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everyday electronics

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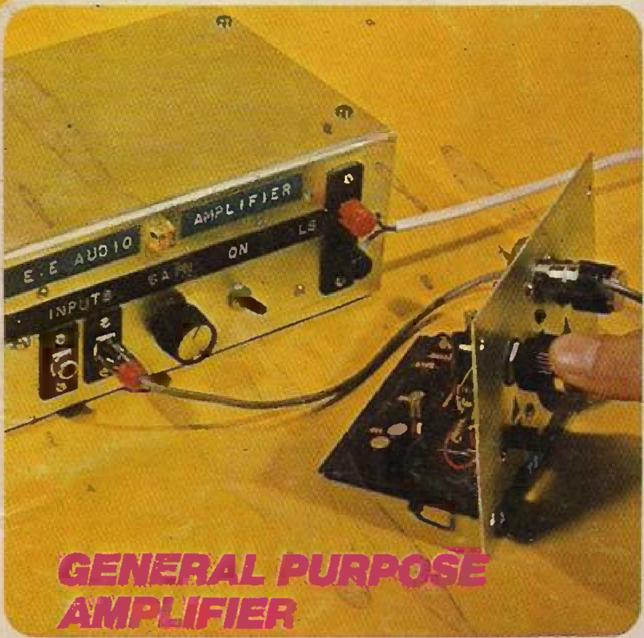

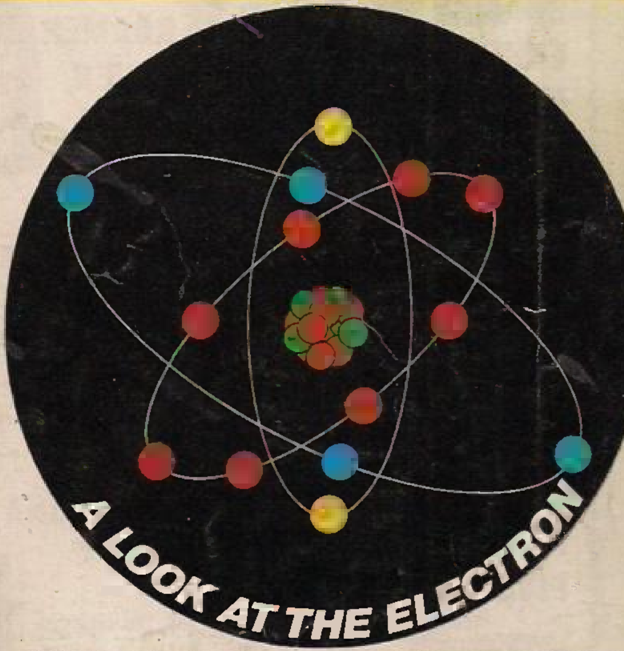

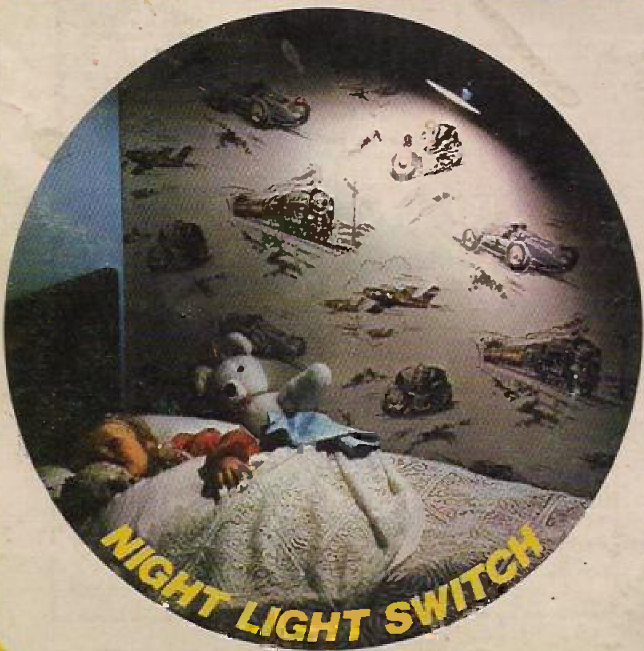

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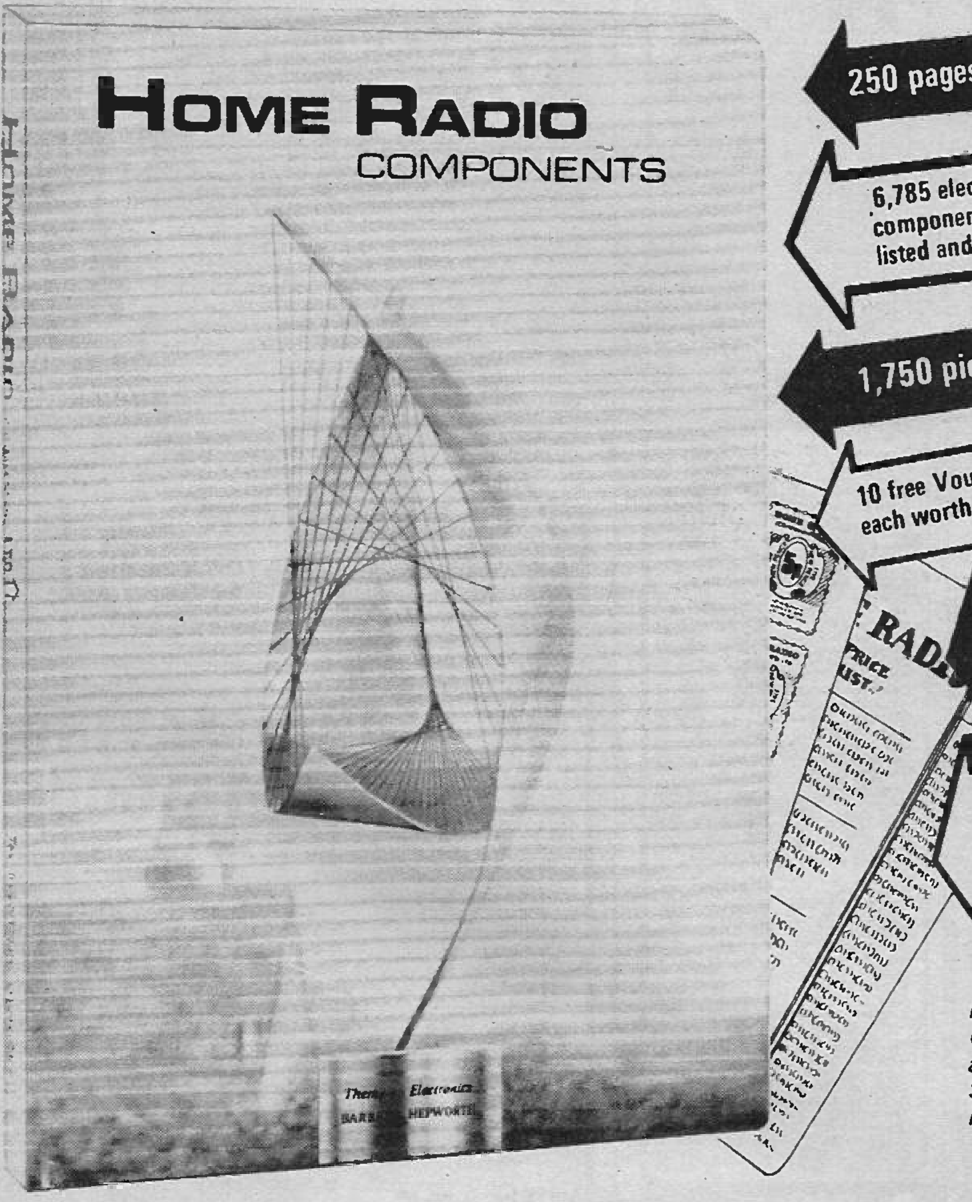

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is this the price you pay?

Probably, if you're still using an ordinary soldering iron. Ordinary soldering irons can cause damage to transistors and integrated circuits – damage which wastes time and costs money. Now, with the unique ANTEX X25 and CCN low leakage soldering irons no harm can come to the most delicate equipment, even when soldered 'Live'.
(You could be making quite a saving).

(All prices mentioned exclusive of V.A.T.)

MODEL X25
220-240 Volts or 100-120 Volts. The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with it's truly remarkable heat-capacity will easily "out-solder" any conventionally-made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8". 2 other bits available 3/32" and 3/16". Totally enclosed element ceramic and steel shaft. Bits do not "freeze" and can easily be removed.
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Suitable for production work and as a general purpose iron.

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220 volts or 240 volts. The 15 watt miniature model CCN also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32". 4 other bits available 1/8", 3/16", 1/4" and 3/64".
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MODEL CN
Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 3/64" to 3/16". Voltages 240, 220, 110, 50 or 24.
PRICE: £1.70 (rec. retail)

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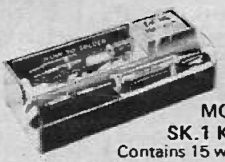
Miniature 15 watt soldeing iron fitted with nickel plated bit 3/32". Voltages 240 or 220.
PRICE: £1.70 (rec. retail)

THE DESIGN CENTRE

MODEL MES.KIT
Battery-operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder"
PRICE: £1.95 (rec. retail)



MODEL SK.1 KIT
Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.
PRICE: £2.75 (rec. retail)

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Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32" heat sink, solder, stand and "How to Solder" booklet.
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Please include 5p P. & P.

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24 Hour Nixie Digital Clock Kit We Supply:

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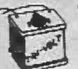
All for the price of the components. £22·50.+50p. P. & P. Please send S.A.E. for more information.



TRI-VOLT BATTERY ELIMINATOR

Enables you to work your transistor radio, amplifier, or cassette, etc. from A.C. mains through this compact eliminator. Just by moving a plug you can select the voltage you require — 6v. 7½v or 9 volts. This means all your transistor power pack applications can be handled by this one unit. Approx. size: 2¾" x 2¼" x 3¼". OUR PRICE — £2·75p + 10p. P. & P. Same model suitably wired for the Philips Cassette — £3·00 + 10p. P. & P.

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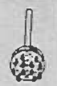
Enables you to work your Transistor Radio. Amplifier or Cassette etc. from the 12 volt car supply positive or neg. earth.
This converter supplies 6, 7½ or 9 volts and is transistor regulated. Approx. size 2¼" × 3½" × 2" Very easy to fit and a real money saving device for £2·50 + 10p. P. & P.



WAFER SWITCHES

1 pole 12 way
2 pole 2 way
2 pole 3 way
2 pole 4 way
2 pole 6 way
3 pole 4 way
4 pole 3 way

18p each. Please inc. 5p P. & P. Up to 3 switches.

ADD LUXURY TO YOUR CAR WITH A MOTOR DRIVEN CAR AERIAL

5 Section
Extended Length 100cm
Length under Fender 40cm
Cable Length 120cm
complete with Fixing Bracket and Control Switch. £5·75 plus 25p P. & P.

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6 volt 70 ohm.
Single Pole Changeover.
Approx. size — 1½" × 1" × ¾".

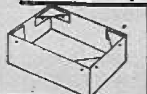
40p plus 5p P. & P.

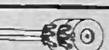
ALUMINIUM CHASSIS

Made from 18 gauge aluminium 4 sided chassis with corner brackets. All are 2½" depth.

6×3—41p	12×3—53p	14× 9—94p
6×4—45p	12×5—61p	16×6 —86p
8×6—58p	12×8—83p	16×10—1·08p
10×7—63p	14×3—60p	

Please send 10p per chassis P. & P.





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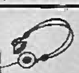
All types 1" and less diameter.

SINGLES		DUAL	
5K	Log or	5K	
10K	Lin Less	10K	
25K	Switch	25K	Less
50K	12p ea,	50K	Switch
100K		100K	40p.
250K	Double	250K	each
500K	Pole	500K	
1M	Switch	1M	
2M	24p ea,	2M	

Up to 3 Pots. Please add 5p. P. & P.



S. G. BROWN "DIPLOMAT" MONO/STEREO HEADSET

Finest quality British made Lightweight Headphones.
Incorporate ceramic piezo electric transducers.
Specification:—Frequency—20-17,500 CPS.
Impedance—Predominantly capacitive. at ·001MFD per earpiece can be regarded as 150K at 1kcs.
Weight—3·5oz. (98 grams).
Please include 10p per set P.P. A Bargain at £1·50 each set

V.A.T.

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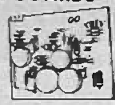
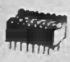


Components galore for the experimenter. Ex computer boards with: Resistors, Capacitors and useful Transistors.

Now at this unbeatable price: 15p each. 7 Boards £1. 10p P.&P.

INTEGRATED CIRCUIT SOCKETS



A must for the experimenter interested in I.C.s. 14 pin, 16p each. 16 pin, 16p each. Please include 5p P. & P. per 3 sockets.

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Brand new range of British made Relays.
Size—1½" × 1" × ¾"
All two changeovers with 250V. 1·5A contacts and suitable for fitting on ·1in Veroboard.

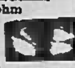
Type	Volts	Current	Ohms.
27/A	12v	17M/A	700 Ω
21/A	12v	28M/A	430 Ω
12/A	6v	33M/A	185 Ω

80p each.
Please include 5p P & P up to 3 Relays.

LOW VOLTAGE AMPLIFIER Few only at £1·75 plus 13p P. & P.

5 transistor amplifier complete with volume control, is suitable for 9V d.c. and a.c. supplies. Will give about 1W at 8 ohm output.
With high IMP input this amplifier will work as a record player, baby alarm, etc., amplifier.

LOUDSPEAKER BARGAINS



E.M.I. 450 set 3. 8. 15 ohm
£3·75 plus 38p. P. & P.
E.M.I. 350 set 8 ohm.
£7·00 plus 38p. P. & P.

MINI LOUDSPEAKERS

2¼" (57mm) 8ohm — 50p each
2¼" (57mm) 40ohm — 50p each
2¼" (57mm) 80ohm — 50p each

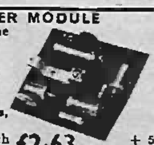
Please include 5p. P. & P. up to 3 Mini-Loudspeakers

EA1000 3 WATT AUDIO AMPLIFIER MODULE

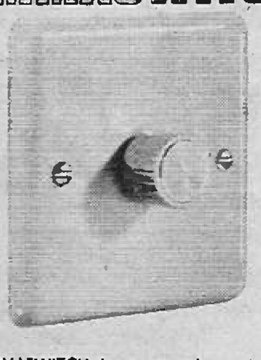
An Audio Amplifier designed around the TAA621 Linear I.C.:—

Supply Voltage	9–24V
Speaker Imp.	8–16 ohm
Frequency	50hZ–25kHz
Overall Size	2in × 3in × ¾in

Ideal Amplifier for radios, record players, stereo units, etc.
Full technical data and diagrams with each module. All guaranteed and a bargain at £2·63 + 5p P. & P.



Vary the strength of your lighting with a DIMMASWITCH



The DIMMASWITCH is an attractive and efficient dimmer unit which fits in place of the normal light switch and is connected up in exactly the same way. The white mounting plate of the DIMMASWITCH matches modern electric fittings. Two models are available, with the bright chrome knob controlling up to 300 w or 600 w of all lights except fluorescents at mains voltages from 200-250 v, 50Hz. The DIMMASWITCH has built-in radio interference suppression:

600 Watt £3·20* Kit Form £2·70*
300 Watt £2·70* Kit Form £2·20*

All plus 10p post and packing *from 1st April please add appropriate percentage of V.A.T. increase. Please send C.W.O. to:—

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25 boards for £1 (25p).

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10,000μ 75v, 33,000μ 40v, 10,000μ 35v, 4½ x 2½ in. dia., 25,000μ 25v. 20,000μ 30v, 8,000 55v, 40,000μ 10v, 4½ x 3 in. dia. 50p (12p). 15,000μ 15v, 4½ x 2 in. dia. 20p (10p). 2,000μ 25v wire ended, 3 x 1 in. dia. 15p (5p) or 12 for £1·50 (15p).

250 MIXED CAPACITORS 60p (8p)
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ASSORTED RELAYS 8 for £1 (25p)
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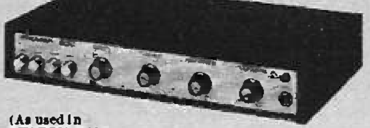
PREMIER 800 STEREO AMPLIFIER



(As used in SYSTEM '800')

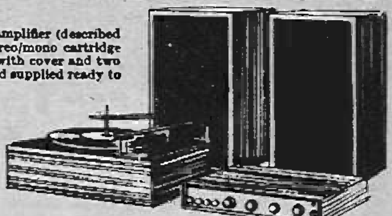
A truly high quality stereo amplifier—compare the specification, compare the price. Output: 5 watts per channel. Frequency response: 30-20,000 Hz = 2 db. Distortion: 1% Output Impedance 8 ohms nom. Inputs equalised to R.I.A.A. Magnetic 4mV. Ceramic 100mV. Tuner 100mV. Tape 100mV. Tape out 150mV. Din sockets for inputs and outputs. Controls: Bass, Treble, Volume, Balance, Selector. Mono/Stereo switch. Stereo headphone socket. Attractive slim line design black leatherette cabinet with aluminium front panel. Size 12¼" x 6¼" x 2¾".

ONLY **£15·00** Carr. 50p.

Mk. 11 Version available with Teak Finish Cabinet. £16·25. Carr. 50p.

PREMIER HI-FI STEREO SYSTEMS

SYSTEM "800"



Consists of the Premier 800 Mk II all transistor stereo amplifier (described left) Garrard auto/manual record player unit fitted stereo/mono cartridge with diamond stylus and mounted in teak finish plinth with cover and two cloth front loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 800 Mk II amplifier has an output of 5 watts per channel with inputs for ceramic and magnetic pick-up, tape and tuner also tape output socket and headphone socket. Controls: Bass, Treble. Volume, Balance, Selector. Mono/Stereo switch. Headphone socket. Power on/off. Teak finish cabinet with aluminium front panel. Size: 12¼in × 6¾in × 2¾in.

£35·00

Carr. £1·75

SYSTEM "TWO"

as above but with slotted front teak finish loudspeakers, Garrard SP25 Mk. III and magnetic cartridge.

£45·00

Carr. £1·75

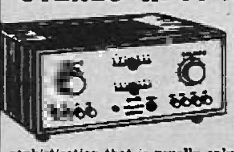
SYSTEM "THREE"

This consists of KLINGER KC903 stereo amplifier giving 6 watts rms per channel with Bass, Treble, Volume and Balance Controls. Inputs for Magnetic and Ceramic pick-up. tuner, tape in and out. Stereo headphone socket. Garrard SP25 Mk. III in teak finish plinth with cover and fitted Sonotone 9TAHCD diamond stereo cartridge. A pair of HMF Speakers size 16½" × 10½" × 9" fitted EMI units complete the matching system.

£57·75 Carr. £1·75

FREE
LEADS AND PLUGS SUPPLIED WITH ALL SYSTEMS

PREMIER PARAGON
STEREO HI-FI AMPLIFIER



Gives the best possible reproduction of records, radio and tape at a reasonable price.

Fitted with all the controls and facilities you're ever likely to want, the Paragon gives you a degree of sophistication that is usually only found with amplifiers costing twice its price. It has bass and treble slide controls, volume and balance knobs, and eight push-buttons. There's also a standard stereo jack socket on the front panel, plus a ceramic/magnetic cartridge switch and a mains outlet socket on the back panel.

Specifications 10 + 10 watts into 8 ohms. Power/frequency response: 0dB 10 watts into 8 ohms -3dB 20Hz - 25KHz. Distortion typically less than 0·25%. Inputs for Magnetic phono (4mV) Ceramic phono (66mV) Radio/Tape (100mV). High and low filters. Teak finish cabinet. Size: 12¾" × 5¾" × 10½".

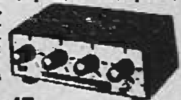
£28·00 P. & P. 50p.

PREMIER STEREO SYSTEM '65'

Consists of the Premier Paragon Stereo Amplifier, Garrard SP25 III in teak finish plinth with cover and fitted Goldring G800 stereo magnetic cartridge plus a pair of Marsden Hall Annex 100 Loudspeaker Systems. Complete with Free leads and plugs. **£65** Carr. & Insurance £1·75

VERITAS STEREO/MONO SOUND MIXER

Battery operated audio mixer. Size 6 × 3 × 2in. suitable for crystal microphone low impedance microphone, with transformer, radio, tape, etc. Max. input 1·5v. Max. output 2·5v. Gain 6 dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.



PREMIER PRICE **£3·47** P. & P. 15p

E.M.I. 13×8in. HI-FI SPEAKERS

Fitted two 2½in tweeters and crossover network. Impedance 8 or 15 ohm. Handling capacity 10W. Brand new.

£3·47 P. & P. 50p

NEW PREMIER COMPACT STEREO SYSTEM

All transistor stereo amplifier mounted into teak finish plinth with cover and Garrard 2025 T/C autochanger and a pair of matching teak finish cloth front speaker systems.

★ Output 4 watts rms per channel.
★ Separate volume, bass, treble and balance controls.
★ Stereo/Mono ceramic cartridge.
★ Tape/Tuner input and Tape output sockets.
★ Complete with all leads ready to use.

PREMIER PRICE ONLY **£30** Carr. & Ins. £1·50

GARRARD SP25 MK III SINGLE RECORD PLAYER FITTED GOLDRING 800 MAGNETIC STEREO CARTRIDGE. COMPLETE IN TEAK PLINTH WITH COVER.

Total list price over £34.

