

An exciting hobby.... for everyone

# everyday electronics

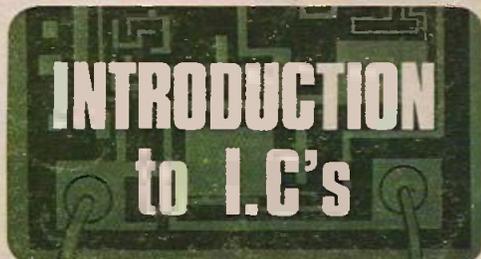
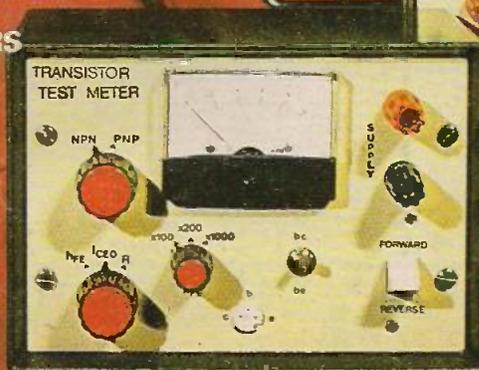
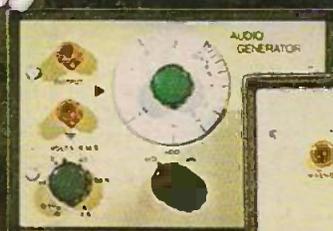
FEB. 74  
15p

**MADE TO MEASURE...  
ESPECIALLY  
FOR YOU!**

**e e**  
**TEST GEAR FIVE**

- \* A SET OF INSTRUMENTS YOU WILL BE PROUD TO OWN
- \* INEXPENSIVE - EASY TO BUILD PROFESSIONAL FINISH
- \* FOR ALL CONSTRUCTORS AND EXPERIMENTERS

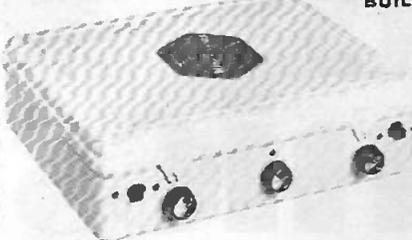
\* *In this issue*  
**No.1...  
POWER SUPPLY  
UNIT**



# NEW EDU-KIT MAJOR

COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT.

BUILD THESE PROJECTS WITHOUT  
SOLDERING IRON OR SOLDER.



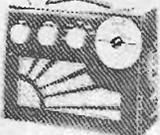
Total Building Costs  
**£7.23** P & Ins. 44p.  
(Overseas P & P £1.85p.)  
(+ 10% VAT 72p)

★ 4 Transistor Earpiece Radio ★ Signal Tracer ★ Signal Injector ★ Transistor Tester NPN-PNP ★ 4 Transistor Push Pull Amplifier ★ 5 Transistor Push Pull Amplifier ★ 7 Transistor Loudspeaker Radio MW/LW ★ 5 Transistor Short Wave Radio ★ Electronic Metronome ★ Electronic Noise Generator ★ Batteryless Crystal Radio ★ One Transistor Radio ★ 2 Transistor Regenerative Radio ★ 3 Transistor Regenerative Radio ★ Audible Continuity Tester ★ Sensitive Pre-Amplifier.

★ 24 Resistors ★ 21 Capacitors ★ 10 Transistors ★ 31 loudspeaker ★ Mica Baseboard ★ 3 12-way connectors ★ 3 Volume controls ★ 2 Slider Switches ★ 1 Tuning Condenser ★ 3 Knobs ★ Ready Wound MW/LW/SW Coils ★ Ferrite Rod ★ 6 1/2 yards of wire ★ 1 yard of sleeving, etc. ★ Parts price list and plans 50p (FREE with parts).

## ROAMER TEN

with VHF including aircraft. 10 Transistors. Latest 4" 2 watt Ferrite Magnet Loudspeakers, 9 Tunable Wavebands, MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Stations also Aircraft Band. Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600 mw Transistors. Car Aerial and Tape Recording Sockets. 10 Transistors plus 3 Diodes. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and Tone Control. Attractive Case in black with silver blocking. Size 9" x 7" x 4". Easy to follow instructions and diagrams. Parts price list and plans 80p (FREE with parts).  
Total Building Costs **£8.50** P. P. & Ins. 62p  
(Overseas P. & P. £1.85) (+ 10% VAT 85p)



## NEW EVERYDAY SERIES

Build this exciting new series of designs  
E.V. 5 5 Transistors and 2 diodes. MW/LW. Powered by 41 volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" x 5 1/2" x 2 1/2" approx.  
Parts price list and Plans 15p. Free with parts.  
Total Building Costs **£2.73** P & Ins. 30p  
(Overseas P & P £1.25p) (+ 10% VAT 27p)

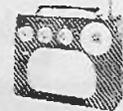


E.V. 6 Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, 3" loudspeaker, etc. MW/LW coverage. Push Pull output. Parts price list and Plans 15p. Free with parts.  
Total Building Costs **£3.60** P & P & Ins. 30p  
(Overseas P & P £1.25p) (+ 10% VAT 36p)

E.V. 7 Case and looks as above. 7 Transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" loudspeaker. Parts price list and easy build plans 20p. Free with parts.  
Total Building Costs **£4.08** P & P & Ins. 31p  
(Overseas P & P £1.85) (+ 10% VAT 40p)

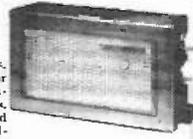
## ROAMER EIGHT Mk 1 NOW WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mw transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt Ferrite Magnet Loudspeakers. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 x 7 x 4 1/2 approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).  
Total Building Costs **£6.98** P & P & Ins. 47p  
(Overseas P. & P. £1.85) (+ 10% VAT 69p)



## POCKET FIVE

3 Tunable wavebands. MW/LW, W and Trawler Band. 7 stages, 5 transistors and 2 diodes. Sensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 5 1/2" x 1 1/2" x 3 1/2" approx. Plans and parts price list 15p. (Free with parts).  
Total Building Costs **£2.28** P & P & Ins. 26p  
(Overseas P & P £1.25p) (+ 10% VAT 22p)



## TRANSONA FIVE

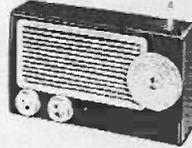
Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and parts price list 15p (Free with parts).  
Total Building Costs **£2.50** P & P & Ins. 26p  
(Overseas P & P £1.25p) (+ 10% VAT 25p)



## TRANS EIGHT

8 TRANSISTORS and 3 DIODES

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 x 5 1/2 x 2 1/2 in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).



Total Building Costs **£4.48** P & P & Ins. 33p  
(Overseas P & P £1.25) (+ 10% V.A.T. 44p)

• Callers side entrance "Lave lls" Shop  
• Open 10-1, 2.30-4.30 Mon - Fri. 9-12 Sat.

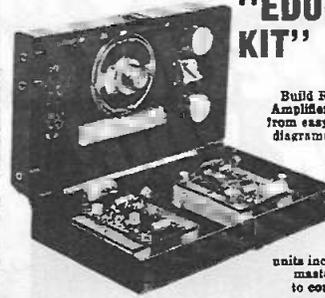
## NEW ROAMER NINE

WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors. 9 Tunable wavebands. Roamer Ten, built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mw transistors. 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange. Attractive all white case with red grille and carrying strap. Size 9" x 7" x 2 1/2" approx. Parts Price list and Plans 20p (FREE with parts).  
Total Building Costs **£6.95** P & P & Ins. 44p.  
(Overseas P & P £1.85p) (+ 10% VAT 69p)

## "EDU-KIT"



Build Radios Amplifiers, etc. from easy stage diagrams. Five

units including master unit to construct

Components include: Tuning Condenser; 2 Volume Controls; 2 Slider Switches; Fine 3" Tone Moving Coil Speaker; Terminal Strip; Ferrite Rod Aerial; 2 Plugs and Sockets; Battery Clips; 4 Tag Boards; 10 Transistors; 4 Diodes; Resistors; Capacitors; Three 1/2" Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction.  
Parts price list and plans 25p (FREE with parts).

Total Building Costs **£5.50** P & P & Ins. 33p  
(Overseas P & P £1.85) (+ 10% VAT 55p)

## ROAMER SIX

Case and looks as Trans-Eight

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3, Trawler band plus an Extra Medium waveband for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 x 5 1/2 x 2 1/2 in. approx. Plans and parts price list 25p (FREE with parts).

Total Building Costs **£3.98** P & P & Ins. 31p  
(Overseas P. & P. £1.85) (+ 10% VAT 39p)

## RADIO EXCHANGE CO

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A top quality speaker ideal where small size is important. Manufactured by E.M.I. for a well-known hi-fi set maker. Size: 7in. x 4in. Impedance: 8 ohms. Flux: 39,000. Max. Free range: 90Hz to 12kHz. Power handling: 5W. Unbeatable. Price: £1.80. Free postage on this item.

### CRESCENT P.300. DISCO CONTROL PACK.

A control unit which when connected to twin decks makes a disco of professional quality. We supply a smart front panel which incorporates controls, switch and input sockets. The control module, I.C. construction, incorporating mixing, pre-amp and head-phonics listening amplifier. The power pack enables this unit to work from the standard mains. \* Inputs include Mic, Tape/Cassette and Twin Decks. \* Controls include Mic, Tape, Each Deck and P.T.T. Full instructions are included with every Pack. MONO - £14 plus 20p P.P. STEREO - £17 plus 20p P.P. Send S.A.E. for more information.

### STEREO / MONO HEADPHONE VOLUME CONTROL BOX

Plug Stereo phones into this control box and you then incorporate a right and left hand volume control and a stereo/mono switch. Complete with stereo jack plug and 2 m cable. A Bargain at £1. Plus 10p P. & P.

### LOW VOLTAGE AMPLIFIER

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 AMP input this amplifier will work as a record player, baby alarm, etc., amplifier.



### "CRESCENT" DIGITAL CLOCK KIT

24 Hour Nixie Digital Clock Kit We Supply:  
\* A complete set of components  
\* A complete set of easy to follow instructions  
\* Printed circuit made to make construction as simple as possible  
\* A cabinet and front panel to give a professional finish.  
All for the price of the components.  
Please send S.A.E. for more information. £29.50 Inc. P. & P.

**TWO WAY STEREO ADAPTOR**  
Stereo jack plug to two stereo line sockets complete with 110 mm of cable. For plugging two stereo inputs into one. A Bargain at 65p plus 5p P & P.

### ★ THE POWER AMP MODULE

4P 100W  
170W. r.m.s. pk. wave 300W instantaneous peak into 8 ohm (60W into 16 ohm). £14.25, carr. 45p.

### ★ THE PRE-AMP MODULE

Four control pre-amp, Vol. Bass, Treble, Middle controls. Designed to drive most amplifiers using P.T.T. first stage. £3.98 carr. 25p.

### ★ THE POWER SUPPLY MODULE PS100

It is supplied complete with the mains transformer, 29.66, carr. 50p. Complete fixing instructions are supplied and no technical knowledge is required to connect the three ready wired modules. A fantastic bargain. If you purchase all three modules, £25, carr. 75p. Send S.A.E. for further details on this or our ready built amplifiers

### "CRESCENT" CATALOGUE

If you are a constructor you should own a copy. Send 20p inc. Postage.

### MINI LOUDSPEAKERS

2 1/2" (57mm) 40ohm - 50p each  
2 1/2" (57mm) 80ohm - 50p each  
Please include 5p. P. & P. up to 3 Mini-Loudspeakers

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### 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, 7.1v or 9 volts. This means all your transistor power pack applications can be handled by this one unit. Approx. size: 2 1/2" x 2 1/2" x 3 1/2". OUR PRICE - £2.75p + 10p. P. & P. Same model suitably wired for the Philips Cassette - £3.00 + 10p. P. & P.

