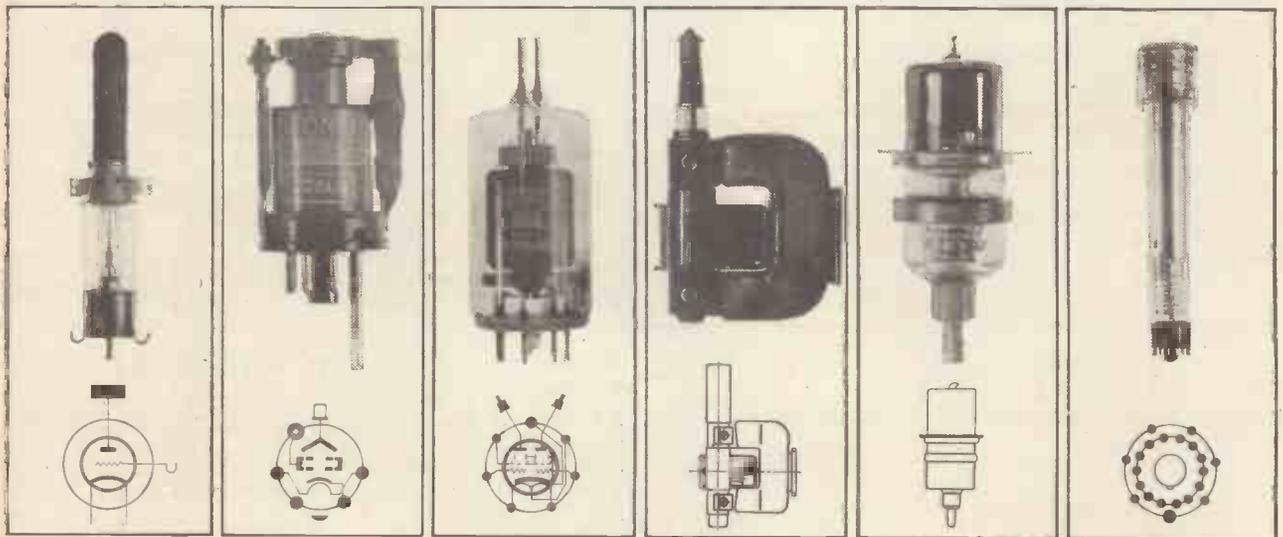
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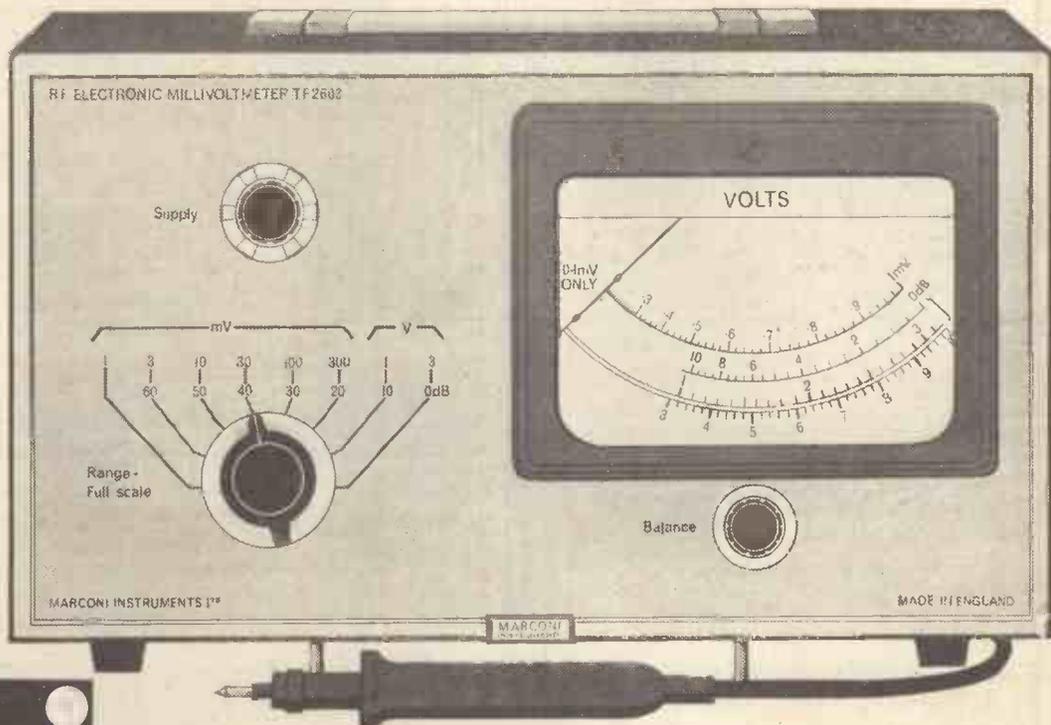
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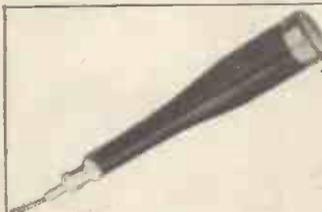
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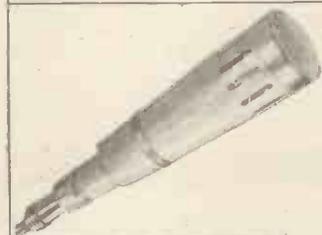
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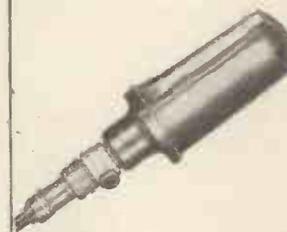
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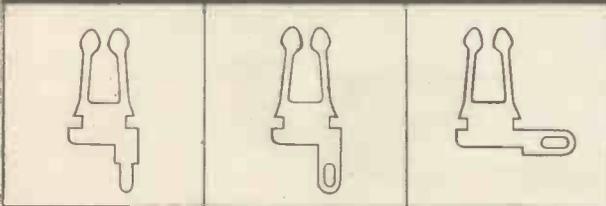
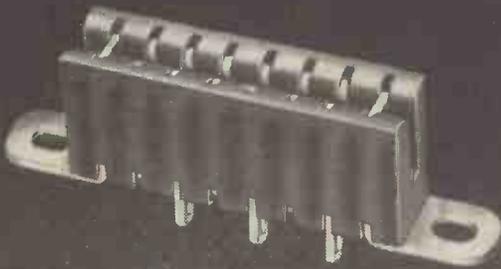
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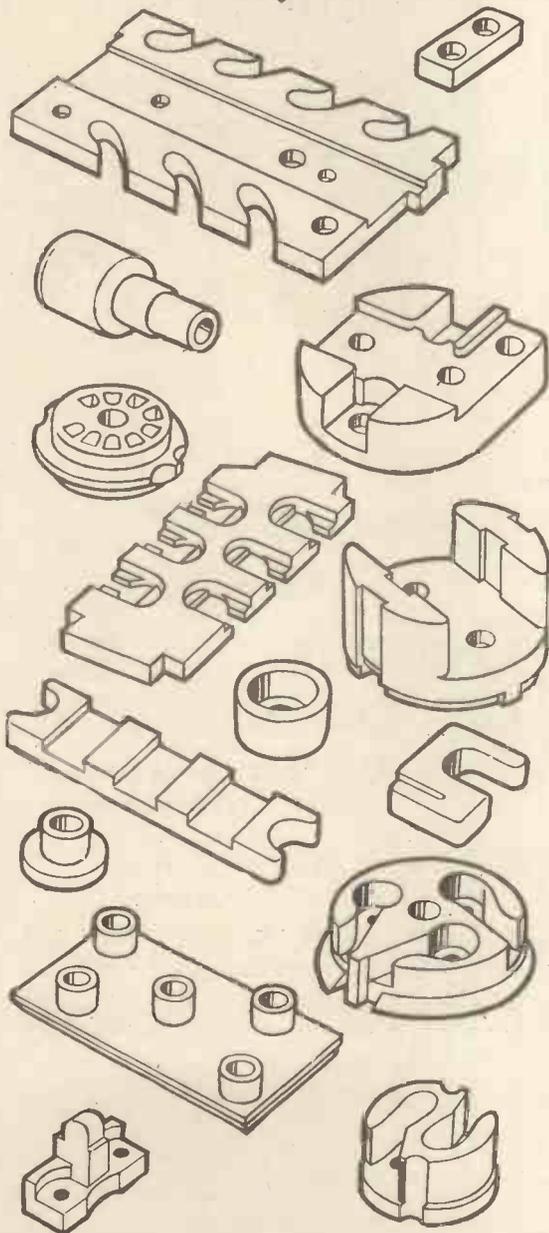
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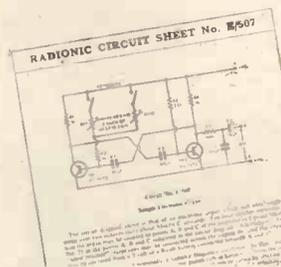
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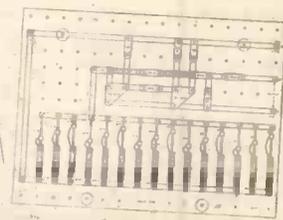
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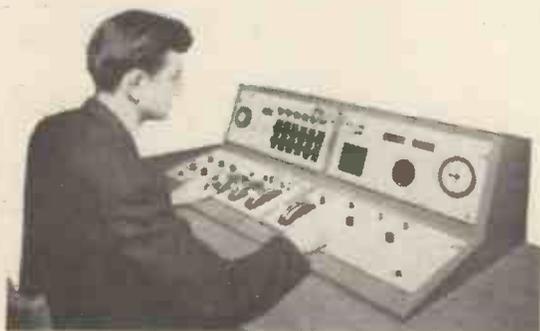
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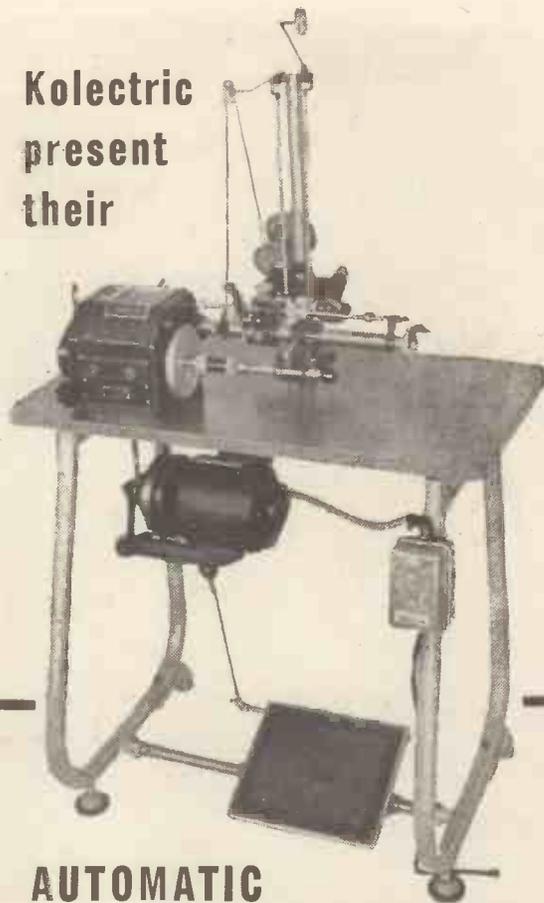
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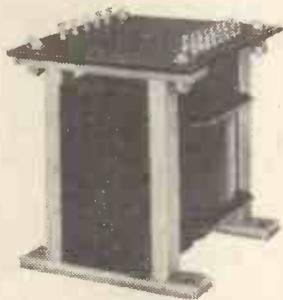
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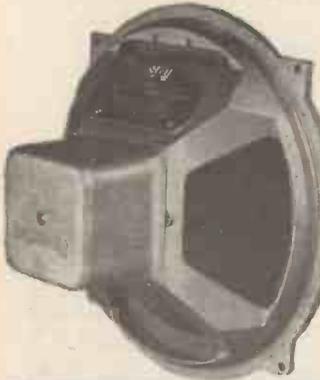
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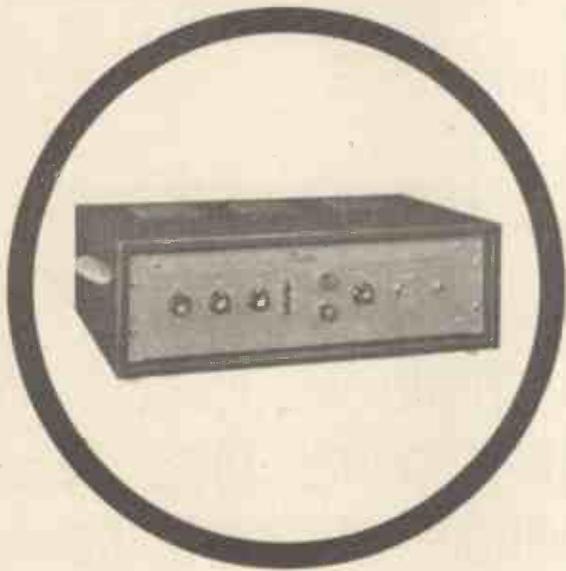


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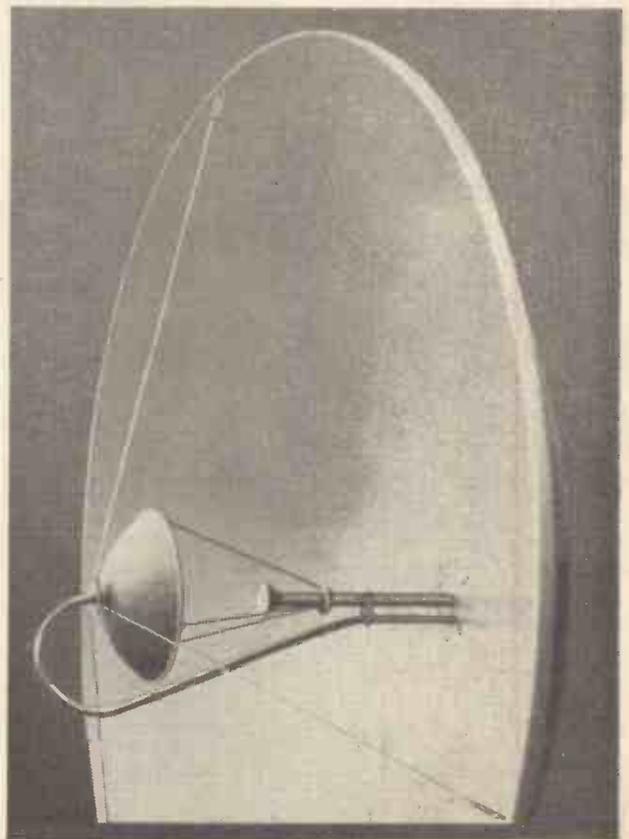
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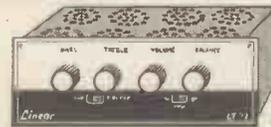
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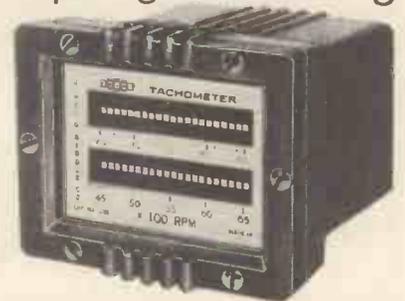
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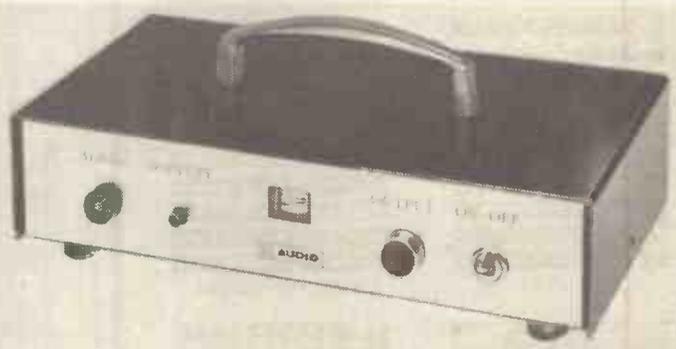
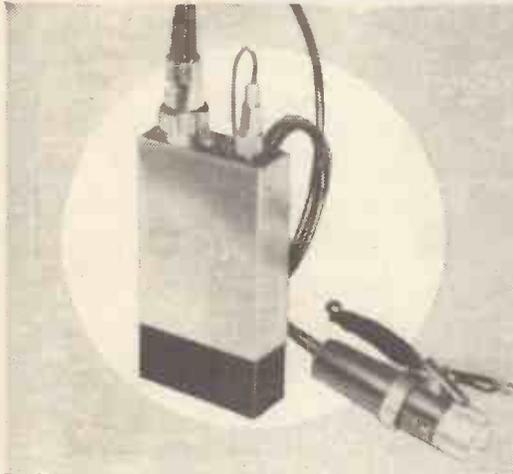
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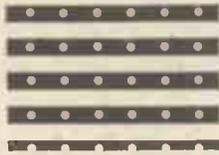
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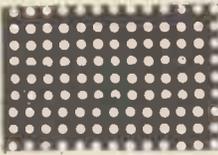
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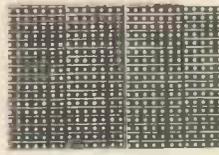
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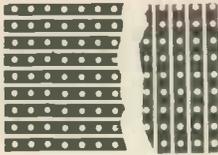
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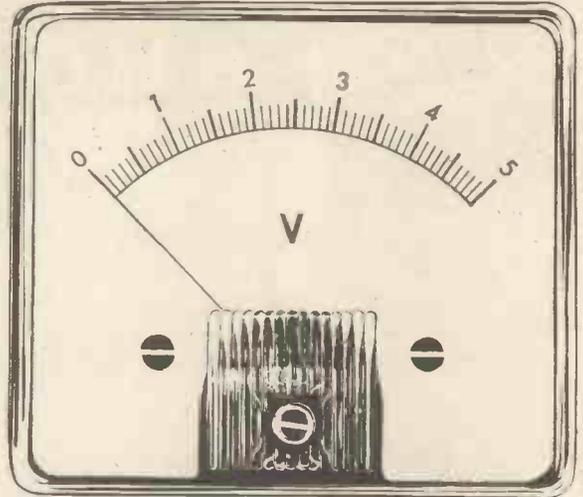
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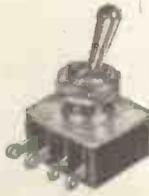
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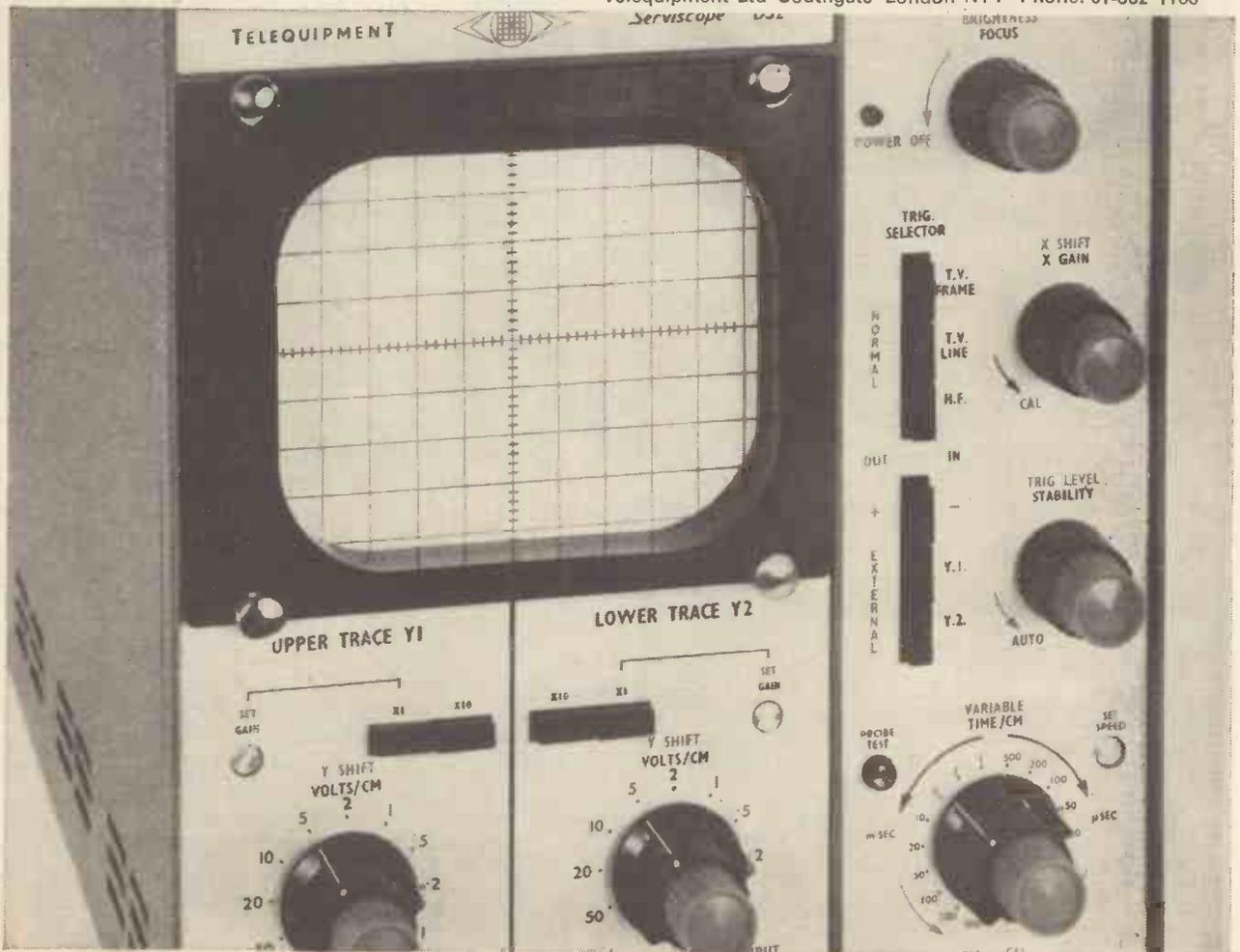
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## OCTOBER 1967

- 463 What is the Electronics Industry?
- 464 Domestic Receiver Techniques
- 472 Stereo Signal Simulator by D. E. O'N. Waddington
- 476 Colour TV Standards Converter
- 482 Semi-stabilized D.C. Supply by G. W. Short
- 483 German Colour Television Starts
- 488 Wireless World Digital Computer—3
- 496 New Measurement Techniques
- 500 Colour TV Circuit Round-up by T. D. Towers

## SHORT ITEMS

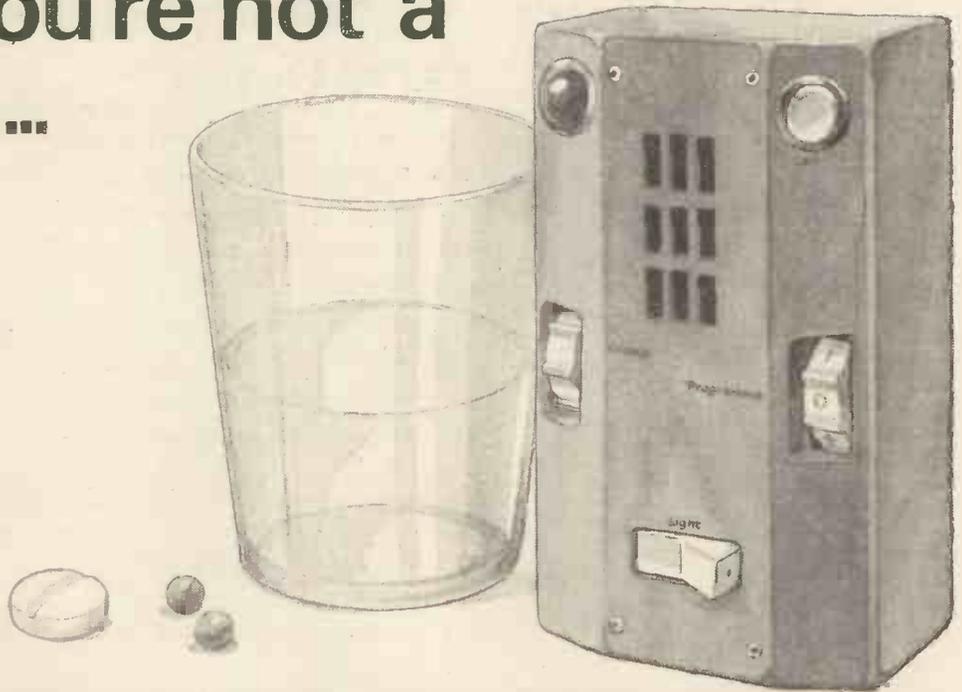
- 470 R.S.G.B. Show
- 471 BBC-2 Reception
- 471 Stroboscopic Hologram Interferometry for Transducers
- 475 Temperature Compensation Method for Oscillators
- 495 Manchester Electronics Show
- 498 Bistable Resistors
- 505 Component Specifications

## REGULAR FEATURES

- |                         |                                 |
|-------------------------|---------------------------------|
| 463 Editorial Comment   | 499 World of Amateur Radio      |
| 478 World of Wireless   | 506 Letters to the Editor       |
| 480 Personalities       | 509 News from Industry          |
| 482 Books Received      | 510 New Products                |
| 487 October Meetings    | 516 Conferences and Exhibitions |
| 494 Books Received      | 516 H.F. Predictions            |
| 495 Literature Received |                                 |