PREMIER PRICE **£17·95** P. & P. £1

METER BARGAIN

MODEL LT 102 MULTIMETER

A precision made pocket sized test meter, ideally suited for testing electronic circuits or electronic appliances. Supplied complete with test lead and batteries. RANGES—DC Voltages: 15, 150, 600 (1,000 opV). AC Voltage: 15, 150, 600 (1,000 opV). DC Current: 150mA. Resistance: A-100K ohms. (centre 2·5 Kohms) £2·47 p. & p. 25p complete with test leads and battery.

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Designed to the highest possible standard. Fitted 2½in. speaker units with soft padded ear muffs. Adjustable headband, 8 ohms impedance. Complete with 6ft lead and stereo jack plug.

£2·47 P. & P. 25p.

ROGERS RAVENSBROOK SEMI-PROFESSIONAL MODEL (as illustrated). (List £18·50).

OUR PRICE **£11.00**
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P. & P. 25p each

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LOW NOISE CASSETTES in library cases

C60 (List 71p) 45p
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P. & P. 10p

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Screw fixing—fully guaranteed.
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C120	52p	£1·40	£2·76	£4·50

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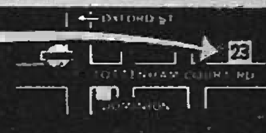

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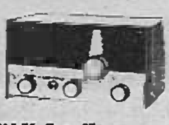
Also see opposite page and next two pages

UNR-30 RECEIVER



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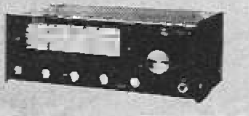

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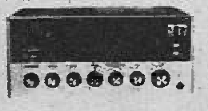

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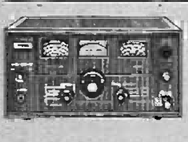

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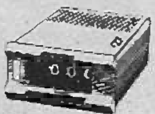

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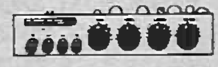

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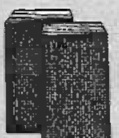

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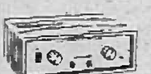

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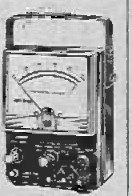

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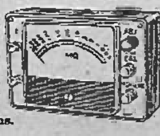

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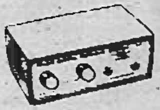

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everyday electronics

PROJECTS. THEORY....

COMPLICATED OR SIMPLE

In the popular mind anything described as "electronic" is still, all too commonly, interpreted as being necessarily of frightening complexity, and possessing deep secrets capable of being unravelled only by highly trained minds. The truth is, of course, that electronics *can* be fantastically complicated, but equally it can be delightfully simple.

Really it all boils down to a question of the kind and nature of service or function required, the degree of accuracy demanded, and any need to withstand special or particularly arduous environmental conditions. Electronic circuitry comes in all shapes and sizes, but the most highly involved and sophisticated designs rely upon precisely the same basic ideas as do the smallest and most modest of designs.

AN INCENTIVE

Designs for home constructors presented in this magazine come in the latter class. All Everyday Electronics circuits are simple, and without any elaboration not strictly essential for the function they are intended to perform. Most importantly, they are good examples of uncomplicated circuits *applied to meet real everyday needs of ordinary people.* Needs that the electronic equipment manufacturers hardly even recognise, let alone attempt to satisfy. (To be fair, because of their novel character and sometimes rather individualistic appeal, many of these projects are not altogether suitable for mass production operations.) So the private person has an additional incentive to build his own gadgets, and pieces of equipment. The alternative, so often, is to go without.

WITH INTEREST

In the prevailing climate of ever-rising prices, it is worth reflecting on the large number of varied designs which can be built for a few pounds. As we have well demonstrated in these pages, this hobby need not involve any great outlay, but the amount expended will be amply returned—with interest.

Talking of interest, whoever embarks upon electronic construction—however simple—gains an insight into a tremendously fascinating world of technology. From quite modest beginnings, anyone can easily develop their interest and set out to acquire greater knowledge of this powerful technology which is rapidly assuming greater influence over every one of us, in all aspects of modern life.

Fred Bennett.

Our May issue will be published on Thursday, April 19

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VOL. 2 NO. 4 APRIL 1973

CONSTRUCTIONAL PROJECTS

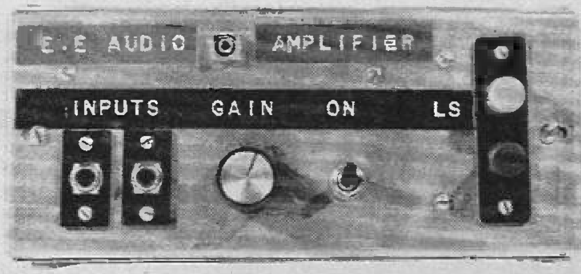
GENERAL FEATURES

VALUE ADDED TAX

Prices quoted in this issue were correct at time of going to press. From April 1 1973 there will be no purchase tax, but a large number of goods will carry Value Added Tax.

V.A.T.

GENERAL PURPOSE AMPLIFIER



A 1 watt output audio amplifier, suitable for equipment testing or for general use.

By F. C. Judd.

A SMALL amplifier has many applications in the electronic construction workshop or in the home generally and can, in fact, be regarded either as a valuable piece of testing equipment or simply as a piece of audio gear. It can be used for testing or using any radio or electronic equipment that normally has no amplifier e.g., a radio tuner or a signal generator and in other ways such as testing microphones, gramophone pick-ups and tape record/replay units etc. or for guitar practice with electric guitars.

The amplifier described here is quite easy to build even though the circuit may look a little complex because of the mixture of *pnp* and *npn* transistors. The amplifier will provide up to 1 watt output into an 8 ohm loudspeaker although any small speaker of say 5 to 15 ohms can be used.

Two inputs are provided one being rated at 5mV which is suitable for low level signal sources such as 200 ohm microphones or guitars whilst the other input, because the impedance is fairly high, can be used for ceramic or crystal pickups, radio tuners or the output from a tape recorder etc.

Both inputs are connected to the first stage of the amplifier via a gain control (VR1) so that signal levels can be adjusted to prevent overloading. The frequency response of the amplifier is −3dB at 100Hz to −3dB at 10,000Hz, not hi fi but certainly very acceptable for many applications.

CIRCUIT

The circuit is shown in Fig. 1. One input (SK1) is taken via R1 which is an attenuator to provide an input sensitivity of about 500mV and also a fairly high input impedance. The other input (SK2) goes straight to the gain control VR1 and has a sensitivity of 5mV for 1 watt output from the amplifier.

The input transistor (TR1) which is an *npn* type, acts as a pre-amplifier and as a d.c. difference amplifier comparing the voltage derived from the potential dividing network R6, R3 and R2 with the voltage appearing between TR4 emitter and the common earth or positive supply rail. The high loop gain of the circuit keeps the small difference between these two voltages constant so that one has a definite relationship to the other regardless of spreads in the charac-

Approximate cost of components £4·20 plus case and loudspeaker

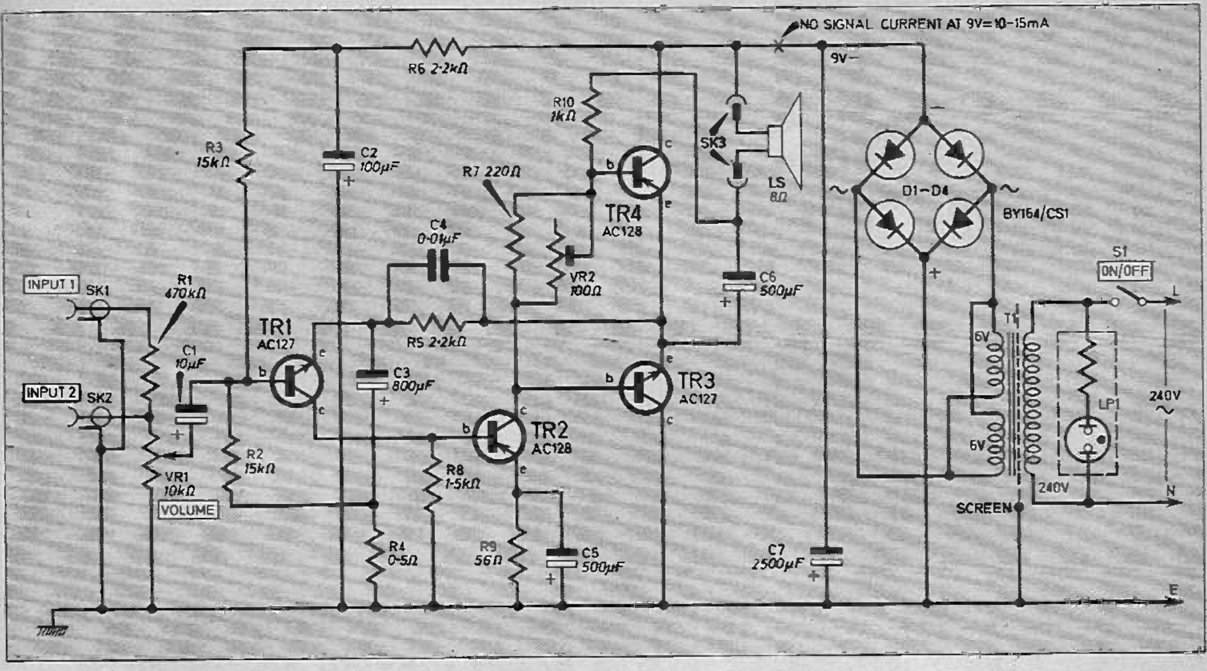


Fig. 1. Complete circuit diagram of the General Purpose Audio Amplifier.

teristics of the transistors and small variations in component values. Negative feedback is taken via R5 and C4 from the output stage to the emitter of TR1.

The amplifier circuit is powered from a 9V positive earth supply provided by transformer T1, the bridge rectifier D1-D4 and smoothing capacitor C7. Note that as the amplifier draws a fairly large current at peak power levels (for a miniature transformer to supply) the transformer chosen has two 6V secondary windings which are connected in parallel to maintain the peak current requirements. If any transformer other than the one specified is used, it must have a 6V winding capable of supplying about 500mA current.

Components....

Resistors

R1	470kΩ	R6	2·2kΩ
R2	15kΩ	R7	220Ω
R3	15kΩ	R8	1·5kΩ
R4	0·5Ω	R9	56Ω
R5	2·2kΩ	R10	1kΩ

All ±10% ¼ W

Capacitors

- C1 10μF elect. 12V
- C2 100μF elect. 12V
- C3 800μF elect. 12V
- C4 0·01μF
- C5 500μF elect. 12V
- C6 500μF elect. 12V
- C7 2,500μF elect. 12V

Variable Resistors

- VR1 10kΩ log. carbon
- VR2 100Ω skeleton preset

Semiconductors

- TR1 AC127 germanium *npn*
- TR2 AC128 germanium *pnp*
- TR3 AC127 germanium *npn*
- TR4 AC128 germanium *pnp*

SEE **SHOP TALK**

D1–D4 BY154/CSI or similar 50V, 0·5A bridge rectifier.

Miscellaneous

- SK1 Single phono socket
- SK2 Single phono socket
- SK3 Two-way connector for LS1
- LS 8Ω 5 to 8 inch moving coil loudspeaker capable of handling 1W. (5 to 15Ω can be used).
- T1 240V primary 6V, 500mA secondary (Eagle type MT280 or similar—see text).
- S1 Single pole mains on, off switch.
- LP1 Mains neon indicator (incorporating resistor)

Case, 7 × 5 × 3 inches—universal chassis parts CU158 (2 off) CU145 (2 off), CU147 (2 off), control knob, heatsink clips, standard TO1 type (2 off), 0·15 inch matrix plain perforated Veroboard, 5 × 4½ inches and 3¼ × 2¾ inches, aluminium angle for fixing brackets, connecting wire, 3 core mains lead and fused plug, 4BA fixings.

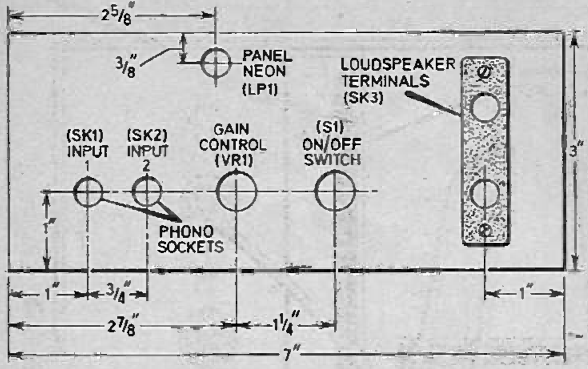
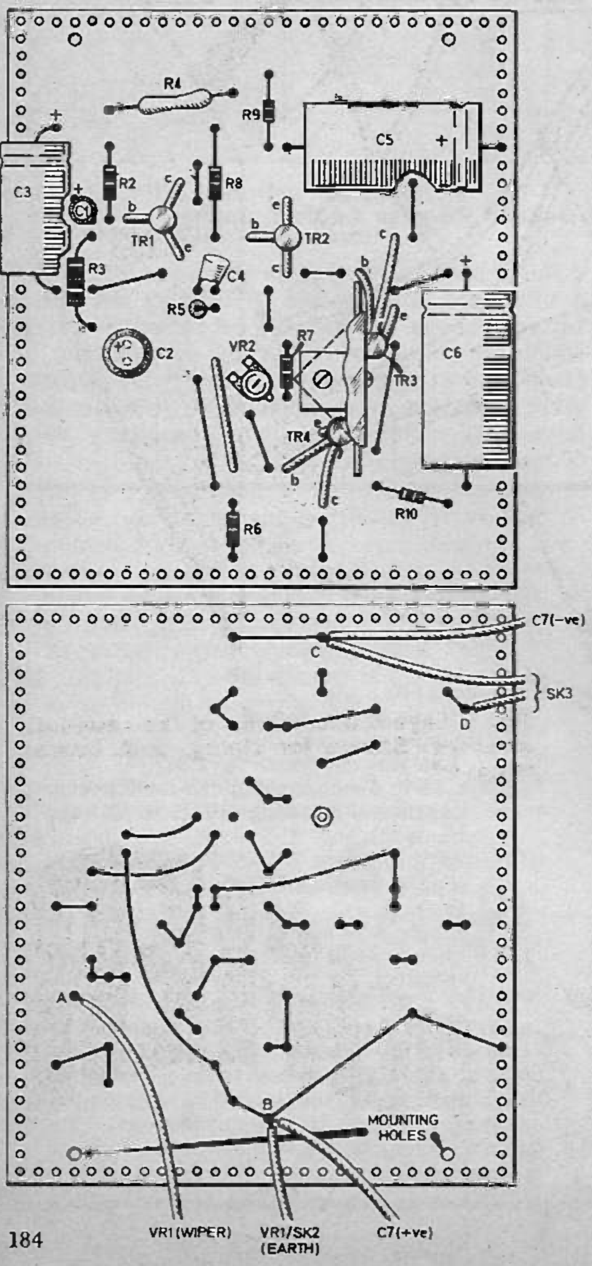


Fig. 2. Front panel details.

Fig. 3. Layout and wiring of the amplifier component board.



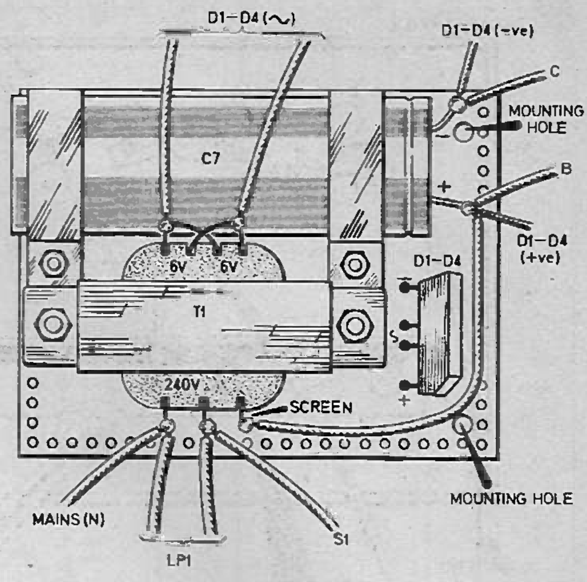


Fig. 4. Layout and wiring of the power supply.

CONSTRUCTION

The prototype, as shown in the photographs, and Figs. 2 to 5, was housed in a box measuring 7 x 5 x 3 inches made from Home Radio universal chassis parts. Any similar size box can be used. The front panel, which carries the amplifier and power supply circuit boards, as well as input sockets and gain control should be made up as shown in Fig. 2.

The amplifier itself is arranged on a plain perforated circuit board measuring 5 x $4\frac{1}{2}$ inches, as shown in Fig. 3. Great care must be taken over wiring because of the d.c. coupling used throughout and because two transistors are *pnp* and two are *npn* and can only be differentiated by their type number viz: TR1 and TR3 are *npn* (AC127) and TR2 and TR4 are *pnp* (AC128). Connections are shown in Fig. 3 together with details of the heatsink for TR3 and TR4. Double check the wiring and particularly the position and connection of the transistors.

The small heatsink used on TR3 and TR4 is not suitable for continuous operation when the amplifier is enclosed in the aluminium case. To overcome this a small bracket should be fixed to the heatsink and this bracket screwed to the case by means of a self tapping screw. This will ensure that the unit is kept cool at all times.

The power supply is assembled on a circuit board measuring $3\frac{1}{4}$ x $2\frac{3}{4}$ inches as shown in Fig. 4. This is fairly straight forward but note the parallel connection of the two 6V secondary windings of the MT280 transformer T1.

The two circuit boards are positioned as shown in the photographs and wired up as shown in Fig. 5, which also shows the connections to the panel components; VR1 (gain control), the two input sockets, the loudspeaker terminals and mains on-off switch etc.

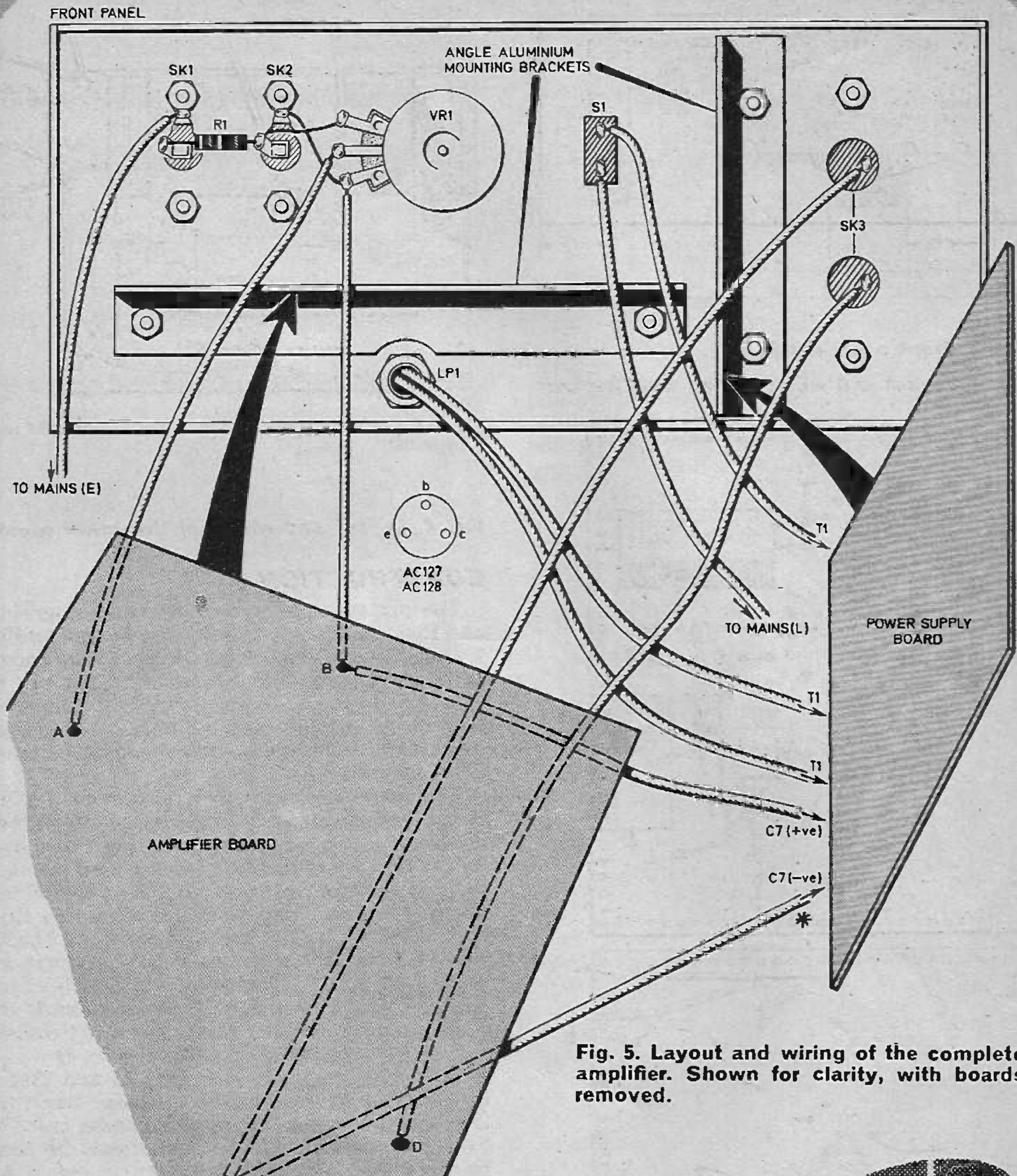
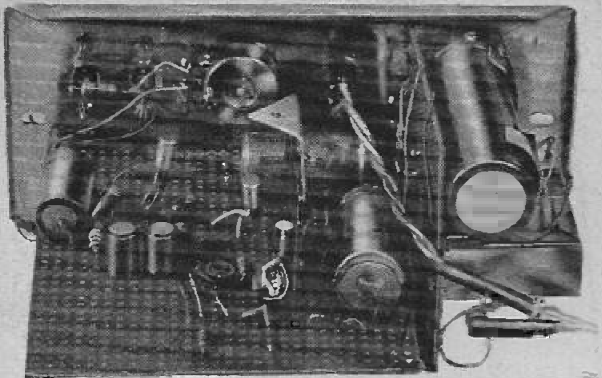


Fig. 5. Layout and wiring of the complete amplifier. Shown for clarity, with boards removed.