### TRI-VOLT CAR CONVERTER

Enables you to work your Transistor Radio, Amplifier or Cassette etc. from the 12 volt car supply positive or negative. This converter supplies 6, 7.1 or 9 volts and is transistor regulated. Approx. size 2 1/2" x 3 1/2" x 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.



### 200/250V MAINS RELAY

Heavy duty contacts. 2,500V coil. All new and unused D.P.D.T. mains relays 50p + V.A.T. Carr. Free. Special quantity price: £40 per 100 relays.



### "CRESCENT BEAT BRITE" SINGLE CHANNEL SOUND TO LIGHT UNIT

This fantastic little box approx. 4" x 3" x 2 1/2" when connected to the output of a sound source from 1 to 100 watts produces a psychedelic light display of up to 1000 watts. Complete with a sensitive level control the unit is fused and can not harm your amplifier. A Bargain at £7.50 plus 10p P. & P.

### MAISS TRANSFORMER

Fused Primary 240V. Secondary 220V @ 50mA. 6.3V @ 1A. This transformer is made to a very high standard and is a small size: 2in x 2 1/2in x 2 1/2in. 63p plus 15p 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 12pole, 100K Switch  
100K Double 250K 40p.  
500K Pole 500K each  
1M Switch 1M  
2M 2M

Up to 3 Pots. Please add 6p. P. & P.

### MINIATURE RELAYS

Brand new range of British made Relays. Size - 1 1/2" x 1" x 1"  
All two changovers with 250V. 1-5A contacts and suitable for fitting on 1m Veroboard.  
Type Volts Current Ohms.  
27A 12v 173mA 700Ω  
31A 12v 233mA 430Ω  
32A 6v 333mA 185Ω  
80p each.  
Please include 5p P. & P up to 3 Relays.



**PLUGS**  
Pack 107 5 pin Din 22p  
Pack 108 3 pin Din 20p  
Pack 135 1/2" Jack 27p  
Pack 130 1/2" Jack Stereo 50p  
Pack 103 Loudspeaker Plug 17p  
Pack 100 Phono Plug 7p  
Pack 230 3 pin Socket 25p  
Pack 236 5 Pin Socket 33p  
Pack 234 1/2 speaker Socket 33p

### READY MADE LEADS

3 pin to 3 pin Din 70p  
3 pin to open end 55p  
5 pin to 5 pin Din 90p  
5 pin to open end 70p  
5 pin to 4 phono plugs £1  
Speaker lead Din to spade 12ft. 40p  
Extension lead Din plug to socket 12ft. 70p  
All leads approx. 6ft. in length.

### DIAMOND STYLI

8TA; 9TA; 9TAHC; GP91; ST4; ST9; EV26; GC8  
All at 80p each.  
Double Diamond £1.25.  
Diamond suitable for Orbit NM22; G800; M3D £2.25 each.

### HEADPHONES

Sennheiser HD414 £12.50  
AKG K50 £6.50  
Beyer DT485 £35.00

### RECORD CARE

Cecil Watts Duse Bug £1.20  
Parastatic Disc Preener 45p  
Antistatic Fluid 20p  
Duse Bug Spares (Brush & Roller) 15p  
Prices inc VAT and Post.

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Cassette Caddy £1.20  
Cassette Head Cleaner 35p

### ZONAL ILFORD TAPE

5" Standard 600ft 25p  
5 1/2" Standard 900ft 50p  
7" (Plain boxed) 1200ft 60p  
7" (Westminster Boxed) 1800ft. £1.25  
7" Reel of Leader Tape (Blue or green) 75p

### MICROPHONES

AKG D109 £11.50  
AKG D202E1 £39.50  
AKG D190C £17.00  
AKG D190E £18.20  
AKG D224 £50.00  
Sennheiser MD211N £45.00  
Sennheiser MD413N £27.00  
Sony ECM50 £85.00  
Audio RMS7F Radio Mike £210.00

### SPEAKERS

E.M.I. 350 Kit 8 ohms £8.20  
E.M.I. 450 Kit 8 ohms £4.50

### CARTRIDGES

Golding G800 £6.00  
Orbit NM22 £4.00  
Shure 75J6 £6.00  
Sonotone 9TAHC (Dia) £2.00  
Sonotone 8T4A (Dia) £1.50  
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YES, "YOU'VE GOT THE WHOLE WIDE WORLD IN YOUR HANDS"! ALMOST UNBELIEVABLE! Think of the year 1984 and what might be produced then—now get the fantastic **ASTRAD 17** and SEE for yourself that the incredible Russians have done it all NOW! It's the radio perfectionist's dream come true! **THIS ONE SUPERSEDES ALL EARLIER MODELS!** It will probably make your present radio seem like a "crystal set"! Complete with optional battery eliminator for both battery and mains use! We're almost giving them away at only £18.50—a mere fraction of even today's Russian miracle price! We challenge you to compare performance and value with £80 radios! \*Send quickly, test on mail order 7 days approval, from receipt of goods. Refund if not delighted. Or call. Volume controlled from a whisper to a roar that would fill a hall! Much wider band spread, for absolute "pin-point" station selection! Plus "MAGIC EYE" tuning level indicator for ultra perfect tuning sensitivity! Yes, the Russians have surpassed themselves, proving again their fantastic ability in the field of electronics and brilliantly reflecting their advanced micro-circuitry techniques in the field of spaceship and satellite communications. Yes, **EVERY WAVE** AND instantly at your fingertips including Standard Long, Medium, Short and Ultra Short Waves to cover the four corners of the earth during 24 hours a day including all normal transmissions, VHF/FM/USW, AM: LW, MW, SW, gets, locally, local & new stations, not yet operational, and messages from all over the world! Expensive TURRET TUNER side control waveband selection unit (as used on expensive T.V.'s!). Every waveband clicks into position giving incredible ease of station tuning! Genuine push-pull output ON/OFF volume and separate Treble and Bass tone controls for utter perfection of reproduction and tone! Press-button dial illumination! Take it anywhere—runs economically on standard batteries (obtainable everywhere) or direct through battery eliminator from 220/240V AC mains supply. Internal ferrite rod aerial plus built-in "rotatable" telescopic aerial extending to 39 in approx. It's also a fabulous **CAR RADIO**. Can also be used through extension amplifier, tape recorder or public address system. SIZE 13in x 10in x 4 1/2in overall approx. Magnificently designed, in highly polished cases. Made to give years of perfect service. Purer & sweeter tone than ever. (U.K. service facilities & spares available for years & years to come, if ever necessary!). With **WRITTEN GUARANTEE**, manual with simple operating instructions & circuit diagram. **PLUS** ultra sensitive earphone for personal listening. **ONLY £18.50** (with mains/battery eliminator £2.25 extra) **BOX, POST, ETC. 45p. NO MORE TO PAY! \*BUT WAIT**, for only 75p extra you get the sensational "COMPUTERISED" **WORLD TUNING GUIDE** (it enables you to zone & time in a flash for transmissions the whole world over—even a child can do it in a flash—it even lets you know when to tune into the U.K. when abroad. **NO GUESSING! NO MESSING!**) **PLUS** Standard 'longlife' batteries and Converter Plug. (Sorry—We cannot change these new radios for any earlier model purchased.) Send quickly to Uxbridge Road address, or call at either Store. **BUT HURRY! SHOPERTUNITIES SAVE YOU ££'s and ££'s.**

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**WAVEBANDS:**  
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**Plus 5 SHORT WAVEBANDS**  
**Plus ULTRA SHORT WAVES**  
**(V.H.F. AM, F.M., MW)**  
**(LW, USW.)**

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**BATTERY/MAINS AC Combined V.H.F. AM/FM RADIO and CASSETTE TAPE RECORDER & PLAYER**

**WITH REMOTE CONTROL MICROPHONE**

**RECOMMENDED RETAIL PRICE £44**

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**Cassette TAPE RECORDER & PLAYER**

**With remote control microphone.**

**FIRST CLASS MAKERS**

**WE COULD CHARGE UP TO £26.97!**

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Order by post to Uxbridge Road address or call at either store. Bargains galore at both stores. **(COMMERCIAL TRAVELLERS PLEASE NOTE: Merchandising office at Holborn Store.)**

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## SIDE 2 FLUORESCENT LAMP INVERTER

Power failures needn't leave you in the dark! Details are given for building an 8W, 13W or 20W version of this useful unit, all powered from a 12V source.

Also this month...

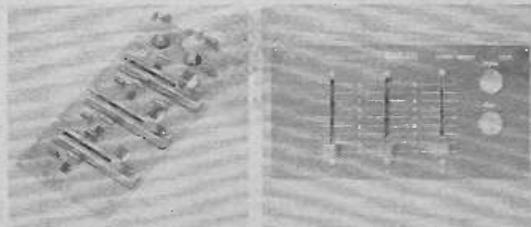
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PRACTICAL  
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Order the March issue now!  
**OUT FRIDAY FEBRUARY 8**

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- ★ Three Inputs easily adjustable to suit users input requirements, e.g., Mic., Tape, Disc., etc.
- ★ Uses advanced design with five integrated circuits.
- ★ Slider fader volume controls mount directly on P.C. board.
- ★ Full range bass and treble controls.
- ★ Guaranteed top grade components with fibreglass printed circuit board, ready-drilled and tinned.
- ★ Battery operated (2 x PP3) not supplied with kit.
- ★ Easy to follow assembly Instructions (available separately 25p).
- ★ Attractive ready punched facia plate, available at extra cost, gives that professional finish to the unit.
- ★ Size: 9-5" x 4-8" x 2".

PRICE: KIT ONLY £11.00  
FACIA PLATE £1.50  
MANUAL AND ASSEMBLY INSTRUCTIONS 25p  
AVAILABLE READY BUILT WITH FACIA £15.00

ALL PRICES INCLUDE V.A.T. & POSTAGE IN U.K.

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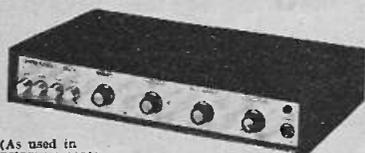
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## PREMIER 800 STEREO AMPLIFIER



(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. Dlx sockets for inputs and outputs. Controls: Bass, Treble, Volume, Balance, Selector. Mono/Stereo switch. Stereo headphone socket. Attractive slim line design. Teak cabinet with aluminium front panel. Size 12½" x 6½" x 2½"

ONLY £17.85 Carr. 50p.

## 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.

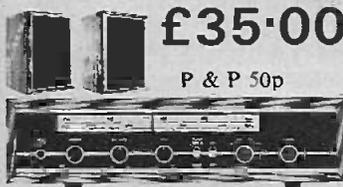
Specification: 10-10 watts into 8 ohms. Power/frequency response: 0dB 10 watts into 8 ohms—3dB 20Hz—25KHz. Distortion typically less than 0.25%. Inputs for Magnetic phono (4mV) Ceramic phono (66mV) Radio/Tape (100mV). High and low filters. Teak finish cabinet. Size: 12½" x 5½" x 10½".

£27.50 P. & P. 50p.

### PREMIER STEREO SYSTEM '64'

Consists of the Premier Paragon Stereo Amplifier, Garrard SP25 III in teak finish plinth with cover and fitted Goldring 8000 stereo magnetic cartridge plus a pair of Marston Hall Annex 100 Loudspeaker Systems. Complete with Free leads and plugs. £64 Carr. & Insurance £17.75

## MSB-3002 Stereo Tuner Amplifier



£35.00

P & P 50p

Fantastically low-priced stereo tuner amplifier covering LW, MW & VHF with built-in decoder for stereo reception. Output 2 x 4 watts RMS. Input for ceramic or crystal pick-up. Output for tape recorder. Switched A.F.C. Stereo headphone socket. Controls—volume, tone, balance, selectors and tuning. Attractive walnut finish cabinet with 2 matching speakers.