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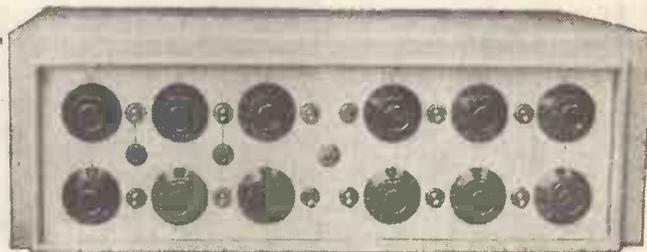
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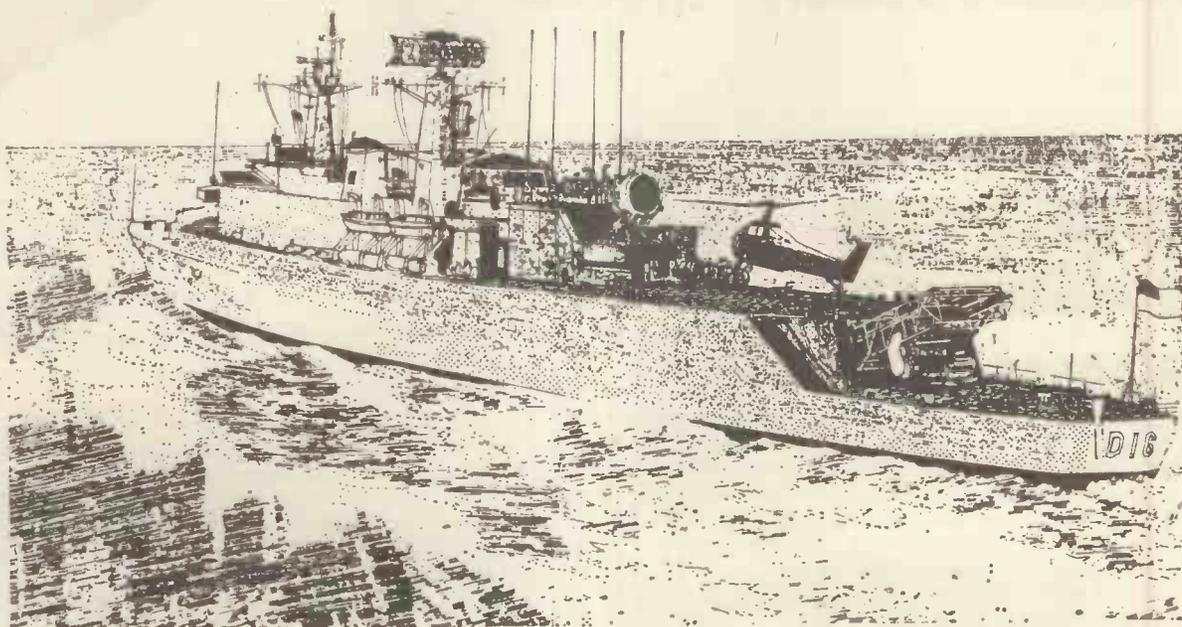
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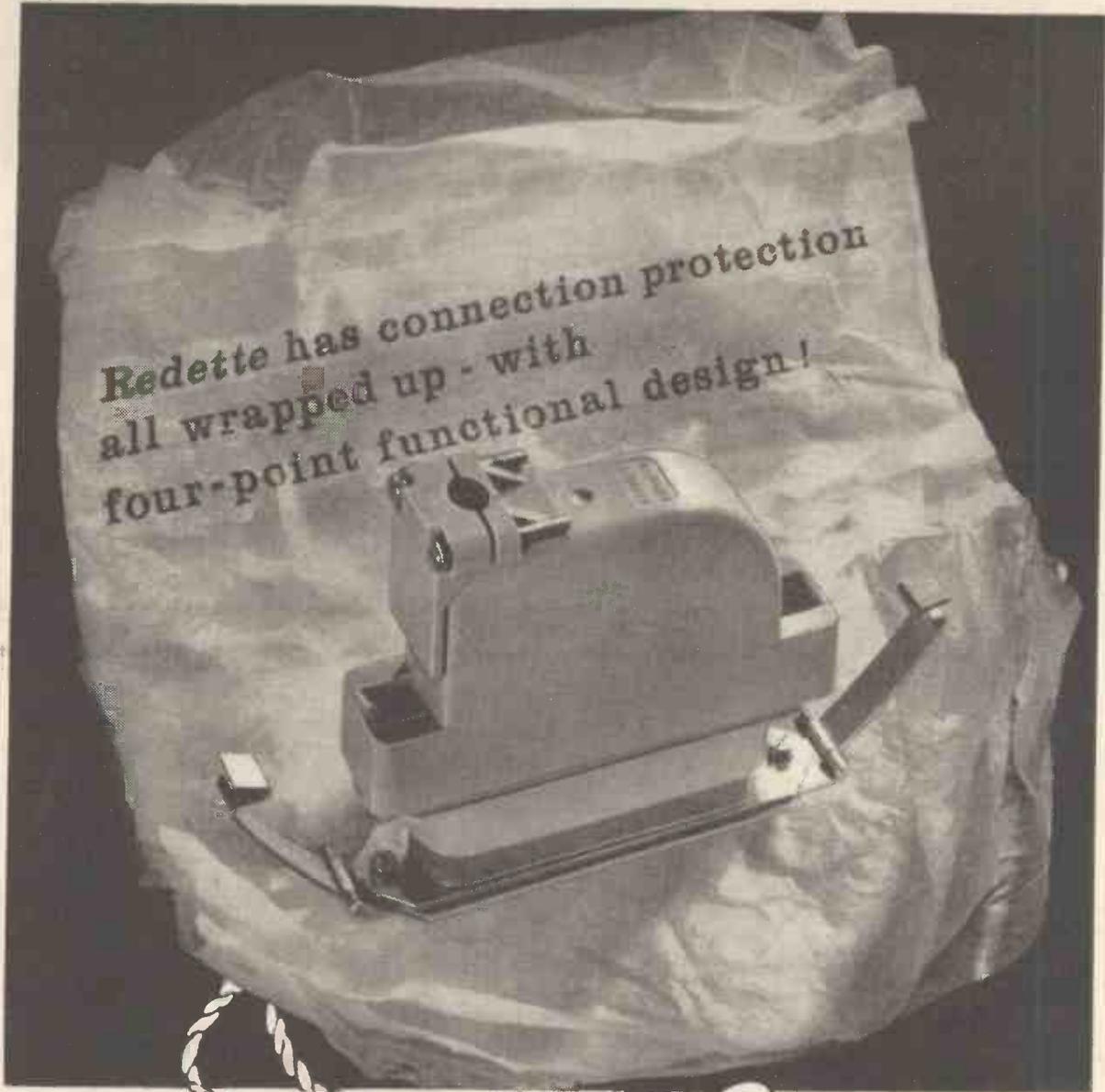
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**MALLORY**

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The new Redette range by McMurdo is wrapped in the protection of a specially designed plastic cover - with four big features to give you greater working efficiency, longer life, simpler use and better all-round value! *Point one* is the cover itself - smoothly styled in rugged ABS plastic to keep out dust and moisture and fend off bumps and knocks. *Second point* is the cable clamp. Choice of two positions for top or end cable entry for extra versatility! *Point three* is the flexible ABS plastic shroud that protects chassis-mounted plug-pins and assists polarization and the *fourth point* is strong, secure latching, with nickel plated phosphor bronze retaining clips. With a choice of four ways too (16, 26, 38 and 52) no wonder the well-protected Redette range has big-value connector efficiency all wrapped up! Write or 'phone for facts now.

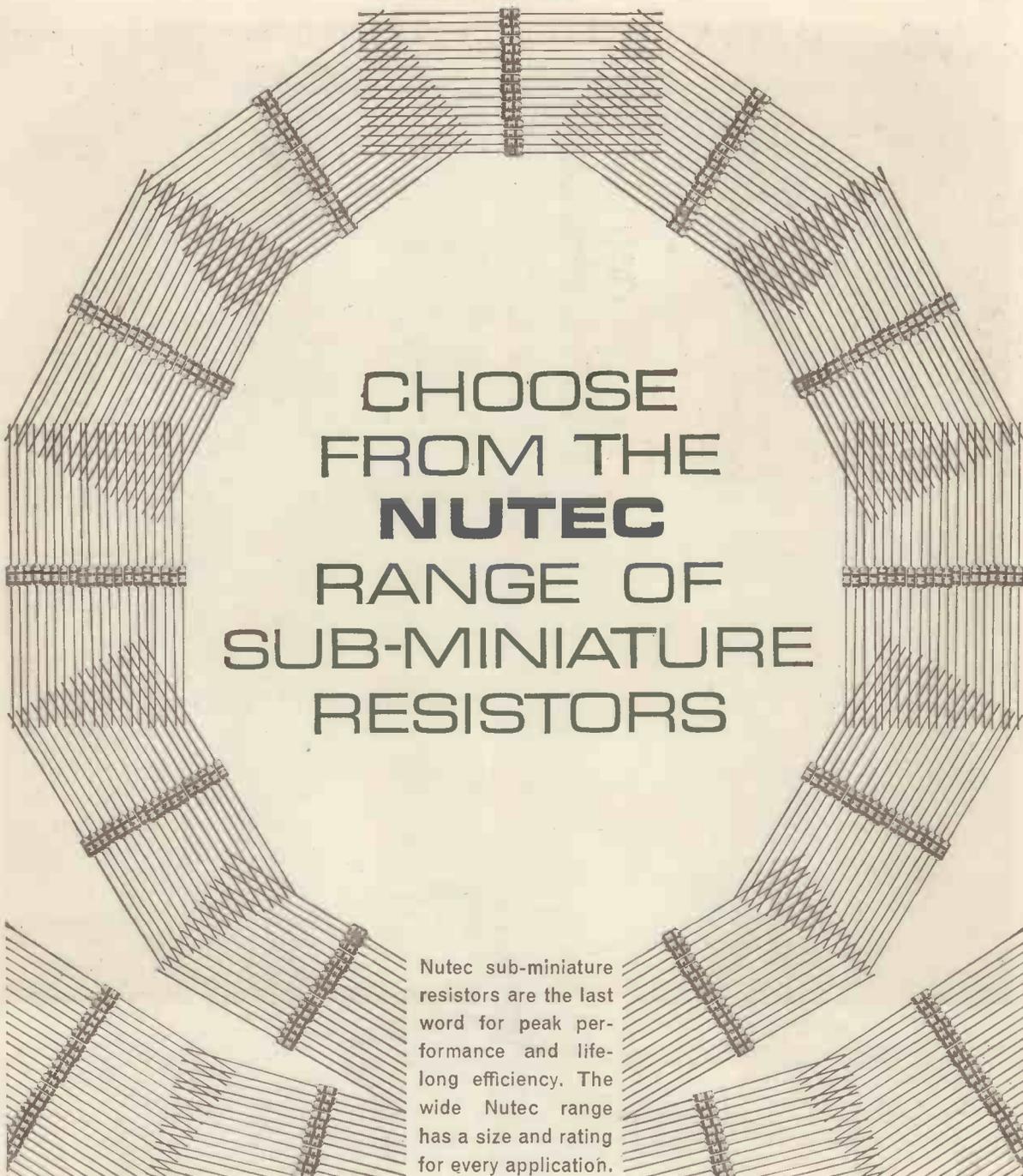
When these covers are fitted to  
Sockets it is advisable to use  
Sockets with Plug type mounting  
plates, i.e. without floating  
bushes.

Write to: Technical Sales Department,  
THE MCMURDO INSTRUMENT CO. LTD  
RODNEY ROAD, PORTSMOUTH, HANTS  
Tel: PORTSMOUTH 35361 Telex 86112

**MCMURDO**

LUGTON & CO. LTD., 207/210 Tottenham Court Road, London, W.1. Telephone Museum 3261.  
SASCO, P.O. Box No. 20, Gatwick Road, Crawley, Sussex. Telephone: Crawley 28700. Chipping Sodbury 2641. Cumbernauld 25601. Hitchin 2242  
PORTUGAL: Agencia Anglo Portuguesa, Avenida Fontes Pereira de Meno 15-40 LISBON 1. SINGAPORE: Nanyang Radio Co., 213 Victoria St., SINGAPORE 7.  
SOUTH AFRICA: Joseph Teer & Son (pty) Ltd., 40 Clommel Chambers, Cr. Eloff & Market Streets, JOHANNESBURG. (Box 1630).

WW-113 FOR FURTHER DETAILS



CHOOSE  
FROM THE  
**NUTEC**  
RANGE OF  
SUB-MINIATURE  
RESISTORS

Nutec sub-miniature resistors are the last word for peak performance and life-long efficiency. The wide Nutec range has a size and rating for every application.

It's hard to resist the variety of Nutec resistors . . . ranging from 1/4 watt right down to 30 mW for carbon film, and 2 watt down to 1/10 watt for metal film, with extra low temperature coefficient types available too! Want to know more about resistors from Nutec? Get in the picture by posting this coupon now!

*Please send me the facts now - plus a free sample!*

NAME .....

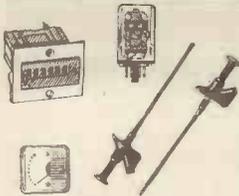
POSITION .....

ADDRESS .....

WW/10.

NUTEC ELECTRONICS LTD., MERCANTOR HOUSE, 5 EAST STREET, SHOREHAM-BY-SEA, SUSSEX TEL: 4498  
WW-114 FOR FURTHER DETAILS

# CONTIL AND PIDAM SYSTEMS



### ACCESSORIES

A full range of accessories are available for PIDAM. Shown are the meter, scaled 0-9, at 32/6. Test prods insulated and flexible with fine steel clips at the tip, red or black at 11/6. High speed resetting counter including bezel and socket, with speed of over 40 operations per sec. 150/- . Plug-in Octal relay 24v. with two changeover at 17/6. Not shown: 8 range test meter, 39/6. Oscilloscope made for us by Advance, £25.

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

### PIDAM PLUG-IN MODULES, PRICES

per module range from 9/6 to 28/- and all necessary accessories are supplied. A complete starting kit is only £19/19/-. (normally £22/16/-).

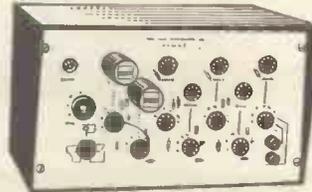


**B1** (Bistable) module shows B9A base for ease of connection, Pins 7, 8, 9 are always power connections.



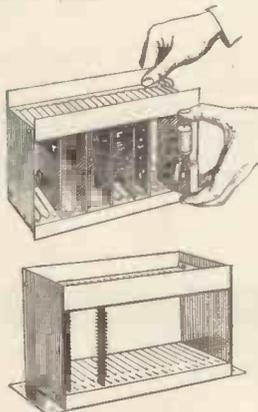
### PIDAM BROCHURE

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



### PIDEc

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



### PRINTED CIRCUIT CHASSIS

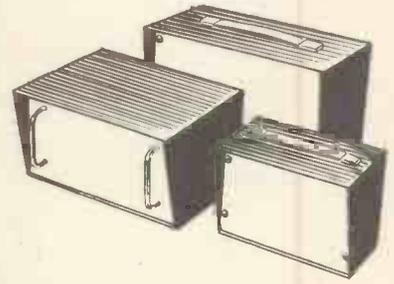
Printed circuit chassis type "P" which fits into 1277 or 16127 case, or type "Q" which can be mounted on an aluminium chassis. Both types take up to 20 boards and connectors on 1/2" centres. Prices from 45/6 down to 37/- for quantities.

## CONTIL CASES

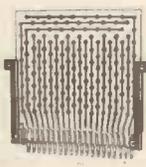
Contil cases are mass-produced to give the lowest prices yet. In 21-gauge steel. Finished hammer blue, with 18-gauge front panel supplied with easy-to-strip protective covering for easy marking out. For ease of ordering Contil cases are described by their dimensions, i.e. 755 is 7" x 5" x 5". Individually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

Range of chromium-plated and Delrin handles available with matching chassis, spare panels, etc.	ONE	FIVE
755	45/6	44/-
867 or 975	47/6	46/-
1277	53/-	51/-
16127	98/6	96/6
191010	133/-	130/-

Kit £11/19/-, (normally £14/12/-).



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



### "BRIGHTLIFE" NEONS

25,000 hr. average life with high intensity and resistor in housing; either 3/8" or 1/2" dia. Standard units 160-250v. with 6" lead variants. 10 at 2/6 each with 10 different caps. In quantity down to 1/6 each. Neon only, down to 6d each.



### SUB-MINIATURE NEON

The smallest yet. Type "Q2" overall dia. 3/16", body length 1/2". With resistor for mains, 3/6 each. Minimum quantity down to 2/4 each.

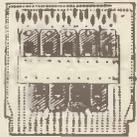


### REED SWITCH

The West Hyde Reed Switch works at up to 2,000 times a second for more than fifty thousand million operations. Ideal for: over and under speed monitors, counting, timing, switching, rev counting, etc. Hermetically sealed and moulded. Prices from 14/- each to 7/- each per thousand.

### DIVIDE BOARD

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

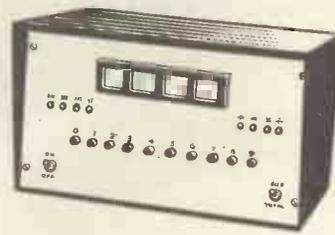


### TRANSFORMERS

Two West Hyde transformers are available for transistorised equipment one at 2 amps, giving 6, 10, 15, 18 and 30v. i.e., 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 with 12-0-12 and 15-0-15. The second at 1 amp. 6, 10, 18v. taps. Price 32/- and 22/-.



### DIGITAL COMPUTER MODULES



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

### CONTIL LOW COST PRINTED CIRCUIT BOARDS

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

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

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



**WEST HYDE DEVELOPMENTS LTD.**

30 HIGH STREET, NORTHWOOD, MIDDLESEX

Tel: Northwood 24941

# Lasky's Radio

## DEMONSTRATION STUDIOS

### Lasky's High Fidelity Sound Centres

With the opening of our latest branch to be devoted exclusively to High Fidelity equipment, 118 Edgware Road, London, W.2, we have created a companion and complementary Hi-Fi Centre to the now famous 42 Tottenham Court Road, W.1. Together these Centres offer you the unique facility of seeing and hearing all the latest equipment by all the World's leading manufacturers together with a wide range of equipment cabinets and speaker enclosures. 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 a considerable cash saving 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.

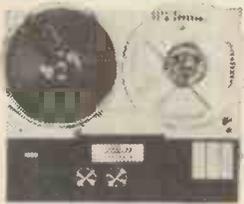
## PACKAGE DEALS

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". Prices 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".

## TAPE RECORDERS

### MAGNAVOX 363 TAPE DECKS

The very latest 3 speed model—1, 3, 7 1/2 i.p.s., available with either 1 track or 1 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 13 1/2 x 11 x 5 1/2 in. deep below unit plate. For 200/250 v. A.C. mains, 50 c.p.s. operation. New unused and fully guaranteed.



**LASKY'S PRICE** 1 track model **£10.10.0** Carriage and Packing  
 1 track model **£13.9.6** 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.  
 1 track model ..... **LASKY'S PRICE** £14/19/6 Carriage & Packing 4/8  
 1 track model ..... **LASKY'S PRICE** £15/19/6 Packing 4/8 extra  
 Optional Extra: Control panel escutcheon to tape deck and amplifier controls.  
**LASKY'S PRICE** 12/6. Post & Packing 2/6.

## 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, 1 1/2 and 3 1/2 i.p.s., capstan drive system (wow and flutter better than 0.3% at 3 1/2 i.p.s.). • Built-in 110/240 v. A.C. converter for mains operation or uses 4 x 1.5 v. batteries. • Takes 5 in. spools giving 3 hrs. twin track recording at 1 1/2 i.p.s. and 1 1/2 hrs. at 3 1/2 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. • 2 1/2 x 4 1/2 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, 5 in. 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** 24 GNS. Post free.

## NEW INTERNATIONAL TAPE

### FAMOUS AMERICAN MADE BRAND TAPE AT RECORD LOW PRICES

3in. Message tape, 150ft. ....	2/6	5 1/2in. Long play, 1,200ft. Acetate. ....	12/6
3in. Message tape, 225ft. ....	3/6	5 1/2in. Standard play, 800ft. P.V.C. ....	11/6
3in. Message tape, 300ft. ....	7/6	5 1/2in. Triple play, 2,400ft. Mylar. ....	45/-
3 1/2in. Triple play, 600ft. Mylar. ....	10/-	5 1/2in. 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/-
5 1/2in. Double play, 1,800ft. Mylar. ....	22/6	7in. Triple play, 3,600ft. Mylar. ....	50/-

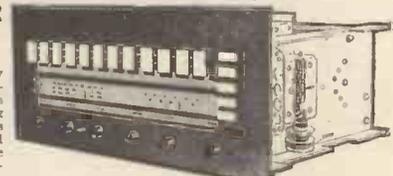
1/- Post extra per reel; 4 reels and over Post Free.

Musicalcassettes—over 200 titles in stock, Philips, Mercury, Fontana, C.B.S., Pye, Reprise, W.B. Send S.A.E. for full list.

## AMPLIFIERS

### SOLID STATE MULTIPLEX STEREO AM/FM TUNER AMPLIFIER CHASSIS

Model T10E—made for U.K. use by famous North American manufacturer and originally installed in De Luxe Hi-Fi console costing several hundred pounds. The chassis is of outstanding appearance and quality and offers many unique features plus an extremely comprehensive spec.



Features: • Separate transistorised AM and FM tuners • 3 AM wavebands—LW, MW and Continental T.R. band • full FM cover with 5 push-button preselected stations (sep. tuning controls for AM and FM ranges) • built-in multiplex decoder with unique FMX feature which provides automatic switching from mono to stereo where stereo signal is received and vice versa • unique split amplifier facility for simultaneous play of radio plus any other source • channel reverse • switched inputs for tape and auxiliaries (sep. sockets for tape in and out) • switched extension speaker outlet • thermal-safety trip • socket for stereo headphones. **TECH. spec:** Output 10 watts RMS per channel; output imp. 8 Ohm p.c.; sensitivity 50 mV for 8W output at 1 Kc.; input imp. 100K Ohm p.c.; 12 unique tumblers type function controls, 8 push-button wavechange and station selection controls, vol., bass, treble and balance controls, push-button contour (loudness) control; illuminated tuning scale; AM ranges: MW 620-1640 kc/s., LW 140-290 kc/s., Continental TR 170-345 kc/s.; FM range 88-108 Mc/s with switched AFC. Operates on 200/250 V. A.C. 50 or 60 c/s. Size: 17 1/2 x 8 x 12 in.

**LASKY'S PRICE** 59 GNS. Post & Packing 20/-.

### SANSUI MODEL MP-2 STEREO MULTIPLEX DECODER

A superbly high quality auxiliary decoder for use with an FM Stereo Tuner/Amplifier without multiplex or with a stereo amplifier and sep. FM tuner without multiplex. The unit is housed in a free standing hammer enamel metal cabinet with brushed aluminium control panel and knobs—size 4 1/2 x 4 1/2 x 12 1/2 in. Controls for power on/off filter (interference reducer) and dimension (separation) control. Power on neon and stereo beacon which lights when stereo signal is received. **Brief Spec:** 3 valves with Germanium and Silicon Diodes; Frequency response: 50 c/s to 15 Kc/s. — 2dB; Channel separation: over 35 dB at Kc/s.; distortion less than 1% 0.2-3 v. input signal. Operates on 200/250 v. A.C. Complete with connecting leads and full instructions. **LASKY'S PRICE** £9.19.6 Post 5/-.



## SPEAKERS

### FOSTER FGS 104 BOOKSHELF SPEAKER SYSTEM

A new high quality bookshelf speaker system by the well known Foster Co. of Japan. This system incorporates the latest developments in speaker miniaturisation and has a performance equal to many larger and more expensive units. The sealed infinite baffle type housing is finished in high quality leak veneer. The system comprises a 3 in. dual range speaker, tweeter and crossover network—for 8 W, 16 Ohm imp. operation. Screw tag connections at rear. Cabinet size 9 1/2 x 6 1/2 x 6 1/2 in.



**LASKY'S PRICE** £9.19.6. 2 for £17.10.0. Post 1-0/-; 2-8/6.

## RECORD PLAYERS

### B.S.R. AUTOCHANGERS NEW LOW PRICES

Fully guaranteed complete with cartridge and stylus  
 UA16 9v. battery model ..... £5 19 6  
 UA20 4-speed mains model ..... £5 19 6

**NEW—B.S.R. UA70** (Illustrated left)  
 4 speed mains autochanger superb modern styling at amazingly low price.

**LASKY'S PRICE** £9/19/6 (ex cartridge)

## GARRARD AUTOCHANGERS

AT30 .....	£10 19 6	A1000 .....	£8 6 0
AT6 Mk. II .....	£10 19 6	A2000 .....	£8 16 6
3000LM with stereo cartridge .....	£8 19 6	GARRARD BASES	
A70 .....	£19 9 0	WB1 .....	£3 16 3
Lab. A Mono/Stereo .....	£14 19 6	WB2 .....	£5 5 0
Lab. A on plinth .....	£15 19 6	CLEARVIEW PERSPEX COVERS	
A50 .....	£7 7 0	WB1 .....	£3 17 0
		WB2 .....	£5 7 11

### TRANSCRIPTION MOTORS

GARRARD 401 .....	£30 9 0
GARRARD Lab. 80. Mk. II. ....	£30 7 2
CONNOISSEUR	
Craftsman II .....	£17 2 11
Craftsman III .....	£22 19 6
Model B .....	£25 4 0
LENCO GL58 .....	£17 1 9
LENCO GL68 .....	£19 10 7
LENCO C88 .....	£15 15 0
LENCO GL70 .....	£29 18 8
LENCO C90 .....	£21 19 5
THORENS TD135 I .....	£26 5 0
THORENS TD135 II .....	£40 6 8
THORENS TD124 II .....	£40 5 8
THORENS TD150 .....	£20 13 2

### SINGLE PLAYERS

Auto. start and stop. Complete with pick-up and crystal cartridge.	
EMI with Stereo cartridge .....	£3 19 6
COLLARO Junior 4-speed .....	£3 9 6
GARRARD SRP12 .....	£4 7 6
GARRARD SRP10 mains model .....	£4 19 6
GARRARD SRP10 batt. model .....	£4 19 6
GARRARD SRP25 Light 1/2table .....	£9 19 6
GARRARD SRP25 Heavy 1/2table .....	£10 19 6
(Garrard SRP25 are ex-cartridge)	
PHILLIPS AG1016 .....	£12 12 0
BRAUN PC4L Stereo .....	£8 19 6

All other current models available. Postage on all above 5/- extra.

## LASKY'S RADIO FOR FINEST VALUE and COURTEOUS SERVICE

WW—117 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 31-543kj 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 11 1/2 x 6 1/2 x 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: 50/- deposit and 11 monthly payments of 12/9. Total H.P.P. £10/0/3.

Data 2/G. Refunded if you purchase parcel. Four U2 bats, 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.

## 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 x 1 x 2 1/2in. **PRICE 27/6**

TYPE LRPC 4. 5 transistor. Input sens. 150mV., output 330mW., output imp. 15Ω., size 2 1/2 x 1 1/2 x 2 1/2in. **PRICE 18/6**

TYPE LRPC 5. 6 transistor. Input sens. 8mV., output 3W., output imp. 3Ω., size 3 1/2 x 1 1/2 x 1 1/2in. **PRICE 59/6**

LRPC 9. High to Low input matching preamplifier. Input imp. 1 megohm, output imp. 2 k/ohms. Size 1 1/2 x 1 1/2 x 2 1/2in. **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 2 1/2 x 1 1/2 x 2 1/2in. **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 1 1/2 x 1 1/2 x 1 1/2in. 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**

## SINCLAIR SUPER MINIATURES

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

The Micro 8 miniature radio kit	£2 19 6	THE Z-12 12 watt amp. and pre-amp., fully built	£4 9 6
THE MICRO-FM (tuner/receiver) kit	£5 19 6	PZ-3 POWER PACK for Z-12	£3 19 6
The Micromatic miniature radio kit	£2 19 6	STEREO 25 pre-amp. control unit, fully built	£9 19 6
Fully built and tested	£3 19 6		

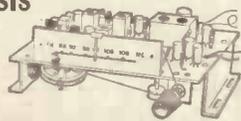
## BARGAIN—UHF TV TUNERS

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 x 6 x 1 1/2in. Fully tunable—complete with PC86 and PC88 valves. **LASKY'S PRICE** with valves, 29/6. Without valves 7/6.

## TRANSISTOR FM TUNER CHASSIS

Fully tunable—range 88 to 108 Mc/s. Completely wired on printed circuit, 10.3 Mc/s. IF. 8 transistors and 3 diodes. Slow motion tuning drive. Size 6 1/2 x 4 x 2 1/2in. Operates from any 9 v. D.C. source. Full data and circuit supplied.

**LASKY'S PRICE £7.19.6** Post 5/- extra.

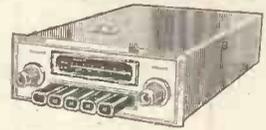


## SPECIAL INTEREST ITEMS!

### 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 6 1/2 x 5 1/2 x 2 1/2in.—front panel 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 x 4in. elliptical 8 Ω dynamic speaker 17/6 extra—Post FREE.

#### SPECIAL OFFER—LOCKING CAR AERIAL

Model S3003 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.

## 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 x 2 1/2in. (illus.)	100μA	47/6
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5 mA D.C.	32/6	1 mA S Meter
300 V D.C.	32/6	39/6



TYPE MK-35A 1 1/2in. square	22/6	TYPE MK-45A 2in. square	25/-
1 mA DC	22/6	1 mA DC	25/-
5 mA DC	22/6	5 mA DC	25/-
300 V DC	22/6	300 V DC	25/-
100μA	29/6	500μA	25/-
500μA	27/6	1 mA S Meter	35/-
1 mA S Meter	29/6		

TYPE KR-65 3 1/2 x 3 1/2in.	36/-	TYPE MK-65A 3in. square	36/-
1 mA DC	35/-	1 mA DC	35/-
5 mA DC	35/-	5 mA DC	35/-
300 V DC	35/-	300 V DC	35/-
500μA	42/6	500μA	39/6
1 mA S Meter	39/6	1 mA S Meter	37/6

## MICROPHONE BARGAIN

### STC MODEL 414

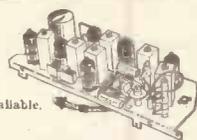
A high quality omni-directional moving coil microphone—suitable for use with sound reinforcement and P.A. systems, tape recorders, transistor amplifiers, etc. Attractive grey moulded case for free standing or hand held use—size 2 1/2 x 2 1/2 x 2 1/2in. Complete with 6ft. screened cable. New and unused in maker's cartons—fully guaranteed.