GENERAL PURPOSE AMPLIFIER



TESTING

It would be best to first check the power supply voltage by disconnecting the negative rail from the amplifier board and measuring the voltage between the power supply negative and positive i.e., across C7. This should be about 9V.

If a milli-amp meter is available connect at the starred point in Fig. 5 i.e., between the power supply negative (C7) and the negative rail of the amplifier board. With the supply on and with VR1 turned off, the current to the amplifier should be set to about 12mA by adjusting the preset VR2. If no milli-amp meter is available set VR2 with its slider to midway position.

Those able to check voltage and current should be able to obtain readings approximately equal to those shown in Table 1.

Table 1: Amplifier Test Measurements

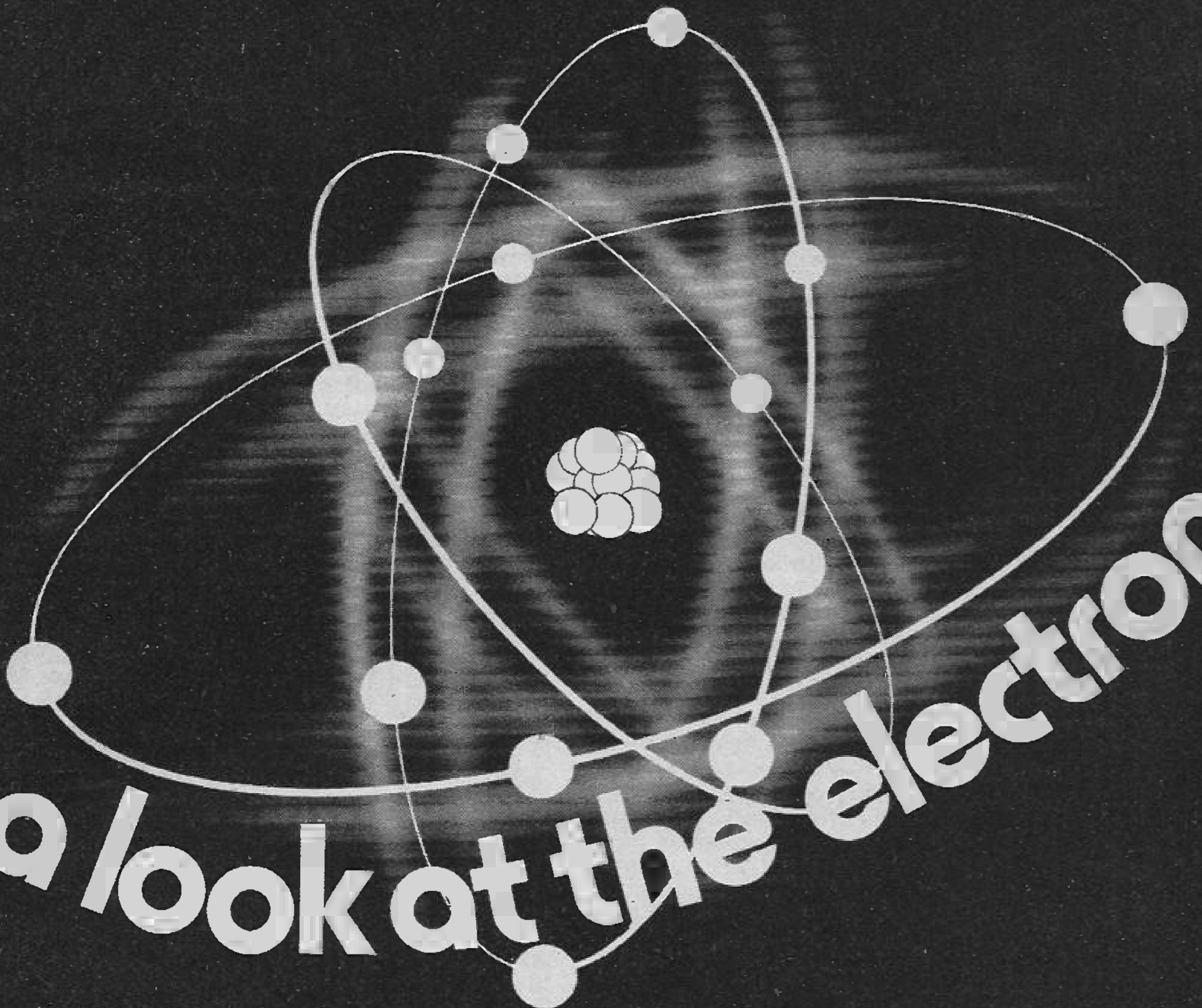
Measurement	Current
Supply standing current (no input signal)	10–15mA
Supply current (maximum power output)	100–150mA
Measurement (no input)	**Voltage**
Supply	9V
TR1 base	4V
emitter	4·2V
collector	0·4V
TR2 base	0·4V
emitter	0·25V
collector	4·8V
TR3 base	4·8V
emitter	4·9V
collector	0V
TR4 base	5·2V
emitter	4·9V
collector	9V

As mentioned earlier the loudspeaker may be any small 5 or 8 inch type of 5, 8, or 15 ohms impedance (preferably 8 ohms for optimum performance) capable of handling 1 watt. It should be housed in a suitable enclosure which may be a plywood box of about 12 by 12 inches (front) by about 6 inches deep and closed in at the back. The amplifier will operate well with the *MW/LW Radio Tuner* (described in September 1972 E.E.) and could be used for monitoring during tape recording as well as the various applications outlined at the beginning of this article.

SAFETY

When operating the amplifier the loudspeaker should not be disconnected, nor should the output be short circuited as this could result in damage to the output transistors.

The amplifier should be connected to the mains supply by way of a three core mains lead and a mains plug fused at ½ amp. The chassis of the amplifier should be earthed as shown and the unit should not be used with any a.c./d.c. equipment such as a television or older type valve record player, unless it is fitted with proper amplifier output socket. ▣



a look at the electron

By S. McClelland

ELECTRONICS is based on the behaviour of but one particle—the *electron*. However, this single particle is fascinating and so some features of its strange world will be briefly examined.

THE ATOM AND THE ELECTRON

All matter is made up of atoms which in turn are composed of equal numbers of extremely minute positive charges (protons) in a central nucleus and negative charges (electrons) which circle around it rather like planets in a minature solar system, so that the atom as a whole is electrically neutral.

Thus, it is mainly empty space—its diameter can be over 10,000 times that of the nucleus where most of the mass in concentrated. For example, consider Fig. 1, which shows the simple structure of an atom of sodium.

It will become apparent that atoms of different elements (e.g. sodium and carbon) are distinguished by their different numbers of protons, and hence, electrons.

The other particles in the nucleus with no charge, and called neutrons, need not concern us here since they only effect the mass of the atom and not its electrical properties.

ENERGY LEVELS

Sodium has 11 protons, 11 electrons, and 12 neutrons. Work by the great physicist, Niels Bohr, in 1913, showed that the electrons in, for example, an atom of sodium, can only move in certain, well-defined orbits, each of which is associated with a particular energy, but that they can transfer from one to another of these so-called *energy levels* under certain circumstances if they could lose or gain a definite or

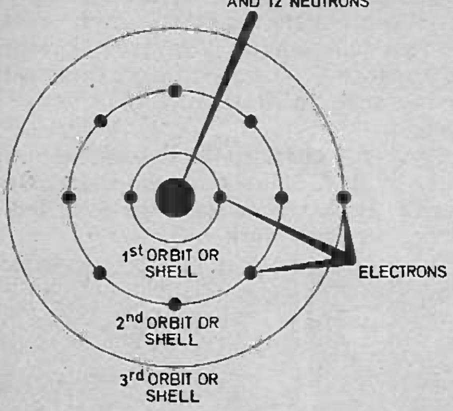


Fig. 1. The spatial arrangement (schematic) of electrons in an atom of sodium.

discrete amount of energy in the process.

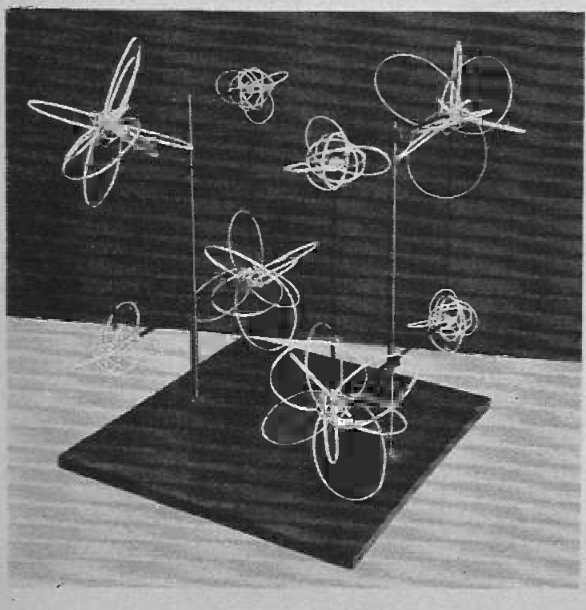
As an analogy, think of a lift in a department store moving up and down; in order to move up a floor the lift motor must be supplied with power (e.g. electricity), but to move down again a floor the motor can act as a generator and supply power since the lift can "freewheel" down as it were, under its own weight.

In ideal circumstances, we should be able to say that the particular amount of power originally supplied to the lift in ascending would be given out again by the lift in descending.

VISUAL ENERGY CHANGE

We can show this on this sub-atomic scale, too. Sprinkle a few crystals of any compound of sodium, for example, table salt (sodium chloride) or washing soda (sodium carbonate) into a flame, a pronounced yellow colour will be given to the flame.

A model of sodium chloride with Bohr orbits—lattice.



At first, some of the electrons in the sodium constituent of the compound will be promoted to higher energy levels as heat energy of the flame is supplied to them. However, they soon re-occupy their original orbits and, in doing so, they emit the energy (which just happens to be yellow light) that was originally donated to them to enable them to transit.

Since this energy output, in the form of emitted light, is found to be characteristic of the atoms present in a specimen (e.g. the sodium ion has an energy output corresponding to a particular yellow light), then unknown samples can be analysed on this basis. This is the technique used with the spectroscope and related instruments. (Fig. 2).

Although the straightforward Bohr theory became much more complicated when electrons were found to have properties associated with waves (see later), its essence can be readily understood.

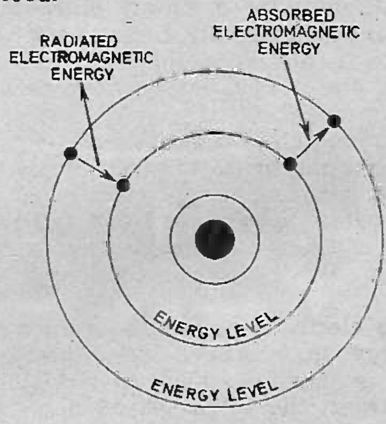


Fig. 2. Simple arrangement of two energy levels in an atom.

This concept of energy levels in atoms can be used to explain a wide range of phenomena from how a laser operates to the reasons for electrical conduction, insulation, and semiconduction.

CONDUCTORS, INSULATORS AND SEMICONDUCTORS

All solids are made up of regular arrangements of atoms called lattices. As a result of the atoms being packed quite closely together in a lattice, the narrow energy levels of each individual atom merge together with the equivalent levels of the other atoms, and comparatively wide *energy bands* are formed.

The energy band which holds the outer electrons in each atom, or valency electrons, is called the *valence band,* but as there are energy levels with no electrons, there are also empty energy bands.

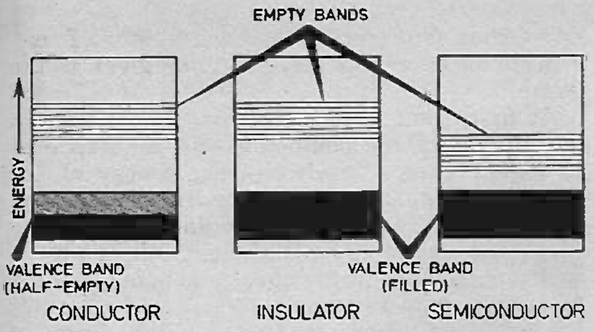


Fig. 3. Energy band diagrams. Note the relative spacing of the empty bands and valence band in the insulator and conductor.

Now, for conduction to take place in a solid (i.e. the flow of current under an applied electromotive force) the valence electrons must be given enough energy to lift themselves into a higher energy level and thus move from atom to atom in the solid. This movement of charges constitutes an electric current. (Fig. 3.)

Electrons in *conductors* have no difficulty in doing this, since for a variety of reasons the valence band is half-empty. Hence, empty energy levels are easily accessible to the valence electrons, and they consequently need little energy to transfer.

On the other hand, *insulators* have no partially-empty bands and hence to reach empty energy levels, the valence electrons must reach a completely separate, empty band and this requires quite a lot of energy not normally available from low-voltage sources. No conduction, therefore, takes place.

Valence electrons in *semiconductors* require less energy to transfer, for although their structure is roughly similar to insulators, the space between the valence band and the next empty band of higher energy is relatively narrow. Indeed, the heat energy associated with room temperature can provide this energy, ie. the substance conducts, while at very low temperatures insufficient energy is provided and therefore the semiconductor becomes an insulator.

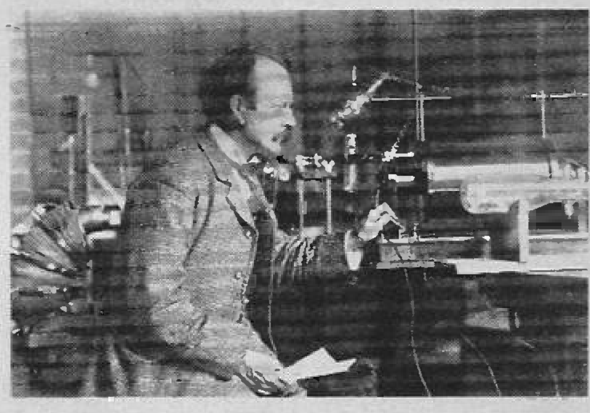
The properties of a semiconductor can be modified by the introduction of carefully controlled, minute amounts of impurity atoms. The latter alter the natural arrangement of energy levels by introducing new levels and produce the familiar *p* and *n* type semiconductor so vital for the operation of the transistor.

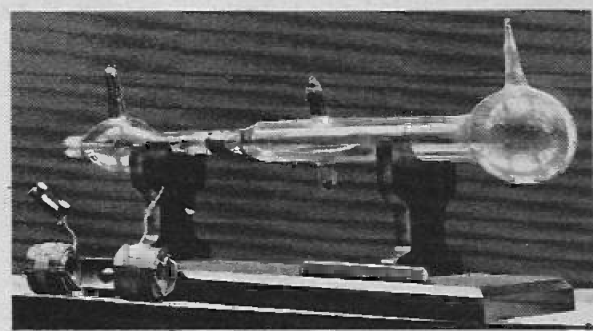
PHYSICAL PROPERTIES

The electron is an extremely minute particle—almost two thousand times lighter than the proton. In fact, it belongs to a class of sub-atomic particles called *leptons* or *light particles*.

Although G. J. Stoney postulated the existence of the electron as the fundamental particle of electricity in 1881, the existence of the particle was confirmed and an estimation made of its mass by J. J. Thomson at Cambridge in 1897. He was investigating rays from the cathode in a vacuum tube, and in a famous experiment he used apparatus not far removed from today's cathode-ray tube to determine their charge-to-mass ratio.

The electron's charge was determined accurately later by R. A. Millikan in the United States of America. Both physicists were awarded the Nobel Prize for their work.





Upper photograph: The discoverer of the electron—J. J. Thomson. Lower, his apparatus for the determination of the charge to mass ratio of the electron.

QUANTIZATION

An interesting point to note is the basic nature of the electron's charge. No charged particle has yet been discovered that carries a charge less than that (numerically) of the electron, although physicists are presently suggesting that such fractionally-charged particles may exist called *quarks* in order to explain the structure of some strange particles.

The same point also applies to another property of the electron—its spin. The electron, besides orbiting the nucleus also appears to spin on its own axis, rather like a top, and this spin must always have a definite positive or negative value, corresponding to the "directions", as it were, in which it actually spins. It is found that any particle which possesses spin can only have this numerical value or simple multiples of it.

We say that properties, such as charge and spin, for which certain values only exist, are *quantized*.

Remote as they seem, these properties are related to many everyday phenomena; spin, for example, is thought to give rise to magnetism in some metals.

Table 1: The Electron

Parameter	Numerical value
Charge (e)	$1{\cdot}6 \times 10^{-19}$ coulombs
Rest mass (m_o)	$9{\cdot}11 \times 10^{-31}$ kilogrammes
Charge to mass ratio (e/m)	$1{\cdot}76 \times 10^{11}$ coulombs/kilogramme

PRODUCTION OF ELECTRONS

(1) THERMIONIC EMISSION

Thermionic emission, as the name implies, is emission by heat. This takes place in ordinary valves and electron guns e.g. in cathode ray tubes.

In a simple diode valve, the nickel cathode is usually heated by a filament causing it to emit electrons in much the same way as heat energy causes liquids to evaporate. The electrons thus produced collect around the cathode until a positively biased anode attracts them and thus enables current to flow.

However, a negatively-biased anode (with respect to the cathode) repels these electrons back to the cathode, and no current flows, i.e. the device is a simple rectifier.

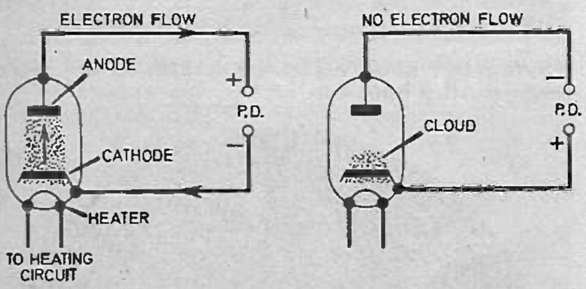


Fig. 4. The diode valve, thermionic emission.

(2) PHOTOELECTRIC EMISSION

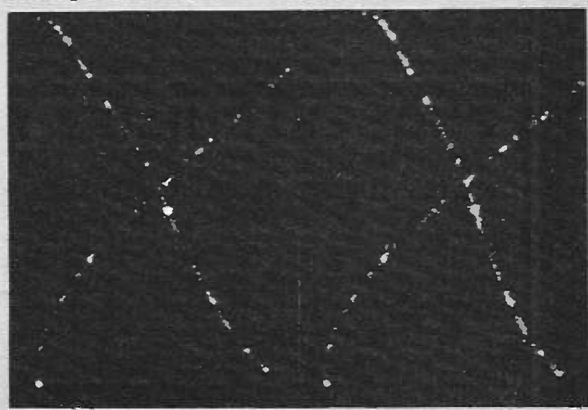
Electromagnetic radiation, e.g. light above a certain frequency, incident on certain elements (e.g. zinc) causes electrons to be emitted from the element. This phenomenon is known as the *photoelectric effect* and the emission as *photoelectric emission*.

It can be explained in terms of the minimum energy required to remove an electron from a particular energy level in an atom of the element, and it is used to advantage in the various types of photoelectric cell or photocell e.g. the selenium solar cell which is used to produce electricity to power some spacecraft.

(3) RADIOACTIVE DECAY

Some forms of the elements called isotopes are radioactive, that is, their atoms are so unstable that they spontaneously break up or decay to yield simpler entities.

Such decay, if it involves the production of electrons, is sometimes described as *Beta decay*, and it is thought to operate by a neutron inside an atom decaying to an electron, proton and a mysterious, ghostly particle called an *antineutrino*, which has no charge and travels at the speed of light.



Stereoscopic photo of electron tracks using a cloud chamber.

DETECTION OF ELECTRONS

Once electrons have been produced they must obviously be detected and tracked. Ideally, we should like to see the paths of the particles as they interact with each other but we are talking of times of the order of minute fractions of a second and of particles whose size is almost infinitesimal.

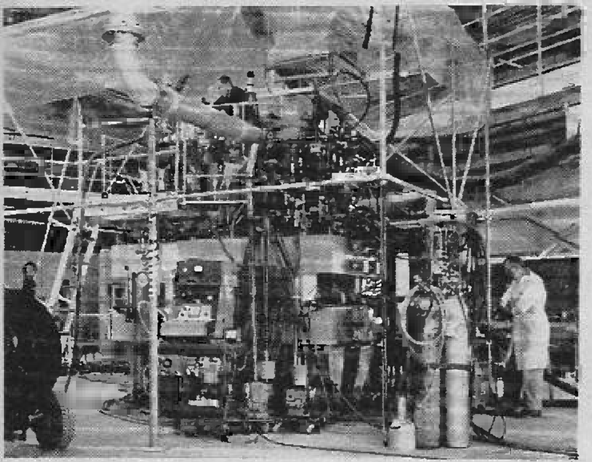
However, in an indirect way, we can effectively see the progression of the reactions and to do this instruments called cloud chambers and bubble chambers are used.

The operation of the bubble-chamber will be described as it has largely superseded the cloud chamber for experimental purposes, although both are based on largely the same principle.

THE BUBBLE CHAMBER

In a bubble chamber, which is basically a big tank, liquid hydrogen is heated under pressure until it is just about to boil. Then the pressure is suddenly reduced and this places the liquid hydrogen into what is known as a "superheated state", i.e. it is for a short time considerably above its boiling point at that lower pressure.