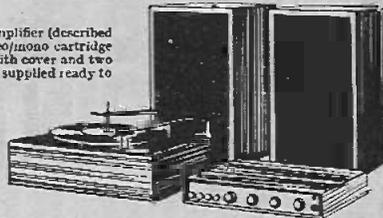
# PREMIER HI-FI STEREO SYSTEMS

## SYSTEM 'ONE'

Consists of the Premier 800 Mk II all transistor stereo amplifier (described left) Garrard automatic record player unit fitted stereo/mono cartridge with diamond styli 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: 12½in. x 6½in. x 2½in.

£43.00

Carr. £1.75



## SYSTEM 'TWO'

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

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Carr. £1.75

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### 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.

£31.00 Carr. & Ins. £1.50

## STEREO HEADPHONE EXTENSION LEAD

15 foot curly cord. £1.50. P. & P. 10p.



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

PREMIER PRICE

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P. & P. £1

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- ★ Fast forward
- ★ Eject
- ★ 3 watts per channel output
- ★ 12v DC negative earth
- ★ Speaker impedance: 8 ohms
- ★ Measures 170mm. D. x 152mm. W. 50mm. H.
- ★ Matching pair of wedge-shaped speakers.

ONLY £19.95 P. & P. 50p.



## MODEL CT-330 MULTITESTER



The Model CT-330 Multitester is a de-luxe, accurate and high sensitivity instrument having many features which are desirable and required in testing modern electronic equipment. The Model CT-330 is very compact and of sturdy construction. Only the finest parts are used—1% resistors, low-resistance selector switch, clear scale and rugged meter movement. Ranges: DC Voltages: 0, 0.6, 6, 30, 120, 600, 1,200, 3,000, 6,000V (20,000ohms/V). AC Voltages: 0, 6, 30, 120, 600, 1,200V (10,000 ohms/V). DC Current: 0, 0.6, 6, 60, 600mA. Resistance: 0, 6k, 60k, 6M, 60M (30, 3k, 30k, 300k ohms at centre scale). Capacity: 0-00003-0-01µF. 0-001-0-2µF. Decibels: -20 to +63dB.

£12.64

P. & P. 25p

## MODEL 630 MULTITESTER



Ranges: DC Voltages: 0, 2, 15, 60, 300, 600, 1,200V (30,000 ohms/V). AC Voltages: 0, 6, 30, 120, 600, 1,200V (15,000 ohms/V). DC Current: 0, 0.03, 3, 30, 300mA. Resistance: 0, 16k, 160k, 1.6M, 16M ohms (10, 100, 10k, 100k ohms at centre scale). Decibels: -20 to +63dB.

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## MULTIMETER 20,000 O.P.V.



Compares with meters costing double its price. Features large easy-to-read meter, unusually high sensitivity—wide choice of ranges. With test leads, batteries and manual. Size: 4½" x 3½" x 1". Ranges: DC Voltages: 5, 25, 50, 500, 2,500V, (20,000 O.P.V.). AC Voltages: 10, 50, 100, 600, 1,000V (10,000 O.P.V.). DC Current: 50µA, 2.5, 250mA. Resistance: 6k, 6M ohms. Decibels: -20 to +22 db. Capacitance: 10µF to 0-100µF, 0-100µF to 0-1µF. Optional leather case. £8.85 P. & P. 25p

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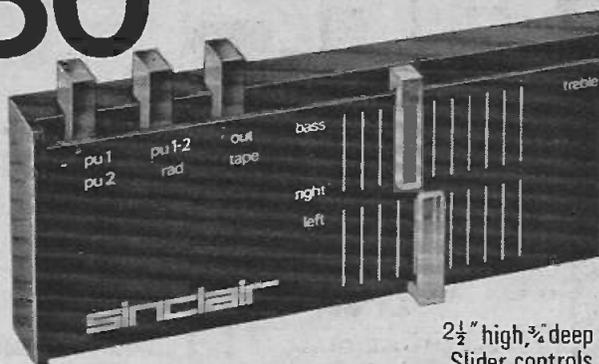
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# Project 80

the slimmest, most elegant hi-fi modules ever made

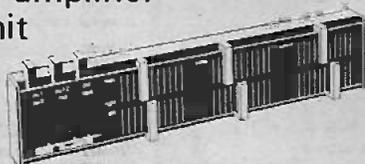
Living with hi-fi takes on new meaning with Project 80 modules. They can be assembled virtually anywhere, creating opportunities to install systems hitherto only dreamed about and never before made practical. Quality and reliability are everything you could wish for. Units are mounted by 6BA bolts at rear passing through drilled holes, cases are in black with white embellishment.



2½" high, ¾" deep  
Slider controls  
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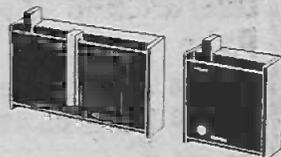


Size—260 x 50 x 20mm (10½ x 2 x ¾ ins)  
Inputs—Mag. P.U. 3mV RIAA corrected; Ceramic P.U., Radio, Tape  
S/N ratio—60db  
Frequency range—10Hz to 25KHz +3dB  
Power requirements—20 to 35 volts  
Outputs—100mV + AB monitoring for tape  
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R.R.P. **£11.95** +£1.19 V.A.T.

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FM Tuner  
Size—85 x 50 x 20mm  
Tuning range—87.5 to 108 MHz  
Detector—I.C. balanced coincidence.  
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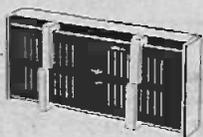


Decoder—  
With gallium arsenide tuning beacon and 19-transistor I.C.  
Size—47 x 50 x 20mm

FM tuner R.R.P. **£11.95** +£1.19 V.A.T.

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Size—108 x 50 x 20mm (4¼ x 2 x ¾ ins)  
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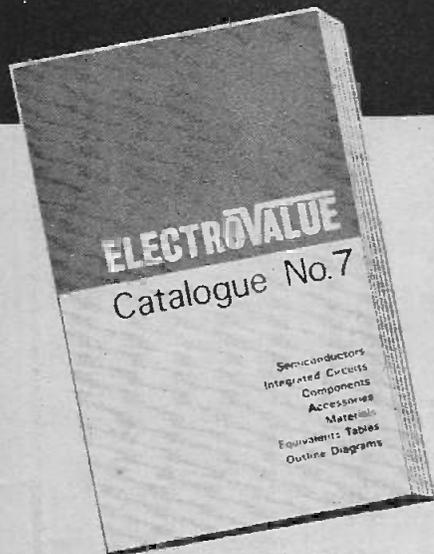
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8N7420N	0-20 0-18 0-16	8N7493N	0-85 0-80 0-75	8N74173N	1-86 1-86 1-45
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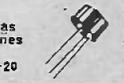
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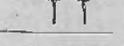
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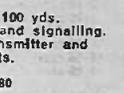
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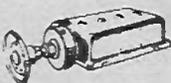
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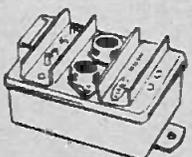


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465	Quartz XTAL checker	2-30
220	Signal Injector	15-50
390	VOX	19-30
432	Testakit	6-55
670	Buffer Battery Charger	6-25
885	Capacitive Contact Alarm	18-75
850	Electronic Keyer	58-50
820	Electronic Digital Clock	

ALL KITS OFFERED SUBJECT TO STOCK AVAILABILITY

Prices correct at time of preparation. Subject to change without notice.



### BUILD THIS TUNER

MW/LW Radio Tuner to use with any amplifier. Features Mullard RF/IF module Ferrite aerial, built in battery. Excellent results. Size 7" x 2 1/2" x 3 1/2". All parts £4-85, carr. 15p.

### MULTI-USE & RADIONIC KITS

10-1	10 Projects	3-60
8-1	10 Projects	8-00
150-1	150 Projects	13-20
	Telephone Communicator	7-20
X20	20 (Elec.) Projects	4-95
X40	40 (radio) Projects	9-45

All transistor circuits with hand books

All tests offered subject to availability. Prices correct at time of press E & OE 10% VAT TO BE ADDED TO ALL ORDERS. UK post etc. 15p per order unless stated.



## GARRARD BATTERY TAPE DECK

GARRARD 2 speed 9 volt tape decks. Fitted record/erase and oscillator/erase heads. Wind and rewind controls. Takes up to 4" spools. Brand new complete with head circuits. £9-50 carr. 30p

## TOP QUALITY SLIDER CONTROLS

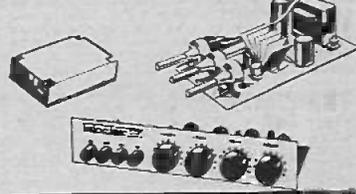
60mm stroke high quality controls complete with knobs (post. etc. 15p any quantity).  
 Singles Log and Lin 5K, 10K, 22K, 50K, 100K, 250K, 500K, 1 Meg. 45p each.  
 Ganged Log and Lin 10K, 22K, 50K, 100K, 250K, 65p each.  
 (Quantity discounts available)  
 Complete with knobs.

## MARRIOT TAPE HEADS

4 TRACK MONO or 2 TRACK STEREO  
 '17' High Impedance £2-00  
 '18' Med. Impedance £2-00  
 R730/E73 2 track mono Record/erase low Imp. 75p pair.  
 Erase Heads for '17' and '18' 75p  
 '63' 2 track mono. HI Imp. £1-75  
 '43' Erase Head for '63' 75p  
 (Post, etc. 15p any quantity).

## SINCLAIR, MINIATURE AMPLIFIERS & TUNER/DECODER

AMPLIFIERS (carr. etc. 20p)	
4-300, 0-3 watt 9 volt	1-75
104, 1 watt 9 volt	2-80
304, 3 watt 9 volt	2-95
555, 3 watt 12 volt	3-10
E1208, 5 watt 12 volt	5-10
608, 10 watt 24 volt	4-10
410, 10 watt 28 volt	4-95
E1206, 30 watt 45 volt	9-95
E1210, 2 1/2 + 2 1/2 watts 12 volt	7-25
RE500, 5 watt IC mains operated Amplifier with controls	£6-30
SAC14, 7 + 7 watt Stereo with controls	£8-70
SAC13, 15 + 15 watt Stereo with controls	£11-75
SINCLAIR (carr. 20p) PROJECT 60	
Z30 3-57	Z50 4-37
Stereo 60 Preamp.	7-97
PZ5 £2-97	PZ6 £2-37
PZ8 (for Z50) £4-77	(TRANS £2-95)
AFU £4-45	
New SINCLAIR PROJECT 60	
Stereo Preamp.	11-95
Audio Filter Unit	6-95
Z40 15 Watt Amp.	5-45
Z60 25 Watt Amp.	6-95
PZ5 Mod. for 1 on 2 Z40	4-98
PZ6 Mod. (S Tab)	7-88
PZ8 Mod. (S Tab)	7-98
1 on 2 Z60	7-98
TRANSFORMER FOR PZ8	2-95
Project 605 Kit	18-95

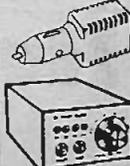


## POWER SUPPLIES FOR EVERY PURPOSE

(All cased unless stated chassis)  
 470C 67 1/2 volt 300 MA (includes Multi-Adaptor for Tape Recorders, etc.) 2-15 post 20p  
 Car Lighter Voltage Adaptors 300mA (State voltage 0v, 7v, 9v) 1-95 ea. post 25p  
 SC202 3/6/7 1/2 volt 400mA 3-35 carr. 30p  
 HC24R Stabilised version 4-35 carr. 30p  
 P500 9 volt 500mA 2-90 post 20p  
 P11 24 volt 500mA (chassis) 2-90 post 20p  
 P15 26/28 volt 1 amp (chassis) 2-90 post 20p  
 P1080 12v 1 amp (chassis) 4-25 post 20p  
 P1081 45v 0-9 amp (chassis) 7-50 post 20p  
 P12 4-12 volt 0-4 amp 7-15 post 30p  
 SE101A 3/6/12 volt 1 amp (Stab.) 10-30 post 25p  
 RP16 6/7 1/2/9/12 1 amp (Stab.) 10-20 post 30p

## FIBRE OPTICS

0-01 Diam. Mono Filament £1-50 per 25 metre reel  
 0-13 Diam. 64 Fibres Sheathed £1-00 per metre  
 SPRAYS 15mm Diam. Mares Tails £9-50.