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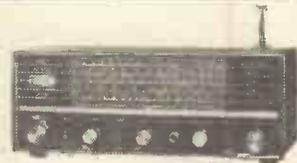


**LASKY'S PRICE 29/6** Post & Packing 2/6.

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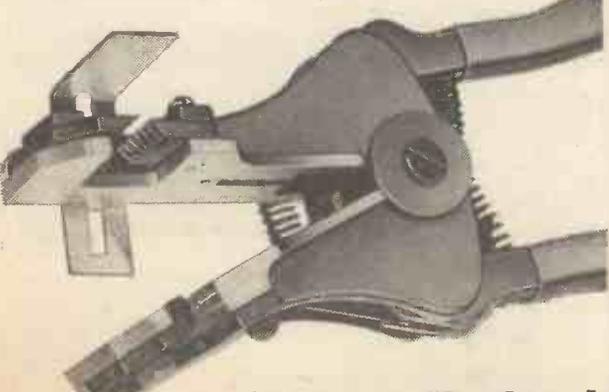
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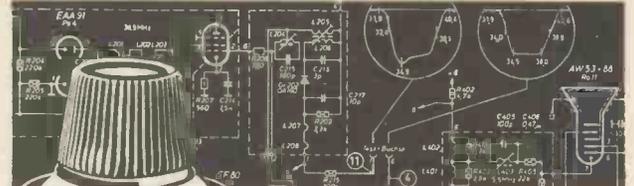


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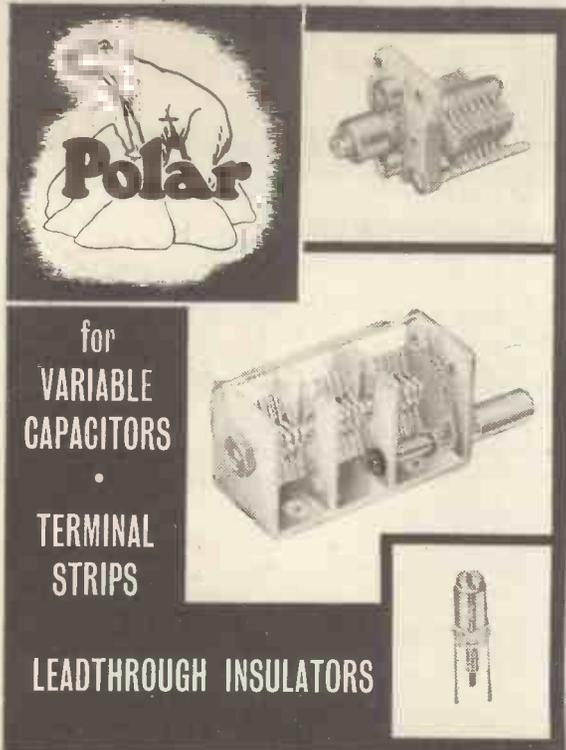
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EB91 3/-	EB91 3/-	8TV280/80	6C0 3/-	8699 18/-	OC89 7/6
EB91 3/-	EB91 3/-	8TV280/80	6D0 3/-	8699 18/-	OC89 7/6
EB91 3/-	EB91 3/-	8TV280/80	6E0 3/-	8699 18/-	OC89 7/6
EB91 3/-	EB91 3/-	8TV280/80	6F0 3/-	8699 18/-	OC89 7/6
EB91 3/-	EB91 3/-	8TV280/80	6G0 3/-	8699 18/-	OC89 7/6
EB91 3/-	EB91 3/-	8TV280/80	6H0 3/-	8699 18/-	OC89 7/6
EB91 3/-	EB91 3/-	8TV280/80	6I0 3/-	8699 18/-	OC89 7/6
EB91 3/-	EB91 3/-	8TV280/80	6J0 3/-	8699 18/-	OC89 7/6
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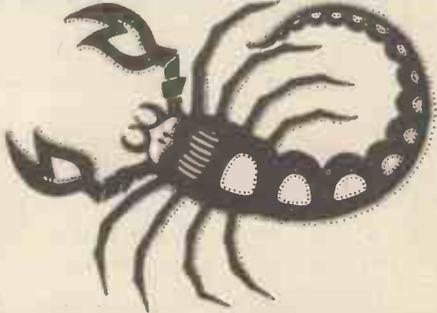
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8 Models—Any Voltage.  
Over 150 type bits.  
6 v. to 240 v.  
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**LONG LIFE BITS.**  
**EASY BIT/ELEMENT INTERCHANGE.**  
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One Customer writes: "... 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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INTRODUCING THE VALRADIO "B" SERIES  
SINEWAVE output 200W (120W also available).  
FREQUENCY: 50 c/s  $\pm$  1/2 c/s (60 c/s to order).  
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- ★ WILL OPERATE ALMOST ANY ELECTRONIC OR ELECTRICAL EQUIPMENT.
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### AUDIO LABORATORY INSTRUMENTS

#### LOW DISTORTION OSCILLATOR (Series 2)

An instrument of high stability providing very pure sine waves, and square waves, in the range of 5 Hz to 500 kHz. Hybrid design using valves and semiconductors.

##### Specification

Frequency coverage: 5 Hz-500 kHz (5 ranges)  
Output Impedance: 600 Ohms.  
Output Voltage: 10 Volts r.m.s. max.  
Output Attenuation: 0-110 dB continuously variable.  
Sine Wave Distortion: 0.005% from 200 Hz to 20 kHz increasing to 0.015% at 10 Hz and 100 kHz.

Square Wave Rise Time: Less than 0.1 microseconds.  
Monitor Output Meter: Scaled 0-3, 0-10, and dBm.  
Mains Input: 100 V.-250 V. 50/60 Hz.  
Size: 17 1/2 x 11 x 8 in.  
Weight: 25 lbs.  
Price: £125.  
Rack mounting version available.

#### DISTORTION MEASURING SET (Series 2)

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

##### Specification

Frequency Range: 20 Hz-20 kHz (6 ranges)  
Distortion Range: 0.01%-100% f.s.d. (9 ranges)  
Sensitivity: 100 mV.-100 V. (3 ranges)  
Meter: Square law r.m.s. reading.  
Input Resistance: 100 kOhms.  
High Pass Filter: 3 dB down at 350 Hz.  
30 dB down at 35 Hz.  
Frequency Response:  $\pm$  1 dB from second harmonic of rejection frequency to 250 kHz  
Power Requirements: Included battery.  
Size: 17 1/2 x 11 x 8 in.  
Weight: 15 lbs.  
Price: £90.  
Rack mounting version available.

#### VOLTMETER (new item)

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

##### Specification

Sensitivity: 1 mV.-300 V. f.s.d. (12 ranges)  
Calibration Accuracy: 2% f.s.d.  
Frequency Response:  $\pm$  1 dB, 10 Hz-500 kHz.  
Input Impedance: 1 MOhm. 1 mV.-300 mV.  
10 MOhm. 1 V.-300 V.  
Meter Scaled: 0-3, 0-10, and dBm.  
Power Requirements: Included battery.  
Size: 11 1/2 x 6 1/2 x 6 in.  
Weight: 7 lbs.  
Price: £35.

## RADFORD ELECTRONICS LTD

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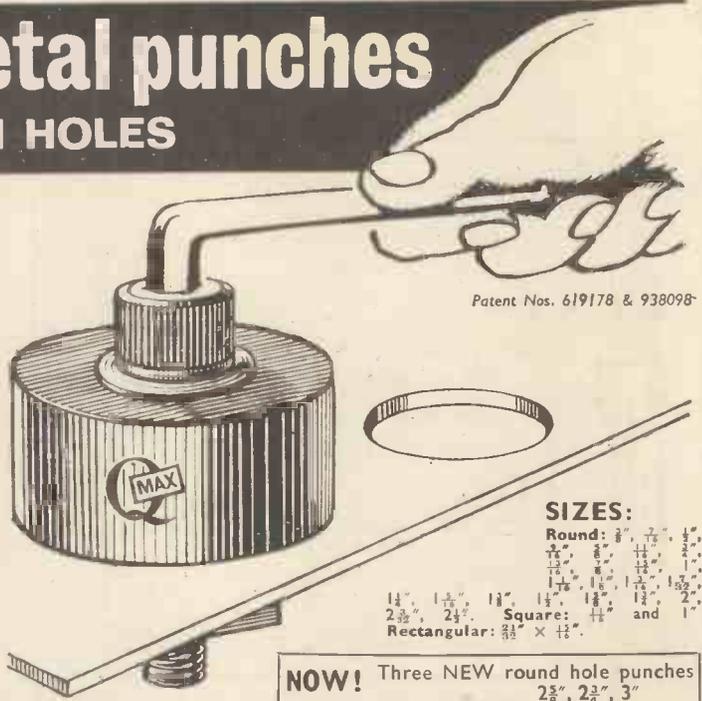
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## FOR QUICK AND CLEAN HOLES

- 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

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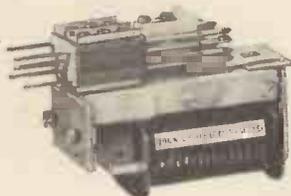
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Square:	$\frac{1}{8}$ "	$\frac{7}{16}$ "	$\frac{1}{2}$ "	$\frac{5}{8}$ "	$\frac{3}{4}$ "	$\frac{7}{8}$ "	$1\frac{1}{8}$ "	$1\frac{1}{2}$ "	$1\frac{3}{4}$ "	$2\frac{1}{8}$ "	$2\frac{1}{2}$ "	$3\frac{1}{8}$ "	$3\frac{1}{2}$ "	$4\frac{1}{8}$ "	$4\frac{1}{2}$ "	$5\frac{1}{8}$ "	$5\frac{1}{2}$ "	$6\frac{1}{8}$ "	$6\frac{1}{2}$ "	$7\frac{1}{8}$ "	$7\frac{1}{2}$ "	$8\frac{1}{8}$ "	$8\frac{1}{2}$ "	$9\frac{1}{8}$ "	$9\frac{1}{2}$ "	$10\frac{1}{8}$ "	$10\frac{1}{2}$ "	$11\frac{1}{8}$ "	$11\frac{1}{2}$ "	$12\frac{1}{8}$ "	$12\frac{1}{2}$ "	$13\frac{1}{8}$ "	$13\frac{1}{2}$ "	$14\frac{1}{8}$ "	$14\frac{1}{2}$ "	$15\frac{1}{8}$ "	$15\frac{1}{2}$ "	$16\frac{1}{8}$ "	$16\frac{1}{2}$ "																																																																																	
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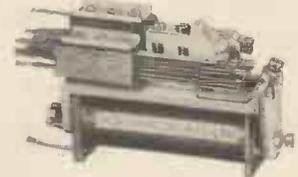
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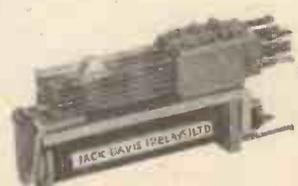


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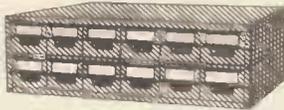
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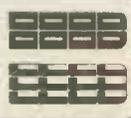
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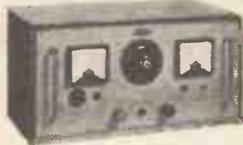
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**FEATURES.** Type 250VRU 30/20. 0-30 v. Continuously Variable up to 20A  
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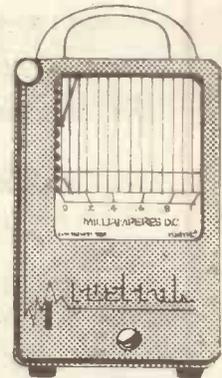
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*The Rustrak recorder is  
accurate under all conditions  
of temperature and humidity.*

*It uses no ink, heated stylus  
or voltage sensitive paper...*

*logs information automatically  
and at any one of 99  
chart speed combinations...*

*records events of as little as  
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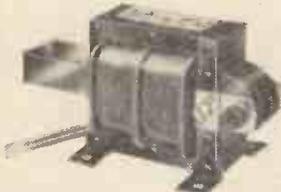
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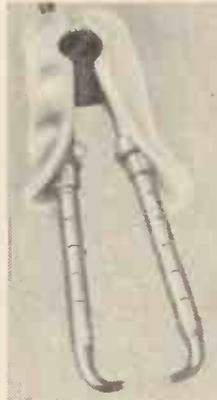
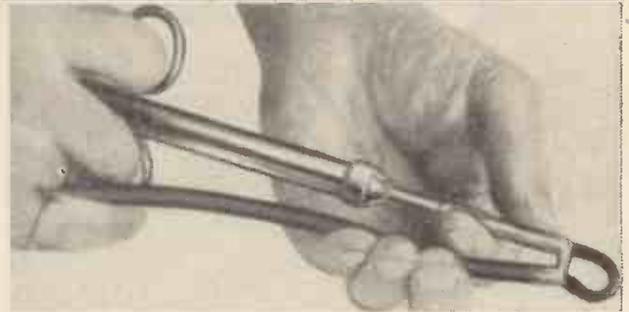
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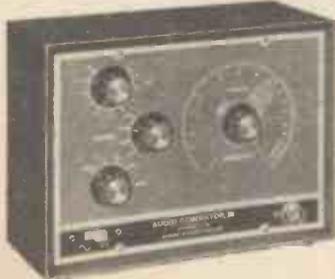
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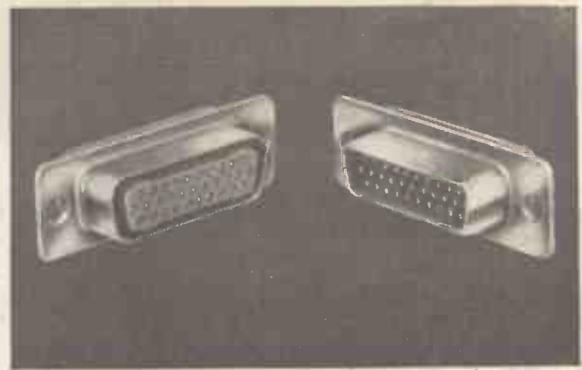
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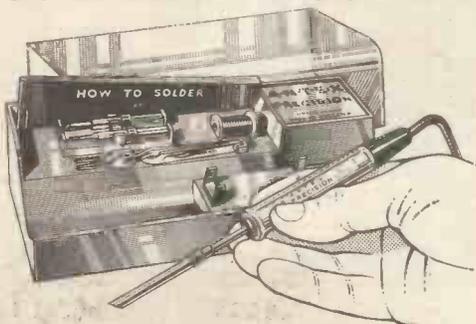


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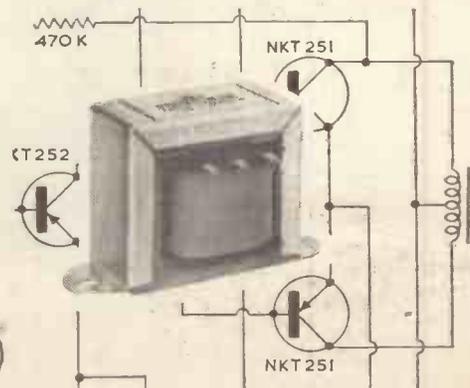
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7 adjustments, precision tooled, speed adjustable 10 w.p.m. to as high as desired. Weight 2 1/2 lb. £412/6 post paid. TRANSISTORISED MORSE OSCILLATOR Fitted 2 1/2 in. Moving Coil Speaker. Uses type PP3 or equiv. 9 v. battery. Complete with latest design Morse Key. 22/6, plus 1-6 P. & P.



## 100 WATT POWER RHEOSTATS

(NEW) Ceramic construction, winding embedded in Vitreous Enamel, heavy duty brush assembly designed for continuous duty. AVAILABLE FROM STOCK IN THE FOLLOWING II VALUES: 1 ohm 10a., 5 ohm 4.7a., 10 ohm 3a.; 25 ohm 2a.; 50 ohm 1.4a.; 100 ohm 1a.; 250 ohm 7 a.; 500 ohm 45 a.; 1,000 ohm 280 mA; 1,500 ohm 230 mA.; 2,500 ohm 2 a. Diameter 3 1/2 in. Shaft length 3/4 in. dia, 1 1/2 in. 27/6. P. & P. 1/6.



## 50 WATT POWER RHEOSTATS

1 ohm 7a.; 5 ohm 3a.; 10 ohm 2.25a.; 25 ohm 1.4a.; 50 ohm 1a.; 100 ohm .7a.; 250 ohm .45a.; 500 ohm .3a.; 1,000 ohm .22a.; 2,500 ohm .14a. All at 21/- each. P. & P. 1/6.

## 25 WATT POWER RHEOSTATS

10 ohm 1.5a.; 25 ohm 1a.; 50 ohm .75a.; 100 ohm .5a.; 250 ohm .3a.; 500 ohm .2a.; 1,000 ohm .15a.; 1,500 ohm .12a.; 2,500 ohm .1a.; all at 14/6 each. P. & P. 1/6.

## SWING ARM RHEOSTAT

Especially designed for educational use. 0-10 ohm in precision 1 ohm steps. Max. current 5 amp. Size: Height 1 9/16 in. Width 1 1/2 in. Depth 6 1/2 in. Price £41/9/6. P. & P. 7/6.

## NICKEL CADMIUM BATTERY

Sintered Cadmium Type 1.2 v. 7AH. Size: height 3 1/2 in., width 2 1/4 x 1 1/4 in. Weight: approx. 13 ozs. Ex-R.A.F. Tested, 12/6. P. & P. 2/6.

## SANWA Multi Range Meters

We have now decided to stock just one Multi Range Meter **SANWA**

Acknowledged throughout the world as the ultimate in test meters. Four types from stock. Price from £32/-, full range of spares and repair service available. Descriptive leaflet on request.

**SPECIAL OFFER OF FIRST GRADE GUARANTEED TRANSISTORS.** OC83-3 for 12/6 OC81-4 for 10/- OC81D-4 for 10/- OC45-3 for 10/- OC44-3 for 10/-. Post paid.

## 34R SILICON SOLAR CELL

4x.5 volt unit series connected output up to 2 v. at 20 mA. in sunlight. 30 times the efficiency of selenium. As used in power Earth Satellites, 37/6. P. & P. 1/-.

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Teaches the principles of light sensitive devices and their application. 26/- post paid.

## 230 VOLT A.C. GEARED MOTORS

Type D15G 5 r.p.m. 1.7lb. inch, £29/6, P. & P. 3/- Type B16G 80 r.p.m., 26lb. inch, £21/2/-, P. & P. 3/- Type D16G 13 r.p.m. 1.45lb. inch, £21/7/6. P. & P. 3/-.

## UNIVERSAL DEMONSTRATION TRANSFORMERS

A complete composite apparatus, comprising a robustly built Transformer and electro-magnet with removable coils and pole pieces. Coil tapped for 230 v., 220 v., 110 v., 115 v., 6, 12, 36, 110 v.

A.C. These coils are also used for D.C. experiments. Complete with all accessories as shown. £17 plus 15/- carr. Leaflet on request.



230 v. A.C. RELAY. 2 c/o 2 amp. contacts. 9/6 ex new equip. P. & P. 1/6.

## SLIDER RESISTANCE

200 ohm 1.25 amp., 37/6. P. & P. 3/6.

Condenser 5,000 m/d 50 v. 1 1/2 x 4 1/2 in. 12/6. New.

THYRISTOR 400 p.i.v., 3 amp., 9/6 post paid  
THYRISTOR 400 p.i.v., 8 amp., 28/6 post paid

## LATEST TYPE

### SELENIUM BRIDGE RECTIFIERS

30 volt 3 amp., 11/-, plus 2/6 P. & P.  
30 volt 5 amp., 16/-, plus 2/6 P. & P.

## COAX CABLE

Approximately 100 yard reels, 30/- a reel, plus 7/6 carriage.

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Finest quality soft chamois earmuffs. Superb reproduction. Complete with jack plug, 25/6 P. & P. 2/6. MOVING COIL HEADPHONE AND MIKE. Soft rubber ear-pieces with M/C Mike fitted 5-way plug as on No. 19 set. New in makers packing 16/6 plus 3/6 C. & P.



A.C. AMMETERS 0-1, 0-5, 0-10, 0-15, 0-20 amp. F.R. 2 1/2 in. dia. All at 21/- each.

A.C. VOLTMETERS 0-25 v., 0-50 v., 0-150 v. M.I. 2 1/2 in. Flush round all at 21/- each. P. & P. extra. 0-300 v. A.C. Rect. M-Coil 2 1/2 in. 29/-  
0-300 v. A.C. Rect. M-Coil 3 1/2 in. Type W23. 5/-

## LATEST TYPE SIEMENS MINIATURE RELAY

In Transpare Case. 4 c/o 700 ohm 14/6. Base 4/- 2 c/o 700 ohm coil, size 1 1/2 x 1 1/2 in. 15/- inc. base. VARLEY TYPE VP4 (similar to illus.), 5,800 ohm, 4 c/o. New 12/6, less base. Similar to above. Mfd. by GRUNER, 4 c/o, 2,400 ohm coil. New, 10/-, less base.



## UNISELECTOR SWITCHES

### NEW

BRAND NEW 4 Bank 25 Way Uniselector, 3 Bank 4 Homing, 25 ohm coil, 12-24 v. D.C. operation, £41/7/6 plus 2/6 P. & P.



### 8 BANK 25 WAY

12-24 v. D.C. operation, £6/6/-, plus 4/- P. & P.

## USED STANDARD SIZE UNISELECTOR SWITCHES

75 ohm coil, 24 v. D.C., 6 bank 25 position, 5 non-bridging, 1 bridging wiper 6 bank arranged to give 3 banks, 50 positions. These switches have been carefully removed from equipment. All at 35/- each. P. & P. 2/6.

## MINIATURE UNISELECTOR SWITCH



3 banks of 11 positions plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Carefully removed from equipment and tested. 22/6, plus 2/6 P. & P.

## SUPER POWER ALLOY MAGNET

These fantastic ex WD magnets weighing only 4 lbs. will lift well over 100lbs. Fitted with swivelled handle and keeper. Size 4 in. x 3 1/2 in. x 1 1/2 in. Packed in original makers' case of two. Price 30/- per pair, plus 7/6 P. & P.



## L.T. TRANSFORMERS

All primaries 220-240 volts.	Type No.	Sec. Taps	Price	Carr.
	1	30, 32, 34, 36 v. at 5 amps.	£3/5/-	6/-
	2	30, 40, 50 v. at 5 amps.	£5/5/-	6/6
	3	10, 17, 18 v. at 10 amps.	£3/10/-	4/6
	4	6, 12 v. at 20 amps.	£4/17/6	6/6
	5	17, 18, 20 v. at 20 amps.	£5/12/6	6/6
	6	6, 12, 20 v. at 20 amps.	£5/5/-	7/6
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### TRANSISTOR STEREO 8 + 8

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W. mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work, Cir-Kit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief Specification: Freq. response +3dB. 20-20,000 c/s. Bass boost approx. to +12dB. Treble cut approx. to -16dB. Negative feedback 18dB. over main amp. Power requirements at 25V. at 6 amp.

**PRICES:**  
 Amplifier Kit . . . . . £9/10/0. P. & P. 4/6.  
 Power Pack Kit . . . . . £2/10/0. P. & P. 4/-.  
 Cabinet (as illus.) . . . . . £2/10/0. P. & P. 5/6.  
 (Special Offer—£14/10/0, post free if all above ordered at same time.)

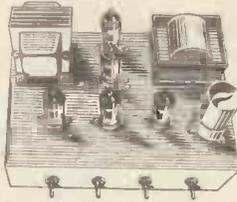
Circuit diagram, construction details and parts list (free with kit) 1/6 (S.A.E.)

### HSL "FOUR" AMPLIFIER KIT

3-VALVE, 4 WATT USING ECC83, EL84, E280 VALVES FOR A.C. mains 200/240 v. ★ Heavy duty double-wound mains transformer with electrostatic screen. ★ Separate bass, treble and volume controls, giving fully variable boost and cut with minimum insertion loss. ★ Heavy negative feedback loop over 2 stages ensure high output at excellent quality with very low distortion factor. ★ Suitable for use with guitar, microphone or record player. ★ Provision for remote mounting of controls or direct on chassis. ★ All this builds on to a chassis size only 7 1/2 in. wide x 4 in. deep. Overall height 4 1/2 in. ★ All components and valves are brand new. ★ Very clear and concise instructions enable even the inexperienced amateur to construct with 100% success. ★ Supplied complete with valves, output transformer (3 ohms only), screened lead, wire, nuts, bolts, solder, etc. (No extras to buy.) PRICE 79/6. P. & P. 6/-.  
 Comprehensive circuit diagram, practical layout and parts list 2/6 (free with kit).

### 10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for milk and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up: 2 EL84s, ECC83, EF86, and EZ80 rectifier. Simple instruction booklet 1/6 (Free with parts). All parts sold separately. ONLY £79/6. P. & P. 8/6. Also available ready built and tested complete with standard input sockets, £95/-. P. & P. 8/6.



### 3-VALVE AUDIO AMPLIFIER MODEL HA34

Designed for Hi-Fi reproduction of records. A.C. mains operation. Ready built on plated heavy gauge metal chassis, size 7 1/2 in. w. x 4 in. d. x 4 1/2 in. h. Incorporates ECC83, EL84, E280 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate bass, treble and volume controls. Negative feedback extended for remote mounting of controls. The HA34 has been specially designed for us and our quality order enables us to offer them complete with knobs, valves, etc., wired and tested for only £45/-. P. & P. 6/-.  
 back line. Output 4 1/2 watts. Front panel can be detached and leads provided for remote mounting of controls. The HA34 has been specially designed for us and our quality order enables us to offer them complete with knobs, valves, etc., wired and tested for only £45/-. P. & P. 6/-.  
 BRAND NEW 3 OHM LOUSPEAKERS  
 5in., 12/6; 6 1/2in., 15/6; 8in., 22/6; 10in., 27/6; 7 x 4in., 16/6; 10 x 6in., 27/6. E.M.I. 8 x 5in. with high flux magnet, 21/6. E.M.I. 13 1/2 x 8in. with high flux ceramic magnet, 42/6 (15 ohm 45/-). P. & P. 5in. 2/-, 6 1/2 and 8in. 2/6, 10 and 12in. 3/6 per spkr.

TV U.F.E. TUNER AND SOUND AND VISION I.F. PANEL By world famous maker. Suitable for use in conversion of TV sets to BBC2 (625 line reception). OFFERED (less valves) AT THE BARGAIN PRICE OF ONLY 27/6. Post paid. (We regret that no correspondence can be entered into on this item).

### HIGH GAIN 4-TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1

● Peak output in excess of 1 1/2 watts. ● All standard British components. ● Built on printed circuit panel, size 6 x 3in. ● Generous size driver and output transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GT 14 or S1 Mullard OC81D and matched pair of OC81, o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 2/6 (Free with Kit). All parts sold separately. SPECIAL PRICE 45/-. P. & P. 3/-. Also ready built and tested 52/6. P. & P. 3/-.  
**SPECIAL PURCHASE!**  
**B.B.E. GUY**  
 9 volt Battery Operated Record Player Units. 4 speeds, Automatic stop. Plays any size record. Complete with mono 4/0 head and sapphire stylus. ONLY 59/6. P. & P. 5/6. (With stereo cartridge 12/6 extra.)  
 Ideal for use with the above amplifier.



### 4-SPEED PLAYER UNIT BARGAINS

Mains Models. All brand new in maker's original packing.  
**SINGLE PLAYERS.** Carr. 5/6 on each.  
 B.S.R. TU/12 £35/6. Garrard SP25 de luxe . . . £10 19 6  
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**AUTO CHANGERS.** Carr. 6/6 on each.  
 B.S.R. U425 Super slim £5 2 6. GARRARD 2000 £7 10 0  
 GARRARD 3000 £8 15 0. GARRARD 1000 with Hi-Fi cartridge £6 19 6. Latest GARRARD AT60 Mk. II £12 0 0.  
 All the above units are complete with 4/0 mono head with sapphire stylus or can be supplied with stereo head at 12/6 extra.