To show that the boiling point of a liquid increases as the external pressure increases,



The Brookhaven 20 inch bubble chamber, New York.

think of an ordinary pressure-cooker in which it is possible to heat food well above the boiling point of water at normal pressure because the pressure inside is higher and so dictates that the water should boil at a greater temperature.

In the bubble chamber, the liquid hydrogen's temperature is such that bubbles will form around any alien body (e.g. dust, or charged hydrogen ions) so if an electron hurtles through the chamber, being charged, it will knock out some electrons from the hydrogen atoms and the latter will then become positively charged ions.

Bubbles will form around these ions and they will clearly define the path of the original electron.

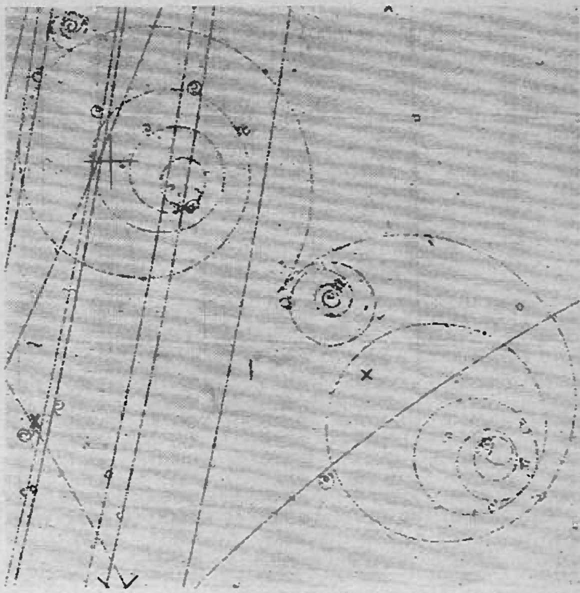
In other words, the apparatus is arranged so that boiling takes place selectively along the electron's track which can be seen and photographed as a line of bubbles. To make the bubbles, however, the original particle must be charged.

USE OF BUBBLE CHAMBER PHOTOGRAPHS

The courses of many reactions can be inferred from bubble chamber photographs; for example, if a track apparently starts from nowhere in the picture, it can be deduced that an uncharged particle or non-ionizing radiation gave rise to the charged particle which made the track.

Very often, a bubble chamber is used in conjunction with an electromagnet to study the way a particle behaves in a magnetic field. A curved track will be produced by the particle and an examination of this yields mass, charge (oppositely-charged particles curve in different directions), momentum (mass multiplied by velocity) and other information about it.

Thus, although other instruments exist for the detection of charged particles, it will be seen that the bubble chamber is one of the most useful.



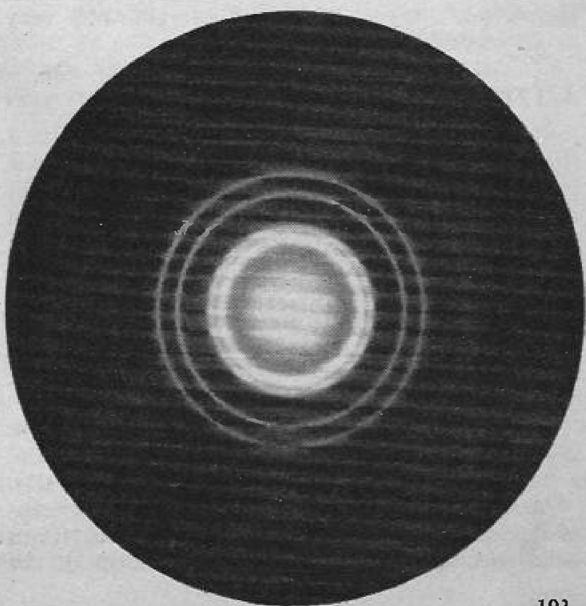
Bubble chamber photograph of electron/positron pair creation and other tracks.

WAVE ASPECT OF THE ELECTRON

In the 1920's, the electron and all other particles were shown to behave like light itself and have both a particle and a wave aspect. This amazing and apparently contradictory situation arose because electrons were found to exhibit diffraction, a property associated with waves.

If light rays from a single source and of the same wavelength are allowed to pass through two (or more) small slits which are close together, each slit will act as a source itself and the waves emerging from the slits will interfere with each other (i.e. alternately reinforce and

Photograph showing electron diffraction rings produced by gold foil.



destroy each other) so that an image of light and dark bands forms on a screen placed in front of the slits.

Diffraction also occurs if a beam of electrons are projected through a metal foil, for example. The spaces between the atoms act as very tiny slits and the scattered electrons will build up a series of concentric rings on a suitably placed photographic plate as a result of being diffracted by the lattices in many directions.

Diffraction experiments such as this suggested that the wave associated with the electron possessed a wavelength of the order 10^{-12}m.

As a result of this very difficult concept, first put forward by Louis de Broglie and developed by Erwin Schrödinger's wave mechanics, the philosophy of the atom was totally changed. Instead of speaking of definite electron orbits in the atom, we must speak of orbiting electron clouds separated by discrete intervals of energy which represent the probability of the electron's position at a given moment.

Werner Heisenberg also showed it was impossible to know both the exact position and velocity of an electron at the same time, since by examining the particle one must disturb, and therefore change its energy.

ELECTRON MICROSCOPE

A more familiar result is the electron microscope (EVERYDAY ELECTRONICS, July 1972) which can be used to examine very small objects. This is because the waves associated with the electron have a much shorter wavelength than those of visible light on which the optical microscope depends, and hence its resolving power is greater.

As an analogy, think of the very small effect that the medium-sized ruts in a road would produce if you were driving a tractor with huge wheels, but you would soon discover they exist if you were trying to ride a bicycle with very small wheels across them.

ANTIMATTER—THE POSITRON

In 1928, P. A. M. Dirac formulated a brilliant theory that indicated that every particle in existence should have its own "antiparticle"—its identical twin in every respect except that it would be oppositely charged.

Thus, the antiparticle of our, ordinary, negative electron would be a positive electron, or positron, as it came to be known.

The theory was triumphantly proved correct when in 1932, C. D. Anderson identified the positron in cloud chamber studies.

A simple analogy may help the reader to grasp the relationships between an electron and a positron but it must not be taken too literally.

Imagine a metal tray, the sort with groups of cup-shaped depressions, that are sometimes used to bake small pies for example. If all the depressions were filled with pies that fitted them exactly, and you ignored the different textures of metal and pie you could not tell the difference between pie and tray, by touch alone.

However, if the pie was lifted from the depression you could immediately distinguish them merely by touch, the pie having a lower convex surface, the depression an upper concave surface. From something that was not detectable, we arrived at two things which were (Fig. 5).

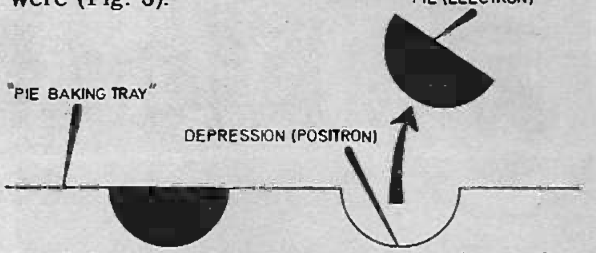


Fig. 5. Analogy of electron-positron pair creation.

ELECTRON—POSITRON PAIR

In a similar way, it was theorized that the positron bears largely the same relation to the electron, as does the depression to the pie which occupies it.

As in the first instance, the electron and positron are undetectable in normal space, but if energy, in the form of electromagnetic radiation called gamma rays, is supplied, the electron is removed and exists independently from the vacancy it occupied i.e. the positron.

The process is called "pair-creation", and both particles can be identified in a bubble chamber.

However, the process is reversible—if an electron collides with a positron, both are destroyed and their matter liberated as energy. This is called "pair-destruction" and because ordinary matter is by far the more abundant of the two in our universe, free positrons have extremely short existences.

Positron-electron pairs are formed when cosmic rays, which originate from outer space, impinge upon our atmosphere. A cosmic ray "shower" takes place with many pair-creations and destructions.

It is interesting to note that the positron was discovered by cosmic ray studies.

Physicists believe that the phenomena of antimatter may even be involved with the flow of "time" itself, and the possibility of other universes, besides our own, in existence.

UNLIMITED ADVANCES

We have seen some features of the strange world of the electron. If this knowledge can be developed by physicists and then applied (as was brilliantly done in the invention of the transistor), the future indicates almost unlimited advances in electronics. ▣

BASIC Electricity

6

The Transformer and Domestic Electricity By Maureen Birch

A TRANSFORMER is a device for changing the voltage level of an alternating supply and utilises the principle of induction caused by a change in magnetic field—similar to that described last month.

It consists of two coils of wire—electrically isolated from each other—wound on a core of magnetic material; this core, like that of a motor armature, is made up from laminated sheets of soft iron that are usually punched in the form of a shape that will interlock with itself to give a strong support to the coil, see Fig. 6.1. One coil is called the **primary** and the other the **secondary**.

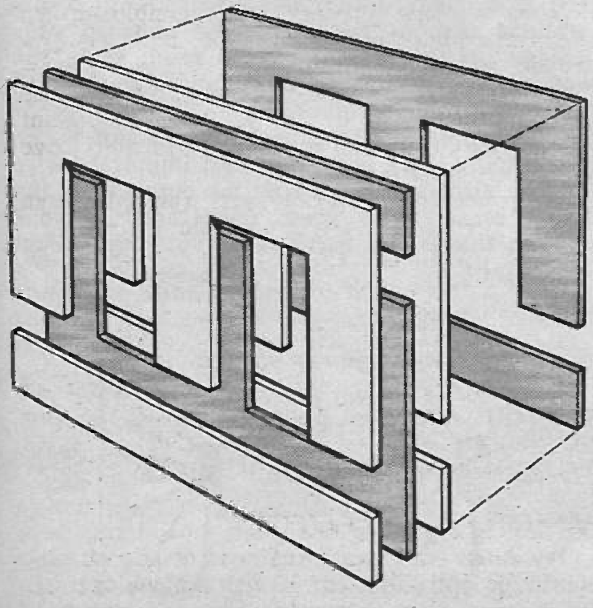


Fig. 6.1. Interlocking transformer laminations are stacked together through the bobbin and clamped firmly.

TRANSFORMER ACTION

If an alternating current is passed through the primary (from an alternating voltage source), the magnetic field strength through the core also alternates and this constantly changing field strength induces an e.m.f. across the secondary winding which can be used to make a current flow in an external circuit.

If there are more turns on the secondary than the primary, the voltage output will be greater than the input by more or less the ratio of turns. You cannot get power for nothing and although the output voltage will be higher in the instance quoted, the current that the secondary can supply will be less.

Having less turns on the secondary than on the primary you can get a lower output voltage at higher current. To all intents and purposes, the input voltage multiplied by the input current will equal the output voltage multiplied by the output current.

As voltage multiplied by current gives us power we can say that a transformer will convert voltage levels with virtually no power loss, i.e. it is a very efficient process.

In actual fact there is always a small amount of power loss caused by electrical currents induced within the core itself and these dissipate themselves as heat. Laminating the core and insulating the laminations from each other reduces these currents—called **eddy currents,** and one of the qualities of a transformer is its ability to avoid these core losses.

APPLICATIONS

Transformers (see Fig. 6.2) have many applications in electronics, the most common being to convert the 50Hz mains voltage to a low level so that we can drive transistor circuits.

A lesser understood application is to give electrical isolation between a piece of equipment and the mains. Many early radio sets were a.c./

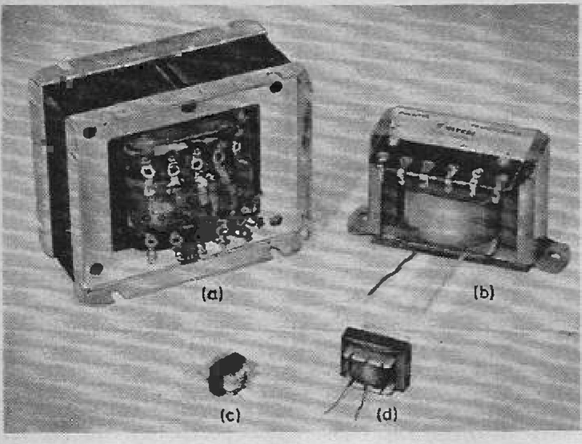


Fig. 6.2. Transformers: (a) Multiple tapped mains (b) low voltage tapped booster (c) and (d) transistor radio matching types.

d.c. and did not have transformers in them; older readers will probably remember the warnings on the back of such sets that the chassis could be live and there was a risk of electrocution if the metalwork of the chassis was touched.

We do not find this very frequently in radio sets today but the non-isolated television set is still with us and the unwary should never attempt to touch the chassis of any television set while it is plugged into the mains.

Many people tend to think that it is only the 25,000 volts inside the set that is dangerous; although it is, the dangers from a live chassis can be just as lethal.

MATCHING

Transformers are also used in what we might call low power circuits in instances where we might need a reasonable voltage at fairly low current from a source that produces a very low voltage at reasonable current. This is typical of low **impedance** microphones (impedance being the resistance to alternating current) and frequently one has to **match** a microphone to an amplifier by means of a transformer.

A very common everyday type of transformer is the bell transformer that has several output voltages available—these are generated simply by having a secondary coil with tappings taken from it at required intervals.

A.C. NECESSARY

A transformer cannot give an output voltage unless the input current, and hence the field in the core, is varying, therefore you cannot step up, or step down the voltage of a battery directly.

This can be done indirectly by using the battery to power an oscillator that produces a varying current and then this current is applied to a transformer. This type of circuit is called a static inverter and is used frequently to drive fluorescent light tubes from car batteries.

ELECTRICITY TO YOUR HOME

Transformers have enabled the Central Electricity Board to overcome one of the problems in the distribution of electricity throughout the country (see Fig. 6.3).

Electric current flowing through a wire causes heat, and this is equivalent to a loss of power; it is therefore more efficient when carrying current over long distances in overhead wires to keep the current as low as possible.

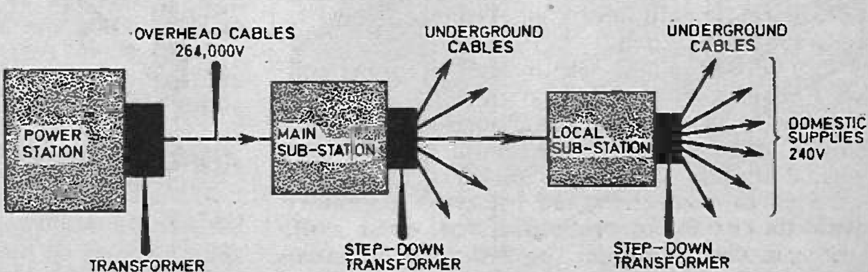
However, the recipients of the current still need power and the low current is compensated for by having it at very high voltages.

Usually the voltage produced at the generating station is stepped up by a transformer to 132,000 or 264,000 volts before being fed to the overhead cables of the national grid.

At major sub-stations this is stepped down to one or two thousand volts (kV) for local distribution by underground cable to the minor substations such as the unmanned units in your village or at the end of the road. Here the voltage is transformed down again to the 240 volts we are all familiar with.

The supply enters your house on two wires, but usually there is a third most important wire which, although it carries no current in the usual sense, is of great importance to your safety; this is the **earth** wire, but more about this later.

Fig. 6.3. How electricity is brought to your house from the power station.



EARTH WIRE

The two wires that carry the main current into your house have designating names, one is called **neutral** and the other line (**live**).

As mentioned previously voltages are always measured with respect to something, because voltages are differences in potential between two points in a circuit. When considering electrical power on a reasonable scale one can say that the earth around us can be taken as a fairly stable potential reference.

The potential difference between the neutral line and earth is usually very small (there is always some difference—contrary to some people's belief) and never more than a volt or two in the worst case. Although you should never do it, you could, in theory, touch the neutral mains wire and not get an electric shock.

On the other hand the mains line lead has a varying potential difference between it and neutral and this 50Hz voltage gives rise to a sort of average level known as the r.m.s. level (r.m.s. stands for root mean-square) and this is usually 240 volts.

Because we are considering an alternating supply, this means that the mains line is varying by plus and minus 240 volts r.m.s. with respect to neutral which is to all intents and purposes, with respect to earth.

We have mentioned that the 240 volts is a sort of average and in actual fact the line voltage can rise to a peak of about 380 volts at the peaks of each cycle. Touching the line connection to the mains, and you are assured of getting a very nasty electric shock.

Obviously there is a big difference between the line and neutral wires and this is why one must take special care to see that they are connected to an appliance the right way round. The appliance will work quite satisfactorily if the leads are reversed but it immediately becomes dangerous.

POINTS TO NOTE

All pieces of equipment, whether they are electric clocks, drills, radios or record players should be connected to the mains with a fuse in the line lead and in most instances the case (if it is metal) should have a good connection made between it and earth.

If a wire becomes loose inside the equipment, or it overheats and insulation starts to melt, there is a chance that the dangerous line lead might short circuit to the metal case; if you picked up the appliance and there was not a good earth connection, and you were in contact with the earth, concrete floor, or worse still, water in the bathroom, the 240 volts potential difference between line and earth would be applied across you and current would flow—this is what gives an electric shock.

Most of us have had a mild electric shock and have survived; why were we not killed? The answer is quite simple—we were very lucky because we probably did not make a very good connection to ground and the current that flowed through us was not very great. Tap water is a conductor of electricity and is also very well connected to ground through underground pipes, hence electric shocks in the bathroom are invariably serious and frequently fatal.

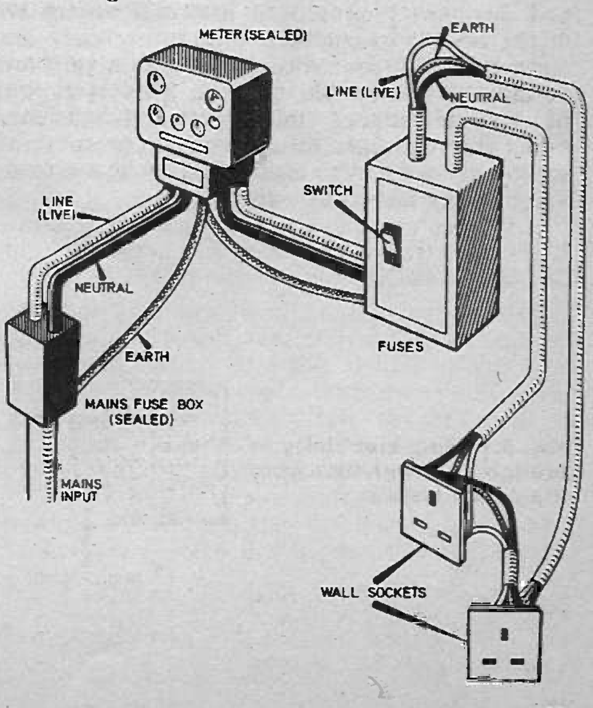
If, however, the case of the equipment is already connected to a good earth, the mains line will short directly to ground and a very high current will flow through the case and the earth wire—thus by-passing you.

This heavy current flows down the line lead and through the fuse which is made of low melting point wire and the heavy current rapidly heats up the fuse wire until it melts and breaks the circuit (via the fuse) on the line side.

A fuse can be made to have different amounts of current above which it will **blow** and one should always use a fuse with a current rating just higher than the current equipment will usually draw; then, even though you may not get a catastrophic short to earth, any sign of perished insulation etc, that gives rise to an increase in current will cause the fuse to melt —a good early indication that something needs attention.

Many people are tempted to replace the fuse with one of a higher current, this should **never** be done because the fuse blowing in the first place indicates a fault which should be rectified before the equipment is used again.

Fig. 6.4. Schematic drawing of part of a household "ring main".



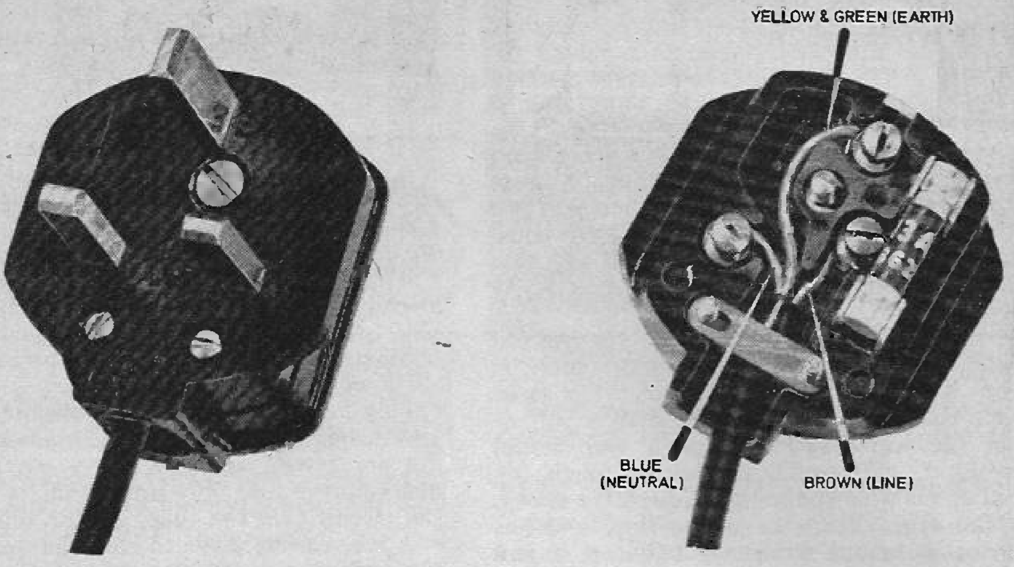


Fig. 6.5. Shows a 13A square-pin ring main plug with colour identification of the line, neutral and earth wires.