# Henry's LIMITED

EDGEWARE ROAD, W2

SEE FACING PAGE FOR ADDRESSES

# YATES ELECTRONICS (FLITWICK) LTD

DEPT. E.E., ELSTOW STORAGE DEPT.  
KEMPSTON HARDWICK,  
BEDFORD.

C.W.O. PLEASE. POST AND PACKING  
PLEASE ADD 10p TO ORDERS UNDER £2.

Catalogue which contains data sheets for most of the  
components listed will be sent free on request.  
10p stamp appreciated.

Callers Welcome Mon. to Sat. 9 a.m. 5 p.m.

**PLEASE ADD 10% VAT**

## RESISTORS

1W Iskra high stability carbon film—very low noise—capless construction.  
1/2W Mullard CR25 carbon film—very small body size 7.5 x 2.5 mm.  
1W 2% ELECTROSIL TRS.

Power watts	Tolerance	Range	Values available	Price
1/2	5%	4.7Ω-2.2MΩ	E24	1p-0.8p
	10%	3.3MΩ-10MΩ	E12	1p-0.8p
	2%	10Ω-1MΩ	E24	3p-5p
	10%	1Ω-3.9Ω	E12	1p-0.8p
1	5%	4.7Ω-1MΩ	E12	1p-0.8p
	10%	1Ω-10Ω	E12	6p-5p
	2%	1Ω-10Ω	E24	6p-5p

Quantity price applies for any selection. Ignore fractions on total order.

## DEVELOPMENT PACK

0.5 watt 5% Iskra resistors 5 off each value 4.7Ω to 1MΩ.  
E12 pack 325 resistors £2.40. E24 pack 650 resistors £4.70.

## POTENTIOMETERS

Carbon track 5kΩ to 2MΩ, log or linear (log 1/2W, lin 1/4W).  
Single, 12p. Dual gang (stereo), 40p. Single D.P. switch, 24p.

## SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C.  
mounting (0.1 matrix).  
Sub-miniature 0.1W, 5p each. Miniature 0.25W, 7p each.

## TRANSISTORS

AC107	15p	AF126	20p	BF115	25p	OC42	12p	2N3707	12p
AC126	12p	AF139	32p	BF173	20p	OC44	12p	2N3708	10p
AC127	15p	AF178	32p	BF177	28p	OC45	12p	2N3709	11p
AC128	15p	AF180	40p	BF178	32p	OC70	12p	2N3710	11p
AC131	12p	AF181	40p	BF179	32p	OC71	12p	2N3711	11p
AC132	12p	BC107	12p	BF180	32p	OC72	12p	2N3819	32p
AC176	15p	BC108	12p	BF181	32p	OC81	12p	2N4062	12p
AC187	25p	BC109	12p	BF194	14p	OC82D	12p	2N4384	20p
AC188	23p	BC147	12p	BF195	14p	2N2646	60p	2N4289	20p
AD140	50p	BC148	12p	BF197	15p	2N2904	20p	40360	35p
AD149	45p	BC149	12p	BF200	32p	2N2926	10p	40361	35p
AD161	38p	BC157	14p	BFY50	20p	2N3054	50p	40362	40p
AD162	36p	BC158	14p	BFY51	20p	2N3055	60p	40408	40p
AF114	20p	BC159	14p	BFY52	20p	2N3702	13p	ZTX108	15p
AF115	20p	BC187	23p	BUY105	22p	2N3703	12p	ZTX100	15p
AF116	20p	BD131	75p	OC26	45p	2N3704	13p	ZTX302	20p
AF117	20p	BD132	75p	OC28	50p	2N3705	12p	ZTX500	15p
AF118	38p	BD133	75p	OC35	50p	2N3706	11p	ZXT503	20p

## ZENER DIODES

400mW 5% 3.3V to 30V, 12p.

## WIRE WOUND POTS, 3W, 10, 25.

50Ω and decades to 100kΩ, 35p.

## DIODES

DIODES	RECTIFIER	1250V	1A	12p	SIGNAL	7p
IN4001	50V	1A	7p	OA85	5p	
IN4002	100V	1A	8p	OA91	5p	
IN4004	400V	1A	8p	OA202	7p	
IN4006	800V	1A	10p	IN4148	8p	
IN4007	1000V	1A	10p	BA114	5p	

## SLIDER POTENTIOMETERS

86mm x 9mm x 16mm, length of track 59mm.  
SINGLE 10K, 25K, 100K log. or lin. 40p.  
DUAL GANG, 10K + 10K etc. log. or lin. 60p.  
KNOB FOR ABOVE, 12p.  
FRONT PANEL, 65p.  
18 Gauge panel 12in x 4in with slots cut for use  
with slider pots. Grey or matt black finish com-  
plete with fixings for 4 pots.

## BRUSHED ALUMINIUM PANELS

12in x 6in, 25p  
12in x 2 1/2in, 10p  
9in x 2in, 7p

## THYRISTORS

2N5060 50V 0.8A 30p  
2N5064 200V 0.8A 47p  
106F 50V 4A 40p  
106D 400V 4A 55p

## ALUMINIUM BOXES

AB7	2 1/2" x 5 1/2" x 1 1/2"	50p	AB14	7" x 5" x 2 1/2"	84p
AB8	4" x 4" x 1 1/2"	50p	AB15	8" x 6" x 3"	108p
AB9	4" x 2 1/2" x 1 1/2"	50p	AB16	10" x 7" x 3"	122p
AB10	4" x 5 1/2" x 1 1/2"	50p	AB17	10" x 4 1/2" x 3"	108p
AB11	4" x 2 1/2" x 2"	60p	AB18	12" x 5" x 3"	120p
AB12	3" x 2" x 1"	44p	AB19	12" x 8" x 3"	160p

## HEATSINKS—REDPOINT

2W	24p	4W	45p	TO5 Clip	5p	TO1 Single	5p
3W	36p	5W	60p	TO18 Clip	5p	TO1 Double	8p

## TRANSFORMERS All have 240V primary

MT30/2	0-12-15-20-24-30V	2A	£2.85
MT50/1	0-19-25-33-40-50V	1A	£1.90
MT50/1	0-19-25-33-40-50V	1A	£2.55
MT50/2	0-19-25-33-40-50V	2A	£2.50
MT60/1	0-24-30-40-48-60V	1A	£2.10
MT60/1	0-24-30-40-48-60V	1A	£2.80
MT60/2	0-24-30-40-48-60V	2A	£3.80

## MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0.001μF, 0.0015μF, 0.0022μF, 0.0033μF, 0.0047μF, 22p, 0.0068μF, 0.01μF,  
0.015μF, 0.022μF, 0.033μF, 3p, 0.047μF, 0.068μF, 0.1μF, 4p, 0.15μF, 6p, 0.22μF,  
7p, 0.33μF, 11p, 0.47μF, 13p,  
160V: 0.01μF, 0.015μF, 0.022μF, 0.033μF, 0.047μF, 0.068μF, 3p, 0.1μF, 0.15μF,  
4p, 0.22μF, 5p, 0.33μF, 6p, 0.47μF, 7p, 0.68μF, 11p, 1.0μF, 13p.

## MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0.01μF, 0.015μF, 0.022μF, 3p, 0.033μF, 0.047μF, 0.068μF,  
3p, 0.1μF, 4p, 0.15μF, 0.22μF, 5p, 0.33μF, 6p, 0.47μF, 8p, 0.68μF, 11p, 1.0μF,  
13p, 1.5μF, 20p, 2.2μF, 24p.

## MYLAR FILM CAPACITORS 100V

0.004μF, 0.002μF, 0.005μF, 0.01μF, 0.02μF,  
2p, 0.04μF, 0.05μF, 0.068μF, 0.1μF, 3p.

## CERAMIC DISC CAPACITORS

100pF to 10,000pF, 2p each.

## ELECTROLYTIC CAPACITORS

(μF/V) 1/63, 1-5/63, 2-2/63, 3-3/63, 4-7/63, 6-8/40, 6-8/63, 10/25, 10/63, 15/16, 15/40,  
15/63, 22/10, 22/25, 22/63, 33-6-3, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6-3,  
68/16, 100/4, 100/10, 100/25, 150/6-3, 150/16, 220/4, 220-6-3, 220/16, 330/4, 6p, 47/63,  
100-40, 150/25, 220/25, 330/10, 470/6-3, 7p, 68/63, 150/40, 220-40, 330/16, 1000/4, 10p,  
470/10, 680/6-3, 11p, 100/63, 150/63, 220/63, 1000-10, 12p, 470/25, 680/16, 1500/6-3, 13p,  
470/40, 680/25, 1000/16, 1500/10, 2200-6-3, 18p, 330/63, 680/40, 1000/25, 1500/16,  
2200/10, 3300/6-3, 4700/4, 21p.

## SOLID TANTALUM BEAD CAPACITORS

0.1μF	35V	2.2μF	35V	22μF	16V	12p
0.22μF	35V	4.7μF	35V	33μF	10V	
0.47μF	35V	6.8μF	25V	47μF	6.3V	
1.0μF	35V	10μF	25V	100μF	3V	

## VEROBOARD

0.1	0.15	
2 1/2 x 3 1/2	22p	16p
2 1/2 x 5	24p	24p
3 1/2 x 3 1/2	24p	24p
3 1/2 x 5	27p	27p
17 x 2 1/2	75p	57p
17 x 3 1/2	100p	78p
17 x 5 (plain)	—	82p
17 x 3 1/2 (plain)	—	60p
2 1/2 x 5 (plain)	—	42p
2 1/2 x 3 1/2 (plain)	—	11p
Pin insertion tool	52p	
Spot face cutter	42p	
Skt. 50 pins	20p	

## JACK PLUGS AND SOCKETS

Standard screened	18p	2.5mm insulated	8p
Standard insulated	12p	3.5mm insulated	8p
Stereo screened	35p	3.5mm screened	13p
Standard socket	15p	2.5mm socket	8p
Stereo socket	18p	3.5mm socket	8p

## D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin  
Plug 12p. Socket 8p.  
4 way screened cable, 15p/metre.  
6 way screened cable, 22p/metre.

## BATTERY ELIMINATOR

£1.50  
9V mains power supply. Same size as PP9 battery.

## LARGE (CAN) ELECTROLYTICS

1600μF	64V	74p	2500μF	64V	80p	4500μF	16V	50p
2500μF	40V	74p	3200μF	100V	£2.60	4500μF	25V	£1.68
2500μF	50V	58p	3200μF	16V	50p	5000μF	50V	£1.10

## HIGH VOLTAGE TUBULAR CAPACITORS—1000 VOLT

0.01μF	10p	0.047μF	13p	0.22μF	20p
0.022μF	12p	0.1μF	13p	0.47μF	22p

## POLYSTYRENE CAPACITORS 160V 2 1/2%

10pF to 1,000pF E12 Series Values. 4p each.

## SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI

The GDI is the world's first semiconductor that can convert a concentration of gas  
or smoke into an electrical signal. The sensor decreases its electrical resistance when  
it absorbs oxidizing or combustible gases such as hydrogen, carbon monoxide,  
methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air  
or smoke. This decrease is usually large enough to be utilized without amplification.  
Full details and circuits are supplied with each detector.  
Detector GDI, £2. Kit of parts for detectors including GDI and P.C. board but  
excluding case. Mains operated detector £5.20. 12 or 24V battery operated audible  
alarm £7.30. As above for PP9 battery, £6.40.

## PRINTED BOARD MARKER

97p  
Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to  
dry, and immerse the board in the etchant. On removal the circuit remains in high  
relief.