### QUALITY RECORD PLAYER AMPLIFIER MK. II

A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, E280 valves. Separate bass, treble and volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7 1/2 in. w. x 3 in. d. x 6 in. h. Ready built and tested. PRICE 59/6. P. & P. 6/-.  
 ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet on right. PRICE 59/6. P. & P. 7/6.

### DE LUXE QUALITY PORTABLE R/P CABINET

Uncut motor board size 14 1/2 x 12in., clearance 2in. below, 5 1/2in. above. Will take amplifier above and any B.S.R. or GARRARD Autochanger or single Player Unit (except AT60 or SP25.) Size 18 x 15 x 8in. PRICE £39/6. Carr. 9/6.

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**MINIATURE SILVER ZINC ACCUMULATOR.** 1.5 volt, 1.5 ampere. Size 2in. x 1.13in. x 0.63in. Weight 1 1/2 oz. Ideal for model work, 12/6 ea. 120/- doz., post 9d. **STROBOSCOPE FORK.** 125 cycles. P.O. No. 5, 30/- ea., post 2/-.

**GEARED MOTORS.** For window displays 3 RPM or 1 RPM, 24 v. A.C., 4 watts, reversible, 35/-, Post 2/6.  
**TRANSFORMER** to operate the above from 230/240 v. A.C. 20/-. Post 4/6.

**KEY SWITCHES** (3 position).  
 4 C Non Lock/4 C Non Lock 16/6.  
 4 C Non Lock/6 C Lock 20/-.  
 2 C Lock/2 C Lock 12/6.  
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 Many other types.

**Low Capacitance 8 C Muirhead 17/6.**  
 Stop/2 C Lock 7/6. All  
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**SPEAKERS ELAC 5in. ROUND**  
 9700 Gauss. 3Ω. 7/6. Post 2/6.

**TELEPHONE BULBS No 2. Tubular.**  
 6, 12 or 24 v., 7/6. Lenses 6d. ea.

**AUTO TRANSFORMERS** by S.T.C. Totally enclosed C-core type. 110/250 volts. 8 tappings. 50 cycles. 1,000 watts. Size 6 1/2 x 5 1/2 x 5 1/2 in. £4. Post 10/6.

### ONE HOLE FIXING SWITCHES

**SINGLE POLE** Double Throw, 3 amp. 250 v. A.C. can be used as ON/OFF or CHANGE-OVER switch.  
 12/- per dozen, 85/- per 100  
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**VEEDER-ROOT MAGNETIC COUNTERS WITH ZERO RESET 800 COUNTS PER MINUTE, COUNTING TO 999,999.** 230 volts A.C. or 110 v. D.C., 65/-. Post 3/-.  
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 P.O. 201 with cord, 3/-, post 1/6;  
 P.O. 316, 3 Point, 4/6, post 9d.

**POTENTIOMETERS, RESISTORS, WIREWOUND AND CARBON.** Quantities ex-Stock. Low prices.  
**MAINS TRANSFORMERS.** Output 300-0-300 volts, 250 mA, 6.3 volts, 9 amp, 25/-. Post 6/-.  
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 RACAL Inst. type PU 156C, A.C. input 200/250 v D.C. Output positive HT 200/300 v stabilized. Load current 250 ma negative HT 150 v. stabilized 15 ma. NEW £45

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Microamps 0/100 2 1/2 in. MC 40/-  
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 Volts 5-0 5 2 1/2 in. MC. . . . . 25/-  
 Volts 0/40 2 in. MC. . . . . 37/6  
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**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 21½ x 12½ x 18½ in. and ready for immediate mains operation (200-250 v. 50 c/s.). Supplied BRAND NEW in original crate, complete with spares and manual. £20. Carr. 50/-.

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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 3½ in. deep panel. Mains operation 200/250 v. 50 c/s. BRAND NEW. £5/19/6. Carr. 10/-.

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150-695 Kc/s. 3.4-7 Mc/s. 28 volt D.C. Input. Very good condition, £4/19/6. Carr. 10/6.

**HRO TUNING METER.** 0-1 ma. New and boxed 25/- Post 2/-.

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Portable dose rate meter containing modern type rectangular 50 micro-amp meter CVX 494, electrometer valves, etc. BRAND NEW. In canvas carrying case £3/19/6. Postage paid.

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MARCONI TF-801A/J. Covers 10 to 310 Mc/s. (4 bands). DIRECTLY calibrated. Int. Mod. at 400, 1,000 and 5,000 c/s. Attenuated or force output. Guaranteed overhauled, accurate and in perfect working order. £35. Carr. £1.

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**MARCONI "Q" METER.** Type 329G. As new condition and in perfect working order. £65. Carr. 50/-.

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As new condition complete with crystal and valves. In perfect working order but WITHOUT calibration charts. £9/19/6. Carr. 10/6.

**MICROAMMETERS**

R.C.A. 0-500 microamps. 2½ in. circular flush panel mounting. Dials are engraved 0-15, 0-600 volts. As used in the American version of the No. 19 set. BRAND NEW and boxed 15/- P. & P. 1/6.

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Knobs, Medium size, Set of 8... 10/-  
Knobs, Large size... 5/6  
Condenser (3 x 4 mfd.) Post 4/6... 12/6  
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**MINIATURE RELAYS**

240 v. A.C. coils. Contact assembly 2 " makes " and 1 C.O. 5 amps. Size 2 x 1½ x 1 in. Unused and removed from brand new equipment 8/6 post paid.

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MARCONI type TF.1093/1. Range 0-14 pH. direct reading. Full temperature compensation. Scale expansion providing discrimination of 0.01 pH. A.C. mains operation. BRAND NEW complete with electrode stand and manual. Full details on request. £35.

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Nos. 36402 and 36411. Unused with handbook. List Price £300/£320. Our Price £65.

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TT1S Transistor Tester	£37 10
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VM77C AC Millivoltmeter	£40 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 33% 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.

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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. Cathode follower probe for H.F. testing. Operates from A.C. mains 100 to 250 volts. A completely reliable quality instrument. Supplied fully checked with all leads, graticule, visor, circuit etc. £22/10/- Carr. 30/-.

**AVO CT38 ELECTRONIC MULTIMETER**

95 range Valve Voltmeter incorporating 14 D.C. and 14 A.C. current ranges from 10µA f.s.d. to 25A f.s.d. Voltage ranges from 250 mV f.s.d. to 10,000V f.s.d. for both D.C., A.C. and low radio frequencies. Radio frequencies up to the order of 250 Mc/s. are covered with diode head used externally. The input resistance on D.C. volts is 10MΩ or 100MΩ dependent on the range in use. Four resistance ranges cover from 0.2Ω to 1000MΩ, whilst 30 wattage ranges give readings from 50µW f.s.d. to 5W f.s.d. Supplied in perfect condition with all accessories. £22/10/- Carr. 15/-.

**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 capacitors 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.

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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.

**PULSE GENERATOR. MARCONI TYPE TF.675 F.**

Repetition frequency 50 c/s. to 50 kc/s. Pulse duration 0.15 to 100µ sec. Variable amplitude positive or negative pulses of up to at least 30 volts peak across a load of 1kΩ or 50 volts across 100kΩ. Internal 0.1 and 0.5µ sec. delay lines. BRAND NEW complete with Manual. List Price £125. Our price £45.

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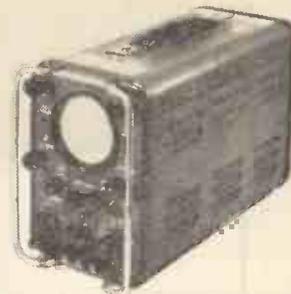
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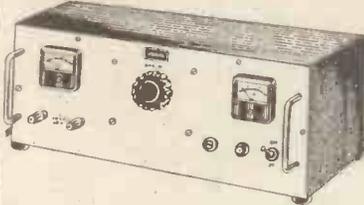
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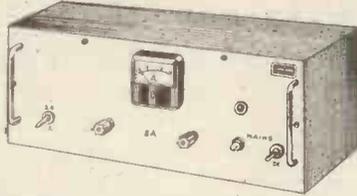


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L.T. TRANSFORMERS TURN TO PAGE 108

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75 .5/6	9024 2/6
76 .5/6	9026 2/6
77 .5/6	9028 2/6
78 .5/6	9030 2/6
79 .5/6	9032 2/6
80 .5/6	9034 2/6
81 .5/6	9036 2/6
82 .5/6	9038 2/6
83 .5/6	9040 2/6
84 .5/6	9042 2/6
85 .5/6	9044 2/6
86 .5/6	9046 2/6
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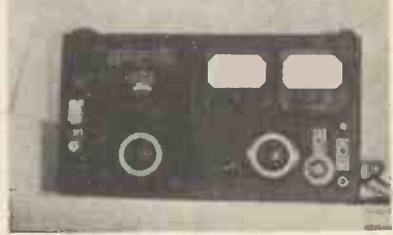
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**MELODY SIX. MED & LONG WAVES.** 6 transistors and 2 diodes. Push-pull output, tuning condenser, ferrite rod aerial. 3in. speaker, etc.,  $6\frac{1}{2} \times 3\frac{1}{2} \times 1\frac{1}{2}$ in. ONLY 59/6. P. & P. 3/6. Plans and parts list 2/- (free with kit).



**POCKET FIVE. MED. & LONG WAVES & TRAWLER BAND.** 5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, 3in. speaker, etc.  $6\frac{1}{2} \times 3\frac{1}{2} \times 1\frac{1}{2}$ in. ONLY 42/6. P. & P. 3/6. Plans and parts list 1/6 (free with kit).

**SUPER SEVEN. MED. LONG & TRAWLER BAND.** 7 transistors and 2 diodes. 3in. speaker, 2 R.F. stages, push-pull output, etc.  $7\frac{1}{2} \times 5\frac{1}{2} \times 1\frac{1}{2}$ in. ONLY 79/6. P. & P. 3/6. Plans and parts list 2/- (free with kit).

**ROAMER SEVEN Mk. 4.** 7 wavebands—MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. 7 transistors and 2 diodes. Ferrite rod aerial and telescopic aerial. Socket for car aerial. 7 x 4in. speaker. Airspaced ganged tuning condenser, etc. Size  $9 \times 7 \times 4$ in. ONLY 15/19/6. P. & P. 5/6. Plans & parts list 3/- (free with kit).



**ROAMER SIX.** 6 wavebands—MW1, MW2, SW1, SW2, LW and Trawler Band. 6 transistors and 2 diodes. Ferrite rod and telescopic aeriels. 3in. speaker. Top grade components. Size  $7\frac{1}{2} \times 5\frac{1}{2} \times 1\frac{1}{2}$ in. ONLY 79/6. P. & P. 3/6. Plans and parts list 2/- (free with kit).

**RADIO EXCHANGE. 61 High Street, Bedford.**

**Phone: 52367**

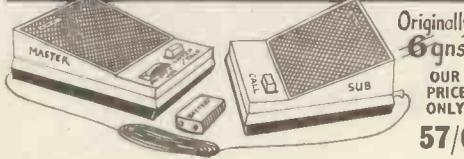
### 4-STATION INTERCOM



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. 6/6 in U.K.

Usually 18/6  
Our Price Only  
**£6/9/6**

### INTERCOM/BABY ALARM



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. 3in. 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 18 gns. P. & P. 12/6 in U.K.

### Transistor TELEPHONE AMPLIFIER



Why not increase efficiency of Office, Shop and Warehouse with this incredible De-Luxe Portable Transistor TELEPHONE AMPLIFIER which enables you to take down long telephone messages or converse without holding the handset. A useful office aid. A must for every telephone user. 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.

Usually 6/6  
OUR PRICE ONLY

**55/-**

**WEST LONDON DIRECT SUPPLIES (W.W.),**  
169 Kensington High Street, London, W.8

## ADVANCE TEST EQUIPMENT

- VM76 Valve Voltmeter**  
R.F. Measurements in excess of 100 MHz and d.c. measurements up to 1,000V with accuracy of  $\pm 2\%$ . D.c. range—300 mV-1 kV f.s.d. A.c. range—300 mV-300 V r.m.s. Resistance in 8 ranges, 0.02-500 Megohms.  
**Manufacturer's price £90: Our price £72**
- VM77C: A.C. Millivoltmeter**  
1 mV-300 V full scale in 12 ranges. Freq. range 15 c/s-4.5 Mc/s. Input impedance 10 Megohms 20 p.f. Calibrated in r.m.s. volts for sine wave input and dB. 100-250 V a.c. input.  
**Manufacturer's price £55: Our price £40**
- VM78: A.C. Millivoltmeter**  
Transistorised. 1 mV-300 V in 12 ranges. Freq. 1 c/s-1 Mc/s. Input impedance 2 Megohms 60 p.f. Calibrated in r.m.s. for sine wave and input dB.  
**Manufacturer's price £70: Our price £55**
- TT1S: Transistor Tester (CT472)**  
Suitable for measuring medium and low powered transistors. Current gain (B) can be measured in range 10 to 500 for p.n.p. and n.p.n. types, either in circuit using the clip on probes provided. Small compact instrument.  
**Manufacturer's price £57: Our price £37/10/-**

Special offer of 10% discount for schools and Technical Colleges, etc. These are current production, manufactured in U.K. by Advance Electronics Ltd. (not discontinued models). BRAND NEW, all in original sealed carton. Carr. 10/- extra per item.

- VM79: UHF Millivoltmeter**  
Transistorised. A.c. range 10 mV-3 V f.s.d., 10 ranges. D.c. current range 0.01  $\mu$ A-0.3 mA f.s.d., 10 ranges. Resistance 1 Ohm-10 Megohms in 7 decade ranges. Complete with probe.  
**Manufacturer's price £180: Our price £125**
- J1B Audio Signal Generator**  
15 c/s-50 kc/s in 3 ranges. Output 600 Ohms, 0.1 mW-1 W (0.25-24 V), variable. Attenuation 20 dB-600 Ohms (Attenuator is incorporated), output 10 mW (2.5 V). 100-250 V a.c.  
**Manufacturer's price £46: Our price £30**
- J2B Audio Signal Generator**  
Same specification as for the J1B except that this model has an additional 2 in. meter calibrated 0-40 V a.c.  
**Manufacturer's price £50: Our price £35**
- H1B: Audio Signal Generator**  
15 c/s-50 kc/s in 3 ranges. Sine wave 200  $\mu$ V-20 V r.m.s. Square wave 1.4 mV-140 V peak to peak (approx.). 100-250 V a.c.  
**Manufacturer's price £42: Our price £30**
- SG66: LF Generator**  
5 c/s-125 kc/s. Sine and square wave in 5 ranges. Output is indicated with 2 in. square meter. Decade attenuator range of 50 dB. 100-250 V a.c.  
**Manufacturer's price £95: Our price £65**

S.A.E. for all enquiries. If wishing to call at Stores, please telephone for appointment.

# W. MILLS

3-B TRULOCK ROAD, TOTTENHAM, N.17

Phone: Tottenham 9213

**DE-ICER Controller Mk. 3.** Contains 10 relays D.P. changeover heavy duty contacts, 1 relay 4P, C/O (235 ohms coil). Stud switch 30-way relay operated, one five-way ditto, D.C. timing motor with Chronometric governor 20-30 volts 12 R.P.M.; geared to two 30-way stud switches and two Lexed solenoids, 1 relay relay, etc., scaled in steel case, size 4 x 5 x 7in. £3 each, post 7/6.

**GEARED MOTORS (Reversible).**

24 v. Open gears with governor approx. 10 r.p.m., 25/-, post 2/6.  
A.C. Motor 115 v. 50 c/s. 1/300 H.T.P., 3000 r.p.m. Capacitor 1mf., 25/-, post 3/-. Dalmotor SC5, 28 v. D.C. at 45 amps; 12,000 r.p.m. output 750 W. (approx. 1 h.p.), brand new, £2/10/- each, post 7/6.  
28 v. D.C., 200 r.p.m. (ideally suited for opening garage doors), current consumption approximately 6 amps. Price £3/10/-, postage 7/6.

**CONDENSERS.** 10 mfd. 1,000 v., 12/6, post 2/6. 8 mfd., 1,200 volts, 12/6, post 3/-. 8 mfd. 600 volts, 8/6, post 2/6. 0.25 mfd., 2 kv., 4/-, post 1/6.

**AUTOMATIC PILOT UNIT Mk. 2.** This complex unit of diodes and valves, relays, magnetic clutches, motors and plug-in amplifiers, with many other items, price £7/10/-. £1 carriage.

**U.S.A. DESK MICROPHONE CRV/5108/A.** Complete with 7 yards of screened cable and universal jack (adjustable), 10/- each, post 3/-.  
TS125A, with leads, etc., price, £25, carriage 10/-.

**APNI ALTIMETER TRANS. REC.,** suitable for conversion 420 mc/s. complete with all valves 28 v. D.C. Dynamotor and 3 relays, 11 valves, price £3 each, carr. 10/-.

**TRANS./RECEIVER UNIT Mk. 3.** Freq. 2 to 8 mc/s., RT or CW., MCW., requires external power supply. Complete station, £9, carriage 25/-.  
Trans-rec. only, £3/10, carr. 15/-.

**ROTARY TRANSFORMERS.** 24 v. input, 175 v. at 40 mA output 25/-, plus 2/- post. 12 v. input. 225 v. at 100 mA. output, 25/-, plus 3/- post (All the above are D.C. only).

**CANADIAN C52 TRANS./REC.,** freq. 1.75 to 16 mc/s. on three bands. R.T., M.C.W. and C.W. Crystal calibrator, etc., power input 12 volt D.C., new condition complete set. £50, carr. £2/10/-. Used condition in working order, £25, carr., £2/10/-. C52 receiver only (less outer case), £8/10/-. carr. 15/-. Transmitter only £7/10/-. carr. 15/-. Power unit C52 rec., new £3/5/-. Used power units in working order, £2/5/-. carr. 10/-.

**AVO MULTIRANGE No. 1 ELECTRONIC TEST SET:** £25 each, carr. £1.

**HRO RECEIVER.** Model 5T. This is a famous American High Frequency superhet, suitable for CW., and MCW., reception crystal filter, with phasing control. AVC, and signal strength meter. Freq. range 50 kc/s. to 30 mc/s., with set of nine coils. Receiver only in working order, £18/10/-. carr. 15/- each. Set of nine coils, £12/10/-. available only with set. Power unit for HRO, 100/240 v. A.C., £2/15/-. carr. 10/-.

**SPECIAL OFFER:** Complete HRO SET (Receiver, Coils & Power Unit) for £30, plus 30/- carr.

**HRO-M-SETS** available with UX type valves; secondhand cond., with 5 coil and power unit, £20 each, carr. 30/-.

**CONVERTERS.** Type 8a, 24 v. D.C., 115 v. A.C. at 1.8 amps 400 cycles, 3-phase, £6/10/- each, post 8/-.

**ADAPTOR WAVEGUIDES TO COAXIAL UG 183/U (M Band).** Price 30/- each, post 3/-.

**TRANS./REC.510/A.** This is a lightweight transmitter/receiver principally used for long range communications. Frequency tunable 2-10 Mc/s. and has facilities for "VOICE" or "CW" working. The operator can set up 4 crystal controlled channels within this band and select the required frequency by means of a switch on the panel of the transmitter. Power requirements 1½ v. and 90-7½ v. The power output is approx. 0.2 watts for "VOICE" (unmodulated) and 0.5 watts for "CW". Suitable for mobile units or can be used as a base station with improved aerial system. In excellent condition. £15 each, carr. 10/-.

**MARCONI DEVIATION TEST SET, TF934:** freq. 2.5-100 Mc/s. Can be extended to 500 Mc/s. Deviation range 0-3, 0-25 and 0-75 Kc/s. £35 each, carr. £1.

**MARCONI IMPEDANCE BRIDGE, TF-373:** inductance 5µh-100H in 5 ranges, capacity 5pF-100µF in 5 ranges, resistance .05 meg.-1 meg., power supply 250 v. A.C. £37/10/- each, carr. 15/-.

**CT.49 ABSORPTION AUDIO FREQUENCY METER:** freq. range 450 c/s-22 Kc/s., directly calibrated. Power supply 1.5 v.-22 v. D.C. £12/10/- each, carr. 15/-.

**TACAN.** Trans./Receiver, same as ARN21, British made, STC, TR9171 complete with five 2C39As with associated valve-holders. As new, price £25. Used condition, £15, carriage £1.

**RELAY UNITS.** 2 high speed relays H96E, 1700 + 1700 ohms, 1 change-over relay 14,000 ohms, 1 CV 455, 100 ohms and 1 meg. pot., etc. Mounted in box, 4in. x 6in. x 3in., 30/- each, 4/- post.

**RECEIVERS.** Type AR88D: freq. 540 Kc/s-32 Mc/s. £45 each, carr. £2.

**AR88 SPEAKERS.** New in cartons, metal case with black crackle finish. 59/6 ea., post 7/6.

**AR88 SPARES.** Antenna Coils L5 and 6 and L7 and 8. Oscillator coil L.55. Price 10/- each, post 2/6. By-pass Capacitor K.98034-1, 3 x 0.05 mfd. and M.98034-4, 3 x 0.01 mfd., 3 for 10/-, post 2/6. Trimmers, 95534-502, 2-20 p.f. Box of 3, 10/-, post 2/6. Block Condenser, 3 x 4 mfd., 600 v., £2 each, 4/- post. Filter Choke, L45 and 50, K901433-501, 25/- each, 4/- post.

**MARCONI VARIABLE ATTENUATOR:** TF338B, 0-150dB, impedance 600 ohms, as new, £10 each, used cond., £5 each, carr. 15/-.

**AIRCRAFT RECEIVER ARR2.** 235-258 Mc/s. tunable, 24 v. D.C. input, £3 ea. 7/6 carr.

**SIGNAL GENERATORS:**

**MARCONI TF-144G:** freq. 85 Kc/s.-25 Mc/s, internal and external modulation, power supplies 200/250 v. A.C. (Secondhand cond.), price £25 ea.; or available in transit case complete with spares, in first class condition £30 ea., carr. on both 30/- ea.

**TS155c/UP** (as new): price £75 each, carr. £1.

**CT53.** Freq. range 8.9-300 Mc/s. with calibration chart. Output 1µV-100 mV. internal square wave and sinewave modulation at 100 c/s., external modulation 50 c/s.-10 Kc/s, 230 v. A.C. Complete with chart, etc., price £27/10/- ea., carr. £1.

**MARCONI TF801A/1** Freq. 10-300 Mc/s, 4 bands, output 200mV, Attenuator 0-110dB. Input 75 ohms. £65 each, carr. £1.

**MARCONI TFS17-F/1:** Covering 10-18 Mc/s, 33-58 Mc/s., 150-300 Mc/s. £10 each, carr. £1.

**MARCONI CT218:** price £65 each, carr. 30/-.

**CT.480 and 478:** 1.3-4.2 Mc/s, F.M. or A.M., price £75 each, carr. 30/-.

**TELEPHONE EQUIPMENT:**

**GPO STANDARD DESK TELEPHONES,** new £2 each, or £3/15/- a pair, post 7/6 per telephone.

**GPO 'CANDLESTICK' TYPE TELEPHONE.** Upright model with receiver, ideal novelty for converting to lampshade. Available any colour, £5/10/- ea., post 7/6.

**TELEPHONE WIRE:** 220 yds., 15/- a roll, post 4/-.

**GPO TERMINAL BLOCKS, FUSE AND PROTECTOR,** 7/6 each, post 2/6.

**TELEPHONES (PORTABLE) TYPE "F"** Suitable for all outdoor activities up to a range of 5 miles, in excellent condition. Price, complete with batteries, £5/10/- per pair, carriage 10/-.

**TELEPHONES TYPE "L"** Portable in excellent condition. £3 a pair (without batteries), post 10/6.

**TELEPHONE EXTENSION CORD.** Brown, 3-way; comes in lengths of 6ft. and 14ft. 7/6 and 15/- respectively. Post 2/6.

**BATTERY CHARGERS:** 100-250 v. A.C. Input 12 v. 15 amp. Output (2-Rate Charger complete with Sun-vick thermal switch for fast or trickle charge), price £12/10/- each, carr. 30/-.

**COMMAND RECEIVERS:** Model 3-6 Mc/s. and 6-9 Mc/s., as new, price £5/10/- each, post 5/-.

**BC-433-G COMPASS RECEIVER:** Freq. 200-1,750 kc/s. in 3 bands, suitable for aircraft, boats, etc. Complete with 15 valves, power supply input 24 v. D.C. at 12 amps. Receiver only £5 each, Carr. 15/-.

**TCS MODULATION TRANSFORMERS,** 20 watts, pr. 6,000 C.T., sec. 6,000 ohms. Price 25/-, post 5/-.

**NIFE BATTERIES:** 6 v. 75 amps., new, in cases; £15 each, £1 carr.; 6 v. 160 amps., new in cases, £25 each, £1/10/- carr.; 4 v. 160 amps., new, in cases, £20 each, £1/10/- carr.

**LR.7 Cells,** only, 1.5 v. 75 amps., new, £3 each, 12/- carr. The above batteries are low resistance designed to give heavy surge for starting and can be stored for long periods without any effect to their performance.

**WAVE GUIDES FLEXIBLE CG-182/APM40.** Length 18 inches. Price £2 each, post 4/-.

**MACHMETERS:** Range 0 : 1 and 0 : 1.2, 6A/3384 & 5325 respectively, price 30/- each, postage 5/-.

**FUEL INDICATOR Type 113R :** 24 v. complete with 2 magnetic counters 0-9999, with locking and reset controls mounted in a 3in. diameter case. Price 30/- each, postage 5/-.

**AVOMETER MODEL 7** Secondhand condition, £12/10/- each, post 10/-.

**DRY BATTERIES, NO. 1.** HT 90 v. and 7½ v., size 2½in. x 3½in. x 5in., 5/- each, or 5 for £1, post 4/- and 7/6 respectively.

**BATTERY NO. 4** (suitable for bells, etc.) 4½V, size 4½in. x 6in. x 2½in. 5/- each. Post 3/-.

**UNISELECTORS** (ex equipment): 10 Bank, 50 Way, alternate wipe, £2/5/- ea. 6 Bank, 25 Way, alternate wipe, £2/2/6 ea. 8 Bank, 25 Way, £2/5/- ea. 6 Bank, 25 Way, £2 ea. 4 Bank, 25 Way, 35/- ea. All the above are 75 ohm coil. Postage 4/- per uniselector.

**DALMOTORS** (All ex equipment):

**Actuator Type SR-43:** 28 v. D.C. 2,000 r.p.m., output 26 watts, 5 inch screw thrust, reversible, torque approx. 25 lbs., rating intermittent, price £3 each, postage 5/-.

**Model PM84:** 28 v. D.C. @ 2 amps., 4,500 r.p.m., output 40 watts continuous duty complete with magnetic brake. Price £2 each, postage 4/-.

**Model SR-2:** 28 v. D.C. 7,000 r.p.m., duty intermittent, output 75 watts, price 25/- each, postage 4/-.

**MOTORISED ACTUATOR:** 115 v. A.C. 400 c/s. single phase, reversible, thrust approx. 3 inches complete with limit switches, etc. Price £2/10/- each, postage 5/- (ex equipment).

**D.C. MOTOR:** 27 v. D.C. with gear box, 4 r.p.m. Price 25/-, postage 3/- (ex equipment).

**GEARED MOTOR:** 28 v. D.C. approx. 200 r.p.m. complete with precision potentiometer 40k ±3%, 2.5 watts linear plus or -0.25% Price 30/-, postage 4/- (ex equipment).

S.A.E. for all enquiries. List available 6d.  
If wishing to call at Stores, please telephone for appointment.

**W. MILLS**

3-B TRULOCK ROAD, TOTTENHAM, N.17

Phone: Tottenham 9213

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LONDON'S LARGEST SUPPLIERS OF  
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OPEN ALL DAY  
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## MULTI-TAPPED TRANSFORMERS

**MOST TYPES, FULLY SHROUDED AND TERMINAL BLOCK CONNECTIONS. ALL PRIMARIES 220-240 VOLTS**

\*Denotes Unshrouded Types.