MODERN DOMESTIC WIRING

Modern houses have a central fuse box with high current fuses feeding mains into ring main circuits around the house; these are recognised because they use the now common square-pin sockets and plugs see Fig. 6.5.

These sockets are designed to carry an *absolute maximum* current of 13 amperes, but because not all pieces of equipment need this sort of current, the plugs that are used with these sockets have a fuse cartridge that can have a rating of anything from 1 amp up to the maximum of 13 amps.

The fuse you use should be carefully matched to the appliance that is to be connected via that plug. Most of these plugs are supplied with a 13 amp fuse but this should not be used if you are going to run, say, a table lamp; a 2 amp fuse would be more than adequate.

CALCULATION

Most pieces of equipment you buy indicate the amount of current they draw, but in some cases this is quoted indirectly as the amount of power they consume. This is measured in watts or thousands of watts (kilowatts). You can, however, calculate the current quite simply by dividing the number of watts by the supply voltage to arrive at the current.

For example, a 2,500 watt electric fire running from a 240 volt supply will draw a current of $\frac{3{,}500}{240}$ amps, which is about 10·5 amps; a 100 watt electric light bulb on the same supply will draw just under half an amp.

OLDER HOUSE WIRING

In older houses where round pin plugs are still in use, the circuit is protected by a fuse in the fuse box; these are usually rated at 5, 10 or 15 amps—depending on the type of circuit and on the thickness of wire used in the house wiring.

These plugs must be used with special care because it is too easy to break the rules and have a serious accident.

If you used a 3 kilowatt electric fire on a 5 amp circuit (and had quite wrongly substituted a 15 amp fuse in the fuse box), the fire would probably work and you might think all was well but this definitely would not be the case.

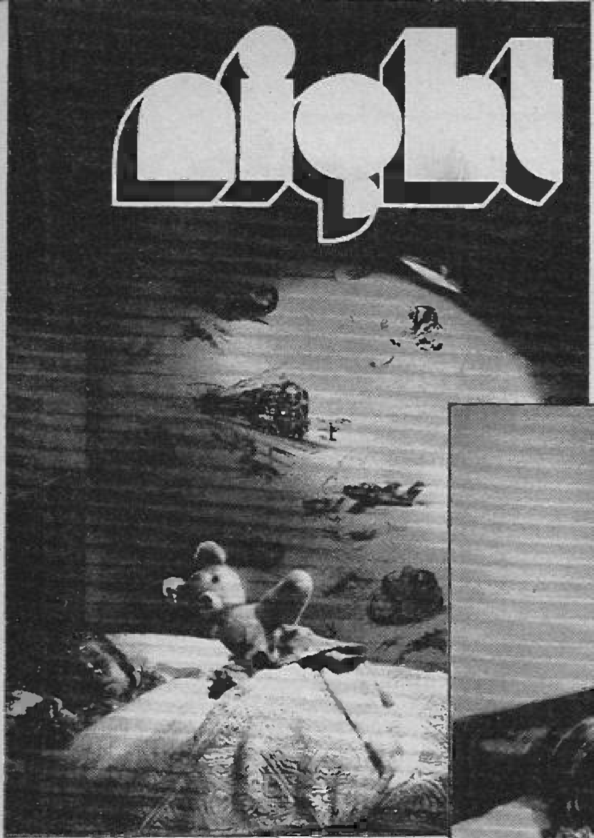
For a start, the plug would get hot and start to smoulder and worse still, the wiring behind the walls and perhaps along the wooden floor joists would also get hot, possibly red hot, and a major fire could start before you were aware of the danger.

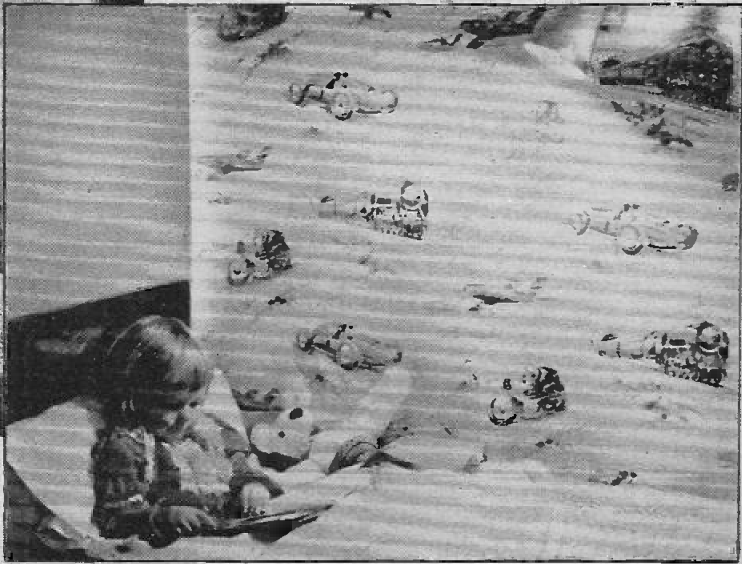
ADAPTORS

Adaptors are available to extend the outputs from either square pin or round pin sockets. These are very useful but are a temptation to the unwary. Although several appliances can be plugged in where only one was previously, the supply wire in the wall is still the same and cannot carry any more current than the maximum quoted for the single socket.

Electricity in the house is a wonderful ally, but a dangerous enemy. Handled with care and in a sensible way it is quite safe, but the basic rules must be adhered to, to the letter, otherwise very unpleasant accidents can occur. ▣

night light switch





By E. J. Byatt

A simple control to dim a lamp.

THIS simple design was created to meet two main requirements, namely to provide a dim light for use as a night light, television light or for illumination in a child's bedroom, whilst still providing full brilliance at the touch of a switch.

To enable the unit to be versatile it was decided to mount the switch in a separate case into which any lamp with a bulb of 200 watts or less may be plugged. The unit contains one switch to change from full to half power and a neon indicator to show when it is connected to the mains.

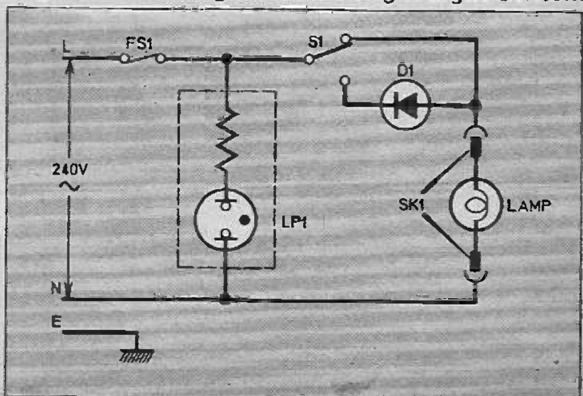
CIRCUIT DESCRIPTION

The circuit (Fig. 1) is so simple that it requires very little explanation. Switch S1 is used to change from full to half power; in one position it connects the lamp directly across the mains supply, in the other position it connects the lamp in series with diode D1 across the supply.

Let us assume the diode to be perfect i.e. when the cathode is negative with respect to the anode (Fig. 2a) the diode is considered as a short circuit. When the cathode is positive with respect to the anode (Fig 2b) the diode acts as an open circuit. However this circuit employs a.c. mains supply across the diode so the polarity across the diode will be alternating equally in either direction. Therefore for half the supply wave, the diode will be open circuit and for the other half it will be a short circuit, consequently the voltage across the lamp during a series of sine waves will be as shown in Fig. 3. This is known as half-wave rectification and the shape of the wave is known as pulsating d.c.

In terms of input and output voltages the mean d.c. output is 0·45 times the r.m.s. input i.e. $240 \times 0{\cdot}45 = 108$V d.c.

Fig. 1. Circuit diagram of the Night Light Switch.



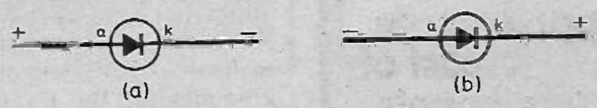


Fig. 2. Biasing of the diode (a) acts as a short circuit (b) as an open circuit.

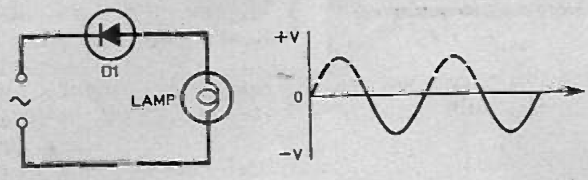


Fig. 3. Resultant output waveform with the diode in an a.c. circuit.

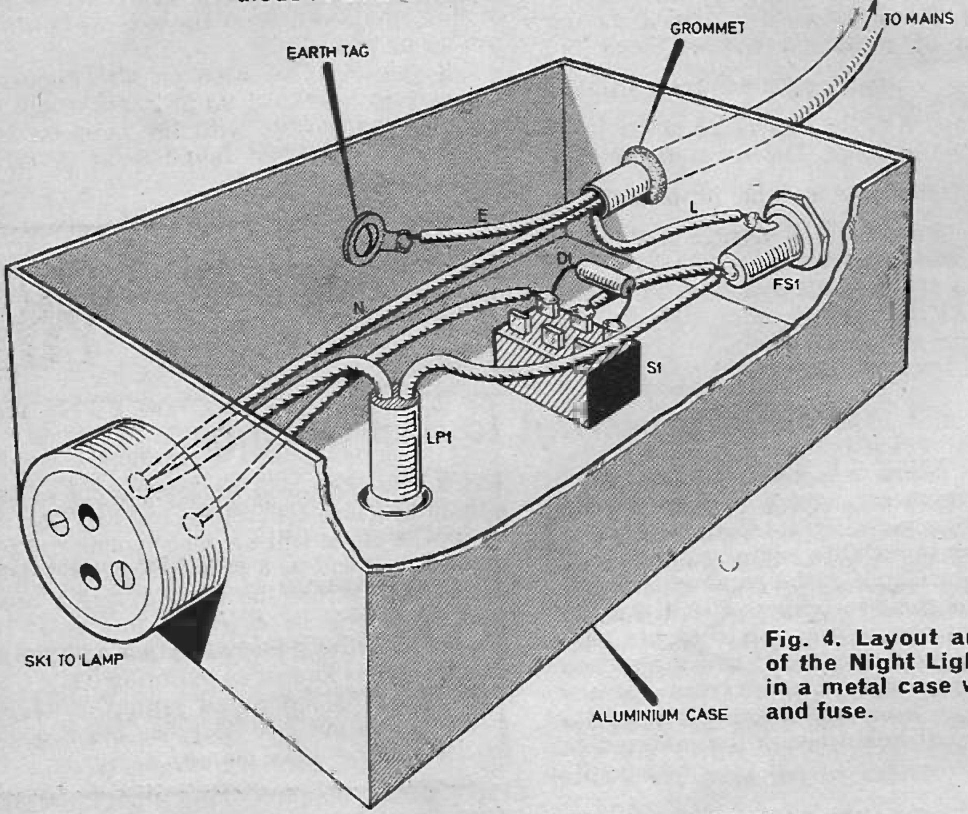
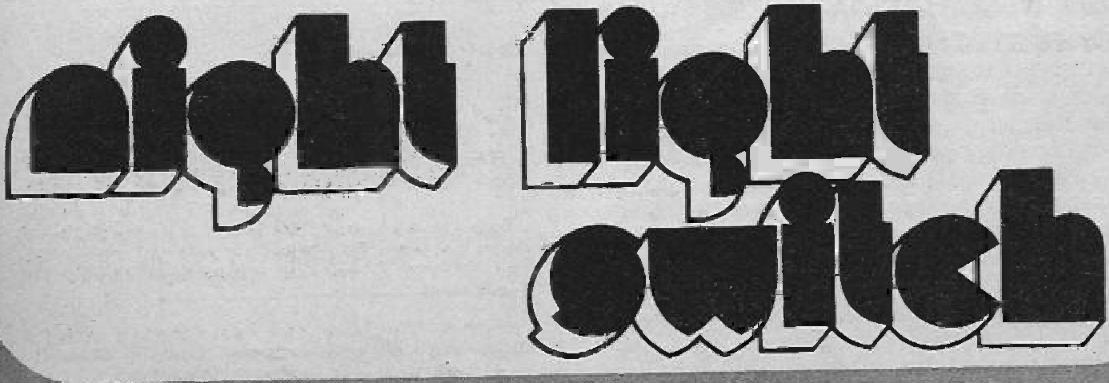


Fig. 4. Layout and wiring of the Night Light Switch in a metal case with earth and fuse.



night light switch

Thus by switching the diode in circuit we are dropping the voltage level to the bulb by more than half.

BRIGHTNESS

To calculate the effect this will have on the brightness of the lamp we must calculate the wattage used by particular lamps. Using the formulae $\frac{V^2}{R}$, where V is the voltage across the lamp (108V) and R is the resistance of the lamp we can find the wattage. The resistance of the lamp can be calculated by the formulae $\frac{V^2}{W}$ where V is the normal rated voltage of the bulb and W the normal wattage.

Hence for a 100W, 240V lamp the resistance is

$$\frac{240 \times 240}{100} = 576 \text{ ohms}$$

Thus the resultant wattage will be

$$\frac{240 \times 240}{576} = 20 \text{ watts}$$

This figure is only a rough estimate as the actual resistance of the lamp varies with temperature and since, in the second case, the lamp is operated at a lower temperature than is normal, its resistance will not be exactly the same. However, it can be seen that the diode, which dissipates virtually no power, is reducing the lamp output by some 80 per cent.

As mentioned above, the diode dissipates virtually no power and hence not only is the output reduced by about 80 per cent, the power consumed is also reduced by a similar amount.

CONSTRUCTION

The main thing to remember when constructing the unit is that mains voltage is employed and hence care must be taken to make sure the unit is safe. There are two ways of doing this; installing all the components inside an insulated plastic case or installing the components in a metal case which is properly earthed and with a fused supply.

The first method is probably the best, provided a suitable container that can be securely fixed together can be found. However, since small aluminium boxes are available from most component suppliers and a fuse is never a bad precaution, we shall detail construction in an aluminium case as shown in Fig. 4.

Commence construction by cutting the case to hold S1, LP1 and SK1, the earth tag and a grommet for the three core mains lead to the supply. Next mount the components as shown and then wire them up, together with D1; the polarity of the diode is not important.

Check all connections and make sure that the earthing tag is making good contact to the case and is wired to the earth pin of a three pin plug. Insert a 1 amp fuse, plug a lamp into SK1 (not more than 200W bulb) and switch on. Change S1 from "half" to full power or vice versa and check the brilliance of the lamp.

If the fuse blows for any reason, indicator LP1 will extinguish, in such cases disconnect the mains supply and check the unit for faults before replacing FS1.

The unit can be used on all lamps—except fluorescent types—of up to 200W. Slight flickering may be noticed with the lamp on reduced power. This was not found to be annoying on the prototype unit. ▣

Components....

SEE SHOP TALK

Diode
D1 400V 1A silicon type

Switch
S1 Single pole double throw mains toggle type

Neon
LP1 Mains indicator incorporating resistor

Socket
SK1 Two-way mains light socket (panel mounting)

Fuse
FSI Miniature fuse holder and 1 amp fuse

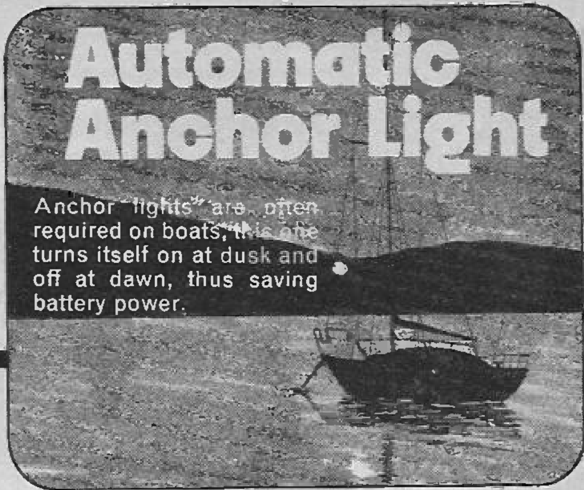
Miscellaneous
Case—metal or plastic approx 3 × 2 × 1½ inches (see text), three core mains lead, mains plug, earth tag, 4BA fixing.

PLEASE TAKE NOTE

Egg Timer **(March 1973 issue) a link should be made between C1 (negative) and the earth tag. The N and L on the mains lead should be transposed.**

Beta Treble Boost and Fuzz **(January 1973) a better fuzz may be produced if R2 is reduced; in some cases to as low as 15 kilohms.**

NEXT MONTH



Workshop Components and Tools....

An article describing a suggested stock of components and tools that will enable the constructor to set up a useful workshop. Useful testgear is also detailed.

FREE inside Semiconductor Wall Chart

Semiconductor parameters and base connections on a coloured chart.

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May issue on sale Thursday, April 19

INDICATOR AUDIBLE WARNING

A useful unit to add to your car's indicator system.

By P. E. J. Lacey

Although most modern-car indicator systems are self cancelling with visual indication and audible indication (the "click" produced in the flasher unit) that the indicators are operating, this is quite often not enough.

You will often see a car being driven along a straight road with one indicator flashing when the driver has no intention of turning or pulling in. It has been left on accidentally when the self-cancelling mechanism didn't work, the visual indication is obscured by reflection and the "click" drowned by either engine or wind noise or even the radio.

It would therefore be helpful to the driver, and safer, for himself and others, if a distinct tone was evident when the indicators were activated, and remained on until the indicators were switched off.

This is what the Indicator Audible Warning unit provides when wired up to the car indicator system.

As can be seen, the unit uses only eight components and is very easy to construct; current consumption is only 30mA and operation will not generate interference on the radio.

PRINCIPLE OF OPERATION

The complete circuit diagram of the Indicator Audible Warning unit is shown in Fig. 1.

Transistors TR1 and TR2, both connected in

Approximate cost of components £0·80 less switch

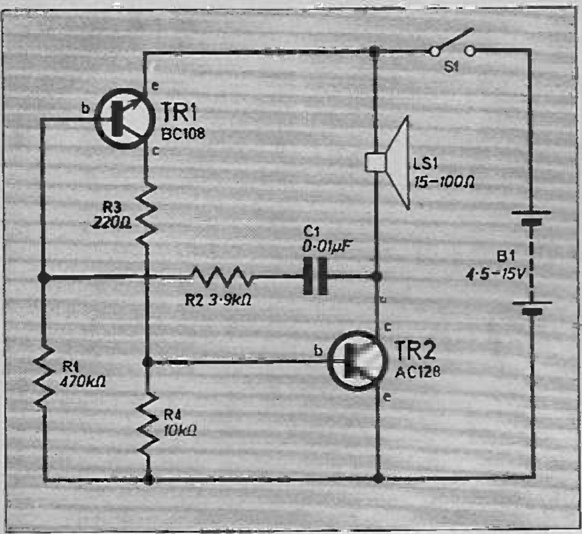


Fig. 1. The complete circuit diagram of the Indicator Audible Warning unit. Switch SI is part of the car's in-built indicator system.

the common emitter mode, form a non-inverting compound amplifier in which voltage gain from TR1 collector is passed to TR2 base.

Transistor TR1 inverts the signal and TR2 re-inverts it so there is no overall inversion. Because of this, positive feedback is provided through the combination of R2 and C1, and the circuit oscillates.

Resistor R1 provides forward bias for TR1 and hence TR2. Excessive current is prevented from flowing through TR1, and TR2 base, by inclusion of resistor R3. The other resistor R4 ensures complete turn-off of TR2 by bypassing leakage currents.

In some respects the circuit's operation is similar to a conventional multivibrator, but the circuit is assymetrical, and the same capacitor, C1, is used to time both halves of the oscillatory cycle.

When the circuit is switched on there is no charge on C1; resistor R1 biases TR1 into a partially conducting state and thus TR1 turns TR2 partially on.

Capacitor C1 then charges through R2, TR1's base-emitter junction and TR2; this charging current turns TR1 fully on and hence TR2 fully on. Eventually C1 is fully charged (the loudspeaker side being most positive), and this charging current no longer flows. The transistors would return to their partially conducting state if it were not for the positive feedback provided by R1 and C1.

The potential at TR2 collector now changes from almost zero volts towards −12V, and this change is transferred to TR1 base via C1 and R2; this is sufficient to turn TR1 off (and hence TR2 off).

Now, previously C1 was charged to nearly 12V; when the transistors turn off, the loudspeaker side of C1 is taken to −12V (via LS1) and the other side must be (instantaneously) at −24V. The transistors remain in the off state while C1 discharges to zero volts through LS1, R2, and R1. As soon as this happens TR1 begins to conduct and the cycle repeats.

Thus it can be seen that the off-time is determined by R2 and R1 with C1, and the on-time is determined by R2 with C1.

CONSTRUCTION

The layout of the components on the Veroboard is shown in Fig. 2. Begin assembly by making the one cut-out necessary on the reverse side of the Veroboard and drill the fixing hole.

Insert the resistors and capacitor in the positions indicated and solder. Solder on the flying leads and solder the correct two to the loudspeaker.

Next, using a heat shunt on the legs of the transistors, solder the latter in position, paying attention to the base connections of the transistors as shown.

CHECKING OPERATION

Check that there is no shorting of components on the component side of the board, and that there are no solder bridges shorting adjacent copper strips on the reverse side of the board.

The unit should now be tested before mounting in the car. This is done quite easily by connecting the battery leads to any battery within the range 3 to 15 volts. When this is done a tone should be heard in the loudspeaker.

The pitch of this tone can be, if required, increased or decreased by decreasing or increasing respectively, the value of C1.

Components....

SEE **SHOP TALK**

Resistors

R1	470kΩ
R2	3·9kΩ
R3	220Ω
R4	10kΩ

All ¼ watt ± 10% carbon.