## METERS

1 1/2" Scale—500uA, 1mA, 10mA, 100mA £1.90

## BULGIN MAINS CONNECTORS

3 Pin 1 1/2A	Chassis Plug	10p	3 Pin 1 1/2A	Chassis Socket	18p
	Line Socket	13p		Line Plug	13p
3 Pin 3A	Chassis Plug	10p	3 Pin 3A	Chassis Socket	21p
	Line Socket	14p		Line Plug	22p
3 Pin 5A	Chassis Plug	16p	2 Pin 5A	Line Plug	20p
	Line Socket	15p			

## THERMISTORS

VA1005	15p
VA1026	15p
VA1033	15p
VA1055S	15p
VA1066S	15p
VA1077	15p
R53	£1.35

## ROTARY MAINS SWITCH

D.P. 2A 32p

## LINEAR IC's

709	14 pin DIL	40p
741	8 pin DIL	40p
741	14 pin DIL	38p
723	14 pin DIL	95p
747	14 pin DIL	85p
748	8 pin DIL	45p
	DIL Sockets 14 pin and 16 pin	16p

## WAVECHANGE SWITCH 23p

1p 12W, 3p 4W, 2p 2W, 2p 6W,  
4p 3W

Understanding Solid State Electronics

Understanding Solid State Electronics

## Understand Solid State Electronics?

Quite possibly you do — it's also quite possible your knowledge is not as broad as it might be and probably you're keen to fill in the gaps.

Whatever the extent of your knowledge in this fast-moving technology, it's a fair bet that this little book can help you find a few missing answers.

Designed for anyone who wants (or needs) to understand how semiconductors work and how they work together in solid state electronic systems, this book takes the reader through a 12-lesson, self-teaching course written in layman's language.

The course, complete with quizzes and glossaries covers basic theory and use of diodes, transistors, thyristors, optoelectronic devices. It also covers logic and bipolar, MOS and linear integrated circuits.

Texas Instruments, acknowledged leaders in the field of semiconductor technology originally produced "Understanding Solid State Electronics" as a 12-hour videotape presentation. Such was the response to the course for a back-up text book that this 242-page volume was published. Now available in the U.K. for the first time, "Understanding Solid State Electronics" priced at £1.20 (inc. p & pl) gives a comprehensive treatment of electronics without assuming any prior knowledge of electronics or mathematics.

Complete the order coupon below, mail it with your remittance to Data Sales, M.S.21, Texas Instruments Limited, Manton Lane, Bedford, and your copy of "Understanding Solid State Electronics" will be despatched by return.



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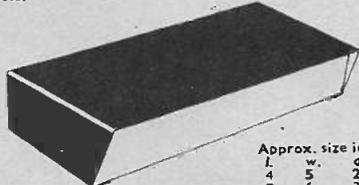
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Solid State Electronics  
at £1.20 each (inc. p & pl)  
(Cheques should be  
made payable to  
Texas Instruments Limited)

### PSYCHEDELIC LIGHTING UNIT IN KIT FORM

Make this fascinating three-channel unit from a kit which contains all components needed to produce an ever changing light display. Takes its drive from the speaker terminals of a record player, tape recorder or portable radio. Will drive a total of 2KW of coloured lamps at 240 volts. Supplied complete with PVC covered steel cabinet with holes ready punched for controls and cable outlets. Master control included. Coloured lamps not supplied. Price per kit £11.95. 240 volt coloured lamps, each 30p.

### METAL CABINETS

These attractive steel cabinets are PVC covered in a range of colours, and offer an economically priced unit for the home constructor. The chassis, which has a white satin PVC finish, provides an easily accessible building area, with an integral fascia panel. The cabinet is supplied complete with stick-on feet. Colours available include Green, Gray Black, White and Blue. Every effort will be made to supply a selected colour, but please give alternatives if possible.



Approx. size in ins.			Price
l	w.	d	
4	5	2½	75p
8	6	3	£1.00
11	6½	3	£2.04

Other sizes to special order. HOLES PUNCHED in front or back panels to your own requirements. Please send S.A.E. for quotation.

### FIXED VOLTAGE REGULATORS

TO3 case. Gives stabilised supply. MVR 5 V, MVR 12 V, MVR 15 V. All priced at £1.65

### VEROBOARD

	0.1	0.15
2½ x 1in	7p	7p
2½ x 3½in	27p	20p
2½ x 5in	29p	29p
3½ x 3½in	29p	29p
3½ x 5in	31p	32p

### D.I.L. REED RELAY

Operates direct from 5 volt TTL logic elements. Normally open contact rated at 0.25A, 100V d.c. Price each £1.50

Our CATALOGUE, priced at 25p post free in U.K., shows most of the R.S. range of professional components. Prices include VAT. All orders over 50p POST FREE—U.K. only. Overseas postage at cost. S.A.E. with all queries please.

## CELETRON-E

P.O. Box No. 1, Llantwit Major, Glamorgan, Wales GF6 9YN

## YOU AIN'T HEARD NOTHIN' YET !!

..... until you tune in to stereo  
perfection with the 'varicap'



Approx. Size 8½" x 2½" x 6½"

Features include push button "Spot On" tuning, with up to 5 pre-set stations (no difficult tuning dial and drive cord). Easy "no problem" construction, requiring only a few simple setting up adjustments with a D.C. Voltmeter. Uses NEW pre-set modules for R.F. and I.F. circuits—no circuit alignment. High efficiency Integrated Circuit Phase Lock Loop Decoder for perfect stereo reception, with stereo lamp indicator. TOTAL KIT price only £28.50 including V.A.T. and postage. With Fibre Glass P.C. Board, neat slimline teak veneered cabinet with brushed aluminium front panels, push buttons etc.

All parts available separately.  
IDEAL FOR USE WITH THE "TEXAN", "GEMINI"  
AND ANY GOOD QUALITY STEREO AMPLIFIER.  
Please send large S.A.E. for full details.

228, ECCLESALL ROAD, SHEFFIELD S11 8PE  
Telephone No. (0742) 668888  
THE COMPONENT CENTRE OF THE NORTH

## ELECTRO SPARES

## es

# The Sinclair Cambridge... no other calculator is so powerful and so compact.

## Complete kit-£24.95! (PLUS VAT)

### The Cambridge – new from Sinclair

The Cambridge is a new electronic calculator from Sinclair, Europe's largest calculator manufacturer. It offers the power to handle the most complex calculations, in a compact, reliable package. No other calculator can approach the specification below at anything like the price – and by building it yourself you can save a further £5.50!

### Truly pocket-sized

With all its calculating capability, the Cambridge still measures just  $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$ . That means you can carry the Cambridge wherever you go without inconvenience – it fits in your pocket with barely a bulge. It runs on ordinary U16-type batteries which give weeks of life before replacement.

### Easy to assemble

All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our service department will back you throughout if you've any queries or problems.

### Total cost? Just £27.45!

The Sinclair Cambridge kit is supplied to you direct from the manufacturer. Ready assembled, it costs £32.95 – so you're saving £5.50! Of course we'll be happy to supply you with one ready-assembled if you prefer – it's still far and away the best calculator value on the market.



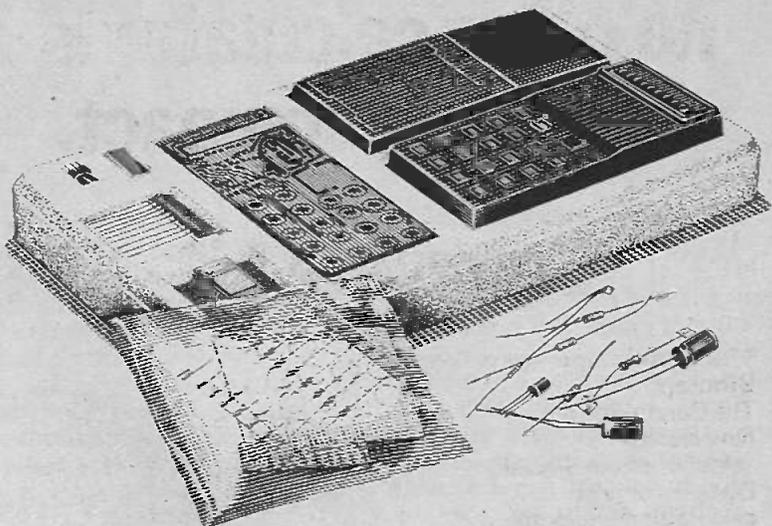
- \* Uniquely handy package.  $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$ , weight  $3\frac{1}{2}$  oz. Smart black and tan styling.
- \* Standard keyboard. All you need for complex calculations.
- \* Keys react with positive click when pressed.
- \* Clear-last-entry feature.
- \* Automatic ('implied') constant – no need for separate operating button.
- \* Common-sense ('algebraic') logic – enter calculations just as you write them.
- \* Calculates to 8 significant digits; fully floating decimal point positions itself automatically.
- \* Clear, bright 8-digit display.
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Everyday Electronics, February 1974

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# everyday electronics

PROJECTS...  
THEORY....

## PLEASE HELP YOURSELF!

It is simple and inexpensive to make a start in the hobby of electronics. The bare essentials in equipment are a soldering iron, screwdriver, wire cutters, pliers, and a modest type of multimeter.

But let us be honest—it is hardly likely to stop just there! After completing a few simple projects the urge to delve progressively further and deeper into the subject comes quite naturally; to conduct experiments and try one's hand at circuit design, for example.

However, visions of the need for additional expensive equipment may cause some enthusiasts to hesitate and ponder over the probable financial outlay involved. Well, we have good and reassuring news in this connection. While many spare time activities do depend upon commercially made equipment that is often expensive, in the case of electronics "do-it-yourself" is doubly true! The most important circuit checks and measurements can be performed with instruments of a kind that the constructor can build himself—provided he is given full design details.

This month EVERYDAY ELECTRONICS introduces the *EE Test Gear Five*, commissioned specially for our readers. Collectively, these five instruments will satisfy all the more usual requirements of the average constructor, experimenter, and designer. While a careful eye has been kept on the budget, these units have been designed to the highest professional standards.

This, then, is an opportunity for every reader to equip himself with a fine set of test gear—

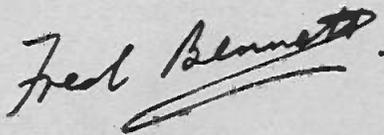
instruments he will be proud to own and use and to show to his friends because they will demonstrate his own handiwork as a constructor. These five handsome instruments will transform the appearance of any "den" or private retreat, however modest. Their good looks are incidental however. The instruments are designed for serious work, not just to impress the visitor—though undoubtedly they will. With the *EE Test Gear Five* before him, the least pretentious of constructors will feel confident to tackle more ambitious projects and maybe venture into some experimental and design work in addition.

A word to the wise. All these instruments will have immediate and lasting value. So start building *your* collection this very month, with item number one—the *Power Supply Unit*.

Those more seasoned enthusiasts who already possess some items of test gear may well consider the merits of having a unified set of instruments with a common power supply linkage. Otherwise, one or more items of the *EE Test Gear Five* could be used to make up any deficiency in their existing equipment.

## OUR NEW PRICE

Soaring costs of materials, especially paper, have caught up with us. Regrettably we have to advise readers that as from next month the price of EVERYDAY ELECTRONICS will be 20p.



Our March issue will be published on Friday, February 15

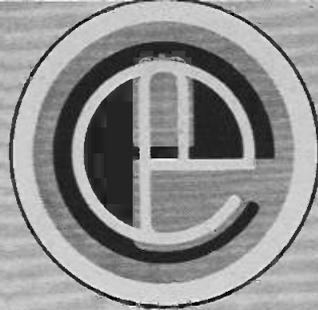
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# EASY TO CONSTRUCT SIMPLY EXPLAINED

VOL. 3 NO. 2

FEBRUARY 1974

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# EMERGENCY

# LIGHTING UNIT

By MIKE HUGHES

Automatically switches on an auxiliary lighting system when mains supply fails

IN these days of perpetual electricity failures it is convenient to have an auxiliary source of lighting in the home. It is mandatory that clubs and public areas have an emergency lighting circuit capable of running from a source independent from the mains.

The simple solution, in either case, is to have a circuit, or circuits, running 12 volt bulbs from an accumulator. This, however, requires that the accumulator is in a constant state of charge. This project is basically a battery charger that is used to keep the accumulator "topped up" but wired into it are two switchable output sockets for running auxiliary lighting and facility is built in for automatic change over to the emergency system, should the mains fail.