TYPE	SEC. TAPS	AMPS.	PRICE	CARR.
1A	25-33-40-50	15	£7 19 6	9/-
1B	25-33-40-50	10	£5 19 6	7/6
1C	25-33-40-50	6	£4 19 6	7/6
1D	25-33-40-50	3	£2 19 6	6/-
2A	4-16-24-32	12	£5 7 6	7/6
2B	4-16-24-32	8	£4 2 6	7/6
2C	4-16-24-32	4	£2 12 6	6/-
2D	4-16-24-32	2	£1 15 0	5/-
3A*	25-30-35	40	£12 15 0	15/-
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/-
4B	12-20-24	20	£5 19 6	8/6
4C	12-20-24	10	£3 19 6	7/6
4D	12-20-24	5	£2 15 0	6/-
5A	3-12-18	30	£7 5 0	7/6
5B	3-12-18	20	£5 9 6	7/6
5C	3-12-18	10	£3 5 0	5/-
5D	3-12-18	5	£2 5 0	6/-
6A	48-56-60	2	£2 17 6	4/6
6B	48-56-60	1	£1 19 6	4/6
7A*	6-12	50	£7 15 0	9/6
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/-
9A	15-30	1 1/2	19 6	4/6
10A	1-15	2	19 6	4/6
11A	6-3	15	£1 17 6	5/6

Note: By using the Intermediate Taps many other voltages can be obtained. Example: Range One: 7-8-10-15-17-25-33-40-50 v. Range Two: 4-8-12-16-20-24-32 v. Range Five: 3-6-9-12-15-18 v.

### SPECIAL OFFER OF WODEN TRANSFORMERS BRAND NEW

No. 1 PRI tapped 200-250 v. E.S. Sec. Tapped 8-15-25-28-30-33-35 v. 15 amps. Tropically finished table top connections. £5/17/6. Carr. 10/-.  
No. 2 PRI 240 v. E.S. Sec. No. 1. 50 v. 4 A. Sec. No. 2. 18-0-18 v. 1A. 55/- P.P. 7/6.  
No. 3. PRI tapped 200-250 v. E.S. Sec. 1. 315-0-315 v. 110 mA. Sec. 2. 175-0-175 25 mA. Sec. 3 5 v. 1.9 A. Sec. 4. 6.3 v. 3.1 A. Sec. 5. 6.3 v. CT4A. Sec. 6.3 v. CT2A. Sec. 6.3 v. 1A. "C" Core table top connections. 50/- P.P. 7/6.

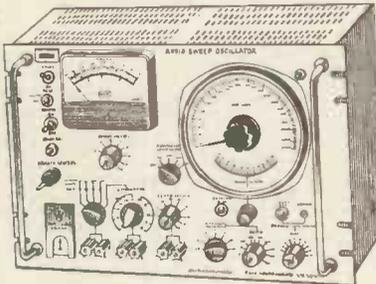
### SURPLUS L.T. TRANSFORMERS ALL BY FAMOUS MAKERS

A. Pri. 200-240 v. Sec. (1) Tapped 38 v., 40 v. 10A. Sec. (2), 6.2, 6.8, 7.3, 7.9, 8.5, 9, 9.5 10, 10.6 v. 18 amps. £7/10/- Carr. 10/-.  
B. Pri. 240 v. Sec. Tapped 53.6, 55.2 v. 6 amps. "C" core, 72/6. Carr. 7/6.  
C. Pri. 200-240 v. E.S. Sec. tapped 32, 34, 38, 40, 44, 46 v. 7 amps. 75/- Carr. 7/6.  
D. Pri. 200-240 v. Sec. 8 v. 6 amps 19/6. P.P. 4/6.  
E. Pri. 200-240 v. Sec. (1) 25 v. 3 A. Sec. (2) 10 v., 0.1 A. Sec. (3) 115 v. 9.6A., 29/6. P.P. 4/6.  
F. Pri. 240 v. Sec. (1) 45 v. 25 M/A. Sec. (2) 1 v. 1/2 amp. 15/- P.P. 3/6.  
G. Pri. 200-250 v. Sec. 6.2 v. 12.5 amps. tropically rated, 25/- Carr. 7/6.

### SMOOTHING CHOKES

PARMEKO Jupiter series Swinging Choke. 34H, 60mA D.C. 70H 34mA D.C. 2.5kv. D.C. Totally enclosed 25/- P.P. 4/6.  
PARMEKO Neptune series 0.7H 450mA 17/6. P.P. 2/6. 1H 300mA 17/6. P.P. 2/6.  
10H 150mA, 12/6. P.P. 2/6. 5H 150mA 10/6. P.P. 2/6. 10H 75mA, 10/6. P.P. 2/6. 5H 60mA 8/6. P.P. 2/6.  
PARTRIDGE 0.5 H, 4 Amps 2.5Ω. £4/10/-, Carr. 10/-.

### DAWE AUDIO SWEEP OSCILLATOR AND CONTROLLER TYPE 443B



20 c/s to 20 Kc/s in a Single Sweep Logarithmic Scale Calibration. Accuracy  $\pm 1\%$   $\pm 1$  c/s. Power supply 110 v. and 200-250 v. Dimensions: 19x12x13ins. Supplied Brand New with Instruction Manual. Less than half Maker's Price. £125, Ex Warehouse. Send 6d. Stamp for Data Sheet.

### DAWE AUTOMATIC L.F. SWEEP OSCILLATOR

Type 444C. 5 c/s to 5,000 c/s in a Single Range. 6-inch dia. dial with Logarithmic Calibration over 216° of Arc. Fre. Accuracy  $\pm 5\%$  Output continuously variable up to 10 v. R.M.S. into a minimum Loyd Resistance of 10KΩ. Monitored on a Panel Voltmeter Power Supply, 110 v. and 200-240 v. 50 c/s. Dimensions: 19x18x9ins. Supplied Brand new with Instruction Manual. Less than half Maker's Price. £100. Send 6d. Stamp for Data Sheet.

### WONDERFUL OFFER!!

SCOTCH MAGNETIC TAPE. Type 3M 459. 1/2 in. 3,600 feet. Suitable for video. Brand new in maker's sealed cartons. List Price £18/10/-. Our Price £3/19/6. P.P. 5/-.

### SMITH'S 4 MINUTE TIMERS

Switch contacts 15 amps 250 volts A.C., complete with chrome bezel and control knob. Min. operation time 30 seconds, max. 4 minutes, brand new, 17/6. P.P. 2/6.

### TEDDINGTON AIR PRESSURE SWITCHES

Type 13A 1AB. Single Pole, CO 250 volt 15 amp. switch contacts. Approx. 1/2 lb. pressure. 3 1/2 ins. dia. with mounting Bracket. 15/- P.P. 2/6.

### BRAND NEW ATLAS PROJECTOR LAMPS TRU-FOCUS

230 v. 750 w., med. pref. B.S.	25/-
115 v. 1,200 w. G17Q B.S.	35/-
115 v. 1,000 w. G17Q	30/-
115 v. 750 w. G17Q	25/-

P.P. all types, 2/-.

### OMRON MIDGET POWER RELAY

Type Mk. 2 24 volts. 2 heavy C.O. contacts. Size 1 1/2 x 1 1/2 x 1 in. 8/6. P.P. 1/6. Type MH401P 4 C.O. contacts, 530 ohms, with base. Size 1 1/2 x 1 1/2 x 1 in. 10/6. P.P. 1/6.

### AMERICAN OIL FILLED CAPACITORS

Mid. D.C.	Price	Post
10 1500	19/6	3/6
8 1000	12/6	3/6
8 600	8/6	2/6
7 600	6/6	2/6
1 600	3/-	1/6

### A.C. RATED CAPACITORS

Mfd. A.C.	Price	Post
45 250	35/-	5/-
25 300	25/-	4/-
10 650	17/6	3/6
5.25 650	12/6	3/-
5 400	10/6	3/-

### WESTINGHOUSE L.T. SUPPLY UNITS

A.C. input tapped 250-250v. D.C. output. Tapped 24-26 volts. Very conservatively rated at 8 amps. Also a separate Tapped A.C. Output of 6-10.6 volts, 18 amps. Completely enclosed in metal wall mounting case. Size: 15 1/2 x 9 x 6 1/2 in. Brand new, £9/10/-, Carr. 15/-.

### STABILISED L.T. SUPPLY UNITS

A.C. Input 220-240 v. D.C. Output Two independent sections giving 24 volts 5 amps. Open unit built in Chassis. Size: 26x7ins. Brand new. Fraction of Maker's Price. £25. Ex Warehouse.

### ZENITH 8 AMP. 0-260v. VARIACS

Factory reconditioned. Guaranteed £12/10/- P.P. Packing and carr. 20/-.

### PARMEKO H.T. TRANSFORMERS

Pri. 220-250v. Sec. 470-0-470v. 104 mA. 327-0-327v. 56mA. 309-0-309v. 35mA. 19-0-19v. 370mA. 6.4v. 3A. 6.4v. 2A. 6.4v. 1A. BRAND NEW, 50/-, Carr. 7/6.

### SPECIAL OFFER G.E.C. 8 MFD. BLOCK CAPACITORS

600v. D.C. wkg. at 71°C. Brand new in maker's cartons, six for 29/6. Carr. 7/6. S.T.C. 5 mfd. 400v. A.C. wkg. 7/6 each. P.P. 2/6.

### SPECIAL OFFER OF BRAND NEW HUNTS ELECTROLYTIC CAPACITORS

Can type 130+60+10 mfd. 350v. wkg. + 10 mfd. 500v. wkg. 25/- per dozen. P.P. 3/6. 100+50+50 mfd. 350v. wkg. 22/6 per dozen. P.P. 3/- 50+30+10 mfd. 350v. wkg. 19/6 per dozen. P.P. 2/6.

### REDCLIFFE HT TRANSFORMERS

Pri. tapped 200-250 v. Sec. 3 separate windings of 130 v. 450 mA. Tropicalised table top connections 45/- Carr. 6/-.

### LOW RESISTANCE SMOOTHING CHOKES

Shrouded type 0.05 H. 0.75Ω 2 amps. 39/6. P.P. 4/- 0.03 H. 0.4Ω, 4 amps. 49/6. P.P. 4/6. 0.02 H. 0.25Ω, 8 amps. 55/- P.P. 6/-.

### VARLEY A.C. 220-240v. SOLENOIDS

16 lb. pull continuous. Spindle length 1 1/2 in. Base size 2 1/2 x 2 1/2 in. H. 2 1/2 in., 25/- P.P. 6d. STC miniature 24v. D.C. solenoids. Spindle length 1 in. Size 2 x 1 1/2 x 1/2 in. Cont. rating, 8/6. P.P. 2/-.

### A.C. SYNCHRONOUS GEARED MOTORS

200-250 v., very powerful. 40 R.P.M. Size 2 1/2 x 2 1/2 x 3 in. Easily adapted to oscillate up to half a revolution. 12/6. P.P. 2/6.

### SMOOTHING CHOKES

PARMEKO Jupiter series Swinging Choke. 34H, 60mA D.C. 70H 35mA D.C. 2.5kv. D.C. Totally enclosed 25/- P.P. 4/6.

PARMEKO Neptune series 0.7H 450mA 17/6. P.P. 2/6. 1H 300mA 17/6. P.P. 2/6. 10H 150mA, 12/6. P.P. 2/6. 5H 150mA 10/6. P.P. 2/6. 10H 75mA, 10/6. P.P. 2/6. 5H 60mA 8/6. P.P. 2/6.

GARDNERS totally enclosed. 1H 1a, 39/6 Carr. 6/-.

### ISOLATION TRANSFORMERS

Fully shrouded. Terminal block connections. Pri. tapped 220-240 v. Sec. tapped 220-240 v. 1 amp. 75/- Carr. 5/- 2 amps. £6/15/-, Carr. 6/6. 3 amps. £7/19/6 Carr. 7/6. 4 amps. £8/10/-, Carr. 7/6.

# VIKING TRANSISTOR

## 40-50 WATT AMPLIFIER

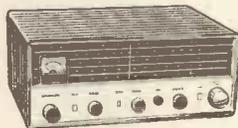
**OPERATING INSTRUCTIONS, GENERAL.** An extremely reliable lightweight amplifier capable of giving 40-50 watts of undistorted sound, made possible by the use of the latest semi-conductors (transistors) and techniques which ensure space-age reliability under the most rugged conditions. It is designed 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 1 only. **INPUTS—CONTROLS—CHANNEL 1 (Tremolo).** This contains two high gain input jack sockets controlled by Volume Control 1 which is mounted directly above the two sockets marked Tremolo. **BASS I.** Gives a controlled boost to the lower frequencies on Channel 1 only. **TREBLE I.** Gives a controlled boost to the high frequencies on Channel 1 only. **TREMOLO.** This operates on Channel 1 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.



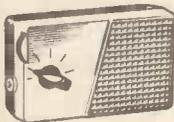
**VALVE VERSION OF THE ABOVE AMPLIFIER** 40-50 watt, A.C. Mains 200/250 volts for 3 and 15 ohm speakers. Price 27 gns. plus £1 postage and packing (No tremolo facilities on this amplifier).

## 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 Transistorised SIGNAL GENERATOR

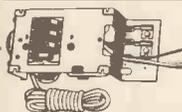


Size 5½ x 3¼ x 1¼ in. For I.F. and R.F. alignment and A.F. output. 700 c/s. frequency coverage 460 kc/s. to 2 Mc/s. in switched frequency. Ideal for alignment to our Elegant Seven and Musette. Built and tested. P. & P. 3/6. **39/6**

## POWER SUPPLY KIT

Incorporating "C" core type mains transformer, full wave metal rectification and smoothing condenser. Smooth output 250 v. 250 mA and 6.3 v. 4 amp., for Heaters.

A.C. Mains 200/250 v. **25/-** P. & P. 9/6.



## TRANSISTORISED 1½ WATT AMPLIFIER

comprising Mullard 2AC, 12B, 20C, 75 and 2 AA129 separate bass and treble volume controls. Complete with Power Supply A.C. mains, 240 v. Size 7½ x 3½ x 2in. Price 50/-, plus 2/6 P. & P.

## The KB DISCOMATIC

Provides 7½ hours of continuous music automatically. It plays up to 40 7in. 45 r.p.m. discs (80 sides) simply by pressing as many pre-selected buttons from one to eighty as required. At any time you can change your selections while playing. Or you can change the entire 40 discs by taking out one rack, inserting another. Complete with interior light, extension speaker sockets and transistorised amplifier. Dimensions: 10½ in. high x 20in. wide x 18in. deep. A.C. mains 240 v. Personal shoppers only. List price 73 gns. plus 10% P.T. surcharge.

Our Price Only **35 gns.**



## RADIO AND T.V. COMPONENTS (ACTON) LTD

21A HIGH STREET, ACTON, LONDON, W.3.

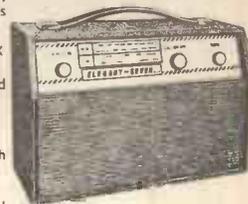
SHOP HOURS 9 a.m. to 6 p.m. EARLY CLOSING WEDNESDAY.

Goods not despatched outside U.K. All enquiries stamped add. envelope. Terms C.W.O.

# 'ELEGANT SEVEN' MK IIa

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.

## SPECIAL OFFER



- ★ De luxe grey wooden cabinet size 12½ x 8½ x 3½ in.
- ★ Horizontal easy to read tuning scale printed grey with black letters, size 1½ x 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 diagrams.
- ★ Car aerial socket.
- ★ Fully tunable over medium and long wave. 168-535 metres and 1,250-2,000 metres.
- ★ All components, ferrite rod and tuning assembly mount on printed board.
- ★ 5in. P.M. Speaker.
- ★ Parts list and circuit diagrams 2/6, free with parts.

ONLY **£4.40** 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 x 2 x 1½ in., 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

Size	Std.	850ft.	9/-	5in.	L.P.	850ft.	10/6	POST & PKG. ON EACH
7in.	Std.	1,200ft.	11/6	3in.	T.P.	600ft.	10/6	1/6.
3in.	L.P.	240ft.	4/-	5in.	T.P.	1,800ft.	25/6	
5½in.	L.P.	1,200ft.	11/6	5½in.	T.P.	2,400ft.	32/6	4 OR MORE
5in.	D.P.	1,800ft.	18/6	7in.	T.P.	3,600ft.	42/6	POST FREE.
7in.	L.P.	1,800ft.	18/6	4in.	T.P.	900ft.	15/-	

## 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 (I<sub>Q</sub>) current drain is approx. 12 mA at 9 volts (4 mA in the output pair). Printed circuit construction. Size: 2½ x 1½ x ¼ in. 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.

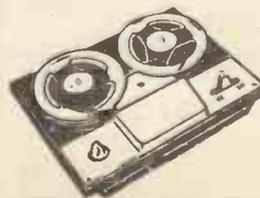
## GEC DOORBELL



Complete with mains transformer, 240 v. A.C., and bell push. Price 12/6 plus 5/6 P. & P.

## BSR TAPE DECKS

200/250 v. A.C. mains  
Type TD2, Tape speed 3½ twin track, £5/19/6.  
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 x 6 x 4in. Price 27/6, plus 5/- P. & P.

## 3 TO 4 WATT AMPLIFIER

3-4 watt Amplifier, built and tested. Chassis size 7 x 3½ x 1in. Separate bass, treble and volume control. Double wound mains transformer, metal rectifier and output transformer for 3 ohms speaker. Valves ECC81 and 6V6, £2/5/- plus 5/6 P. & P. The above in Kit Form, £1/14/6 plus 5/6 P. & P.



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**IMMEDIATE DESPATCH** FULL SPARES AND SERVICE AVAILABLE



**20 Amp. LT. SUPPLY UNIT**

As supplied to Min. of Defence and Crown Agents for overseas Govts. **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 x 12 x 20in. high, in heavy gauge steel cabinet. Grey Hammer finish—Weight: 50lbs. 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 18v. 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.

C. & P. 40/- G.B. (inland).

**£55.0.0**

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 x 7 x 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.

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.

**LATEST SOLID STATE VARIABLE VOLTAGE CONTROLS**

- ★ COMPLETELY SEALED.
- ★ COMPACT AND COMPLETE.
- ★ PANEL MOUNTING.

230 VAC Input. 25—230 volts output.  
5 amp. model £8.0.0  
10 amp. model £13.5.0



**CONSTANT VOLTAGE TRANSFORMERS AUTOMATIC MAINS STABILISER**

Maintain consistently accurate test gear readings.

- ★ No Moving parts.
  - ★ Corrected Wave.
- Input 190-270 v. A.C.  
Output: 240 v. A.C.  
Accuracy: ±1 per cent.  
Capacity: 250 watts.  
Fitted signal lamp and switch.



C. & P. 20/- **£12.10.0**

**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 x 5 x 5in. high.



PRICE **£8.17.6** C. & P. 12/6

**PORTABLE TRANSISTOR TESTER**

SUITABLE FOR PRODUCTION & LABORATORY USE SPECIFICATION.

Alpha 0.7 to 0.997  
Beta 5-300.  
ICO 0-50µA. 5 mA.  
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 and leads.



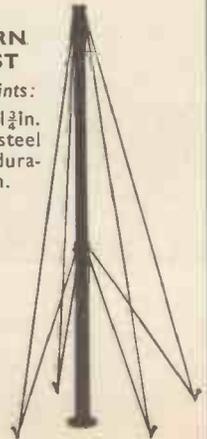
Only **£7.15.0** Plus 7/6 C.&P.

**36ft AERIAL MASTS**

**NEW!**  
LATEST PATTERN TUBULAR MAST

Check these vital points:

- ★ Made from 6ft. x 1¼in. dia. Sheradized steel sections, for durability and strength.
- ★ Extra strong locating base.
- ★ Top cap with fitted pulley and halyard
- ★ 2 sets (8) rot-proof guys
- ★ Rustproofed steel picketing stakes.



**ONLY £15.0.0** EX. WORKS  
Carriage 20/-  
Returnable wood case 30/-

**I.M.O. (ELECTRONICS) LTD.**

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**GEARED MOTOR**

Half rev. per minute. Made by famous Smith Electric, mains operated and quite powerful. Size 3 1/2 x 2 1/2 x 1 1/2 in. deep. Secondary use as pressure 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.



**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.

**BECKERSTAT**  
An Instant Thermostat. Simply push it into your wall socket and plug your fire or other appliance into it. Knob setting. Will save its cost in a season. Normally £2. We offer at 19/6. Plus 2/- post.



**INFRA-RED HEATERS**

Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow 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 ins. Pull switch 3/- extra.



**DRILL CONTROLLER**

Electrically changes speed from approximately 10 revs. to max. Pull power at all speeds by fingertip control. Kit includes all parts, case, everything and full instructions. 19/6, plus 2/6 post and insurance.

**THIS MONTH'S SNIP**

**FOUR-STATION INTERCOM.**



Will save time and improve efficiency. Ideal in home—office—shop—surgery, etc. Complete outfit comprises Master unit and three sub-stations, each of which can call the master and have full two-way working. No wiring problems as sub fitted with 60ft. twin flex and they plug into sockets. Also included is packet of staples—and battery. Nothing else to buy—plus 4/6 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, providing 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.

**2 1/2 kW FAN HEATER**



3 heat positions to suit changes in weather: 1 kW, 1 1/2 kW and 2 1/2 kW; also blows cold for summer, has thermostatic safety cut-out. Proper price £3/17/6. Yours for only £3/15/-, plus 7/6 post and insurance.

**G.U.T RECORD PLAYER**

BSR Record Player for normal music operation. This is the famous BSR Model G.U.T. Four speeds with automatic stop. Play any size of record and is complete with crystal cartridge and staphle strip. Special snip price this month: 67/6, plus postage & insurance 6/6.



**PP3 Eliminator.** Play your pocket radio from the national Save £s. Complete component kit comprises 4 rectifiers—minus dropper resistances, smoothing condenser and instructions. Only 6/6, plus 1/- post.

**WATERPROOF HEATING ELEMENT**  
26 yards length. 70 W. Self-regulating temperature control. 10/- post free.

**9-VOLT PRECISION MOTOR.**  
Intended for driving battery operated tape recorders and record players. Laminated, 6 Pole armature with Brush Gear and rapid start switch. Normally 25/-, Our Price 7/6, plus post and insurance 1/6.

**THERMOSTATS**  
Type "A" 15 amp. for controlling room heaters, greenhouse, airing cupboards. Has 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 1000°F. Suitable for controlling furnace, oven, kiln, immersion heater or to make flame-start or fire alarm. 8/6, plus 2/6 post and insurance.  
Type "D" We call this the Ice-stat as it cuts in and out 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 (18 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 covered 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—developed and chemical bath of all types. Adjustable over range 50° to 130°F. Price 15/-, plus 2/- post and ins.

**MAINS TRANSISTOR POWER PACK.**  
Designed to operate transistor sets and amplifiers. Adjustable output 6 v., 9 v., 12 volts for up to 600mA. (class B working). Takes the place of any of the following batteries: PP1, PP2, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, 5,000 and 500 mfd. condensers. Zener diode and instructions. Real snip at only 14/6, plus 3/6 postage.

Where postage is not definitely stated as an extra then orders over £3 are post free. Below £3 add 2/6. Meni-conductors add 1/- post. Over £1 post free.

**ALL PRICES GREATLY REDUCED**

Type No.	Price	Type No.	Price	Type No.	Price
2N1277	15/-	0A5	5/-	0C75	3/-
2N1278	10/-	0A10	6/-	0C76	3/-
2N1742	25/-	0A47	3/-	0C77	7/-
2N1747	25/-	0A70	2/-	0C78	3/-
2N1748	10/-	0A79	2/6	0C78D	3/-
AC107	9/-	0A81	2/6	0C81	3/-
AC127	4/-	0A85	2/6	0C81D	3/-
ACY17	8/6	0A90	2/6	0C82	3/-
ACY18	5/6	0A91	2/6	0C82D	3/-
ACY19	6/6	0A200	3/6	0C83	4/6
ACY20	5/6	0A202	4/3	0C84	4/6
ACT21	6/-	0C20	12/6	0C139	8/6
ACY22	4/6	0C22	10/-	0C140	12/6
AF114	4/-	0C23	8/-	0C170	5/-
AF115	4/-	0C24	15/-	0C171	4/-
AF116	4/-	0C25	8/-	0C200	9/-
AF117	4/-	0C26	7/6	0C201	12/6
AF118	4/-	0C28	8/-	0C202	13/6
AF139	12/6	0C29	17/6	0C293	12/6
AF186	17/6	0C35	10/-	0CF71	15/-
AF212	15/-	0C36	15/-	ORP12	8/6
AS221	15/-	0C38	12/6	ORP50	10/-
BC107	14/6	0C42	6/6	8B078	6/6
BY100	4/6	0C44	3/-	8B085	8/6
BY213	7/6	0C45	3/-	8B251	10/-
MAT100	7/6	0C46	3/-	8T140	3/-
MAT101	8/6	0C70	3/-	8T141	4/6
MAT120	7/6	0C71	3/-		
MAT121	6/8	0C72	3/-		

**SCR's (THYRISTORS)**

Pin	30V	100V	300V	400V
1 amp	6/6	7/6	8/6	9/6
3 amp	7/6	8/6	9/6	10/6
25 amp	30/-	35/-	47/6	60/-

**SILICON RECTIFIERS**

Rated and guaranteed.	750mA	100v.	1/3	1 Amp.	100v.	3/-
					200v.	4/-
					400v.	6/-
3A					10 Amp.	9/6
					400v	12/6
					400v	14/6

Sub-miniature glass encased—only approx. 1/4 in. long, wire ended.  
400mA 50v. 1/6 100v. 2/6  
200v 4/6.

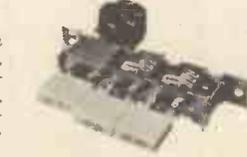
**FLUORESCENT CONTROL KITS**  
Each kit comprises seven items—Choke 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes (for fish tanks and indoor plants). Chokes are super-silent, mostly resin filled. Kit A.—15-20 w. 19/6. Kit B.—30-40 w. 17/6. Kit C.—80 w. 17/6. Kit D.—125 w. 22/-, Kit E.—65 w. 19/6. Kit MF1 is for 6in. 5in. 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, & 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.

**GANGED POTS**  
Standard type and size with good length of spindle—made by Morganite. List price is 10/- each but if you act quickly you can have them at 12/- doz. (or 1/6 each if less than doz.). Following values in stock all 1in. —5K+5K—10K+10K—100K+100K—500K+500K all new and unused. Post 2/6 on 1st doz. then 1/- per doz. 6 doz. or more post free.

**HURSEAL AUTOMATIC TIME SWITCH**  
12 hour. 15A to control heating, lighting, immersion heaters, etc. Regular price £4/4/-. Limited quantity 39/6. P. & P. 3/6.

**3-PUSH SWITCH**

for test meter, hi-h 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 re-marking. 2/3 each. 24/- doz.



**BATTERY OPERATED TAPE DECK**

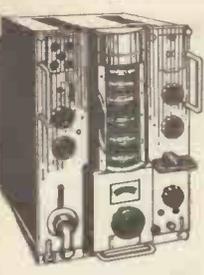


With Capstan control. This unit is extremely well made and measures approx. 6 x 5 x 2 1/2 in. deep. Has three piano key type controls for Record, Playback and Rewind. Motor, is a special heavy duty type intended for operation off 4 1/2 volts. Supplied complete with spools ready to install. Record. Replay head is the sensitive M4 type intended for use with transistor amplifier. Price £4/15/-. Post and insurance 4/6.

**ELECTRONICS (CROYDON) LIMITED**  
(Dept. W.W.), 102/3 TAMWORTH RD., CROYDON, SURREY (Opp. W. Croydon Stn.)  
also at 266 LONDON ROAD, CROYDON, SURREY.