Capacitors

C1 0·01μF

Transistors

TR1	BC108	silicon *npn*
TR2	AC128	germanium *pnp*

Miscellaneous

LS1 15–100Ω miniature loudspeaker.
Veroboard, 10 × 9 holes × 0·1 in. matrix; 4BA nut, bolt and washer; connecting wire; on/off switch (optional, see text).

INDICATOR AUDIBLE WARNING

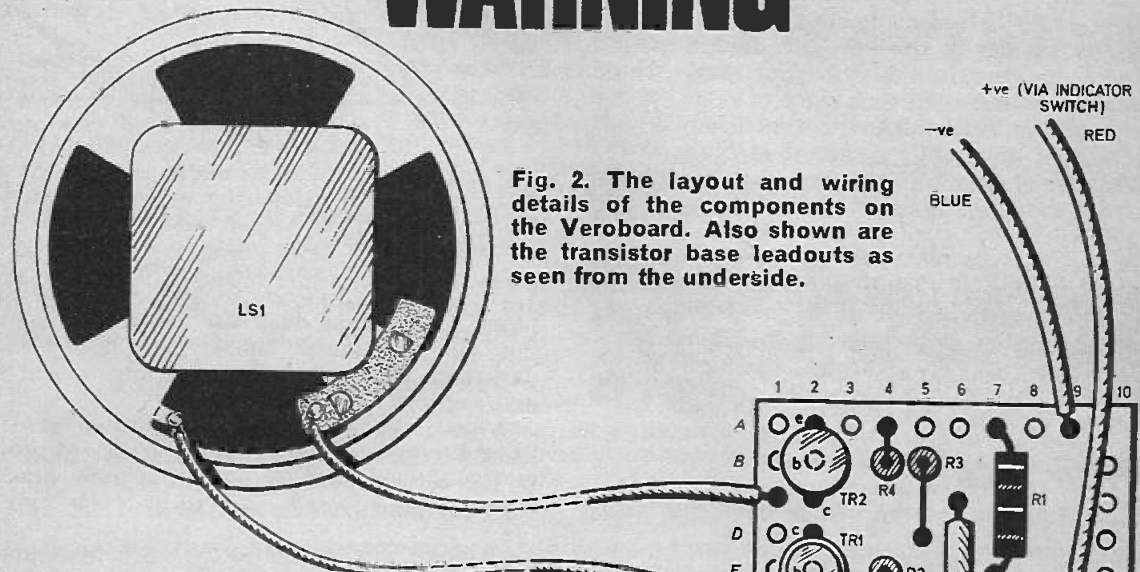
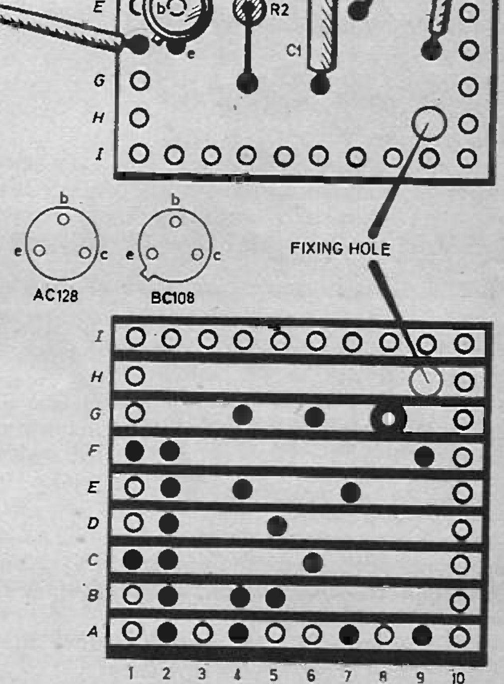
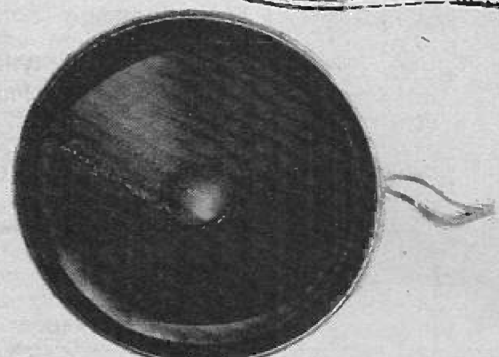
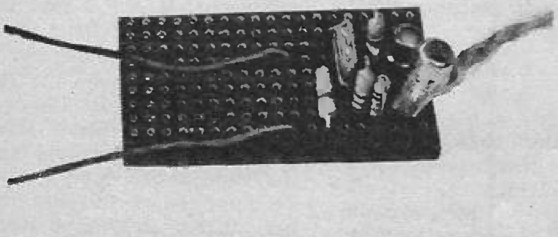


Fig. 2. The layout and wiring details of the components on the Veroboard. Also shown are the transistor base leadouts as seen from the underside.







Photograph of the completed Indicator Audible Warning unit.

FIXING/WIRING IN THE CAR

The unit can be used in cars with either negative or positive earth systems. Connect by means of an earth tag and small nut and bolt the appropriate supply lead to the bodywork of the car. Ensure that a good connection is made.

The other supply lead should be connected to the indicator warning bulb such that when the indicators are set to operate, power is supplied to the unit.

Consult the car electrical wiring diagram if in any doubt before connection.

When in use in the car, the device will be subject to considerable vibration and should therefore be mounted on a piece of foam rubber about half an inch thick; the dimensions of this pad should be slightly larger than those of the board itself; this will prevent shorting of the board if mounted against the car bodywork. The loudspeaker should be fixed in a similar fashion.

A further switch can be incorporated if desired in one of the supply leads so that the unit can be switched off when, for example, the indicator system is undergoing maintenance.

In normal use, the *Indicator Audible Warning* unit will "bleep" whenever the indicators are switched on.

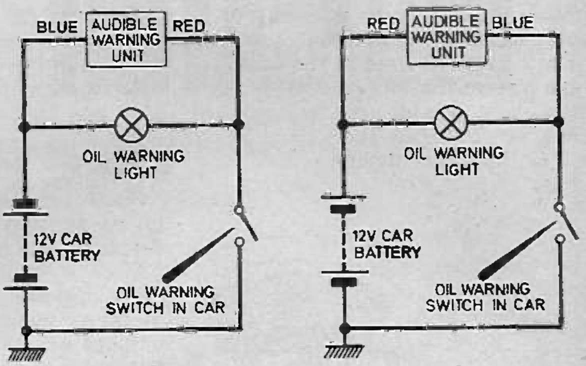
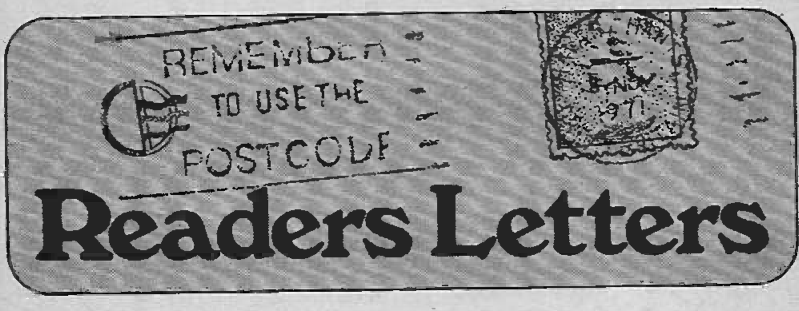


Fig. 3. Wiring details for using the unit as an oil warning indicator.

OTHER USES

This audible warning can be used for many other applications such as: oil pressure warning; doorbell buzzer; morse practice oscillator; darkroom timing indicator; intruder alarm and many others.

When used for oil pressure warning, the unit should be connected across the oil warning light in the correct polarity mode depending on the car's earthing system, see Fig. 3. ■



Chemical Action

With reference to the article by T. A. Lindsey on the *U.H.F. TV Aerial*. While I cannot speak for the efficiency of this aerial he does use and suggest a rather unfortunate combination of materials in its construction i.e. brass fixings, galvanised Weldmesh (this is mainly a zinc coating) and aluminium angle. When these items get together in a damp or wet atmosphere they set up an electrolytic action where the material is eaten away ending in the collapse of the aerial with its attendant consequences; damage to property or person.

I trust that you will bring this to his notice so that he may make an amendment to his design.

This, in the electrical contracting industry, we have to be very careful about.

Trusting that this magazine will continue with its very good work.

P. Ware,
Bristol.

It was suggested that the Weldmesh could be painted for extra protection and that pop rivets could be used for construction (the outside of these are aluminium). If brass screws are used it will help if they are cadmium plated. If Expamet is used with pop rivets the complete aerial will be aluminium.

Interference

I was very interested in your article on *Radio Control Transmitter* in your December edition. I have built a single channel transmitter and receiver before but I was so pleased when I read the article by Mr. D. Bollen, to see it was crystal controlled, as the previous transmitter I built was of the super-regen type and was very unsuitable when I came to use it in conjunction with a model boat and there were other radio controlled models on the lake.

My transmitter interferred with other models and I had to pack up. My son and I were both very disappointed.

When I purchased the January edition of EVERYDAY ELECTRONICS and found that Mr. D. Bollen's article for the receiver was for the super-regen type I was very disappointed, I felt my troubles had started all over again in the fact that other transmitters would interfere with the receiver Mr. Bollen describes.

Could you please put my fears at rest with this matter and if this is the case, could you get Mr. Bollen to let me have a radio controlled receiver circuit using crystal control, as he does say in your December edition that, quote, "The crystal X1 used in the prototype transmitter and receiver next month". I would greatly appreciate anything you could do for me in this predicament.

G. A. Rawlinson
Wallasey

It is difficult to offer a great deal of reassurance to Mr. Rawlinson on the question of interference between different radio control systems in the small area of, say, a boating lake. So much depends on transmitter power output and depth of modulation, as well as receiver sensitivity and selectivity, and this applies to other people's equipment as well as one's own.

The usual approach to the problem of mutual interference is to employ a transmitter and superhet receiver using a matched pair of crystals, on the assumption that everybody else is doing the same; this arrangement will then offer thirteen channels within the 27MHz band (see page 704 November '72 issue of EE). Fair enough! Thirteen channels will allow thirteen models to be operated simultaneously provided that each user comes equipped with thirteen pairs of crystals from which to choose a vacant channel. At around £2 per pair this could be expensive.

There are other ways of avoiding interference, such as tuned audio filters for example, or digital techniques, but whichever way you look at it all solutions involve extra expense and a degree of circuit complexity that would be out of place in the pages of EE. As it stands, the single channel system published in the December '72 and January '73 issues of EE compares very favourably with similar commercial equipment, but is just as prone to interference problems.

Casting my mind back to the days when nearly all radio control receivers were broadly tuned, I am reminded of a very effective way of preventing interference called "etiquette". The principle here was for each operator to take his turn. If anyone disagreed and opted for anarchy, all the others would switch on their transmitters to "jam" the offender, thus making it impossible for him to continue.

D. Bollen

The mention of a crystal for the receiver was inserted by us at the editing stage and was, in fact, an editorial mistake (Ed).

S.O.S.

Could anyone supply me with the official address of TMK test meters in Japan please?

After writing to Radio Japan and telephoning several importers of these instruments in Great Britain I get a cold shoulder from them saying we can repair it but we cannot supply spare parts. An offer of £2 estimate was made for replacing a 20p variable resistor (ohms zero adjust).

I know everyone wants his fair share of the pudding but this is ridiculous. And to refuse giving the name and address of the original makers in Japan is darned right anti-social to say the very least. It makes one wonder how such cloak and dagger marketing is not revealed for what it is; sell quick and forget the rest.

W. D. Logan
16 Spring Street
Hollingworth
Via Hyde, Cheshire

ABC's of Transistors

Please could you tell me the difference between the gradings A, B and C on the BC108 transistor. Would the C grade (BC108C) transistor operate as well as other BC108's in a simple multivibrator circuit. I, and I expect many other readers, have not seen these gradings before on the BC108 and would be grateful if you could clear up this point.

Also could you think of any reason why a green 2N2926 would not work as well as a red 2N2926 in a Schmitt trigger designed for the red type. I realise that the higher grade can generally be used as a substitute for a lower grade but could there be any exceptions.

David Hampton
Brentwood

The letters A, B and C referred to above are used to signify the minimum gain (h_{FE}) of the transistor. For an unlettered BC108 this parameter has a value of 110, for the A, B and C types it is 180, 290 and 520 respectively. All other transistor parameters are common and the lettered types should present no substitution problems in your multivibrator.

There is no reason, as far as we know, that a 2N2926 Green cannot be substituted for a 2N2926 Red transistor in a simple Schmitt trigger circuit. If your circuit does not function with the Green type, it could be due to the transistor being "dud". There could possibly be a case where the higher grade could not be substituted for the lower but this would be unusual.

Buzz Buzz

Referring to your home made buzzer in the January edition of Everyday Electronics I have since experimented with this device and have found that if you connect an electrolytic capacitor of 47μF, 10V across the phosphor-bronze strip screw and the contact screw, observing polarity, this will not only improve the performance of the buzzer but will also prevent interference with the TV and radio and also prevent a nasty shock which one would receive if one touched these two screws.

K. C. Cooper
Crewe

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SHOP TALK

By Mike Kenward

A POINT of general interest concerning buying has been made by a reader recently. The point concerns the cost of items and is particularly related to the Adcola Invader soldering iron. Adcola Products quote the cost of the L646 iron in their advert as being £2·12 whilst elsewhere (in Chromasonics advert) it is quoted as £1·85.

The reason is that the price Adcola show is their recommended retail price, Chromasonics are cutting their profit margin and selling at less than this price. There is now no law against this and it applies to almost all goods—not just electronic equipment; so look before you buy.

More news concerning the Ardente D1001 transformer for the *Radio Control Receiver* (January '73 issue). Since the note we published last month we have discovered that Ardente have been taken over by EMI and EMI have agreed to make the transformer to order. Hence Home Radio have now been able to re-order and—after a delay for manufacture—will again be able to supply the original component.

Home Radio have agreed to do this because of the considerable interest in this project, so to give them an initial idea of how many transformers are still required we advise readers to order as soon as possible, but be prepared for a reasonable delay (probably a few weeks) while EMI set up and manufacture.

Audio Colour Unit

We have received a number of enquiries concerning the *Audio Colour Unit*. Some people are having trouble in obtaining the transformers specified, this is because Eagle have now sold out and do not expect to have any more until April — substitute types can be used.

Another problem with the colour unit is the thyristors—some types are no good in this circuit due to the high gate voltage they require. If you can get type C106D (Henrys stock them) these should be excellent and can pass up to 25 amps on a suitable heat sink. Therefore up to about 5,000 watts can be used on each channel if required!

Indicator Audible Warning

No case has been shown for the *Indicator Audible Warning* and none is required if the unit is mounted to the rear of the dashboard. However should a case be required the unit is small enough to fit inside many of the small plastic boxes or tubs that are used for food or pills etc.

Many chemists now use clear plastic tubs with push on plastic tops for pill containers—most will sell you one very cheaply (about 2p to 5p) if you ask. These are virtually waterproof and are excellent cases for small projects.

Many small loudspeakers are available and we suggest you look around for a cheap 15 to 100 ohm type—if you find one for less than 45p buy it.

Night Light Switch

No problems with buying for the *Night Light Switch*, the only point to watch is that the neon indicator incorporates a resistor to enable it to be used on mains voltage.

Incidentally, since the article was edited and the drawings made we have realised that a single pole single throw switch could be used for S1—it would simply be across D1 and short it out in the "full light" position. If you use this type of switch you will save about 3p—worth mentioning?

General Purpose Audio Amplifier

Few buying problems should arise from components needed for the *General Purpose Audio Amplifier*. The transformer (Eagle MT-280) is available from many suppliers but if in difficulty, contact G.W. Smiths or Chromasonics. The case used for the prototype is constructed from universal chassis parts which regular constructors will now know as being available from Home Radio—other types of metal case can of course be used if required.

Heatsinks for T01 case transistors are generally available but a look at the *Bright Idea* for this purpose (page 209) may be helpful. Just to emphasise the point the component board is plain perforated Veroboard—that means no copper strips. If you cannot obtain the exact bridge rectifier quoted you can use any type with a rating of at least 50V at 0·5 amp.

The loudspeaker sockets used on this project are rather unusual and we have been unable to find the supplier of that *exact* type. A similar spring-loaded type with square tops is produced by Eagle and are available through a number of suppliers. Alternatively screw terminals could be used.

V.A.T.

The "approximate cost of components" quotations in this issue do not include additions for value added tax. We will look at possible price increases in more detail next month. A brief note on V.A.T. appears this month on the contents page.

Last Month's Cover

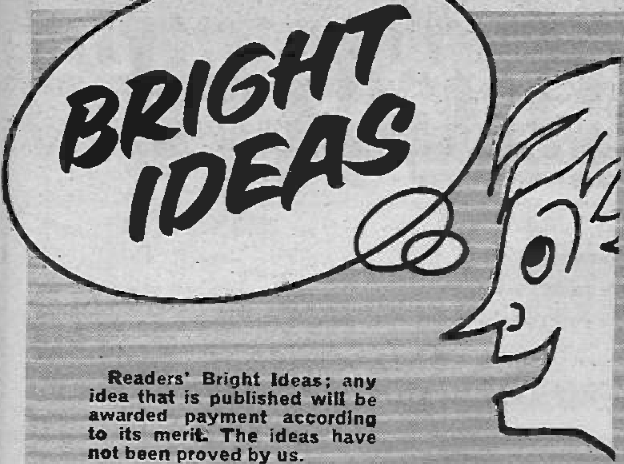
We sometimes get letters about suppliers not doing all they should—normally we can assist and help sort something out—but this time it is us that is in need of sorting out.

Two firms were good enough to assist us last month by supplying photographic "props" for our front cover and we omitted to thank them with an acknowledgement. We hope the firms will forgive us; we can make no excuses, only publish a belated acknowledgement.

Dixon's Photographic kindly loaned the enlarger, which was shown in use with the exposure meter.

Heals of Tottenham Court Road loaned the double egg cup, glass egg timer and table cloth.

Our thanks to both of them.



Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

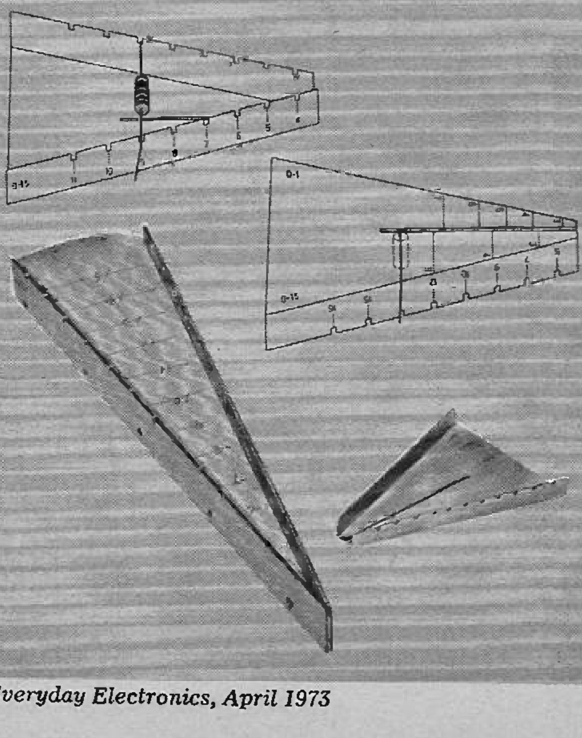
I am somewhere at the back of the class when it comes to electronics so to make up for it I try to be neat when making your projects. Whilst waiting for the next issue of EVERYDAY ELECTRONICS I made this gauge for bending wires to bridge the holes in the matrix boards.

I don't know whether something like this is on the market or whether it will be of interest but the one I made helps me. After bending the shape in aluminium and cutting the slot the calibrations were found by offering the matrix board (0·15inch and 0·1inch) to it and marking. The slot down the centre of the gauge is used for components that are to be mounted upright.

E. R. Wall,
London, SE7

A similar gauge, of slightly different construction was suggested by Mr J. Bayley of Cornwall. This gauge is much larger and can be used while resting on the bench. One side is marked for 0·15inch matrix, the other for 0·1inch matrix.

The gauge is constructed with a wooden base having Formica or plastic sides pinned to it (left in photo).

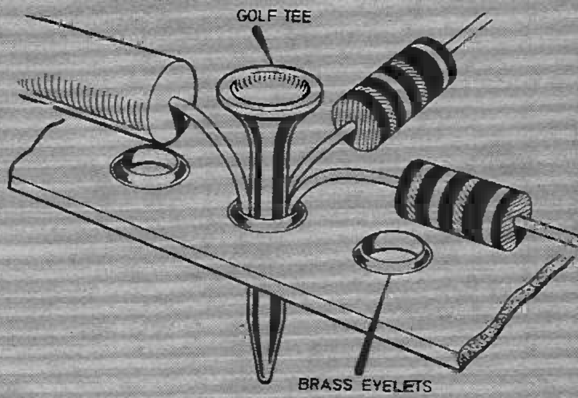


I would like to submit for possible publication in your Bright Ideas column a cheap and inexpensive solderless way of making up circuits before final and permanent assembly on a board.

Obtain from Woolworths some brass eyelets and press them into a piece of hardboard or Paxolin sheet, holes drilled to take them.

Components, up to about 8, can be secured in the eyelets using golf tees as shown in the drawing.

E. M. Terrell
London, E15



I carry out a lot of experimental work using transistors and I find the problem of heat sinks and clamping sometimes frustrating. Fortunately I hit on the idea of using Terry Clips for the purpose and these have proved very satisfactory. Using one or two together they look a professional job, hold the transistor neatly and provide a small heat sink on their own.