## CIRCUIT

The circuit is shown in Fig. 1. A tapped input mains transformer is used that gives a nominal output of 12V r.m.s. (17V peak) at up to 5A. This is fed to a low voltage, high current bridge rectifier giving a full wave rectified output that is fed via a switchable series limiting resistor R2 and ammeter circuit to the terminals of the unit. The stand-by accumulator would be connected to these terminals.

With the series resistor in circuit charge current is limited to about 0.5 to 1A (for trickle charge purposes) but when shorted out with S2 the circuit current is limited only by the internal resistance of the transformer, the resistance of the ammeter circuit and the state of charge of the accumulator. Current could be up to 5A (and even greater). Should there be some major

fault with the accumulator or the output was shorted then current could exceed the 5A (maximum) and a fuse is inserted to prevent overheating etc.

## LIGHTING CIRCUITS

The auxiliary lighting circuits are taken from the battery terminals via the relay contacts to switches S3 and S4 to output sockets on the front panel. These circuits are connected on the front side of the same fuse. Because the relay (normally held in by the 12V a.c. from the transformer) is connected with its "normally closed" contacts in the auxiliary circuit, current cannot flow through the bulbs unless the mains fails. When this happens the relay drops out and current from the battery flows the other way through the fuse into the auxiliary circuit. Thus both circuits are protected by the single fuse.

Some constructors may not wish to build in the automatic change over facility; in which case the auxiliary circuit ought to be separately fused.



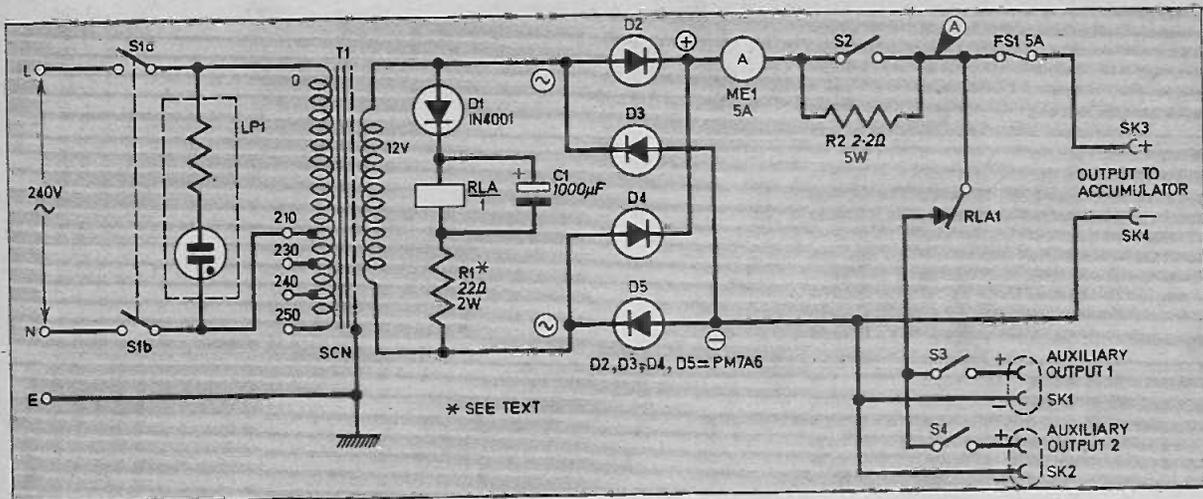


Fig. 1. Complete circuit diagram of the Emergency Lighting Unit.

## CURRENT

If the unit is to be run from the mains via a fused 13A plug there is no need for an internal fuse on the mains input but take note that this is essential if the unit is to be run from non-ring main domestic wiring (a 500mA fuse is sufficient).

With this system the maximum output current to the bulbs is 5 amps (not displayed on the meter) thus the total power loading **must** not exceed 60 watts. In a domestic situation this is more than is necessary and in practice two circuits with a loading of 2 amps each is quite sufficient. Switches S3 and S4 allow selection of either or both external circuits in the usual way.

Remember that this unit provides high currents, consequently heavier gauge wire than usual should be used (10 amp rating preferably) for all internal and external connections (Fig. 2). It is particularly important to have this in mind if the equipment is to be permanently wired into a building's structure. If the wire is too light a gauge not only will you get excessive line voltage drops but the conductors could heat up and present a fire risk.

## INSTALLATION

When installing the equipment make sure the accumulator is in a well ventilated area because hydrogen and oxygen are liberated during charging—a localised build up of these gases could cause an explosion if exposed to a naked flame. Ideally it should be contained in a wooden (frost protected) box outside.

The charger unit should be as close as possible to the accumulator but for convenience it is more likely that the latter would be indoors, nevertheless keep the leads to the accumulator as short as possible. The longer they are the heavier gauge they ought to be to prevent line drop.

When charging a badly exhausted accumulator it is best to charge at the trickle rate for an hour or two before changing to full rate—other-

## Components....

### Resistors

- R1 22Ω 2W (see text)
- R2 2.2Ω 5W

### Capacitor

- C1 1,000μF elect. 25V

### Semiconductors

- D1 1N4001
- D2 } 5A, 24V silicon bridge rectifier (AEI
- D3 } type PM7A6) or equivalent wired group
- D4 } of 5A rectifiers (4 off)
- D5 }

### Switches

- S1 } Two pole 3A 240V on/off toggles.
- S2 } (Both poles shorted together for S2, 3
- S3 } and 4)
- S4 }

### Miscellaneous

- ME1 5A moving iron meter
- RLA1 6V coil, 26ohms with 5A changeover contacts (see text)
- LP1 240V neon indicator—incorporating limiting resistor
- T1 Mains transformer. Primary 0-210, 230, 240, 250. Secondary 12V at 5A (Douglas type MT 85AT)
- FS1 Bulgin panel mounting fuse holder and 5A fuse
- SK1/2 2 plug socket pairs for auxiliary circuits (5A capacity)
- SK3/4 2 red, 1 black 5A screw terminals
- 2 large crocodile clips for accumulator.
- Heavy gauge insulated wire, 3 core mains lead, grommet and cable clamp. Case approx. 200mm x 150mm x 150mm.

SEE  
**SHOP  
TALK**

# EMERGENCY LIGHTING UNIT

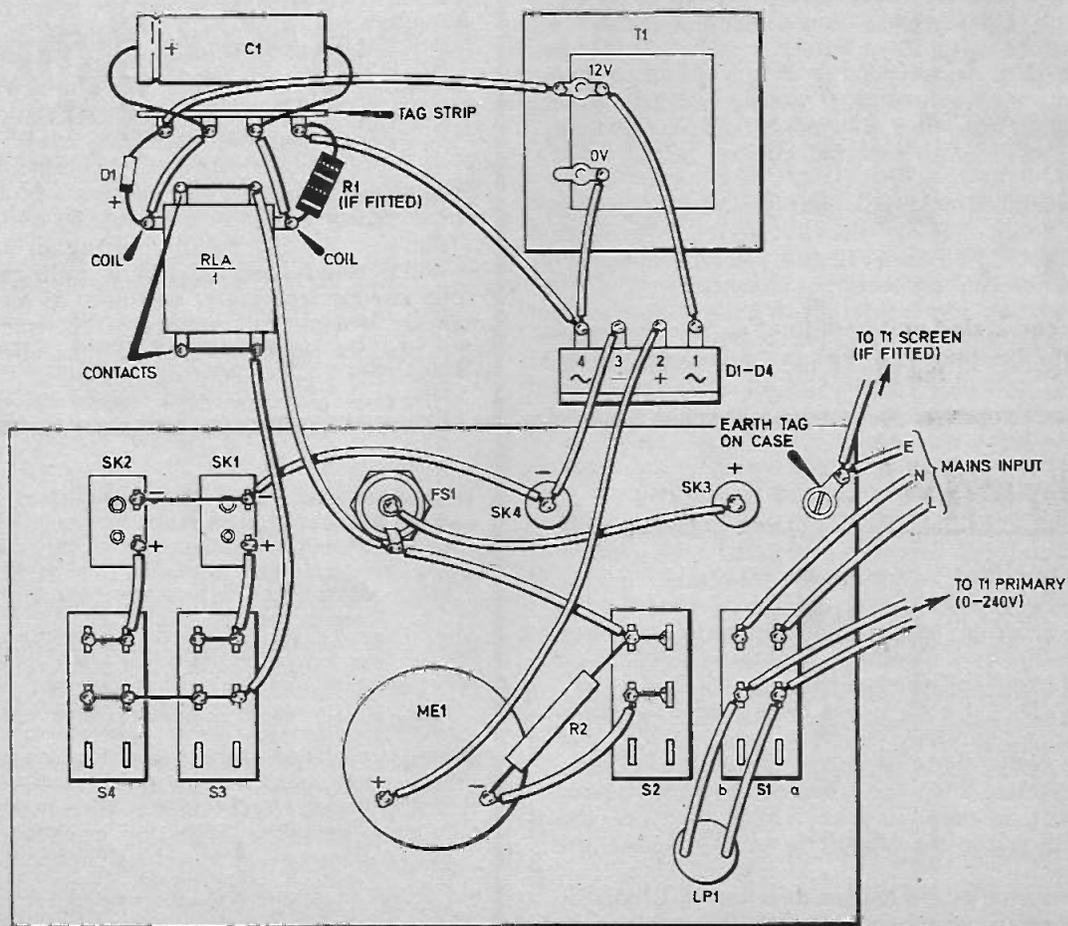
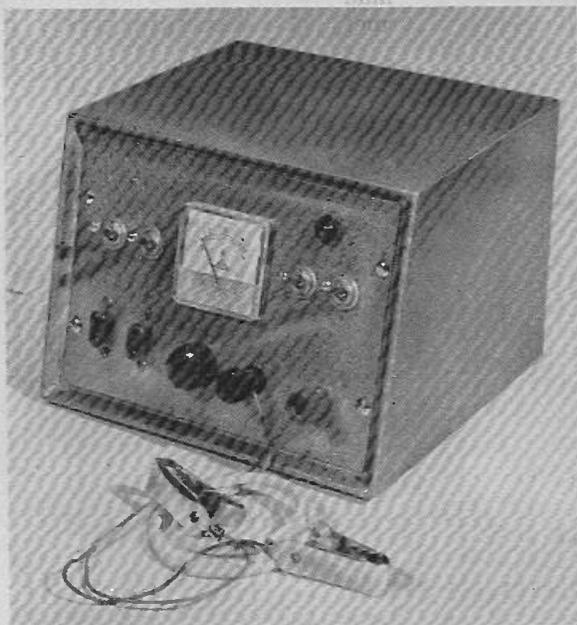
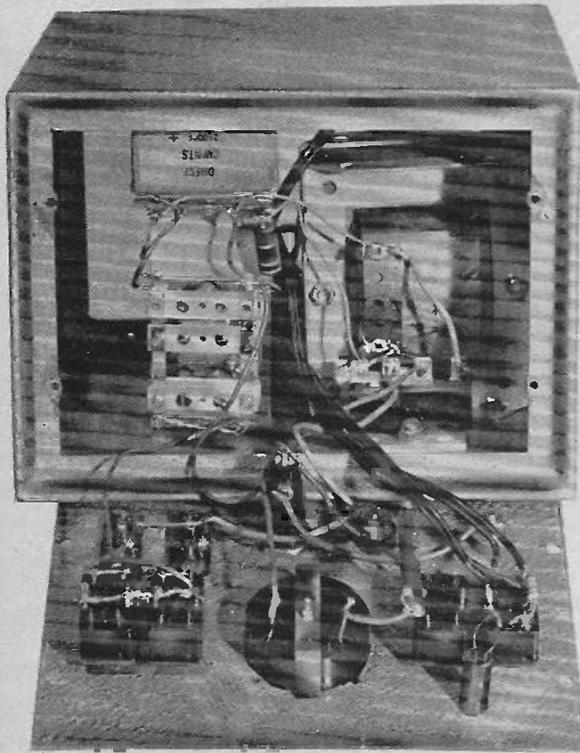


Fig. 2. Layout and wiring of the Emergency Lighting Unit.

wise currents in excess of 5 amps might be drawn. Use can be made of the tapped mains input of the transformer (if such a transformer

has been used) to slightly increase or decrease the maximum charging rates. The output of 12V r.m.s. assumes the supply is connected to the input tapping of the same magnitude (e.g. 240V). If, however, you connect 240V across the 210V tappings the output voltage will increase by about 15 per cent. Connecting to higher voltage tappings will reduce the output voltage and hence the charge current. Should the maximum charge current be higher than required a 0.5 or 1 ohm resistor (5 watt) should be inserted between S2 and FS1 at point A (Fig 1).