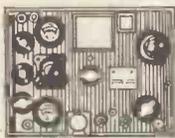
**ADMIRALTY B.40 RECEIVERS**

Just released by the Ministry. High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 850 Kc/s.-50 Mc/s. I.F. 500 Kc/s. Incorporates 2 R.F. and 3 I.F. stages, bandpass filter, noise limiter, crystal controlled B.F.O. calibrator, I.F. output, etc. Built-in speaker, output for phones. Operation 150/230 volt A.C. Size 19 1/2 in. x 13 1/2 in. x 16 1/2 in. Wt. 114 lbs. Offered in good working condition, £22/10/- Carr. 30/-. With circuit diagrams. Also available B41 L.F. version of above. 15 Kc/s-700 Kc/s. £17/10/-, carr. 30/-.



**COLLINS TCS TRANSMITTERS**

Frequency range 1.5-12 Mc/s. in 3 bands. Employ 7 valves. 2 or 1625 PA. 1625 Buffer, 1625 Mod., 3 x 12 A6 Osc. R.T. or C.W. V.F.O. or provision for Xials, incorporate plate and aerial-current meters. Require ext. P.S.U. Offered in excellent condition. £28/10/6 carr. 15/-.



**TWO-WAY RADIOS**

**SUPERB QUALITY, BRAND NEW & GUARANTEED**

- 3 TRANSISTOR £6/15/- PAIR.
- 4 TRANSISTOR £7/19/6 PAIR.
- 5 TRANSISTOR £8/4/- PAIR.
- 6 TRANSISTOR £9/19/6 PAIR.
- 6 TRANSISTOR DE-LUXE LAFAYETTE £17/10/- PAIR.
- 10 TRANSISTOR £22/10/- PAIR.
- 13 TRANSISTOR 500 MW 2-channel 30 ans. PAIR.
- 13 TRANSISTOR 1 WATT 2-channel £35 PAIR.

POST EXTRA



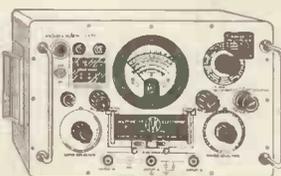
**LAFAYETTE HI-FI SOLID STATE STEREO AMPLIFIERS**

Latest 1967 models now available. Outstanding performance from modern semi-conductors. Provision for all types of inputs and outputs and comprehensive tone controls. Attractive metal cased free standing units.



Model LA-234T. 30 watt £25 Car. 7/6  
Model LA-60T. 60 watt £37/10/- Carr. 7/6. Details on request.

**AVO CT.38 ELECTRONIC MULTIMETERS**



High quality 97 range instrument which measures A.C. and D.C. Voltages, Current, Resistance and Power Output. Ranges: A.C. and D.C. volts 100 mV. to 250 V.; A.C. and D.C. current 10µA-1 amp.; watts 50µW to 5 W.; Resistance 0-200 M.Ω. Incorporates automatic protection against overload. Operation 0/110/200/250 v. A.C. Supplied in perfect condition complete with circuit, lead and R.F. probe. £25. Carr. 15/-.

AVO CALIBRATION TEST UNIT TYPE CT.155. For use with CT.38 Multimeter. Gives 7 standard voltages 250 mV./1 v./2.5 v./10/25/100 v. A.C. and 250 millivolts D.C. from internal standard cell. Operation 0/110/200/250 v. A.C. Brand new £7/10/- P. & P. 10/5.

**TRANSISTORISED TWO-WAY TELEPHONE INTERCOM**

Operative over amazingly long distances. Separate call and press to talk buttons. 2-wire connection. 1000s of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. £5/10/6 pair. P. & P. 3/6.



**LAFAYETTE HI-FI STEREO HEAD PHONES**



- ★ Air cushioned headband
- ★ Soft rubber ear pads
- ★ Frequency response, 25 to 15,000 cycles
- ★ High sensitivity. Impedance 8 ohms per phone. Supplied complete with all cables, wires, overhead junction box and 3-connection plug. 79/6. P. & P. 2/6.

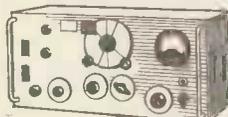
**POWER RHEOSTATS**

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing. 1/4 in. 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. 18/25/50/100/250/500/1000/1500/2500 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.



**MARCONI TEST EQUIPMENT**

TF.144G. STANDARD SIGNAL GENERATOR, 85 Kc/s. 25 Mc/s. 200/250 v. A.C. £25. Carr. 30/-. TF.229G. Q METER. Brand new with all accessories £75. Carr. 30/-. TF.195M. BEAT FREQUENCY OSCILLATOR 0-40 Kc/s. 200/250 v. A.C. £20. Carr. 30/-. All above offered in excellent condition fully tested and checked and after at a fraction of original cost.



**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.

**COSSOR 1035 MK. III DOUBLE BEAM OSCILLOSCOPES**

A limited supply of these latest improved oscilloscopes now available in excellent condition. Use miniature valves and are much lighter than older models. Fully guaranteed. £45. Carr. 30/-. Also available Mk. I £35. Carr. 30/-.



**TYPE 13A DOUBLE BEAM OSCILLOSCOPES BARGAIN**



A high quality instrument offered at a fraction of original cost. Timebase 2 c/s-750 cps. Separate Y1 and Y2 amplifiers up to 5.5 Mc/s. Built-in calibrators at 100 kc/s. and 1 Mc. Operation for 115/250 v. A.C. Available in excellent condition, fully tested and checked, £22/10/- Carr. 30/-.

**NOMBREX Transistorised Equipment ALL Post Paid With Battery**



Model 22. P.S.U. 0 15v. D.C. £14  
Model 30. Audio generator, 10 c/s.-100 kc/s., £19/10.  
Model 31. R.F. Generator, 150 kc/s.-350 Mc/s. £12/10/-  
Transistorised Audio Generator 10-100,000 c/s. Sine or square wave £16/15  
Transistorised resistance capacity bridge 10 100 Meg. 0.1 pf. 100 pF. £9.  
Transistorised Induction bridge 1µH-100H. £18. Mains operated Transistor power supply unit, output 1-15 v. up to 100 mA. £8/10/-.

**LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYSER**



2 Ω - 2,000 MΩ. 2 elements. 200 megohms. Also checks impedance turns ratio, insulation, 200/250 v. A.C. Brand New. £15. 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 7/8; 1 way, 2 c/o, 2b. 7/8; 1 way, 4 c/o, 8/-; 2 way, 3m., 3m. 8/8; 2 way, 2 c/o, 4 c/o, 8/8; 2 way, 2 c/o, 4 c/o, 10/-  
Post extra. Quantities available.



**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 600 Ω 3.8 v. P/P. I.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.

**AMERICAN RECORDING TAPES**

- First grade quality American tapes. Brand new and guaranteed. Discounts for quantities.
  - 3in. 225ft. L.P. Acetate 4/-
  - 3in. 600ft. T.P. Mylar 10/-
  - 5in. 600ft. Std. plastic 8/6
  - 6in. 900ft. L.P. acetate 10/-
  - 5in. 1200ft. D.P. Mylar 15/-
  - 5in. 1800ft. T.P. Mylar 35/-
  - 5in. 1200ft. L.P. acetate 12/6
  - 5in. 1800ft. D.P. Mylar 22/6
  - 5in. 2400ft. T.P. Mylar 45/-
  - 7in. 1200ft. Std. acetate 12/6
  - 7in. 1800ft. L.P. Mylar ..... 15/-
  - 7in. 2400ft. D.P. Mylar ..... 20/-
  - 7in. 3600ft. D.P. Mylar ..... 25/-
  - 7in. 3600ft. T.P. Mylar ..... 58/6
- Postage 2/-. Over £3 post paid.



**★ TRANSISTORISED FM TUNER ★**



6 TRANSISTOR HIGH QUALITY TUNER SIZE ONLY 6in. x 4in. x 2 1/2in. 3 I.F. stages. Double tuned discrimination. Ample output to feed most amplifiers. Operates on 9 volt battery. Coverage 88-108 Mc/s. Ready built ready for use. Fantastic value for money.

**£6.10.0** P. & P. 2/6.

**GARRARD RECORD DECKS**

- SRP12 player mono or stereo .. £4 4 0
  - 1000 changer mono or stereo .. £5 15 6
  - 2000 changer mono or stereo .. £6 19 6
  - 3000 changer mono or stereo .. £7 19 6
  - SP25 player mono or stereo .. £9 19 6
  - SP25 with cast turntable .. £10 19 6
  - AT90 changer mono or stereo .. £10 10 0
  - AT60 Mk. II mono or stereo .. £11 11 0
  - AT70 changer less cartridge .. £19 19 6
  - LAB80 Mk. II changer less cart. £25 0 0
  - 401 transcription deck .. £27 6 0
- All plus 6/- P.P.

**Variable Voltage TRANSFORMERS**

Brand new, guaranteed and carriage paid. High quality construction. Input 230 v. 50-60 cycles. Output fully variable from 0-250 volts. Bulk quantities available. 1 amp. - £4/10/-; 2.5 amp. - £5/17/6; 5 amp. - £9; 8 amp. - £13/10/-; 10 amp. - £17; 12 amp. - £19/10/-; 20 amp. - £32/10/-.



**SILICON RECTIFIERS**

- 200 v. P.I.V. 200 mA ..... 2/6
  - 200 v. P.I.V. 8 amp. .... 5/6
  - 400 v. P.I.V. 3 amp. .... 7/6
  - 400 v. P.I.V. 6 amp. .... 5/6
  - 400 v. P.I.V. 8 amp. .... 7/6
  - 1,000 v. P.I.V. 650 mA. .... 6/6
  - 1,000 v. P.I.V. 5 amp. .... 7/6
  - 800 v. P.I.V. 500 mA. .... 5/6
  - 400 v. P.I.V. 5 amp. .... 3/6
  - 70 v. P.I.V. 1 amp. .... 3/6
  - 150 v. P.I.V. 165 mA ..... 1/-
  - 700 v. P.I.V. 100 amp. .... 49/6
  - 150 v. P.I.V. 25 amp. .... 19/6
- Discount for quantities. Post extra.

**THYRISTOR SILICON CONTROL RECTIFIERS**

- 400 P.I.V. 3 amp. .... 7/6
- 100 P.I.V. 5 amp. .... 13/6
- 200 P.I.V. 5 amp. .... 15/6
- 400 P.I.V. 5 amp. .... 17/6

**S.T.C. 1 WATT ZENER DIODES**

BRAND NEW, LIST 17/6 each. Available 2.4/2.7/3.3/3.9/4.3/13/16/18/20/30/33volts. 5/- each type. P. & P. extra.

**F.M. WIRELESS MICROPHONE**



94-104 Mc/s. Transistorised. Operates from 9 v. battery. Complete with additional secret tie-clip microphone. List £12/10/- ONLY £8/15/- P. & P. 2/6.

**G. W. SMITH & Co. (Radio) Ltd.**  
3-34, Lisle St., W.C.2.  
ALSO SEE OPPOSITE PAGE

# MULTIMETERS for EVERY purpose!

**LAFAYETTE DE-LUXE 100 KΩ/VOLT "LAB TESTER."** Giant 6 1/2 in. scale. Built-in meter protection.

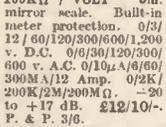


0.5/2.5/10/50/250/500/1,000 v. D.C. 0.3/10/50/250/500/1,000 v. A.C. 0/10/100μA/10/100/500 mA / 2.5/10 Amp. 0/1K/10K/100K/10M/100MΩ. -10 to 49.4 dB. £16/16/- P. & P. 5/-

**TE-900 20,000Ω/VOLT GIANT MULTIMETER** 6 1/2 in. full view meter. 2 colour scale. 0.2/5/10/250/1,000/5,000 v. A.C. 0/2.5/10/50/250/1,000/5,000 v. D.C. 0/50μA/110/100/500 mA/10 amp. D.C. 02K/200K/250 MEG. OHM. £12/10/8. P. & P. 5/-



**MODEL AS - 100D.** 100KΩ / VOLT 5in. mirror scale. Built-in meter protection.



0/3/12/60/120/300/600/1,200 v. D.C. 0/6/30/120/300/600 v. A.C. 0/10μA/6/60/300mA/12 Amp. 0/2K/200K/2M/200MΩ. -20 to +17 dB. £12/10/- P. & P. 3/6.



**NEW MODEL 500, 30,000 O.P.V.** with overload protection. mirror scale. 0.5/2.5/10/25/100/250/500/1,000 v. D.C. 0.2/5/10/25/100/250/500/1,000 v. A.C. 0/50μA/5/50/500 mA. 12 amp. D.C. 0/60K/6 Meg./80 Meg. Ω. £8/17/6. Post paid.

**MODEL TE-12, 30,000 O.P.V.** 0/0.5/30/120/600/1,200/3,000/6,000 v. D.C. 1/6/30/120/600/1,200 v. A.C. 0/60μA/6/60/600 mA. 0/6K/600K/6 Meg./60 Meg. Ω. 50 P.P. 3 MFD. £5/19/6. P. & P. 3/6.



**MODEL AF-105, 50KΩ/Volt.** Mirror scale, built-in meter protection. 0/3/12/60/120/300/600/1,200 v. D.C. 0/6/30/120/300/600/1,200 v. A.C. 0/30μA/6/60/300 mA. 12 Amp. 0/10K/1M/10M/100 MΩ -20 to +17 dB. £8/10/- P. & P. 3/6.



**MODEL TE-80, 20,000 O.P.V.** 0/10/50/100/500/1,000 v. A.C. 0/6/25/50/250/500/1,000 v. D.C. 0-50μA. 5/50/500mA. 0/8K/60K/600 K/6 meg. £4/17/6. P.P. 3/-

**MODEL 500D. WITH METER PROTECTION.** 30,000 o.p.v. 0/1.5/5/50/250/1,000 v. D.C. 0/2.5/10/50/250/1,000 v. A.C. 0/0.5/5/50/250 mA. 0/5K/50K/500K/5 meg. Ω. 0.001-.2 mfd. -20, -22 dB. £5/15/0 P. & P. 3/-



### PROFESSIONAL 20,000 o.p.v. LAB. TYPE MULTITESTER



With automatic overload protection. Mirror scale. Ranges 0/10/50/200/500/1,000 v. D.C. and A.C. 0-500μA. 10 mA. 250 mA. Current 0/20K. 200K. 2 megohm. Decibels -20 to +22 dB. £5/10/- P. & P. 2/6.



**MODEL TE-70, 30,000 O.P.V.** 0/15/60/300/600/1,200 v. D.C. 0/6/30/120/600/1,200 v. A.C. 0/30μA/3/30/300 MA. 0/16K/160K/1.6M/16 Meg. Ω. £5/10/- P. & P. 3/-

**MODEL TE-10A, 90 KΩ/Volt.** 0/25/50/250/500/2,500 v. D.C. 10/50/100/500/1,000 v. A.C. 0/50μA/2.5 mA./250 mA. D.C. 0/6K/6 meg. ohm. -20 to +22 dB. 10-0.100 mfd. 0.100-0.1 mfd. 69/6. P. & P. 2/6.



**MODEL PT-34, 1,000 O.P.V.** 0/10/50/250/500/1,000 v. A.C. and D.C. 0/100/500 mA. D.C. 0/100 KΩ. 39/6. P. & P. 1/6.



**MODEL 250J, 2,000 O.P.V.** 0/10/50/500/2,500 v. D.C. 0/10/50/500/2,000 v. A.C. 0/2 Meg. Ω. 0/250 mA. -20 to +36 dB. 49/6. P. & P. 2/6.

### MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0.7-0.9967. B: 5-200. Ico: 0/50 microamps. 0.5 mA. Resistance for diode 200Ω +1 MEG. Supplied complete with instructions, battery and leads. £5/19/6. P. & P. 2/6.



**R.C.A. AR88 SPEAKERS** 8", 3 ohm speakers in metal case. Black crackle finish to match our 88 Receivers. Available Brand New and Boxed with leads. 59/6. Carr. 7/6.

# CATALOGUE



- ★ ELECTRONIC COMPONENTS
- ★ TEST EQUIPMENT
- ★ COMMUNICATION EQUIPMENT
- ★ HI-FI EQUIPMENT

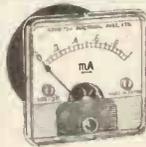
We are proud to introduce our first comprehensive catalogue of Electronic Components and Equipment. Over 150 pages, fully illustrated, listing thousands of items, many at bargain prices. Free discount coupons with every catalogue. Everyone in electronics should have a copy.

Send today 5/- P & P 1/-

Send for your Copy now

### CLEAR PLASTIC PANEL METERS

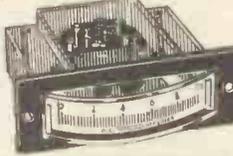
First grade quality. Moving Coil panel meters, available ex-stock. S.A.E. for illustrated leaflet. Discounts for quantity. Available as follows: Type MR, 38P, 1 21/32in. square fronts.



100-0-100μA	27/6	200μA	22/6	100V D.C.	22/6
500-0-500μA	22/6	300mA	22/6	150V D.C.	22/6
1-0-1mA	22/6	500mA	22/6	300V D.C.	22/6
1mA	22/6	700mA	22/6	500V D.C.	22/6
2mA	22/6	1A D.C.	22/6	750V D.C.	22/6
3mA	22/6	2A D.C.	22/6	16V A.C.	22/6
10mA	22/6	5A D.C.	22/6	50V A.C.	22/6
20mA	22/6	3V D.C.	22/6	150V A.C.	22/6
100μA	29/6	50mA	22/6	10V D.C.	22/6
200μA	27/6	100mA	22/6	20V D.C.	22/6
500μA	25/-	150mA	22/6	50V D.C.	22/6
50-0-50μA	29/6				

POST EXTRA. Larger sizes available—send for lists.

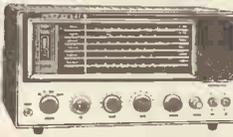
### NEW RANGE OF "SEW" EDGEWISE METERS



**MODEL PE 70** Dimensions 3 1/4 in x 1 1/2 in x 2 1/2 in deep overall Available as follows:

50 microamp	52/6	600 microamp	42/6
50-0-50 microamp	49/6	1 milliamper	39/6
100 microamp	49/6	300 volt A.C.	39/6
100-0-100 microamp	45/-	VU meter	55/-
200 microamp	45/-	Post extras	

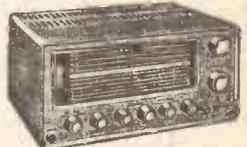
### LAFAYETTE MODEL HA-500 SSB/AM/CW 80 THROUGH 6 METRE RECEIVER



New outstanding Ham Bands only receiver covering the 80/40/20/15/10/8 metre bands. Incorporates 10 valves, product detector, two mechanical filters, 8 Meter, dual conversion on all bands, crystal calibrator, B.F.O. noise limiter, aerial trimmer, I.F.s, 2,808 Mc/s, and 455 Kc/s. Output 8 ohms and 500 ohms. Operations 250/240 volt A.C. Supplied brand new and guaranteed with handbook 42 Gns. Carr. 10/- 100 Kc/s. crystal. 35/-

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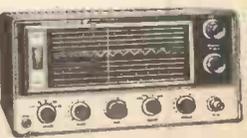
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4" 450' AGFA only	14/-	10/6	4" 600' AGFA only	24/-	18/-	4" 900'	38/6	29/-	5 1/2" 1800'											
4 1/2" 600' AGFA only	22/6	17/-	4 1/2" 900' AGFA only	35/6	26/8	4 1/2" 1200' AGFA only	47/6	35/9	7" 2400'	115/-	86/3									
5" 900'	21/-	15/-	5" 1,200' KODAK only	52/6	39/6	5" 1800'	65/6	49/3												
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4" 450'	14/6	11/8	<b>Triple Play</b>			4" 450'	14/6	11/8	<b>Triple Play</b>		
4 1/2" 600' BASF	21/-	16/10	3" 450'	22/-	17/8	5" 900'	27/6	22/-	3" 600'	24/9	19/6
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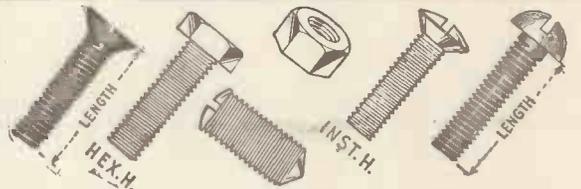
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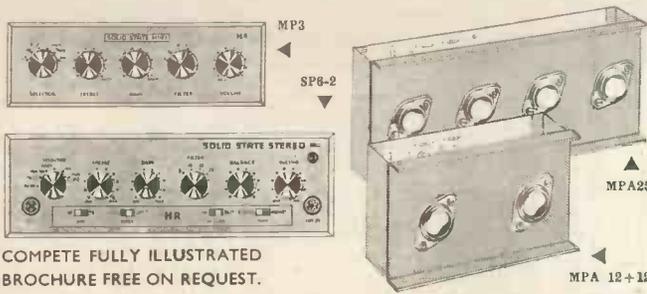
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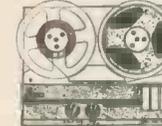
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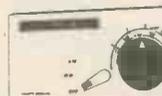
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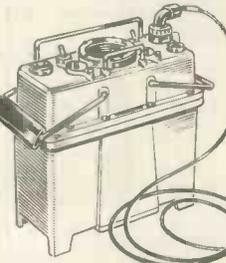
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**MATCHED TRANSISTOR PACKS:**  
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All goods are new, first quality brands only, and subject to maker's full guarantee. We do not handle manufacturers' seconds nor rejects, which are often described as "new and tested" but have a limited and unreliable life.  
Terms of business: Cash with order only. Post/packing 6d. per item. Orders over 25 post/packing free. All orders cleared on day of receipt. Any parcel insured against damage in transit for val of 6d. extra. Callers welcome Mon.-Fri. 9-5 p.m. Sat. 9 a.m.-1 p.m. Complete catalogue of valves, transistors and components with conditions of sale, price 6d.

# DIGITAL VOLTMETERS!



For the first time ever, we proudly present a three digit A.C./D.C. voltmeter for less than £100!

Manufactured by the world famous Hawker Siddeley Group at its Gloucester Works, the Digimeter Type B.I.E. 2123 is a fully transistorised multi-range instrument possessing the following distinctive features:—

**Electrical Characteristics:**

D.C. Ranges: 10mV to 400 V. in four ranges (1000 V for positive voltages).

Accuracy: the greater of ±0.1% of ±1 digit.

A.C. Ranges: 100 mV to 250 V. r.m.s. in three ranges

Accuracy: the greater of ±0.5% or ±1 digit over the frequency range 30 c/s to 10 Kc/s.

Range Change is manual.

Input Impedance: D.C.—15 Mohm on two lower ranges, 1 Mohm on two higher ranges.

A.C.—A.C. coupled, approximately equivalent to a shunt impedance of 8 Kohm in series with the parallel impedances 180 Kohm and 550pF.

Input Characteristics: Single ended, floating. The potential between terminal connected to OV and earth should not exceed 400 V D.C. or 250 V A.C.

Input Filter: 55dB attenuation at 50 c.p.s.

Conversion Time: 300m Sec.

Sampling Rate: 1 reading per 2 secs or manually controlled.

Power Supply: 100/120 V. 200/250 V. 50 c.p.s.

**Mechanical Characteristics:**

Dimensions: 10 1/2 in. high x 7 in. wide x 13 in. deep.

Weight: 15 lbs.

Display Details: Three digit with decimal point indication. Character Height 1 in.

At the price we can offer these instruments, no laboratory can afford to be without one! They are ideally suited to production and inspection applications.

Brand new in manufacturer's packing. With Handbook. **£92.10.0**

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**IMMEDIATE DELIVERY!**

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**HIVOLT PORTABLE E.H.T. GENERATOR**  
Variable output from 0 to 10kv. D.C., Megohms range 200 to 10<sup>3</sup>. A small modern completely portable instrument. Fully transistorised C/W batteries. Weight complete 21 lbs. New condition. **£35**

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For the first time offered in new, boxed condition. Frequency range 38-1,000 Mc/s. Accuracy 1%. Five I.F. stages. Output impedance 600 or 4,000 ohms. Power supply 115 v A.C. (internal). Price complete with three tuning units. NEW £90.

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Output 175 watts can be supplied with variable frequency oscillator 10 c/s to 14 Kc/s. C/w with all usual facilities for, 19in. rack mounting supply volts 240 V A.C. Price £75 + carriage.

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In excellent working condition also Model 1049 D.C. oscilloscope. Prices are £25 and £30 for the 1049, plus 30/- packing and carriage.

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With separate P.S.U. and all leads, plugs, etc., brand new, packed in two transit cases, priced at only £10, plus 30/- p.p.

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All brand new stock. Values 1,000 ohms, 500 ohms, 50K. Price 30/-, p.p. 1/6.

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2 pole 30-way per wafer 6 bank, a master piece in switches, brand new in maker's cartons. Price 80/-.

**100 WAY MINIATURE SAMPLING SWITCHES**

The unit consists of a geared motor driving through a segmented commutator, the outputs are terminated to flying leads, voltage required for motor is 6 V D.C. Brand new. Price 85/-.

**SODECO IMPULSE COUNTERS**

Type TCeZ4PE with pre-selection counting back to Zero as soon as the pre-set number of impulses have been received, voltage 24 V D.C. 185 mA Imp/s 10, 4 digit. Brand new stock. Price £5 ea.

**VEEDER ROOT IMPULSE COUNTERS**

Six digit type with manual reset for 230 V A.C. operation, £4/10/-, p.p. 2/-.. Also same type as above for 110 V D.C. operation, £3/10/-, p.p. 2/-.

**AIRCRAFT RECEIVER TYPE 1392**

Range 100-156 Mc/s. C/W new, original P.S.U. plugs, etc. for operation on 200/250 V. A.C., these receivers were intended for crystal control operation, full details to enable you to make simple conversion supplied with each installation. Price £10, plus carriage 25/-.

**TUNING UNITS ANAPR4**

Complete RF tuning head for the APR4 receiver two types available frequency range 38-95 Mc/s. Price £15. Also Type 3. Frequency range 300-1,000 Mc/s. Price £25. Both types are supplied with Auto Sweep Mechanism and circuit diagrams.

### AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS



Heavy cast construction. Latest high efficiency ceramic magnets. Treated cone surround giving low fundamental resonance. "D" indicates Tweeter Cone providing extended frequency range.

Impedance 3 or 16 ohms. Response 40-18,000 c.p.s.

HF800D 8 in 8 watt	22 19 9	HF120 12 in 15 watt	23 9 9
HF12D 12 in 10 watt	24 19 9	HF120D 12 in 15 watt	23 19 9
HF110D 10 in 8 watt	23 9 9	HF128 12 in 15 watt	24 9 9
HF10D 10 in 15 watt	25 19 9	HF128D 12 in 15 watt	25 5 0
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NEW RANGE OF LINEAR HI-FI AMPLIFIERS IN STOCK

### RECORD PLAYING UNITS

All types available on Credit Terms. Ready for plugging in to Amplifier or Tape Recorder.

**RP2** Consisting of Garrard SP25 fitted Goldring C890 high compliance ceramic Stereo/Mono cartridge with diamond stylus above, plinth and cover. 19 1/2 Gns. Normally £25. Carr. 15/-.

**RP3** As above but with Goldring Lenco GL68 Transcription unit and C890 Cartridge. 26 1/2 Gns. Normally over £33. Carr. 15/-.

**RP3M** with Plekering Magnetic Cart. 34 1/2 Gns. ridge.

### AUDIOTRINE PLINTHS



for Record Playing units. Peak finish only for Garrard 1600, 2000, 3000, AT6 Mk. 2 AT60, SP25 or Goldring GL68. Available with clear Perspex cover as illustrated.

66/-

£5/10/11 complete.

### HIGH FIDELITY LOUDSPEAKER UNITS

Cabinets of latest styling Satin Teak or Walnut, acoustically lined (and ported where appropriate). Credit Terms available on all units.