R. Rigg,
Rochdale, Lancs.

Could be useful for the General Purpose Amplifier *in this issue (Ed.).*

I would like to submit two Bright Ideas the first one is an aid for cleaning the tinned wires of resistors, capacitors or transistors before inserting them into a circuit board. A hard pencil rubber with a slit cut into one side about half way through is all that is needed.

Insert the lead to be cleaned into the slit, apply a slight pressure with the fingers and stroke the lead a few times. The lead will be clean and grease free due to the mild abrasive action of the rubber.

The other idea is as follows; a drilling jig for power transistors i.e. OC35, OC22, etc. Take a "dud" power transistor cut-off the "top hat" portion and remove the innards of the transistor. Punch out the base and emitter feed throughs and you will be left with an exact drilling jig. The same thing applies to old coil bases etc., cut the bases off and keep them as drilling jigs for any future projects.

P. Screeney,
Shefford,
Bedfordshire.

Please Note: this column is intended for constructional ideas and ideas relating to electronic construction. It is not our intention to publish circuits of any description.

All items submitted should be original and not previously published. If similar ideas are submitted by two or more readers the first received will be published.

DEMO CIRCUITS

5 By MIKE HUGHES

The Phase Shift Oscillator

VERY frequently one needs to be able to produce an audio frequency sine wave—perhaps as a signal generator or as part of a piece of equipment. This month's circuit describes a very simple circuit that will produce a good quality sine wave of a fixed frequency using only resistors and capacitors to set the frequency, as opposed to large inductors.

In principle the oscillator can be designed to give an output from one cycle in several seconds to several kilohertz. To demonstrate the operation we shall design it to give a signal in the middle of the audible range and show how it can be modified. The active part of the circuit is called a **phase shift oscillator.**

FEEDBACK

When a transistor is operated in a common emitter configuration as a simple amplifier the output signal at the collector is 180 degrees out of phase with the input at its base—in other words when the input signal goes in a positive direction the output goes in a negative sense. It may sound a silly application, but if the output was connected back to the input through a capacitor the signal fed back would negate the input signal and the level of the output would be reduced; this is called **negative feedback** and it is frequently used to help control the gain of an amplifier.

If the first stage of amplification is followed by a second, identical amplifier, and the output fed back from the second stage to the input of the first, the fedback signal would now be "in phase" with the original input signal (because the second transistor inverts the signal back to the way it was originally). The second transistor has given a further 180 degrees of phase shift and brought the signal back to where it started.

The fed back signal now enhances the input signal and the output will become greater faster until it reaches close on the supply voltage and the increase in the output starts to slow up (**positive feedback**). This means that the positively fed back signal starts to reduce and the output starts to fall. This fall is fed back and becomes self sustaining until the output level reaches a minimum.

This principle of positive feedback is used in most self sustaining, free running oscillators. To get a circuit to oscillate at a known frequency the components used in the positive feedback loop must be frequency dependant. These components (they could be resistors, together with capacitors or inductors in various combinations) allow feedback to occur only at the frequency we have chosen.

PHASE

In the case of this month's circuit the fact that if a current passes through a resistor and capacitor in series with each other there is a difference in phase between the current through the resistor and the voltage across the capacitor is utilised. Look at the simple resistor, capacitor (RC) circuit of Fig. 5.1. If the input voltage

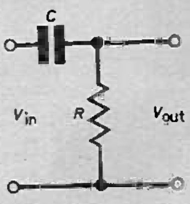


Fig. 5.1 Simple RC circuit.

starts to rise slowly (equivalent to a low frequency) the output will follow it but will be delayed by the fact the capacitor is, in effect, charging up through the resistor to the input voltage; if the input starts to fall again the output will follow but there is another delay because the capacitor is in effect discharging through the resistor.

The delay is governed by the time constant for the resistor and capacitor in question. At very low frequencies the delay approaches a quarter of the period of the input signal, i.e. when the input is maximum positive the output will be passing zero, and when the input is at zero the output will be passing maximum positive.

At very low frequencies capacitors show high reactance and therefore the impedance of our circuit is quite high while the value of the resistance may be quite low; this means that the potential divide effect of the circuit is high and

ZN414 £1.25 POST FREE

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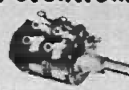
CZ13A	13p			VA1040	10p
E298 ED/A258	10p			VA1053	10p
E298 ZZ/06	10p			VA1055S	10p
GL16	£1			VA1034	10p

Potentiometers



5KΩ	50KΩ	500KΩ
10KΩ	100KΩ	1MΩ
25KΩ	250KΩ	2MΩ

log or lin less switch (& 1KΩ lin) 12p
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Capacitors

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·01µF	18v	5p	0·1µF	30v	5p
·022µF	18v	5p	0·22µF	6v	5p
·047µF	12v	5p	0·47µF	3v	5p

ceramic plate 30V

1000pf	10p	4700pf	10p
2200pf	10p	10,000pf	10p

Ceramic – plate 63V (C333)

1·8pf	8·2pf	33pf	120pf
2·2pf	10pf	39pf	150pf
3·3pf	12pf	47pf	180pf
3·9pf	15pf	56pf	220pf
4·7pf	18pf	68pf	270pf
5·6pf	22pf	82pf	330pf
6·8pf	27pf	100pf	

all 5p. each

mylar film 100V

1000pf	2p	·01µF	3p	·068µF	4p
2000pf	2p	·02µF	3p	·1µF	4p
5000pf	2p	·04µF	3p	·2µF	5p
		·05µF	3p		

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·01µF	3p	·068µF	3½p	·47µF	8p
·015µF	3p	·1µF	4p	·68µF	11p
·022µF	3p	·15µF	4p	1µF	13p
·033µF	3p	·22µF	5p	1·5µF	20p
·047µF	3p	·33µF	6½p	2·2µF	24p

metallised polyester 400V (C281)

·01µF	4½p	·047µF	6p	·22µF	10p
·015µF	4½p	·068µF	6p	·33µF	14p
·022µF	4½p	·1µF	7p	·47µF	15p
·033µF	5½p	·15µF	8p		

silvered mica 1% (>50pf) 500V
2·2pf—820pf 7p 4·7nF—5600pf 19p
1nF—2·2nf 9p 6800pf—·01µF 29p
2·7nF—3·6nF 16p

mixed dielectric 600V

·01µF	7p	·047µF	7p	·22µF	16p
·022µF	7p	·068µF	8p	·47µF	24p
·033µF	7p	·1µF	8p	1µF	33p

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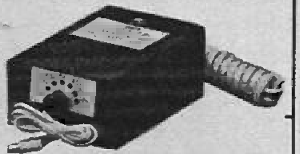

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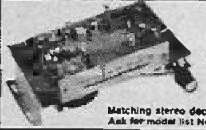

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3300pf	6p	·022µF	9p	·47µF	30p
4700pf	6p	·047µF	12p		

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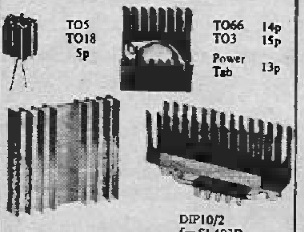
15pf	9p	220pf	9p	1500pf	5p
22pf	9p	250pf	9p	2000pf	6p
68pf	9p	270pf	9p	3000pf	6p
82pf	9p	300pf	9p	5000pf	5p
100pf	9p	750V DISC		10,000pf	6p
120pf	9p	470pf	5p	feed-through	
140pf	9p	1000pf	5p		
150pf	9p	5000pf	5p		
180pf	9p	10,000pf	5p	1000pf	5p

Heat Sinks



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		BF160	21p	MPF105	40p	ZTX500	15p	2N3708	12p	LM380	£1.46
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AF139	20p	BF184	25p	OC45	18p	ZTX531	25p	2N3903	15p	µA709C	45p
BC107	10p	BF185	25p	OC71	11p	2N697	18p	2N3904	17p	µA710	45p
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CAP µF	VOLTAGE 4	6.3	10	16	25	40	63
1	—	—	—	—	—	—	6p
1·5	—	—	—	—	—	—	6p
2·2	—	—	—	—	—	—	6p
3·3	—	—	—	—	—	—	6p
4·7	—	—	—	—	—	—	6p
6·8	—	—	—	—	—	6p	6p
10	—	—	—	—	6p	—	6p
15	—	—	—	6p	—	6p	6p
22	—	—	6p	—	6p	—	6p
33	—	6p	—	6p	—	6p	—
47	6p	—	6p	—	6p	6p	6p
68	—	6p	—	6p	—	—	10p
100	6p	—	6p	—	6p	6p	12p
150	—	6p	—	6p	6p	10p	12p
220	6p	—	6p	6p	10p	12p	18p
330	6p	—	6p	10p	—	—	21p
470	—	6p	10p	—	12p	18p	40p
680	—	10p	—	12p	18p	21p	—
1000	10p	—	12p	18p	21p	40p	80p
1500	—	12p	18p	21p	—	—	—
2200	—	18p	21p	40p	48p	55p	93p
3300	—	21p	—	—	—	—	—
4700	21p	—	—	80p	75p	93p	—

CAP µF	VOLTAGE 16	25	40	64
500	—	—	33p	40p
1250	—	—	50p	—
1600	—	—	—	75p
2000	40p	50p	—	—
2500	—	—	75p	93p
3200	50p	—	—	—
4000	—	75p	93p	—
6400	75p	93p	—	—

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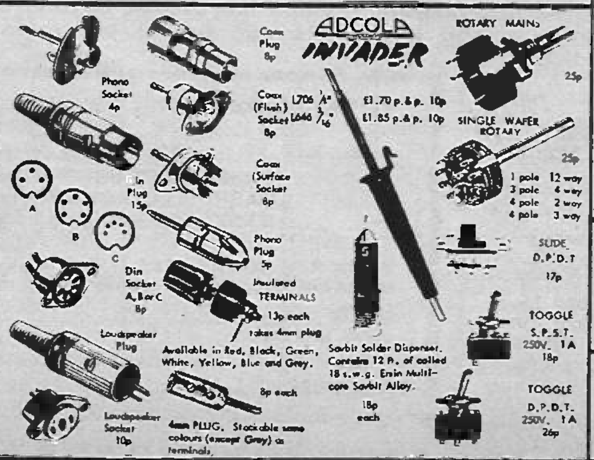
(10)	4"	x 5¼"	x 1½"	40p	8p
11	4"	x 2½"	x 2"	35p	8p
12	3"	x 2"	x 1"	32p	9p
13	6"	x 4"	x 2"	50p	10p
14	7"	x 5"	x 2½"	58p	12p
15	8"	x 6"	x 3"	75p	18p
16	10"	x 7"	x 3"	85p	20p



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1: 2: 4: 8µF	450V	14p	32µF	450V	28p
16µF	450V	15p	50µF	350V	20p
8 + 8µF:	450 V.W	18p	32 + 32µF:	350 V.W	25p
8 + 16µF:	450 V.W	20p	32 + 32µF:	450 V.W	43p
16 + 16µF:	450 V.W	25p	50 + 50µF:	350 V.W	35p

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BF194	15p	OC81	13p	2N1304	25p
BFY50	15p	OC81D	13p	2N1305	25p
BFY51	12p	OC83	20p	2N2646	47p
BSY95A	15p	OC170	24p	2N2926	10p
ME0402	18p	OC200	25p	2N3053	20p
ME0404	14p	OC201	25p	2N3055	49p
ME4401	10p	OC25	25p	2N3702	12p
ME4102	12p	OC28	30p	2N3703	12p
ME6002	14p	OC29	36p	2N3704	12p
ME6101	14p	OC35	25p	2N3705	12p
ME6102	15p	OC36	36p	2N3706	10p
MP8111	32p	TIP29A	48p	2N3707	10p
MP8511	34p	TIP30A	55p	2N3708	9p
MP8513	45p	TIP31A	58p	2N3709	10p
OC41	13p	TIP32A	69p	2N3710	10p

2N3711	10p
40251	49p
40636	55p

DIODES

1N4001	4p
1N4002	4p
1N4003	5p
1N4004	7p
OA90	6p
OA91	6p
OA200	10p
OA202	8p
1S44	10p
1N4149	4p
WO2	32p

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MULLARD POLYESTER CAPACITORS C296 SERIES
400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, 2½p. 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, 3p. 0·047μF, 0·068μF, 0·1μF, 4p. 0·15μF, 6p. 0·22μF, 7½p. 0·33μF, 11p. 0·47μF, 13p.
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, 3p. 0·1μF, 3½p. 0·15μF, 4½p. 0·22μF, 5p. 0·33μF, 6p. 0·47μF, 7½p. 0·68μF, 11p. 1·0μF, 13p.

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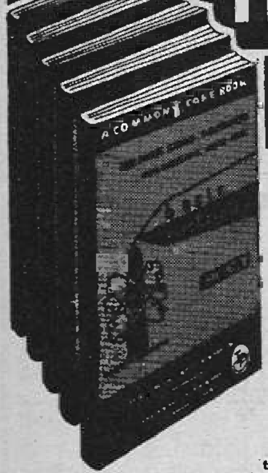

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the output voltage will be very small at low frequencies. If the frequency of the input signal is increased, the potential divide effect becomes less and the output signal will be larger, but the delay between input and output becomes less.

Using three such RC circuits cascaded into

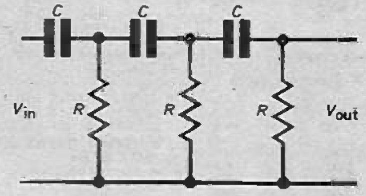


Fig. 5.2. Three RC circuits in cascade.

each other (Fig. 5.2), there will be a certain frequency (depending on the values of the respective resistors and capacitors) when a phase delay of one sixth of the waveform's period for each of the three stages will result (this is equivalent to 60 degrees phase shift). If all the resistance values are the same and identical values of capacitance employed, this frequency will be the same for each of the three stages. Each stage contributes 60 degrees of phase shift and therefore at this single frequency the resultant phase shift is 3×60 or 180 degrees between input and output; lower frequencies will give more shift, higher frequencies less.

The important fact to grasp is that there is only one frequency that will give 180 degrees phase shift. Remember, though, that there is quite an attenuation caused by potential divide effects at each stage and therefore the output will be very much less than the input.

OSCILLATOR

By connecting the phase shift network to a simple transistor amplifier between the output and the input, for one frequency only a signal that is in phase with the input will be fed back and this will give positive feedback. Although the feedback signal is attenuated by the network the transistor acts as an amplifier and, provided the system is correctly designed—with sufficient current gain—the fed back signal will drive the output harder in one direction or the other (depending on which part of the cycle is considered).

Without going into the mathematics of it a current gain of at least 29 is required to get assured, self sustaining oscillation. Below 29 and the circuit will not oscillate; above 29 and the output waveshape will be distorted because the transistor could saturate. The critical frequency that undergoes 180 degrees phase shift for the network is given by:

$$f\text{ (in Hz)} = \frac{1}{2\pi \times R \times C \times \sqrt{6}}$$

where R is in ohms and C in farads.

DEMO CIRCUIT

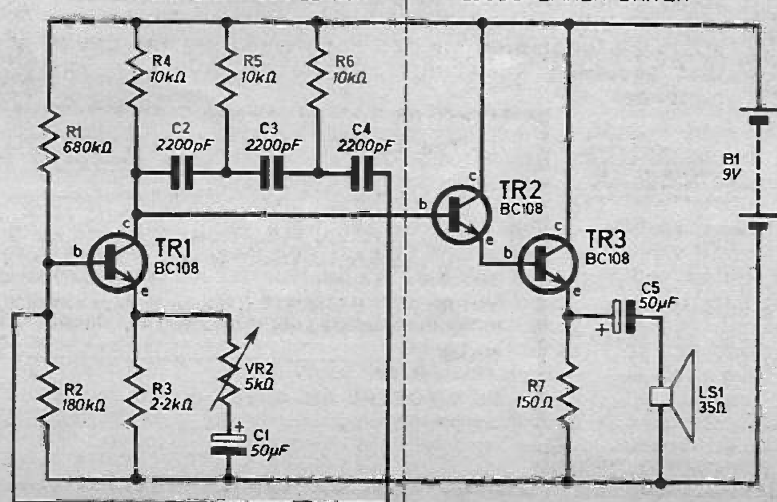
A working demonstration circuit is shown in Fig. 5.3; the phase shift network is clearly seen. Notice that R4 (the first resistor in the network) doubles as the collector load for TR1. The frequency determining components R4, R5 and R6 together with C2, C3 and C4 should all have the same values for the above equation to hold true. The bias circuitry for the transistor is calculated to give a d.c. output that is approximately mid-rail when considering R4 as a normal collector load. The frequency of oscillation for the circuit shown is:

$$\frac{1}{2 \times \pi \times 10{,}000 \times 0{\cdot}0000000022 \times \sqrt{6}}$$

which is approximately 3 kilohertz.

By substituting a different set of capacitors (remember they should be of equal values) the circuit can be made to work at lower or higher

Fig. 5.3. A working demonstration Phase Shift Oscillator:



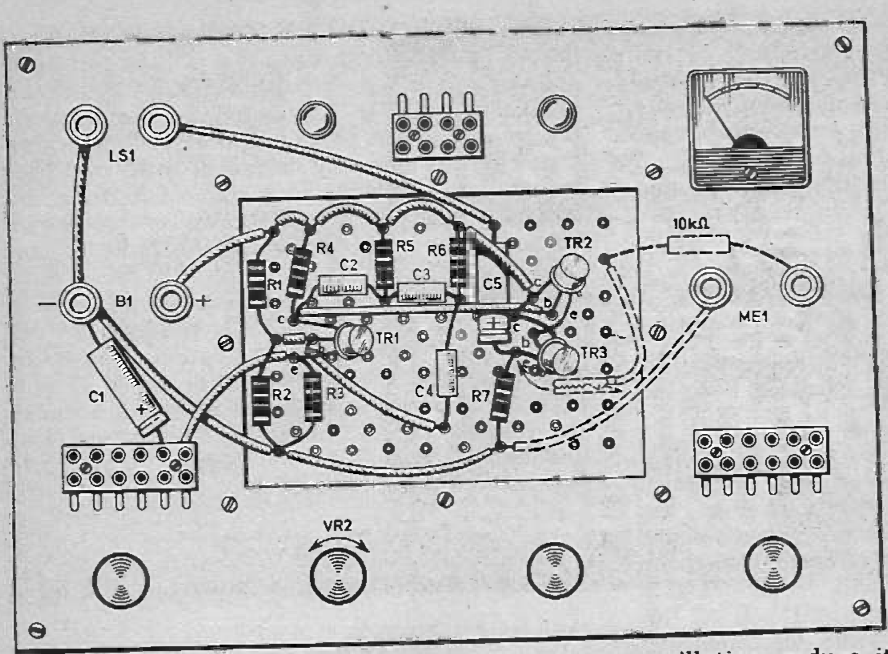


Fig. 5.4. Layout and wiring of Fig. 5.3. on the Demo Deck.

frequencies. Theoretically the values of R4, R5 and R6 could be changed but it would then be necessary to recalculate the bias components. Transistors TR2 and TR3 do not play an active role in the circuit; they are only there to couple in the loudspeaker to provide an interesting audio output. Ideally the overall current gain of the transistor amplifier (TR1) should be 29 and this can be set by adjusting VR2; it should be of the highest resistance value that will maintain oscillation, reduce it to zero and you will see what we mean by the distortion of waveshape as the transistor starts to saturate.

If you have some 1μF (non electrolytic) capacitors to use as C2, C3 and C4 the sinusoidal output can be monitored by substituting the loudspeaker and C5 with a d.c. meter as shown in Fig. 5.4. The frequency should be slow enough to give a measurable reading.

Next Month: A simple bistable.

Ruminations

By Sensor

"It was all right last night"

I have recently spent some time "on the other side of the fence"—that is, on the retail and servicing side of electronics, after very many years in manufacturing. It is often strange to hear the layman (or laywoman) try to describe what is wrong with the television set.

Phrases such as, "There can't be much wrong, it was all right last night." "It's vibrating and buzzing and I'm afraid to touch it" are very commonly used; though the rather startling "it went off with a bang and I switched it off" is not unusual.

The "knowledgeable" customer tries to be helpful—"it's the picture valve," or "the volume control's faulty" or even "the tube's gone"—this was a colour television that merely needed tuning in. This customer became quite rude and abusive when politely asked why he thought the tube was faulty.

To the man in the street a "transistor" is a small portable radio and therefore faults occurring in television or radio are usually attributed to picture valves, power valves and sound valves. How easy would be the serviceman's lot if this were so! It is interesting and often amusing to receive a service call from a customer and then to read the serviceman's report on the set in question!

What shall we see when the public become familiar with integrated circuits? "It's the blue and yellow i.c." or "the p.c. board has gone" or "there's nothing lighting up in the back."

Then there is the hopeful optimist who comes into the service department with half a dozen valves wrapped in newspaper, after these have been tested and replacements purchased for the weaker ones he would usually, after a day or so, ask for the service engineer to call. For the time taken to restore the circuit to its original configuration, subsequent to his attentions, and to diagnose the fault to a leaking decoupling capacitor he ends up with a fair bill, but perhaps he has enjoyed himself!

A Bag of Mystery

I was invited to attend a Burns Supper and perhaps it was the quantity of whisky flowing but I thought how much alike are the integrated circuit and the haggis, that "great chieftain of the pudding race." Each containing many things and each in its protective encapsulation. When surrounded with its supporting components—the haggis with its neeps and tatties and the i.c. with its resistors and capacitors—what joy, what satisfaction from those perfections of man's achievements.

But I have yet to hear an address to the i.c!

1 CHIP RADIO
Ferranti's latest device ZN414—gives results better than superhet. Supplied complete with technical notes and circuits. £1·25 each. 10 for £11.