The completed unit with front panel removed to show construction. Relay types may differ from that shown in the photograph.

## COMPONENTS

Finally, some points about the construction and availability of components. The diode bridge must be capable of passing 5 amps. If you cannot obtain the one specified you can make one up using discrete stud rectifiers (of 5 amps rating each) which are easily obtainable. They should, however, be bolted onto a panel of insulating material prior to fixing in the cabinet.

The relay might present some problems but a variety will do here. Ideally an a.c. 12V coil relay with 5 amp low voltage rating contacts should be used straight across the transformer's secondary, but relays with a.c. coils are not very common. The prototype used a 6V d.c. relay that had a coil resistance of 26 ohms. The d.c. drive is provided by rectifier D1 and the current (from the 12V source) is limited by R1 which should be of 2 watts rating, C1 prevents chatter of the relay contacts. If you locate a 12V d.c. coil relay with 5 amp contacts R1 can be omitted.

Because of problems in locating or making low value shunt resistors for a millimeter a 5 amp moving iron meter was used as a current monitor. Moving coil meters of the same full scale reading could be used just as effectively but are likely to be more expensive. □

# What do you know?

## TERMS

Explain the following terms as used when discussing electronic circuits or phenomenon.

- 1 Direct Coupling
- 2 Bandwidth (applied to a receiver)
- 3 Sensitivity
- 4 Modulation Depth
- 5 Bias

Note. High frequency a.c. bias is used in tape recorders to obtain high quality reproduction from the tape.

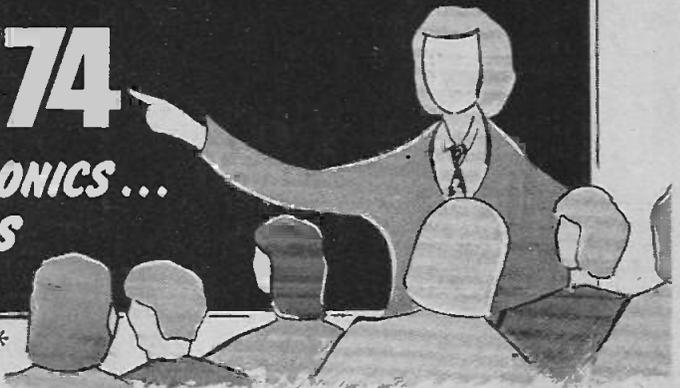
## ANSWERS

- 1 Coupling between two stages of a circuit or two networks where there is a direct current path, i.e. no capacitor is used.
- 2 The extent of a continuous range of frequencies (a band of frequencies) which the receiver is capable of receiving at a certain specified level.
- 3 Normally specified as the least input of a receiver or amplifier which produces an output of a certain specified level.
- 4 A factor which shows the extent to which one signal is modulated by another, usually given as a percentage.
- 5 A steady direct voltage applied to two terminals of a transistor or other active device to set the working point of the device.

# TEACH-IN '74

FOR BEGINNERS IN ELECTRONICS ...  
THEORY AND EXPERIMENTS

TUTOR: PHIL ALLCOCK\*



## LESSON 5 The Transistor

SO FAR we have mentioned the relationship that exists between the base, collector, and emitter currents of an *npn* transistor and have examined the current/voltage characteristic for the emitter/base junction.

### TRANSISTOR CHARACTERISTICS

Manufacturers often publish other characteristics such as the variation of  $I_c$  with  $V_{ce}$ . Such a characteristic is illustrated in Fig. 5.1. Each curve shows the variation of  $I_c$ , as  $V_{ce}$  is varied, for a constant value of base current  $I_b$ .

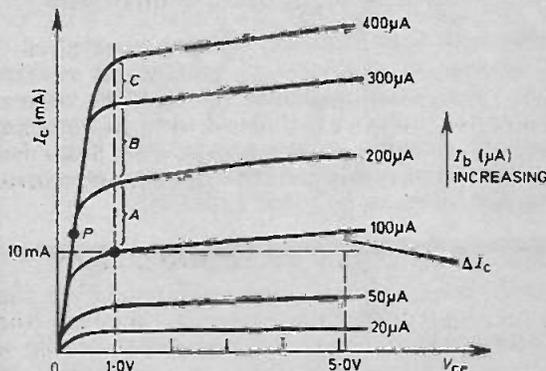


Fig. 5.1. Variation of  $I_c$  with  $V_{ce}$ .

The curves usually relate to a "typical" device and the values for a particular transistor may differ considerably from the published curves since the parameter  $\beta$  has a wide spread. However, the curves are useful in that they illustrate several important features of the transistor.

The first point is that for  $V_{ce}$  values greater than about one volt the collector current is almost constant for a given value of  $I_b$ . The collector current does rise slightly as can be seen from the  $I_b = 100 \mu A$  curve. The current  $I_c$  rises by a small amount, shown as  $\Delta I_c$ , as  $V_{ce}$  increases from 1.0 to 5.0 volts. For a typical device this current change might be about 40 to 100  $\mu A$ . Note

that the collector current for this curve would be about 10mA, if we assume that  $\beta$  is 100, since we saw last month that  $I_c = \beta I_b$ .

Although a change of 100  $\mu A$  seems quite large when compared to the base current of 100  $\mu A$  it represents only one per cent of the total collector current. Consequently for most purposes we can assume that  $I_c$  is independent of the voltage  $V_{ce}$  if  $V_{ce}$  is at least one volt. (For power transistors the change in  $I_c$  can be much larger and may have to be considered.)

### GAIN

The second point which is illustrated by the characteristics is that  $\beta$  does vary somewhat with  $I_c$ . If  $\beta$  was constant, each increase of say 100  $\mu A$  in  $I_b$  would produce a definite change in  $I_c$ , equal to  $(100 \beta) \mu A$ . The changes in collector current can be read off the characteristics by measuring the spacing of the curves at a given  $V_{ce}$ , say 1 volt, whilst noting the corresponding changes in base current for the curves used. For example at  $V_{ce} = 1.0$  volt, changes of 100  $\mu A$  in  $I_b$ , over the range 100 to 400  $\mu A$ , give collector current changes represented by the lengths A, B, C. If these lengths are unequal then  $\beta$  is varying as  $I_c$  rises.

Some manufacturers give a separate curve to show this effect and a typical curve would appear as in Fig. 5.2. The parameter plotted is usually  $h_{fe}$  which is similar to  $\beta$  and is actually a measure of the change in collector current for a small change in base current. The curve shows that  $h_{fe}$  falls at low and high currents. Since the manufacturing spread for  $\beta$ , and hence  $h_{fe}$ , is already large this variation of  $h_{fe}$  with collector current is not important unless a wide variation of  $I_c$  occurs in the circuit used. This situation does occur with "large signal" circuits such as power amplifier output stages.

It is worth noting that some transistors are designed to give reasonably high  $h_{fe}$  values down to collector currents of 1  $\mu A$ . Others have their

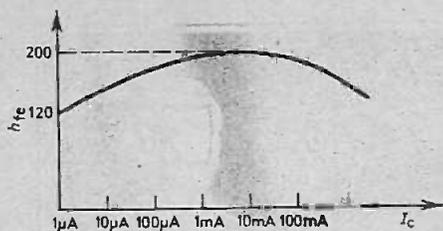


Fig. 5.2. Typical variation of  $h_{fe}$  with  $I_c$

best performance at high currents and for power transistors it may be necessary to ensure that reasonable values of  $h_{fe}$  are still obtained at currents of several amperes.

## SATURATION

A third and very important feature of the transistor is illustrated by considering point P in Fig. 5.1. Notice that at low  $V_{ce}$ , less than one volt typically, all the curves tend to merge into one line. This is the *saturation region* of the transistor, so called because at points such as P the collector voltage is almost zero and the current in the collector reaches a saturation level above which it cannot rise.

If the transistor is made to operate at point P any increase in base current above  $200\mu A$  will have virtually no effect. The collector current has saturated and the additional base current simply flows via the emitter/base junction. Obviously the relation  $I_c = \beta I_b$  no longer holds since  $I_b$  can have any value above  $200\mu A$  without  $I_c$  changing. To realise the full implications of this situation consider the circuit shown in Fig. 5.3.

If  $I_c$  was zero one would have  $V_{ce} = 9V$  (switch S1 open). By closing the switch any base current up to about  $1mA$  can be provided by adjusting VR3. The resistor R1 limits the maximum base current to a safe value. As the base current is increased from zero the collector current, equal to  $\beta I_b$ , also increases and the voltage  $V_{ce}$  falls due to the increasing voltage drop across the collector resistor R2. If we could make  $V_{ce}$  fall to zero the *maximum* current in R2 would be

$$I_c(\text{max}) = \frac{9 \text{ (volts)}}{1 \text{ (k}\Omega)} = 9 \text{ mA.}$$

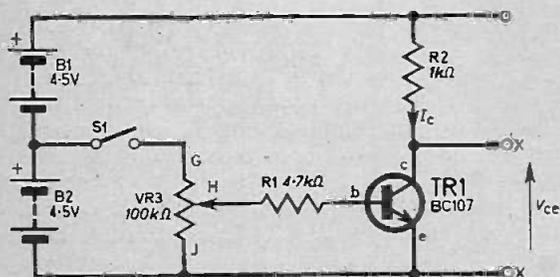


Fig. 5.3. Circuit for testing saturation.

Any attempt to force  $I_c$  higher than this must fail. If the transistor has  $\beta = 100$  the base current corresponding to this maximum collector current will be  $9/100mA = 90\mu A$ . If the base current is made larger than this value the "excess" simply flows via the base/emitter junction but does not give rise to any additional collector current. The transistor is said to be saturated.

The collector voltage never falls to zero in practice and so the manufacturer quotes a typical saturation voltage called  $V_{ce}(\text{sat})$ . The corresponding base and collector currents are usually specified and for the BC107 transistor the specification sheet gives:

$V_{ce}(\text{sat})$  at  $I_c = 10mA$ ,  $I_b = 0.5mA = 250mV$  (max.)  
 $V_{ce}(\text{sat})$  at  $I_c = 100mA$ ,  $I_b = 5mA = 600mV$  (max.).  
 These are maximum values for any sample of the BC 107 transistor, typical values for the same current levels are  $90mV$  and  $200mV$  respectively. The variation of  $V_{ce}$  as VR3 is rotated clockwise is shown in Fig. 5.4. (The letters J, H, G, identify the connections to the 100 kilohm potentiometer (VR3) as shown in the Tutor Board article [Oct. '73] page 534).

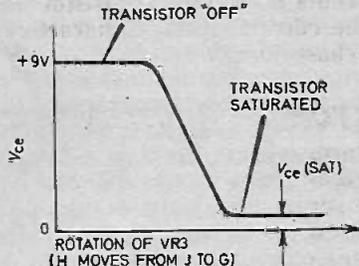


Fig. 5.4. Variation of  $V_{ce}$  with setting of VR3.

This lettering will be helpful as our circuits become more complex and is used in this month's tests. The potentiometers can be left permanently fixed to the tutor board with the 100 ohm control on the left hand side, the 5 kilohm control in the centre and the 100 kilohm control adjacent to the switch.