**The FULTON** Size 11 x 14 x 7 1/2 in. Fitted Volume Control. Ideal as sensitive ext. unit for Tape Recorder etc. Incorporates Audiotrine HF810 8in. speaker with cast chassis and treated cone surround. Response 45-18,000 c.p.s. Rating 8 watts. Imp. 3-15 ohms. Carr. 7/6. **£5.15.0**



**The DORSET** Size 20 x 11 x 8in. Response 45-18,000 c.p.s. Rating 10 watts. Fitted Audiotrine HF811D Speaker 15 ohms. Carr. 9/6. **£8.19.9**

**The DORCHESTER** Size 24 x 15 x 10in. Fitted Audiotrine HF101D Speaker. Rating 12 watts. Impedance 3 or 16 ohms. Frequency Response 30-20,000 c.p.s. Carr. 15/-. **12 1/2 Gns.**

### The BRONTE

Size 22 x 15 x 9in. Fitted Wharfedale Super 8 RBDD or Audiotrine HF 815D Speaker, with Roll surround and dust cone. Rating 6/10 watts. Imped. 3 or 16 ohms. Carr. 10/6. **13 Gns.**

### The GLOUCESTER

Size 25 x 16 x 10in. 12in. High Flux 12,000 line speaker. Cross-over unit and Tweeter. Rating 10 watts. Smooth response 40-20,000 c.p.s. Impedance 15 ohms. Carr. 10/-. **12 1/2 Gns.**



### R-S-C TA12 13 WATT STEREO AMPLIFIER

FULLY TRANSISTORISED. SOLID STATE CONSTRUCTION. HIGH FIDELITY OUTPUT OF 6.5 WATTS PER CHANNEL. Designed for optimum performance with any crystal or ceramic Gram P.U. Cartridge, Radio Tuner, Tape Recorder, "Mike", etc. ★ 3 separate switched input sockets on each channel. ★ Separate Bass and Treble controls. ★ Slide Switch for mono use. ★ Speaker Output 3-15 ohms. ★ For 200-250V. A.C. mains. ★ Frequency Response 30-20,000 c.p.s. -2dB. ★ ± Harmonic Distortion 0.3% at 1,000 c.p.s. Hum and Noise -70dB. ★ Sensitivities (1) 300mV (2) 100mV (3) 100mV (4) 2mV. ★ Handsome brushed silver Facia and Knob. Complete kit of parts with full wiring diagrams and instructions. 11 Gns. Carr. 10/6. Factory built with 12 month guarantee. **14 Gns.** Carr. Teak finished cabinet as illustrated £3/13/6 extra.



### R-S-C-13 WATT HI-FI STEREO SYSTEM



Inc. Garrard SP25 Player Unit Fitted Goldring C890 high compliance ceramic cartridge with diamond stylus. TA 12 Stereo Amp., Plinth and Cover and pair of Dorset Speaker Units. Total £56. Release to use **42 Gns.** Carr. 25/-.

### AUDIOTRINE HIGH FIDELITY SPEAKER SYSTEMS

Consisting of matched 12in. 12,000 line, 16 ohm high quality speaker, cross-over unit and Tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. Standard 10 watt rating. Or Senior 20 watt inc. **5 Gns.** Carr. 192/10 speaker 7 Gns. Carr. 8/9. Carr. 6/9

### LOUDSPEAKER CORNER CONSOLE CABINETS

Attractive design. With polished walnut finish. Model 59/11 Model 8 for 15" speaker and 5 Gns. M for 10" speaker. Size 29 x 19 x 12in. 11 Gns. Carr. 10/6. Model 12 for 12" speaker and 5 Gns. Carr. 10/6. Model 14 for 14" speaker and 5 Gns. Carr. 10/6.

### HI-FI LOUDSPEAKER ENCLOSURES

All types pleasing modern design acoustically lined and ported and beautifully finished in light Teak or Walnut veneer. Credit terms available.

**JES.** Size 20 x 11 x 8in. Gives pleasing results with any 8in. Hi-Fi speaker. Carr. 7/6. **£4.19.9**

**SE8.** For optimum performance with any Hi-Fi 8in. speaker. Size 22 x 15 x 9in. Carr. 7/6. **£5.19.9**

**SE10.** For 10in. Hi-Fi Speaker with provision for Tweeter. Size 24 x 16 x 10in. Carr. 10/-. **£6.19.9**

**SE12.** For outstanding performance with any 12in. Hi-Fi speaker. Carr. 8 Gns. Size 26 x 16 x 10in. Carr. 10/-. **8 Gns.**

ALL LEADING MAKES HI-FI EQUIPMENT & FURNITURE IN STOCK

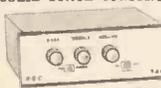
### AUDIOTRINE HI-FI TAPE RECORDER KIT

REALISM AT INCREDIBLY LOW COST: CAN BE ASSEMBLED IN AN HOUR. ONLY 4 PAIRS OF SOLDERED JOINTS PLUS MAINS. S.A.E. for leaflet. Incorporating the latest Magnavox Tapedeck, High Quality Tape Amplifier with switched equalisation for each of 3 speeds. High Flux P.M. Speaker, empty Tape Pool, a Reel of Best Quality Tape and handsome Portable Cabinet of latest styling finished dark grey leathercloth. Size 14 1/2 x 17 x 8 1/2 in. and circuit. Purchased separately would total approx. £34. Performance equal to units in the £50-£60 class. Deposit 4 gns. and 9 monthly payments 59/6 (Total 29 1/2 gns.) 4 Track Model 3 gns. extra. Carr. 19/6. **26 1/2 Gns.**



### RSC TA6 6 WATT HIGH FIDELITY SOLID STATE AMPLIFIER

SOLID STATE CONSTRUCTION 200-250V. AC mains operated



Frequency Response 30-20,000 c.p.s. ±1dB. Harmonic Distortion 0.3% at 1,000 c.p.s. Separate Bass and Treble "lift" and "cut" controls. 3 input sockets for Mike, Gram, Radio or Tape. Input Selector Switch. Output for 3-15 ohm speakers. Max Sensitivity 5mV. Fully enclosed, mounted case, 9 1/2 x 2 1/2 x 3 1/2 in. Attractive, brushed silver facia plate 10 x 3 1/2 in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. Or factory built with 12 months guarantee £7/19/11. **6 Gns.** Carr. 7/6.

### R.S.C. TFM1 TRANSISTORISED VHF/FM RADIO TUNER

★ High-sensitivity. ★ 200-250V. A.C. Mains operation. ★ Sharp A.M. Rejection. ★ Drift-free reception. ★ Simple amp for any amplifier (approx. 500 m.v.). ★ Simple alignment instructions. ★ Output available for feeding tuning meter. ★ Output for feeding Stereo Multiplexer. ★ Tuner head using Silicon Planar Transistors. ★ Designed for standard 80 ohm co-axial input. ★ Blade to match our Super 15 and 30 amplifiers and of the same high standard of performance and reliability. The pre-wired tuning head facilitates speed and simplicity of construction. Printed circuitry. Only first grade transistors and components used. Our latest product giving you the best at half the cost of comparable units. Stereo version available. Carr. 10/-. **25 1/2 Gns.**



### R.S.C. SUPER 15 HI-FI AMPLIFIER R.S.C. SUPER 30 STEREO AMPLIFIER

FULLY TRANSISTORISED 200/250V. A.C. Mains. OUTPUT 10 WATTS R.M.S. cont. into 15 ohms. 15 WATTS R.M.S. cont. into 3-4 ohms.

LATEST MULLARD TRANSISTORS. AD149, AD149, OC127Z, OC81Z, OC44, OC44, OC81Z, OC44, AC107.

5 POSITION INPUT SELECTOR SWITCH EQUALISATION to Standard R.I.A.A. and C.C.I.R. Characteristics for Gram and Tape Heads.

FULL TAPE MONITORING FACILITIES.

SENSITIVITIES: Magnetic P.U. 4 mV. Crystal or Ceramic P.U. 400 mV. Microphone 4.5 mV. Tape Head 2.5 mV. Radio/Aux or Ceramic P.U. 110mV.

FREQUENCY RESPONSE: ±2dB 20-20,000 c.p.s.

TREBLE CONTROL: +15dB to -14dB at 10 Kc/s. NEG. FEEDBACK: 52dB.

BASS CONTROL: +12dB to -15dB at 50 c/s. HUM LEVEL: 75dB.

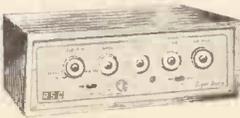
HARMONIC DISTORTION at 10 Watts R.M.S. 1,000 c.p.s. 0.25%.

Complete Kit of parts with full constructional details and point to point wiring diagrams. Carr. 12/6. **11 1/2 Gns.**

Supplied factory built 15 Gns. Carr. 12/6. Terms: Deposit 49/- and 9 monthly payments 35/- (Total £18/4/-). Or fitted in beautiful walnut or Teak veneered cabinet as illustrated 4 Gns. extra.

ALL COMPONENTS ETC. ARE OF A HIGH STANDARD AND SUPPLIED BY LEADING BRITISH MANUFACTURERS.

SOLID STATE CONSTRUCTION SPECIFICATIONS COMPARABLE WITH UNITS AT ALMOST TWICE THE COST



A DUAL CHANNEL VERSION OF THE SUPER 15. Employing Twin Printed Circuits, Close tolerance (100µ) Parts. Matched Components. CROSS TALK: -52dB at 1,000 c.p.s.

CONTROLS: 5 position Input Selector, Bass Control, Treble Control, Volume Control, Balance Control, Stereo/Mono Switch, Tape Monitor Switch, Mains Switch.

INPUT SOCKETS (Matched Pairs). (1) Magnetic P.U. (2) Ceramic or Crystal P.U. (3) Radio/Aux. (4) Tape Head/Microphone. Operation of the Input Selector Switch assures appropriate equalisation.

Rigid 18 s.w.g. Chassis. Size approx. 12in. Wide. 3in. High and 8in. Deep. Neon Panel Indicator. Attractive Facia Plate and 5pin Silver Matching Knobs. Also facilities, etc., except for Ganging and Balance Control, apply also to Super 15.

THESE UNITS ARE EMINENTLY SUITABLE FOR USE WITH ANY MAKE OF PICK-UP OR MICROPHONE (Crystal, Ceramic, Magnetic, Moving Coil, Ribbon). CURRENTLY AVAILABLE. SUPERB SOUND OUTPUT QUALITY CAN BE OBTAINED BY USING WITH FIRST RATE ANCILLARY EQUIPMENT. All required parts, point to point wiring diagrams\* and detailed instructions, Carr. 14/-. **19 Gns.**

Unit factory built 26 1/2 Gns. or deposit £3/9 and 9 monthly payments 59/3 (Total £30/17/-). \*fitted cabinet as Super 15 30 Gns. Carr. 15/- or Deposit £4/15/6 and 9 monthly payments 67/- (Total £34/18/8).

Send S.A.E. for leaflet.

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HI-FI CENTRES LTD.

MAIL ORDERS TO: 102 Henconner Lane, Bramley, Leeds 13. No C.O.D. under £1. Terms C.W.O. or C.O.D. Postage 4/6 extra under £2.5/9 extra under £5. Trade supplied. S.A.E. with enquiries please. HI-FI CATALOGUE 4/6 Open all day. Sats. except High Holborn branch.

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**R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER**

5 watts high quality output on each channel. Sensitivity 60 millivolts. Suitable all crystal or ceramic stereo heads. Ganged Bass and Treble Controls. Provision for use as (mono) 10 watt. Valve line up EC083, EC083, EL84, EZ81. For 2-3 ohm speakers. Complete kit with wiring diagrams and instructions. Or supplied factory assembled with 12 months' guarantee for £11 gns. Terms: Dep. 36/- and 9 monthly payments 25/6 (Total £134/9). Carr. 11/6.

**£8.15.0**

**R.S.C. STEREO/20 HIGH FIDELITY AMPLIFIER**

PROVIDING 10/14 WATT ULTRA LINEAR PUSH-PULL OUTPUT ON EACH CHANNEL. SUITABLE FOR "MIKE", ORAM., RADIO OR TAPE. 7 Valves EC083 (2), EC188 (4), EZ81. Frequency Response:  $\pm 2dB$  30-20,000 c.p.s. Hum Level: 65dB down. Sensitivity: 5 millivolts max. Harmonic Distortion: (each channel): 0.2%. ★ Four-position tone compensation and Input Selector Switch. ★ Stereo/Mono switch.

★ Will amplify direct from Tape Heads. ★ Neon panel indicator. ★ Handsom' Perspex Frontplate. ★ Separate Bass "Lift" and "Cut" and treble "Lift" and "Cut" Controls. Output transformers are high-quality sectionally wound. Output for 3 and 15 ohm spkrs. Complete set of parts, point-to-point wiring diagrams and instructions. Or factory assembled, with our usual 12 months guarantee, **19 Gns.** Carr. 12/6. Or Deposit £3 and 9 monthly payments 42/3 (Total £228/6). Send S.A.E. for leaflet.

**R.S.C. A10 30 WATT ULTRA LINEAR HI-FI AMPLIFIER**

Highly sensitive. Push-Pull high output, with Pre-amp, Tone Control Stages. Performance figures equal to most expensive amplifiers available. Hum level -70dB. Frequency response  $\pm 3dB$  30-20,000 c/s. Specially designed sectionally wound ultra linear output transformer with 807 output valves. All first grade components. Valves E196, E196, EC083, 807, 807, GZ34. Separate Bass and Treble Controls. Sensitivity 12 millivolts so that any kind of Microphone or Pick-up is suitable. Designed for Clubs, Schools, Theatres, Dance Halls or Outdoor Functions, etc. For use with Electronic Organ, Guitar, String Bass, etc. Gram, Radio or Tape. Reserve L.T. and H.T. for Radio Tuner. Two inputs with associated volume controls so that two separate inputs such as Gram and "Mike" can be mixed. 200-250 v. 50 c/s. A.C. mains. For 3 and 15 ohm speakers. Complete kit of parts **12 gns.** Carr. fully punched chassis, point-to-point wiring diagrams and instructions. 12/6. Supplied factory built with EL34 output valves. 12 months' guarantee for 15 gns. If required perforated cover with carrying handles can be supplied for 2L/-. Send s.a.e. for leaflet. Terms: Deposit 48/- and 9 monthly payments of 33/7 (Total £171/0/3).

**R.S.C. A11 HIGH FIDELITY 12-14 WATT AMPLIFIER**

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP. Two input sockets with associated controls allow mixing of "mike" and gram, etc., etc. High sensitivity. Valves EC083, EC083, EL84, EL84, EZ81. High quality sectionally wound output transformer and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE. Frequency response  $\pm 3dB$  30-20,000c/s. Six negative feedback loops. Hum level -60dB. Sensitivity 23 millivolts. Suitable for Crystal or Ceramic P.U.s, all types "mikes". Comparable with the very best designs. For Musical Instruments such as String Bass, Electronic Guitar, etc. Reserve Power 300v, 30mA, and 5.3v. 1.5a. for Radio Tuner or Tape Amp. Size approx. 12 x 8 x 7in. For A.C. mains 200-250v, 50 c.p.s. Output for 3 and 15 ohm speakers. Full instructions and point-to-point diagrams (or factory built £11/15/-). Metal cover with 2 handles available **£8.15.0** for 21/- (Terms on ASSEMBLED UNITS: Deposit 26/6 and 9 monthly payments of 25/9 (Total £133/8/3) Send S.A.E. for leaflet. Carr. 11/6.

**R.S.C. TRANSISTORISED VERSION** of above Complete Kit **9 Gns.** Carr. 9/6. Complete kit with valves

**JASON VHF/FM TUNER** Complete kit with valves. **£6.19.11**

**R.S.C. 4 watt GRAM AMPLIFIER KIT**

Complete set of parts to build a good quality compact unit suitable for use with any record playing unit. Mains isolated chassis. Separate Bass and Treble controls. Output for 2-3 ohms speaker. For 200-250 v. A.C.

**SELENIUM RECTIFIERS F.W. (Bridges)**

All 6/12v. D.C. output. Max. A.C. input 18v. 1a 3/11. 2a 6/11. 3a 9/9. 4a 12/9. 6a 15/9.

**HEAVY DUTY SELENIUM RECTIFIERS** 19/9

12v. 16 amps., F.W. (Bridged). Only

**POWER PACK KIT** Consisting of mains transformer. Metal Rectifier Electrolytics, smoothing choke, chassis and circuit. 200/250v. A.C. mains. Output 250v. 60mA. 6.3v. 2a. Supplied with case in lieu of chassis 28/11. Or assembled 39/11.

**R.S.C. BATTERY/MAINS CONVERSION UNITS**

Type BM1. An all-dry battery eliminator. Size 6 1/2 x 4 1/2 x 2in. approx. Completely replaces batteries supply 1.5v. and 9v. where 'A.C.' mains 200/250v. 50c/s is available. Complete kit with diagram 47/9 or ready for use 59/11.

**GLASGOW - LONDON**

New branches open. See opposite page

LINEAR TAPE PRE-AMPLIFIER. Type LP/1 Switched Equalisation. Position for Recording at 1 1/2in., 3 1/2in., 7 1/2in. per sec., and Playback. EM84 Recording Level Indicator. Designed primarily as the link between a Magnavox Tape Deck and Hi-Fi amplifier suitable most **10 1/2 Gns.** Terms available.

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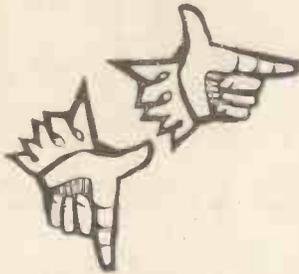
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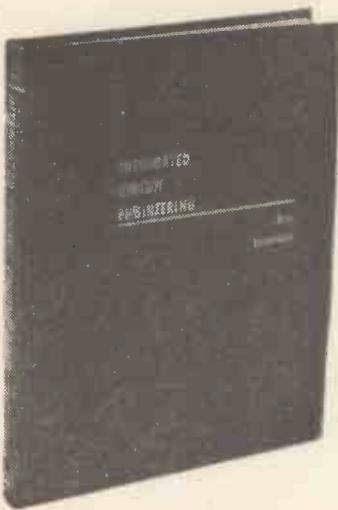
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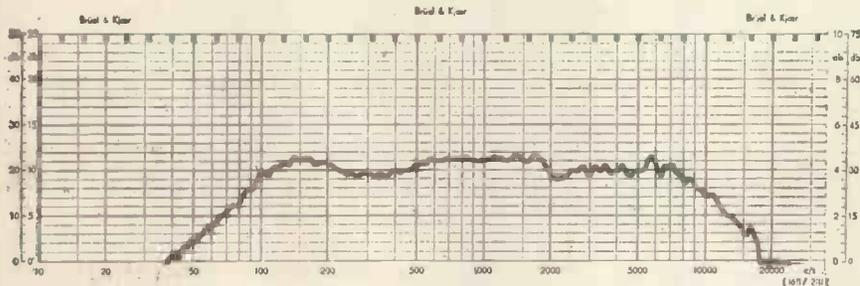
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- 15 OHMS IMPEDANCE
- AN ALL-BRITISH PRODUCT



This curve was taken by an independent testing laboratory and shows why the Sinclair Q.14 achieves such excellent reproduction. Smooth response is maintained to assure the finest possible results from any equipment to which the speaker is coupled. Curve taken against vertical 0-25 dB range and plotted on a log. scale.

## CONSTRUCTION

The sound, or pressure chamber and mounting baffle are of special high-density ultra-low resonance materials made possible by modern bonding and processing techniques. The sound chamber is of seamless construction. The driver unit is mounted to ensure freedom from spurious coloration.

## LOADING

The Sinclair Q.14 has an input impedance of 15 ohms and will comfortably accept loading in excess of 28 watts music power, far greater than that required for average listening requirements. Using the Q.14 in module formation (a unique Sinclair facility) enables a very powerful system to be built up efficiently and economically for highest quality P.A. use.

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Over to next pages, please

WW-160 FOR FURTHER DETAILS

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4. We are very pleased with it. J.D.W., Belfast.
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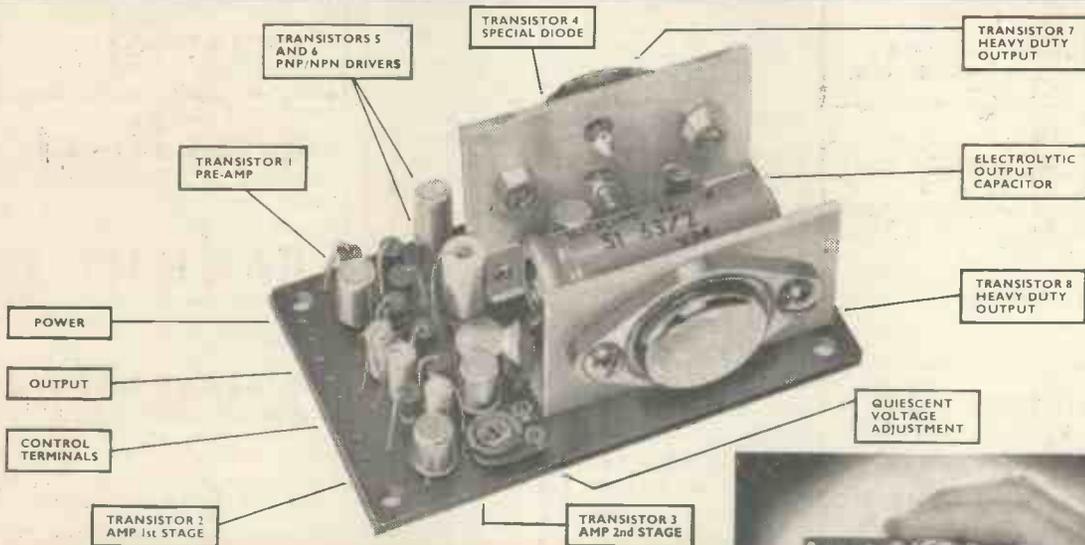
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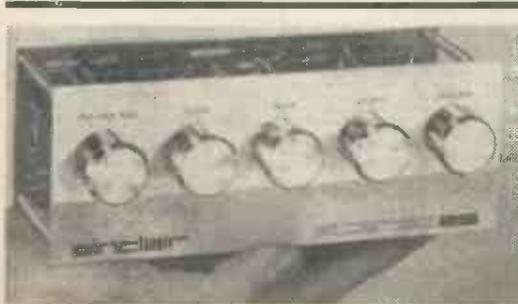
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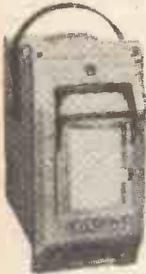
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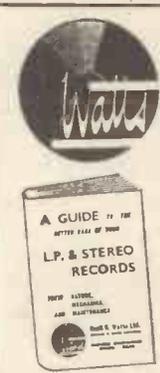
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## The Civil Service

Professional and Technical Appointments

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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):** On the scale £1,040-£1,985 (will become £1,110-£2,052 on 1st January, 1968) depending on age and qualifications. Good prospects of promotion. (Reference: S/85/ASO.)

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**QUALIFICATIONS:** Degree in Mechanical or Electrical Engineering, Physics, or Applied Physics or, exceptionally, very high professional attainment. Final year students may apply.

**SALARY (Inner London):** £877-£1,806. Promotion prospects.

**AGE:** At least 21 and normally under 35 on 31st December, 1967. Some extensions for service in H.M. Forces or Overseas Civil Service. (Reference: S/322).

The above posts are pensionable and **APPLICATION FORMS** are obtainable from the Secretary, Civil Service Commission, Savile Row, London, W.1. Please quote appropriate reference.

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Male Assistant Experimental Officers are required for a three-year tour of duty at Stanley, Falkland Islands, for operating and maintaining advanced apparatus for recording scientific information transmitted by telemetry from satellites (shift work).

Married staff live in rent-free accommodation in modern well-furnished bungalows.

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Minimum pay whilst overseas £800 per annum on scale rising to £1,318. Starting pay at 26 years (or over) £1,092. Additional overseas allowances and shift pay.

Send for details to:—

The Secretary, S.R.C., Radio and Space Research Station, Ditton Park, Slough, Bucks.

**TV Service Engineer & 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 WW 57, 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. [158]

**MEDICAL RESEARCH COUNCIL.** Electronics enthusiast wanted for interesting work on experimental apparatus in well equipped laboratory. Salary according to ability, with good prospects of promotion. Apply: The Director, Powered Limbs Research Unit, West Hendon Hospital, Goldsmith Avenue, London, N.W.9. [1856]

**SERVICE technician** for domestic radio and television German, 31, married, 2 children, presently employed as a service workshop manager in Switzerland, seeks permanent position in England or Ireland. Sound knowledge of radio and television techniques. Fully experienced in fault diagnosis and maintenance work of television and radio receivers, tape recorders, record players, etc. Trained for PAL-Colour-TV-Service by Philips (Zürich) and Telefunken (Hannover). Ability to write German technical descriptions and instructions. Please write to: Helmut Fritze, Rosentalweg 11, 6340 Baar/ZG, Switzerland. [1857]

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Men qualified to at least O.N.C. or who have had similar training in H.M. Services, and are experienced in the final test of complex transistorised V.H.F. assemblies and sub-assemblies, are invited to apply for the above posts.

The Company operates pension, life assurance and sick pay scheme. There are good sports, social and club facilities, plus an excellent cafeteria.

Please address applications to:

The Personnel Officer,

**Ether Engineering Ltd**

Park Avenue, Bushey, Herts.



### RESEARCH ASSISTANT

A Research Assistant with experience in Applied Physics, Electronics or Instrument Design is required to assist in investigations into the electrical and electro-optical properties of organic materials.

The work, which is essentially of a practical nature, is connected with the design and development of new test equipment and techniques and with the development of organic electro-optical devices.

Inventiveness and the ability to think practically are more important than paper qualifications. The post offers an opportunity to those working in the fields of instrument and electronics technology to widen their interest and to enter the rapidly expanding polymer and plastics industry.

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If you are interested, please send a postcard requesting an application to:—

Mrs. A. C. Holdom, Personnel Officer, I.C.I. Petrochemical & Polymer Laboratory, P.O. Box 11, The Heath, Runcorn, Cheshire.

# NATIONAL AIR TRAFFIC CONTROL SERVICES Radio Technicians

\*\*\*\*\*

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**Age.** 19 or over.

**Salary.** From £812 (at 19) to £1,046 (at 25 or over); scale maximum £1,201. From 1st January 1968 these rates will become £828 (at 19) to £1,076 (at 25 or over); scale maximum £1,242. Non-contributory pension for established staff.

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**NEWCASTLE GENERAL HOSPITAL (1,020 beds).** Medical Physics Technician, Grade III, 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 candidate will be expected to hold H.N.C. qualification, although consideration will be given to those with O.N.C. and experience in similar field. Whitley Council Conditions of Service. Salary scale £930-£1,300 p.a. Applications with names and addresses of two referees to Hospital Secretary, Newcastle General Hospital, Newcastle upon Tyne, 4, as soon as possible. [1847]

**UNIVERSITY OF ABERDEEN.** Department of Medical Physics. Applications are invited for the post of Research Assistant to organise and take charge of a small group servicing a wide range of medical electronic equipment and to assist in several development projects. Applicants should have experience of modern electronic techniques and construction methods. Appropriate and wide ranging experience is more essential than formal proof of academic ability. Salary on scale £945-£1,415, with initial placing according to qualifications and experience. Superannuation (F.S.S.U.). Further particulars should be obtained from The Secretary, The University, Aberdeen, AB9 1AS, with whom applications (2 copies) should be lodged not later than October 16th, 1967. [1855]

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**AUTUMN 1967**

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in one or more of the following branches: (i) Carrier Systems: (ii) H.F. and V.H.F. Radio: (iii) Telegraph Machines: (iv) Automatic Exchanges. (Reference M3D/62916 WF)

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## ELECTRONICS TEST ROOM ENGINEER

Applications are invited for an ELECTRONICS ENGINEER, experienced in Testing and Setting to work Electronic and Electro-Mechanical instruments.

This post would be suitable for a man who has had experience in the Services on such work; and has been trained in the appropriate Service's Courses.

Apply stating age, training and experience to the:

Personnel Manager,  
Barr & Stroud Limited,  
Anniesland, Glasgow, W.3.