HI-Q TUNER COMOPNENTS
For experimenting with the ZN414.
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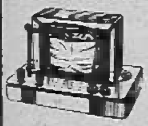
KIT NO. 3. Air spaced TC with slow motion drive 8" ferrit rod, with litz wound LW and MW coils. £1.
KIT NO. 4. Permeability tuner with fast and slow motion drive and LW loading coils. 45p.



12 VOLT 1½ AMP POWER PACK
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Heavy Duty Mains Power Pack. Output voltage adjustable from 15–40V in steps—maximum load 250W—that is from 6 amp at 40V to 15amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price £5·75 plus 65p post.

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500 ohm, operates as speaker or microphone, so useful in intercom or similar circuits, 33p each. £3·50 doz.

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A further buy enables us to offer these at an even lower price—namely 65p each or 5 for £2·50. Send for list of titles. We can't repeat when sold out.

FIRE ALARM BELL
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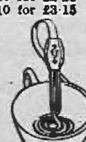
3 core heavy circular T.R.S. waterproof flex, ideal for running down the garden to pool or shed. 1·5mm cores (5 amp) 100 yard coils £4·25 plus carriage 75p up to 200 miles. £1—300 miles £1·50—500 miles.

20 WATT INVERTER
Smart and Brown—For van lighting or camping etc. Will light a 2ft. 20 watt standard fluorescent tube from a 12V car battery, current approx. 2A. Very well made unit using die cast chassis. Size 11½" × 2" × 1½". Price £6·50 complete with lamp holders and tube clips.

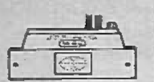
MAINS RELAY BARGAIN

Special this month are some single, double and treble pole changeover relays. Contacts rated at 15 amps. Operating coil wound for 240V. A.C. Good British Make. Unused. Size approx. 1½ × 1". Open construction.
Single pole 25p each 10 for £2·25
Treble pole 35p each 10 for £3·15

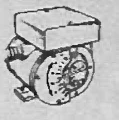
QUICK CUPPA

Mini Immersion Heater. 350W. 200/240V. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. £1·25, post and insurance 20p. 12V car model also available. Same price. Jug heater also available £1·50 plus P. & P. 20p.

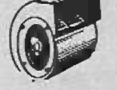
DOOR INTERCOM

Know who is calling and speak to them without leaving bed, or chair. Outfit comprises microphone with call push button, connectors and master inter-com. Simply plugs together. Originally sold at £10. Special snip price £3·50 plus 20p postage.

DIGITAL DISPLAY

Panel mounting unit measuring approx. 3½in. × 1in. × 1¾in. deep. Size of the display aperture is approx. 1¼in. × 1in. Light up to 0–9. Ex equipment but unused and in perfect order. Price £1 each.

10 AMP. DIMMER CONTROLLER. For the control of lighting on stage or in studio or for the control of portable equipment in workshops etc. This has two 13 amp. socket outlets. Each is controlled by a 5 amp. solid state regulator. The overall length is 17", width 3½" and depth 1½". In the end is fitted a master on/off switch indicator, lamp and fuse. Price £7·50.

ZPM—MODULATION MOTOR

Could also be used to open ventilators, doors, valve, damper etc., particularly suitable for remote control. Made by Satchwell. Essentially a reversible geared motor fitted with internal limit switches to stop it at the end of its travel. Size approx. 6" × 6" × 5½" and weighing approx. 10 lbs. This is extremely powerful and would lift a heavy door or open a long line of ventilators. To operate this motor you put the 50 cycle supply through a change over switch. For instance a thermostat with change-over contacts could automatically regulate the temperature in a growing house, chicken hatchery etc. An indicator on the motor graduated 0–10 shows the state of open or close. Also internally fitted is a veriable resistor, wires from this to a volt meter would give a remote indication of the open or close position. A very expensive motor if both direct from Satchwell, our price complete with step down Transformer is £15.

CENTRIFUGAL FAN

Mains operated turbo blower type. Pressed steel housing contains motor and aluminium impeller. Motor is 1/10th h.p. giving considerable air flow but virtually no noise. Approx. dimensions 10½in. wide × 12ins. dia. outlet into trunking 10½ × 4½in. £5·95 plus £1 post and insurance.

TWENTYLITE
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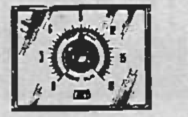
Made by Smiths. Motorised and mains driven in metal case with glass front and chrome surround. Covers a period of 18 hours. During this 18 hours the controlled device can be made to switch on for a period of 15 minutes to 3 hours. Probable cost from Smiths over £6. Special snip price £1·60 plus 20p post and insurance.

THIS MONTH'S SNIP

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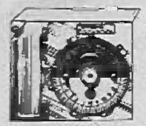
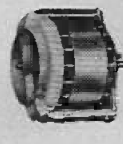
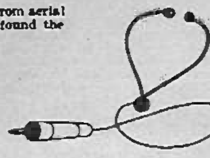

Made by Smiths, these are AC mains operated NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods for 24 hours, 5 amp changeover contacts will switch circuit on or off during these periods. £2·50, post and ins. 23p. Additional time contacts 50p pair.

PAPST MOTORS

Est. 1/40th h.p. Made for 110–120 volt working, but two of these work ideally together off our standard 240 volt mains. A really beautiful motor, extremely quiet running and reversible. £1·50 each. Postage one 23p, two 33p. 230v model £3.

RADIO STETHOSCOPE

Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything — complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2—twin stethoset instead of earpiece 75p extra—post and ins. 20p.

MULLARD AUDIO AMPLIFIERS
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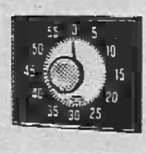
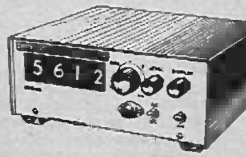
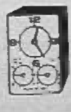
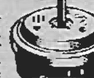


Made by famous Smiths company, these have a large clear dial, size 4½in. × 3½in., which can be set in minutes up to 1 hour. After preset period the bell rings. Ideal for processing, a memory jogger or, by adding simple lever, would operate micro-switch. £1·15.

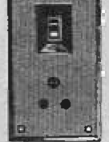
DIGITAL COUNTER TIMER


Very stable and reliable crystal controlled circuit. Capable of work in excess of 15 MHz. Construction simplified by use of 15 integrated circuits. Complete kit with case £39·50 or construction data and price list 50p.

TIME SWITCH

Smiths mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars keep pets warm, halve your heating bill, etc. £1·95.

PRESSURE SWITCH

Containing a 15 amp. change over switch operated by a diaphragm which in turn is operated by air pressure through a small metal tube. The operating pressure is adjustable but is set to operate in approx. 10 in. of water. These are quite low pressure devices and can in fact be operated simply by blowing into the inlet tube. Original use was for washing machines to turn off water when tub has reached correct level but no doubt has many other applications. £1·25, each.

5 PUSH BUTTON SWITCHES
Mains, suitable for audio or R.F. Each switch rated at 250v. 15 amps. 1st (black push button) closes 2 circuits, 2nd (white push button) operates one change-over, 3rd (white push button) operates one change-over, 4th (white push button) opens one circuit. Note: all depressed buttons remain down until cleared by the 5th (red button). Further note: It is a relatively easy job to alter the position of the tags thus making the switches suit your circuit. Fitted with 3 white, 1 red and 1 black button. 30p each or 10 for £2·70.

5A 3-PIN SWITCHED SOCKETS

An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered switch sockets for only 50p plus 18p post and insurance. (20 boxes post free.)

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Fits in place of cigarette lighter Useful method of making a quick connection into the car electrical system. 38p each or 10 for £3·42.

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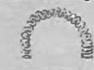
One of our customers has pointed out how easily our box signs can be converted to exit signs. These are illuminated, having a 20W fluorescent lamp with associated control gear. The front is very thick, clear plastic. Directly on to this you can stick down the letters available at most stationers. There is room inside the box for a battery and low volt lamp in the case of power failure. Size of sign is 2ft. high × 14in. wide × 5in. deep. Solidly made from sheet steel and hammer finished in enamel. Price £3·50 plus 50p carriage per 200 miles.

SPRING COIL LEADS

As fitted to telephones, 4 core 15p each, 10 for £1·35. 3 core 10p each. 10 for 90p.

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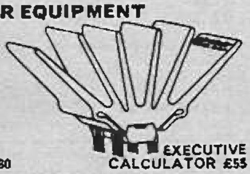

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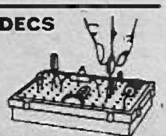

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BZY88C8V2	13p
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OA95	5p
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OC44	20p
OC45	20p
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OC72	20p
OC75	25p
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ZTX320	30p
ZTX330	18p
ZTX500	14p
ZTX501	15p
ZTX502	18p
ZTX503	17p
ZTX504	45p
1N914	4p
1N3754	20p
1N4001	7p
1N4002	7p
1N4003	10p
1N4004	10p
1N4005	12p
1N4006	15p

1N4007	19p
1N4148	4p
1N5400	14p
1N5404	18p
1N5408	25p
1S44	4p
1S920	7p
1S940	6p
1S5009	80p
1S5012	80p
1S5015	75p
1S5018	75p
1S5024	75p
1S5047	75p
2N404	23p
2N696	15p
2N697	17p
2N698	30p
2N706	10p
2N706A	12p
2N708	16p
2N911	50p
2N914	20p
2N918	42p
2N929	25p
2N930	28p
2N1131	24p
2N1132	24p
2N1302	17p
2N1303	17p
2N1304	24p
2N1305	24p
2N1306	30p
2N1307	30p
2N1308	34p
2N1309	34p
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2N2219A	53p
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2N2369	17p
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7402	20p
7403	20p
7404	25p
7405	25p
7408	25p
7409	25p
7410	20p
7413	30p
7420	20p
7425	30p
7430	20p
7440	24p
7442	£1·16
7443	£1·45
7444	£1·45
7445	£2·06
7446	£1·45
7447	£1·25
7450	20p
7451	20p
7453	20p
7454	20p
7460	20p
7470	45p
7472	32p
7473	45p
7474	46p
7475	45p
7476	45p
7480	67p
7482	87p
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7495	80p
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74100	£1·64
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74141	£1·00
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74151	£1·10
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Mfd.	Working Voltage	Price	Mfd.	Working Voltage	Price
1·0	40v	7p	100	16v	6p
1·0	100v	5p	100	25v	6p
2·2	25v	7p	100	40v	7p
2·2	63v	5p	100	63v	10p
4·7	40v	5p	220	25v	8p
10	25v	5p	220	40v	9p
10	63v	6p	470	25v	12p
22	25v	6p	1000	25v	16p
22	40v	6p	2200	25v	34p
47	25v	6p	4700	16v	33p
47	40v	6p			

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Stock values: MFD	Price each
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0·047, 0·068, 0·10	4p
0·150, 0·220	5p
0·33	7p
0·47	8p
0·68	11p
1·0	14p
1·5	20p
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UPM075	0·75	10%	1M -4·7M	E12	1p each
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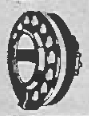

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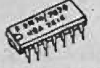
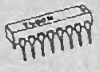
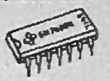

Type	1/11 p	12/24 p	25/99 p
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SN7401	0·20	0·18	0·16
SN7402	0·20	0·18	0·16
SN7403	0·20	0·18	0·16
SN7404	0·20	0·18	0·16
SN7405	0·20	0·18	0·16
SN7406	0·30	0·27	0·25
SN7407	0·30	0·27	0·25
SN7408	0·20	0·19	0·18
SN7409	0·45	0·42	0·35
SN7410	0·20	0·18	0·16
SN7411	0·23	0·22	0·20
SN7412	0·42	0·40	0·35
SN7413	0·30	0·27	0·25
SN7416	0·30	0·27	0·25
SN7417	0·30	0·27	0·25
SN7420	0·20	0·18	0·16
SN7422	0·48	0·44	0·40
SN7423	0·48	0·44	0·40
SN7425	0·48	0·40	0·35
SN7427	0·42	0·39	0·36
SN7428	0·50	0·45	0·42
SN7430	0·20	0·18	0·16
SN7432	0·42	0·39	0·35
SN7433	0·70	0·61	0·44
SN7437	0·65	0·60	0·50
SN7438	0·65	0·60	0·50
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SN7443	1·00	0·95	0·90
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SN7446	2·00	1·75	1·60
SN7447	1·75	1·60	1·45
SN7448	1·75	1·60	1·45

Type	1/11 p	12/24 p	25/99 p
SN7450	0·20	0·18	0·16
SN7451	0·20	0·18	0·16
SN7453	0·20	0·18	0·16
SN7454	0·20	0·18	0·16
SN7460	0·20	0·18	0·16
SN7470	0·30	0·27	0·25
SN7472	0·30	0·27	0·25
SN7473	0·40	0·37	0·35
SN7474	0·40	0·37	0·35
SN7475	0·55	0·52	0·50
SN7476	0·45	0·42	0·39
SN7480	0·80	0·75	0·67
SN7481	1·25	1·15	1·10
SN7482	0·87	0·80	0·70
SN7483	1·00	0·90	0·85
SN7484	0·90	0·85	0·80
SN7486	0·45	0·41	0·38
SN7490	0·75	0·70	0·65
SN7491AN	1·00	0·95	0·90
SN7492	0·75	0·70	0·65
SN7493	0·75	0·70	0·65
SN7494	0·80	0·75	0·70
SN7495	0·80	0·75	0·70
SN7496	1·00	0·97	0·95
SN7497	6·25	5·50	5·00
SN74100	2·50	2·30	2·00
SN74104	1·45	1·35	1·20
SN74105	1·45	1·35	1·20
SN74107	0·50	0·45	0·40
SN74110	0·80	0·70	0·60
SN74118	1·00	0·95	0·90
SN74119	1·90	1·78	1·65
SN74121	0·60	0·55	0·50
SN74122	1·35	1·25	1·10
SN74123	2·70	2·55	2·47
SN74141	1·00	0·95	0·90

Type	1/11 p	12/24 p	25/99 p
SN74145	1·50	1·40	1·30
SN74150	3·35	2·95	2·15
SN74151	1·10	0·95	0·90
SN74153	1·35	1·27	1·20
SN74154	2·00	1·75	1·55
SN74155	1·55	1·47	1·35
SN74156	1·55	1·47	1·35
SN74157	1·80	1·70	1·50
SN74160	2·60	2·40	2·25
SN74161	2·60	2·40	2·25
SN74162	3·40	3·25	2·70
SN74163	3·40	3·25	2·70
SN74164	2·75	2·30	2·10
SN74165	4·00	3·50	3·00
SN74166	4·00	3·50	3·00
SN74167	6·25	5·60	5·10
SN74170	4·10	3·55	3·05
SN74174	2·00	1·75	1·30
SN74175	1·35	1·27	1·16
SN74176	1·60	1·35	1·20
SN74177	1·60	1·35	1·20
SN74180	1·55	1·30	1·20
SN74181	7·00	6·00	5·50
SN74182	2·00	1·80	1·60
SN74184	2·40	2·00	1·80
SN74185A	2·40	2·00	1·80
SN74190	1·95	1·85	1·75
SN74191	1·95	1·85	1·75
SN74192	2·00	1·90	1·80
SN74193	2·00	1·90	1·80
SN74194	2·50	2·25	1·90
SN74195	1·85	1·70	1·60
SN74196	1·50	1·40	1·30
SN74197	1·50	1·40	1·30
SN74198	4·60	3·70	3·35
SN74199	4·60	3·70	3·35

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AAY30	10p
AAY42	15p
AAZ13	10p
AC107	35p
AC126	25p
AC127	25p
AC128	25p
AC176	25p
AC187	25p
AC188	25p
ACY17	30p
ACY20	20p
ACY21	20p
ACY39	55p
AD140	50p
AD149	50p
AD161	35p
AD162	35p
AF117	20p
AF118	50p
AF124	25p
AF139	30p
AF186	40p
AF239	40p
ASY27	30p
ASY28	25p
BA102	30p
BA115	7p
BA145	15p
BAX13	5p
BAX16	7p
BC107	10p
BC108	10p
BC109	10p
BC109C	12p
BC113	15p
BC117	20p
BC143	35p

BC147	12p
BC169C	12p
BC182	10p
BC214	15p
BCY33	75p
BCY34	35p
BCY39	1·00
BCY42	30p
BCY43	25p
BCY55	2·50
BCY70	15p
BCY71	20p
BCY72	15p
BCY87	2·99
BCZ11	50p
BD124	80p
BD131	75p
BD132	80p
BF115	25p
BF167	25p
BF173	25p
BF179	30p
BF180	30p
BF194	15p
BF195	15p
BFS61	25p
BFS98	25p
BFX13	25p
BFX34	75p
BFX37	30p
BFX88	20p
BFY50	20p
BFY51	20p
BFY52	20p
BFY64	50p
BFY90	59p
BLY36	8·00
BSX20	16p
BSY27	15p

BU105	2·25
BY100	15p
BY126	15p
BY127	15p
BYZ13	35p
C106D	65p
GET111	55p
GET115	55p
GET880	45p
LM309K (T03)	1·87
MAT121	25p
MJE340	50p
MJE370	70p
MJE520	75p
MJE2955	1·10
MJE3055	75p
MPF105	40p
NKT214	20p
NKT216	40p
NKT217	40p
NKT403	70p
NKT404	50p
OA5	50p
OA10	35p
OA81	10p
OA91	7p
OA200	7p
OA202	10p
OC16	75p
OC20	95p
OC23	85p
OC26	40p
OC28	65p
OC35	50p
OC36	65p
OC42	40p

OC44	15p
OC45	15p
OC57	50p
OC71	15p
OC72	25p
OC77	45p
OC81	25p
OC83	25p
OC140	55p
OC170	25p
OC171	30p
OC200	45p
OC201	75p
OC202	80p
OC203	50p
OCP71	1·25
ORP12	50p
ORP60	40p
P346A	20p
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RAS508AF	55p
TAA263	75p
TIL209	39p
TIP29A	50p
TIP30A	60p
TIP31A	60p
TIP32A	70p
TIP33A	1·00
TIP34A	1·50
TIP35A	2·50
TIP36A	3·00
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2N987	45p
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2N1132	25p
2N1302	18p
2N1304	22p
2N1305	28p
2N1307	25p
2N1308	25p
2N1613	20p
2N1671	1·00
2N2147	75p
2N2160	59p
2N2217	25p
2N2221	20p
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2N2369A	15p
2N2906	20p
2N2926 (all cols)	10p
2N3053	20p
2N3054	50p

2N3055	55p
2N3440	75p
2N3442	1·25
2N3525	75p
2N3614	59p
2N3615	75p
2N3702	10p
2N3704	10p
2N3705	10p
2N3714	1·80
2N3771	1·75
2N3773	2·00
2N3790	2·25
2N3819	35p
2N3820	50p
2N3866	85p
2N3903	15p
2N3906	12p
2N4061	12p
2N4062	12p
2N4126	15p
2N4871	35p
2N5457	30p
2N5777	55p
2S001	1·00
2S012	10·00
2S018	6·25
2S026	8·90
2S301	50p
2S303	65p
2S324	95p
40250	50p
40360	40p
40361	40p
40362	50p
40408	50p
40486	75p
40636	1·10
40430	1·00

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SILICON RECTIFIERS WIRE ENDED PLASTIC

Type	P.I.V.	1-11
1 amp miniature		
IN4001	50	6
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IN4003	200	8
IN4004	400	8
IN4005	600	10
IN4006	800	12
IN4007	1000	15
1·5 amp miniature		
PL4001	50	8
PL4002	100	9
PL4003	200	10
PL4004	400	10
PL4005	600	12
PL4006	800	15
PL4007	1000	16

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SC40A	100	85p
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SC45A	100	95p
SC45B	200	£1·00
SC45D	400	£1·25
SC45E	500	£1·45
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SC50B	200	£1·35
SC50D	400	£1·65
SC50E	500	£1·85

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40486	(TO5)	80p

3 Amp
T048

15 Amp
T048

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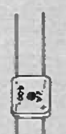
SMALL SIZE AND LOW COST

Type	Volts P.I.V.	Price 1-11
HALF AMP		
BO5/05	50	20p
BO5/10	100	25p
ONE AMP ½ × ½ H TUBULAR		
B1/05	50	25p
B1/10	100	25p
B1/20	200	30p
B1/60	600	35p
ONE AMP (G.I.) TUBULAR		
W005	50	30p
W01	100	35p
W02	200	40p
W06	600	45p
TWO AMPS ½ H × ½ L × ¼		
B2/05	50	35p
B2/100	100	40p
B2/200	200	45p
B2/600	600	50p
B2/1000	1000	60p
FOUR AMPS ½H × ½L × ¼		
B4/100	100	60p
B4/200	200	65p
B4/400	400	70p
B4/600	600	75p
B4/800	800	£1·00
SIX AMPS ½H × ½L × ¼		
B6/100	100	70p
B6/200	200	75p
B6/400	400	90p
B6/600	600	£1·00


SILICON CONTROLLED RECTIFIERS

Type	Volts P.I.V.	Price 1-11
ONE AMP		
CRS 1/05	50	25p
CRS 1/10	100	30p
CRS 1/20	200	30p
CRS 1/40	400	35p
CRS 1/60	600	45p
THREE AMP (TO48)		
CRS 3/05	50	30p
CRS 3/10	100	30p
CRS 3/20	200	35p
CRS 3/40	400	45p
CRS 3/60	600	55p
FIVE AMP (TO66)		
CRS 5/400	400	60p
SEVEN AMP (TO48)		
CRS 7/100	100	60p
CRS 7/200	200	65p
CRS 7/400	400	70p
CRS 7/600	600	95p
SIXTEEN AMP		
SCR 16/100	100	65p
SCR 16/200	200	70p
SCR 16/400	400	80p
SCR 16/600	600	£1·00

1 Amp
T05

3 Amp
T048

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