EXPERIENCED Cinema Sound Engineer required for service and installation; good salary and conditions.—Box W.W. 1822, Wireless World.

THE General Post Office has vacancies for Radio Operators II at its Coast Radio Stations. Applications are invited from men between 21 and 35 years of age who must hold either the Postmaster General's First or Second Class Certificate of Competence in Radio-telegraphy or an identical certificate issued by a Commonwealth Administration or the Irish Republic. The posts, which will be temporary in the first instance, carry a salary scale of £725-£1,061, dependent on age at entry; successful applicants will be eligible to enter the open competitive selection for permanent appointment to be held in the Spring of 1968. Applicants should write to: The Inspector of Wireless Telegraphy, Union House, St. Martin's-le-Grand, London, E.C.1 or telephone London Headquarters 5628 (01-432 5628) for further information. [1849]

## GOVERNMENT OF QATAR — ARABIAN GULF TRANSMITTING ENGINEER

The Government of Qatar seek applicants for the above post in their new Broadcasting Division. Candidates should have a University Degree, plus 5 years' experience.

**SALARY** in range £1,855-£2,300 per annum. Point of entry according to qualifications and experience. Contract period three years.

### NO INCOME TAX

**GRATUITY** payable on completion of contract. Initially bachelor quarters provided, **FREE** fully furnished married accommodation available on completion of short probationary period. **FREE** air passages on appointment, termination and annual U.K. leave for applicant, wife and up to 3 children under 18. Two months U.K. leave per year. **FREE** medical and dental treatment.

**FOR APPLICATION FORMS** apply in writing to "Qatar Vacancy" Tennant Trading Ltd., 9, Harp Lane, Gt. Tower Street, E.C.3.

## RADIO TECHNICIANS

A number of suitably qualified candidates are required for permanent and pensionable employment (mostly in Cheltenham, but from time to time there are some vacancies in other parts of the U.K., including London). There are also opportunities for service abroad.

Applicants must be 19 or over and be familiar with the use of Test Gear, and have had practical Radio/Electronic workshop experience. Preference will be given to candidates who can offer "O" level and GCE passes in English language, Maths and/or Physics, or hold the City and Guilds Telecommunications Technical Intermediate Certificate or equivalent technical qualifications.

Pay according to age, e.g. at 19—£812 at 25—£1046 (highest age pay on entry) rising on 1.1.68 to at 19—£828, at 25—£1,076.

Prospects of promotion to grades in salary range £1,150-£1,941. There are a few posts carrying higher salaries.

Annual leave allowance of 3 weeks 3 days rising to 4 weeks 2 days. Normal Civil Service sick leave regulations apply.

Application forms available from:—

Recruitment Officer (RT),  
Government Communications Headquarters,  
Oakley, Friars Road,  
Cheltenham, Glos.

## AN OPPORTUNITY IN HONG KONG

### A PRODUCTION MANAGER

AND ALSO

### A SENIOR DEVELOPMENT ENGINEER

Required for a

### DOMESTIC RADIO ASSEMBLY FACTORY IN HONG KONG

Excellent Pay and Conditions for the right men

Write full particulars to Box 5036, c/o "Wireless World"

Opportunity for Engineer electrically minded to join well known importers of photographic goods, to service electronic flash equipment. Interesting and progressive work. Excellent salary and L.Vs. - 5 day week.

Some experience in Radio or T.V. an asset.  
Phone CLE 8031 - for appointment.

## TELEVISION ENGINEERS

with management in mind

Rapidly expanding Company in CCTV requires six senior engineers to control its Sales/Service operations in the London, Birmingham, Manchester, Southampton, Leeds and Bristol and West of England areas. Ability to maintain one inch helical scan video VR. 7003 recording machines, T/V monitors and vidicon cameras essential.

In addition to servicing CCTV installations, they will be required to promote new business in their areas. Estate car will be provided and there is a pension scheme. Salary to be negotiated and promotion for the right men guaranteed.

Write giving full details to: **Technical Director, Television Applications Limited, 9/11 Windmill Street, London, W.1.**



# Student Engineers



## PYE TELECOMMUNICATIONS LTD.

have vacancies in their Training Scheme for student engineers between 18 and 21 to take sandwich courses leading to a Higher National Diploma in Electrical Engineering and subsequent professional qualifications.

This is an excellent opportunity for young men who wish to make a career in telecommunications engineering.

Applicants must have passed five subjects in the G.C.E. examinations. Two of these passes must be mathematics and physics, preferably both at advanced level. Students with Ordinary National Certificate (Electrical) and appropriate credits will also be considered.

Please apply to the Personnel Manager,  
PYE TELECOMMUNICATIONS LTD.,  
NEWMARKET ROAD, CAMBRIDGE

## EDITORIAL WRITER

If you are interested in writing about the techniques covered by

“WIRELESS WORLD”

and are between the ages of 28 and 35 you are invited to apply for a vacancy which has occurred on the editorial staff.

Applicants, preferably possessing a degree or H.N.C. in physics, should send details of education and experience to the Editor-in-Chief, “WIRELESS WORLD,” Dorset House, Stamford Street, London, S.E.1.

## TECHNICAL ASSISTANT (PATENTS)

Required by Pye of Cambridge for varied work in their Patent Department. Applicants should have a sound basic knowledge of electronics or light electrical engineering and the ability to interpret and describe the essentials of new technical devices. Previous experience in a Patent Agent's Office would be helpful but is not essential.

Applications, giving brief details of age, qualifications and experience should be addressed to the Personnel Manager, Pye of Cambridge Ltd., St. Andrews Road, Cambridge.

**TEST** Engineers required; experienced in testing radio communications equipment; must be able to diagnose fault conditions, and align and calibrate such equipment; staff appointments; excellent starting salaries.—Call, phone or write: The Personnel Manager, Redifon Ltd., Broomhill Rd., Wandsworth, London, S.W.18. Vandyke 7281. [1848]

**INSTITUTE of Psychiatry**—Technician required to take charge of construction and maintenance of the scientific equipment of one of the departments in the Institute. The work is varied and interesting, and although primarily electronic, may involve some mechanical skills.—Application forms from the Secretary, Institute of Psychiatry, De Crespigny Park, Denmark Hill, London, S.E.5. (Ref. PSY.) [1843]

**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. [149]

### 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, Moat Road, Thornton Heath, Surrey. CR4-8PZ. [143]

**WANTED**, back issues PIEE Pt B and POEEJ, especially POEEJ prior to 1947, IEE prior to 1954 and after 1964.—P. Rockwell, 5800 Hillburne, Chevy Chase, Md. 20015 U.S.A. [63]

**WIRELESS WORLDS** complete 1949 to 1961, offers. —Tel. Wimbledon 9273. [65]

### TAPE RECORDING ETC.

**TAPE** to disc transfer, using latest feedback disc cutters; EPs from 21/-; s.a.e. leaflet.—Deroy, High Bank, Hawk St., Carnforth, Lancs. [162]

### MISCELLANEOUS

**METALWORK**, all types cabinets, chassis, racks, etc., to your own specification, capacity available for small milling and capstan work up to lin bar. PHILPOTT'S METALWORKS, Ltd., Chapman St., Loughborough. [151]

# Computer Engineers

Due to continued expansion NCR require additional **ELECTRONIC** and **ELECTRO-MECHANICAL ENGINEERS** for Computer Maintenance. Posts are available for men wishing to become Site Engineers.

Training Courses are arranged for suitably qualified men. H.N.C. Electronics, City & Guilds Final or equivalent standard required. Men from Forces with radar experience welcome.

Knowledge of electronic or electro-mechanical equipment necessary. Good Pension and Bonus Plan in operation.

Please write for Application Form to The Personnel Officer,

NCR, 1000 North Circular Road, London, NW2, quoting WW9.

Plan your future with

**NCR**

## TEST ENGINEERS

Fenlow Electronics Ltd. have vacancies for test engineers to work on the testing of advanced solid state D.C. Amplifiers, Digital Voltmeters, Spectrum Analysers and Instrumentation Tape Recorders. Selection will be on the basis of experience and ability, although a minimum qualification of O.N.C. would be desirable but not essential. Please reply giving details of relevant experience to:—

Chief Test Engineer, Fenlow Electronics Ltd., Springfield Lane, Weybridge, Surrey.

## CCTV INSTALLATION TECHNICIANS

Salary up to £1,550 per annum plus Tax Free Allowance of approximately £300 per annum.

The work is the installation of complex CCTV systems for a variety of applications mainly in the UK but with occasional opportunities for overseas work.

Applicants should have a good knowledge of television including camera and signal distribution equipment. An apprenticeship in the electronics industry together with a City and Guilds Final or ONC would be a considerable advantage.

Applications giving full details of qualifications and experience should be addressed to Box 5038, Wireless World, Stamford Street, London SE1.

### Science Research Council RADIO & SPACE RESEARCH STATION Ditton Park, Slough, Bucks Experimental Officers/Assistance Experimental Officers

Experimental / Assistant Experimental Officers are required to assist in work on the propagation of radio waves through the ionosphere and troposphere. Duties will include the design and development of apparatus and analysis of the results of experiments. Current work includes studies of the upper atmosphere and ionosphere with apparatus in rockets and satellites, investigation of wave propagation through the ionosphere and troposphere using an 82-foot steerable aerial, study of the propagation of millimetre and sub-millimetre radio waves, and use of lasers for studies of the lower atmosphere. Programmers are also required for duty with a large computer—now being installed.

#### Qualifications:

University or C.N.A.A. degree, H.N.C. or equivalent qualification. If under age 22, five G.C.E. passes including two science or mathematical subjects at "A" level (or equivalent).

#### Salaries

A.E.O. between £568 and £1,243.

E.O. between £1,365 and £1,734.

Send for details to:—

The Secretary, S.R.C., Radio and Space Research Station, Ditton Park, Slough, Bucks.

### Coulter Electronics Limited

require a

### SENIOR TESTER

and a

### JUNIOR TESTER

for work on their specialized electronic equipment for particle sizing. The senior applicant must have had at least two years' experience of fault finding on electronic equipment.

Please apply:

Personnel Manager,  
High Street South,  
Dunstable, Beds.

## TEST GEAR ENGINEER

To design test units and establish test methods for the electrical parts of control and measuring equipment. To assist in the running of the section which develops and constructs these test units.

Applicants should have practical industrial experience of D.C. and low frequency apparatus and components. O.N.C. is desirable but not essential. Starting salary of £1,200 p.a. or more, depending on experience and qualifications.

Apply to the Recruitment Officer, Rank Pullin Controls, Great West Road, Brentford, Middlesex. Tel.: 01-560 1212 Ex. 240

## HOME OFFICE

### SENIOR WIRELESS TECHNICIANS

The Home Office has vacancies for Senior Wireless Technicians in its Central Communications Establishment at Harrow offering interesting work on police, fire and Civil Defence v.h.f., and u.h.f., radio systems.

PAY: Starting at £1,288, rising to £1,504 a year; £1,338 to £1,597 from 1st January, 1968.

HOURS AND LEAVE: 5 day, 40 hour week;  
3 weeks' paid holidays a year.

Applicants should have City and Guilds Intermediate Telecommunications and Technician's Certificate, or a similar standard of qualification, and good experience of construction and maintenance of v.h.f., and u.h.f., wireless equipment.

For full details apply to:

Home Office,  
G.4 Division (Room 208),  
Horseferry House,  
Dean Ryle Street, S.W.1.

## BP SENIOR TECHNICIAN (Electronics)

A vacancy has arisen in the  
COMMUNICATION DIVISION  
at our London Head Office

Applications are invited from men aged 30-35 who have:—

- (i) a sound working knowledge of transistor circuitry, PLUS
- (ii) practical experience in at least two of the following:  
Facsimile; Transistor/Resistor Logic; Recording Systems (disc and tape); Low power VHF systems; Electronic timing and switching devices; Electro-mechanical switching circuitry.

Knowledge of PABX equipment would be an advantage.

Candidates would normally be expected to be qualified to H.N.C. level, but extensive experience in relevant fields of work would compensate for lack of formal qualifications.

The Company offers a Non-contributory Pension Scheme, an excellent Luncheon Club and wide range of social facilities.

Please write giving details of age, qualifications and experience to,

J. C. Pepperell, Recruitment and Placement Branch, The British Petroleum Company Limited, Britannic House, Moor Lane, London, E.C.2, quoting Ref. H.7835/WW7

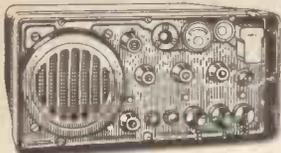
INTERESTED in amateur radio? A new radio society is being formed in the Ilford (Essex) area to be known as the Redbridge Amateur Radio Society and all readers in and around this area are cordially invited to come along and spend a pleasant evening with us; further details may be obtained from.—The Secretary, Mr. T. L. Stoakes, G3JTE, 62, Dudley Rd., Ilford, Essex. [62]

### SERVICE & REPAIRS

REPAIRS.—Our modern service department equipped with the latest test equipment including a wow and flutter meter and multiplex stereo signal generator is able to repair Hi Fi and tape recording equipment to manufacturers' standard.—Telesonic, Ltd., 92, Tottenham Court Rd., London, W.1. 01-636 8177. [169]

## PORTABLE/MOBILE VHF RADIO TELEPHONE

TYPE W.S.B44 MK.3

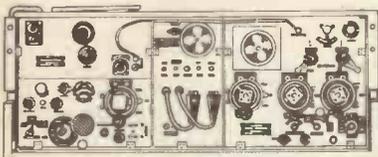


EXPORT ONLY

Crystal controlled 60-95 Mc/s. A modern 12 valve superhet receiver and transmitter

using B7G valves. Line Up: 5-CV138, 2-CV136, 1-CV137, 1-CV140, 2-CV416, 1-CV2129. Amplitude modulation. Cast aluminium case, size 14in. x 12in. x 7in. Weight 31 lbs. Built-in 5in. speaker. Output and Battery Volts Meter. Mike and phones sockets. Internal Vibrator (synchronous type) for 12 v. D.C. operation. Suitable for fixed or mobile use. Available with connecting plugs. Price £15/10/- (including FOB London). Each unit fully tested, and in as new condition. (Crystals for specified frequencies in the 90-95 Mc/s. range can be supplied to order at extra cost.)

## MARCONI CANADIAN TRANSMITTER RECEIVER GROUND STATION No. 52



**WORLD WIDE RECEPTION** **BROADCAST**  
 ★ SHIPPING ★ **AMATEUR** ★  
 Comprises Receiver, Transmitter and Power Unit for 12 v. D.C. operation. Frequency coverage: 1.75-16 Mc/s. (19-170 metres) in 3 fully tunable selected wavebands. Power output 75 watts R.T.; 110 watts C.W.  
 PRICE ONLY £27/10/- Carr. £2/10/- (mainland only). Above items also available separately (less carrier).  
 No. 52 Receiver only £9/19/6. Carriage 20/-.  
 No. 52 Transmitter only £9/10/-. Carriage 20/-.  
 No. 52 Power Unit only £5. Carriage 20/-.

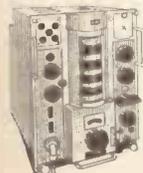
## NATIONAL HRO SENIOR RECEIVERS 5T MODEL



In excellent tested condition. Available with 9 coils coverage 50 Kc/s. to 30 Mc/s. complete with P8U. £31/10/- Carr. 30/-.

## FAMOUS BRITISH R107 RECEIVERS BY COSSOR

Frequency coverage 1.2-17 Mc/s. Continuous in 3 switched bands. B.F.O. RT, CW, AF and IF gain. Aerial Trimmer. Internal speaker and two phone outputs. Internal Power Supply for 100/250 v. A.C. Mains Also 12 v. D.C. making this suitable for 8hp, Mobile or Fixed Station. Excellent condition. Fully tested, complete working. £15. Carr. 30/-.



## MURPHY B40 NAVAL RECEIVERS

5 bands 650 kcs.-30 Mc/s. 10 valves. Built-in speaker, phones output. 2 R.F. and 3 I.F. stages, xtal hand-pumped filter, noise limiter, etc., etc. 150/230 v. A.C. Size 19 1/2 x 13 1/2 x 16in. Cost well over £500. Supplied tested working with circuit diagram. £22/10/- Carr. 30/-.

Also B41, L.F. version £15. Carr. 30/-.

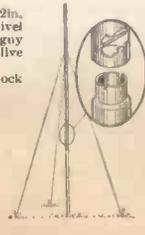
**SPECIAL OFFER!** Both above receivers £30, Carr. £3.

## HALLICRAFTERS

**35FT. AERIAL MASTS** (As illustrated) Seven 5ft. 6in. interlocking sections of 2in. dia. heavy gauge tube. Complete with swivel base plate calibrated in degrees, nylon guy lines, and ground spikes. Finished olive green. £17/10/- Carr. 40/-.

**ALSO 70FT.** 14 sections as above plus block and tackle. £35. Carr. 50/-.

**TELESCOPIC AERIAL MASTS.** Tubular steel copperplated spray finish, ring can locking on each section provides for full or any height required. Buttabutts all fixings and base locations. Bottom section 1 1/2in. diameter. 20ft. 4 section. Closed 5ft. 9in. Weight 16lb. 60/- Carr. 10/- 34ft. 19 section. Closed 6ft. 6in. Weight 20lb. 80/- Carr. 10/-.



## ALL 19 SETS & ACCESSORIES AVAILABLE

S.A.E. All Enquiries—List 1/-

**A. J. THOMPSON (Dept. WW)**

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## RESISTANCE WIRES EUREKA-CONSTANTAN

Most Gauges Available

NICKEL-CHROME MANGANIN  
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ENAMELLED, TINNED, LITZ,  
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SMALL ORDERS PROMPTLY DESPATCHED

B.A. SCREWS, NUTS, WASHERS  
 soldering tags, eyelets and rivets  
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TUFNOL ROD, PAXOLIN TYPE COIL  
 FORMERS and TUBES. ALL DIAMETERS  
 SEND STAMP FOR LIST. TRADE SUPPLIED

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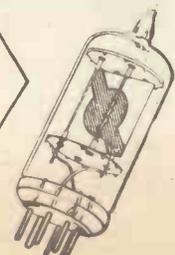
33 Bourne Gardens, London, E.4  
 TELEPHONE 01-254-4688.

**B.B.C.2. TV, RADIO, TAPE REC. SERVICE SPARES.**  
 U.H.F./625, modify your set to B.B.C.2. 1955 to 1963 models covered. Manufacturers' complete kits and tuners, send for free list. Ferguson 625 IF amp chassis 39/6 (or less valves 19/6), circuit and instr. 3/6. p/p 4/6. Philips complete 625 conversion kit including circuit 70/-, p/p 6/- GEC/Sobell sound and vision dual 405/625 IF amp and output chassis 42/6. p/p 4/6. New UHF tuners including valves 29/6, or Philips transistorised 70/-, p/p 4/6. Fireball Tuners, new tested, exclusive offer of special manufacturers types suitable for KB, Ultra, Ferguson, HMV, etc., 75/-, new turret tuners, Brayhead 3001/3 58/6; Cylidon c/f 19/6; Brayhead 10, 16, 35Mc/s 19/6; KB 16, 38Mc/s 10/-; Ekco 16Mc/s 10/-, post 4/6, many others available. TV Signal Boosters, transistorised, Pye/Labcear B1 B3 and u.h.f. battery 75/-, u.h.f. mains 97/6, u.h.f. mast-head 105/-, post free; L.O.P.T.s., scan coils, framed output trans., mains droppers, etc., for all popular makes CRTS. 14, 17, 19in from £4/3 (callers only). Tape recorder belts, heads, motors, etc. Salvaged components, large selection transformers, scan coils, turrets, etc. Enquiries invited. e.o.d. despatch available. Manor Supplies, 64, Golders Manor Dr., London, N.W.11: callers 589B, High Rd., N. Finchley, N.12 (near Granville Rd.). HL. 9118 (day), Spe. 4032 (eveg.).

## ARTICLES FOR SALE

**PHENIX transformers** Correx FT106A, Pri. 0/115/220/240V, E.S. SEC. 48/50/52V 3A, list. 126/- each, brand new, 32/6 each, carr. 5/6, mail only.—Davies, 12, Hampden Hill, Ware, Herts. [59]

## Quartz Crystal Units



For  
**ACCURACY**  
**RELIABILITY**  
**PRICE ECONOMY**  
 you can  
**DEPEND**  
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Write for  
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## THE QUARTZ CRYSTAL CO. LTD.

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## EXCLUSIVE OFFER

PERMANENT OR  
 TRANSPORTABLE STEEL  
 60-FOOT AERIAL TOWERS

As supplied to  
 British and other Governments

★ Unique design.  
 ★ Scientific Construction.

having the following remarkable features.



★ Entirely self supporting, requiring no guys, stays, foundations, pickets or spikes or any attachment to the ground.

★ Fitted with step ladder to the top and balcony with railings all round (You can walk right round the top with both hands free.)

★ 12 feet square at base tapering to 6 feet square at top, they are quite safe when subject to side force winds and will accept 50 square feet superficial area on top at force of 80 m.p.h. They require ground area of 20 feet square.

★ Will support up to 2 tons of equipment on top, the whole tower can be completely lowered to the ground by 2 men in 20 minutes and raised in the same time.

★ Can be completely erected and dismantled by 3 men.

★ Breaks down for transport by 2 men

lorry into parts easily handled by 2 men, there are no small loose parts, no nuts or bolts to get lost or damaged; all screws and adjustments are fully protected from rust and so designed to be free from damage when transported or left loose on the ground.

★ Foolproof—the Tower cannot be erected if not assembled correctly. No skilled labour is required and no special tools are necessary.

★ Can be raised and lowered, erected and dismantled and removed as many times as desired.

★ Everything necessary for the complete tower to be put into use and raised and lowered is provided; full drawings and instructions.

These fine Towers were made in England by B.I.C.C. and cost the Government £2,200 each. They are BRAND NEW and in maker's original packing. You can see one erected at our premises.

Cost £2,200

Price Brand New  
 £345

40-page list of over 1,000 different items in stock available—keep one by you.

★ T-200 Panadaptors 450/470 Kcs.	£30 0
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Carriage extra at cost on all above.

We have a large quantity of "bits and pieces" we cannot list—please send us your requirements—we can probably help—all enquiries answered.

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**ORGANFORD — DORSET**

WESTBOURNE 65051

WW-170 FOR FURTHER DETAILS

## LONDON CENTRAL RADIO STORES

**MODERN HAND SETS** with coiled lead, grey, white and black, 22/6. P.P. 3/-.

**TELEPHONE COILED HAND SET LEADS.** 3 core 5/6. P.P. 1/-.

**MODERN DESK PHONES,** 2 tone grey or black, with internal bell and handset with 0-1 dial. £4/10/-, P.P. 7/6.

**10-WAY PRESS-BUTTON INTER-COM TELEPHONES** in Bakelite case with junction box handset. Thoroughly overhauled. Guaranteed. £6/10/- per unit.

**20-WAY PRESS-BUTTON INTER-COM TELEPHONES** in Bakelite case with junction box. Thoroughly overhauled. Guaranteed. £7/15/- per Unit.

**WIRELESS SET No. 38 A.F.V.** Freq. range 7.3 to 9.0 Mc/s. Working range 1/2 to 2 miles. Size 10 1/2 x 4 x 6 1/2 in. Weight 6 1/2 lb. Includes power supply 8lb—and spare valves and vibrator also tank aerial with base. £6 per pair or £3 single. P.P. 25/-.

**ELECTRICITY SLOT METERS (1/2 in slot)** for A.C. mains. Fixed tariff to your requirements. Suitable for hotels, etc. 200/250 v. 10 A. 80/-; 15 A. 90/-; 20 A. 100/- P.P. 7/6. Other amperages available. Reconditioned as new, 2 years guarantee.

**QUARTERLEY ELECTRIC CHECK METERS.** Reconditioned as new. 200/250 v. 10 A. 42/6; 15 A. 52/6; 20 A. 57/6. Other amperages available. 2 years guarantee.

**TWIN GONG TELEPHONE,** extension belts. 21/-.

**P.M. MOVING COIL SPEAKERS.** 5in. 9/6; 8in. 3 ohm 10/6. Elliptical 7 x 4 1/2 in. 3 ohms 10/6. P.P. 3/6.

**8-BANK UNISELECTOR SWITCHES.** 25 contacts, alternate wiping £2/15/-; 6 bank half wipe £2/15/-; 6 bank half wipe, 25 contacts 47/6. P.P. 3/6.

**DESK PHONES.** Black Bakelite cases, complete with hand set and internal bell with 0-1 dia. 42/6. P.P. 8/-.

**HIGH-SPEED ELECTRO-MAGNETIC COUNTERS.** Ex-Govt. 4 digit. 25/60 v. D.C. Size 4 x 1 x 1 in. Single coil, 2,300 Ω. Single coil 600 Ω. 8/6. P.P. 3/6.

**EX GOVT. BALANCED ARMATURE THROAT MIKES** complete with plug, new. 7/6. P.P. 3/6.

**DESK PHONES** from 35/- . Various types in stock. Final End Selectors. Relays, various callers, also 19 Receivers in stock. All for callers only.

**23 LISLE ST. (GER 2969) LONDON W.C.2**

Closed Thursday 1 p.m. Open all day Saturday

T.V. camera, Pye Lynx auto video output, as new, cost £160; offers over £100.—Mai. 0079. [1861

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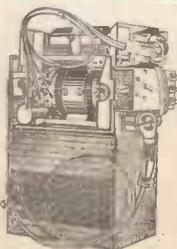
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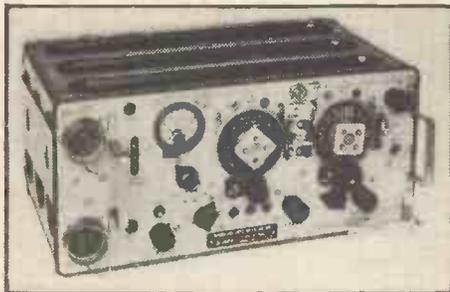
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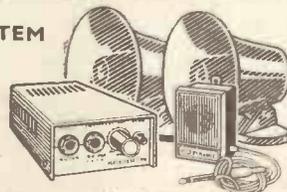
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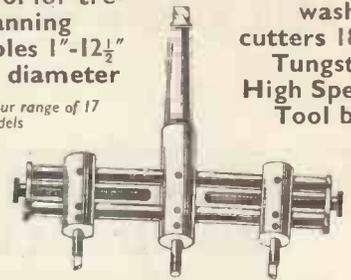
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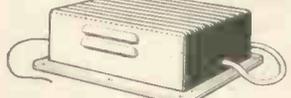
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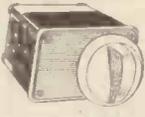


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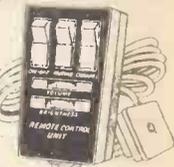
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			60/40	SAVBIT
10	.128	3.251	25.6	24
12	.104	2.642	38.8	36
14	.080	2.032	65.7	60.8
16	.064	1.626	102	96.2
18	.048	1.219	182	170
19	.040	1.016	262	244
20	.036	.914	324	307
22	.028	.711	536	508
24	.022	.558	865	856
26	.018	.46	1292	1279
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TIN/LEAD	B.S. GRADE	MELTING TEMP	
		°C.	°F.
60/40	K	188	370
Savbit No 1	—	215	419
50/50	F	212	414
45/55	R	215	419
40/60	G	234	453
30/70	J	255	491
20/80	V	275	527

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ALLOY	DESCRIPTION	MELTING TEMP.	
		°C.	°F.
T.L.C.	Tin/Lead/Cadmium with very low melting point	145	293
L.M.P.	Contains 2% Silver for soldering silver coated surfaces	179	354
P.T.	Made from Pure Tin for use when a lead free solder is essential	232	450
H.M.P	High melting point solder to B.S. Grade 6S	296-301	565-574

- Contains 5 cores of non-corrosive high speed Ersin flux. Removes surface oxides and prevents their formation during soldering. Complies with B.S. 219, 441, DTD 599A, B.S.3252, U.S. Spec. QQ-S-571d.
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