## THE COLLECTOR/BASE JUNCTION

The collector/base junction is similar to the emitter/base junction since it involves the transition from the base p material to the n material of the collector (for an npn device). In the circuits so far discussed this junction has been reverse biased since the collector (n region) has been made positive with respect to the base. The only exception to this condition is when the transistor is saturated. In this state the voltage  $V_{ce}(\text{sat})$  is less than the corresponding base/emitter voltage which is known as  $V_{be}(\text{sat})$ .

The situation is illustrated in Fig. 5.5 for both (a) saturated and (b) non saturated conditions. Note carefully that the collector base diode is forward biased under saturated conditions but reverse biased under normal conditions. The base/emitter diode is forward biased for both saturated and non saturated states.

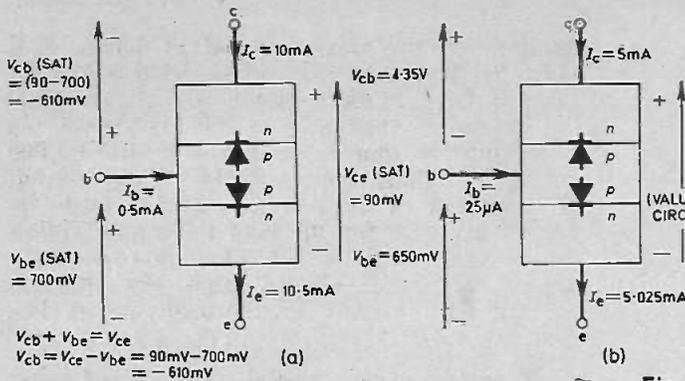


Fig. 5.5. (a) Saturated and (b) non saturated conditions.

### TRANSISTOR LEAKAGE CURRENTS

Early germanium transistors had leakage currents which were often significant and these had to be considered when designing circuits. Nowadays the modern silicon planar types have very low leakage and for most general applications the leakage can be neglected. Leakage currents increase with temperature however and silicon power devices can exhibit appreciable leakage if operating at junction temperatures of say 100 degrees Centigrade or more. The two most common leakage currents are  $I_{cbo}$  and  $I_{ceo}$  and are illustrated in Fig. 5.6.

Current  $I_{ceo}$  is always considerably greater than  $I_{cbo}$  since the leakage current is forced to flow via the emitter/base junction and this gives rise to extra current by virtue of the basic transistor action. The relationship between  $I_{cbo}$  and  $I_{ceo}$  is shown in Fig. 5.6 but note that the  $\beta$  value is for very low current operation and may be much smaller than the specification value.

### JUNCTION VOLTAGE RATINGS

The collector/base junction, like any diode, can only withstand a certain voltage in the reverse-bias condition. The value depends on the external circuit conditions at the base/emitter junction. For the BC107, the absolute maximum voltage between collector and base, with the emitter left open circuit, is 50 volts. The corresponding limit for the emitter/base junction (also with reverse bias and with the collector

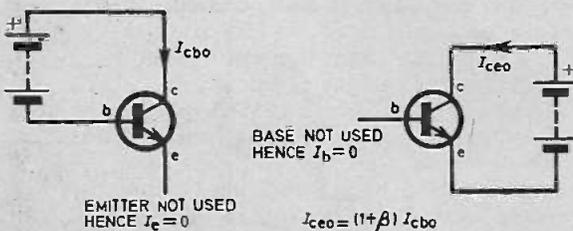


Fig. 5.6. Illustration of leakage currents.

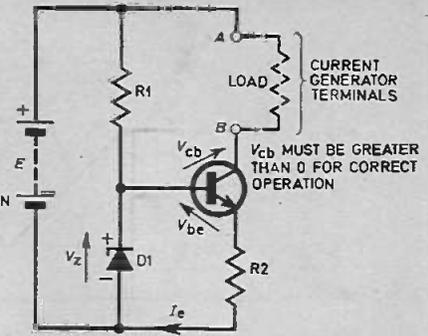


Fig. 5.7. Simple current generator.

open circuit) is only 6.0 volts. These ratings are known as  $V_{cbo(max)}$  and  $V_{ebo(max)}$  respectively. (See table of parameters in last month's Teach-In '74, page 24).

### CONSTANT CURRENT GENERATION

The ideal voltage source is easy to understand since present-day batteries approach the ideal very closely. To be ideal the voltage at the battery terminals must be independent of the current taken. An alternative, which can be very useful, is a current generator which has the property of supplying a constant current, independent of the load voltage. A transistor can be used to make a practical current generator which will operate over a restricted voltage range and one possible circuit is shown in Fig. 5.7.

The resistor R1 allows current to flow via the Zener diode D1 which keeps the voltage across R2 constant since  $V_{be}$  is almost constant for a given transistor emitter current. The current  $I_e$  through R2 must be given by

$$I_e = \frac{V_z - V_{be}}{R_2} \quad \text{where } V_z \text{ is the breakdown voltage of the Zener diode used.}$$

When a load is connected to the terminals A, B the current flowing will be the collector current of the transistor which is almost exactly equal to  $I_e$  (actually  $\alpha I_e$ ) providing the voltage across A, B is small enough to avoid saturation of the transistor. To illustrate the action of the circuit it is instructive to calculate the circuit currents and voltages using some of the techniques so far covered in this series. Let us assume that  $R_1 = 1$  kilohm,  $E = 9$  volts,  $R_2 = 10$  kilohm and  $V_z = 4.7$  volts. The calculations can then proceed as follows:—

- (i) Voltage across R1 =  $(9 - 4.7) = 4.3$  volts.
- (ii) Current in R1 =  $4.3 / 1000 \text{ A} = 4.3 \text{ mA}$ .
- (iii) Assume  $V_{be} = 0.6$  volts, then
- (iv) Voltage across R2 =  $(4.7 - 0.6) = 4.1$
- (v) Current in R2 =  $4.1 / 10,000 \text{ A} = 410 \mu\text{A}$ .

To prevent saturation occurring (which would give incorrect operation of the current generator) it is necessary to restrict the voltage be-

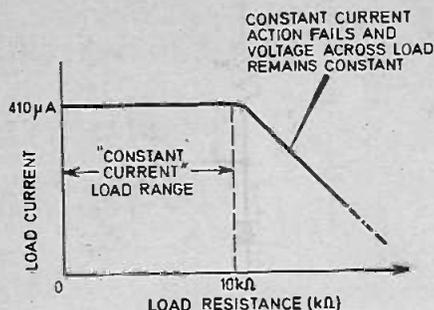


Fig. 5.8. Behaviour of constant current generator.

tween A and B so that the transistor collector base junction never becomes forward biased. Taking  $V_{ce} = 0$  as the limiting condition this

## TUTOR BOARD EXPERIMENTS

### Test No. 15

This test is based on the circuit shown in Fig. 5.3. Plan a neat layout for the Tutor Board and then wire up the components to match the circuit. Note that the switch only controls the connection of the lower 4.5V battery. Wire up the circuit for the 0-10V voltmeter in the usual way and connect the voltmeter to the points indicated on the diagram as XX. Observing polarity! With this connection the voltmeter will register the voltage  $V_{ce}$  for the transistor off.

Set the 100 kilohm control VR3 fully anti-clockwise so that the slider H is at end J. Close the switch. Slowly increase the voltage fed to the transistor base by rotating VR3 clockwise whilst observing the meter. Verify that the voltage  $V_{ce}$  varies as indicated in Fig. 5.4. Estimate the value  $V_{ce(sat)}$  for the transistor used. (The value may be difficult to read accurately since the meter deflection will be very small.)

Switch off the base supply and change the 1 kilohm collector resistor to 10 kilohm. Repeat the test and notice that a smaller rotation of VR3 is now required to give saturation. Why is this so? It is helpful in this test to make pencil marks corresponding to the knob pointer positions at which conduction starts and saturation commences. These marks can be removed with a pencil rubber when the test is complete.

### Test No. 16

This test uses two BC107 transistors to produce a very sensitive current detector. The circuit is quite straightforward and is shown in Fig. 5.9. The circuit should be built on the Tutor Board and VR1 set to the mid-point of its rotation to give a resistance of approximately 50 ohms between points B and C. Check the connections of both transistors carefully as an incorrectly wired circuit could cause damage.

The points X, Y can be the test probes normally used for the voltmeter. If the probes

implies that the maximum voltage across A, B must be limited to the voltage drop across R1 i.e. 4.3 volts. Since  $I_c$  and  $I_e$  are almost equal the maximum resistance of the load connected to A, B must be approximately  $4.3/I_c(\text{mA}) \times 1,000$  i.e. 10.5 kilohms. Consequently a fixed current of about  $410 \mu\text{A}$  will flow through the load connected at A, B for all load resistance values in the range 0 to 10.5 kilohm approximately. Higher resistance values cause the constant current action to fail and the load current then falls below  $410 \mu\text{A}$ , as shown in Fig. 5.8.

Next month we shall describe several useful circuit applications using the components covered in Teach-In '74 to date. These circuits will be treated experimentally and use most of the ideas so far presented.

are not touching each other, the lamp should be off when the switch is closed. Pick up the probes, one in each hand and make a contact between the metal (nail) and the skin. The lamp should light due to the small current that flows via the "skin resistance" of the user. Experiment to see how many people you can connect "in series" between X and Y whilst still operating the light. With high  $\beta$  transistors the lamp should light even if the resistance between X and Y is as high as 10 million ohms and for transistors with  $\beta = 500$ , resistances of 100 million ohms can be detected.

The sensitivity of this circuit can be reduced if necessary by connecting the 100 kilohm potentiometer as a variable resistor, across the base/emitter connections of transistor TR2 (shown dotted). The lower the setting of this resistance, the lower the sensitivity will be. With zero resistance the lamp may not light at all, since only the collector current of TR1 can now flow via the lamp. (TR2 must now be off since its base-emitter junction is shorted out by the zero resistance and no part of the emitter current of TR1 can flow into TR2 base.) This connection of two transistors, without the 100 kilohm potentiometer, behaves like a single transistor having a very high  $\beta$  of 10,000 or more. Why is this so?

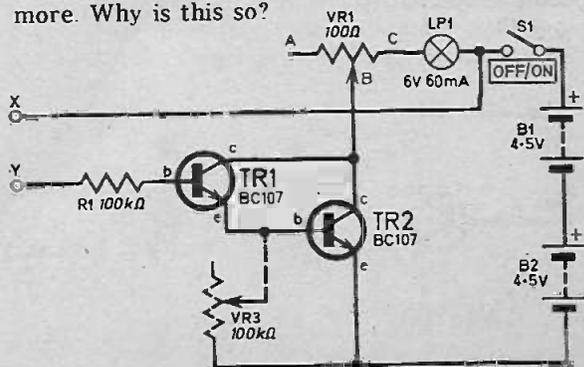
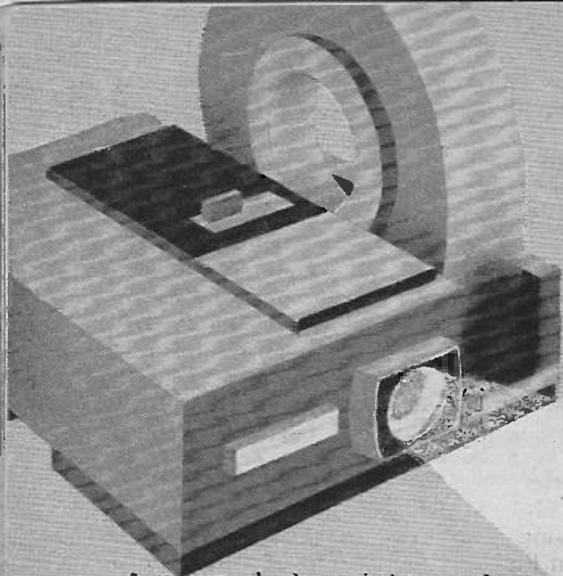


Fig. 5.9. Circuit for Test No. 16.



Approximate cost  
of components  
including V.A.T.

£2.00 plus case

Enables continuous and  
automatic slide shows

ANYONE who has tried to produce a continuous slide show for an exhibition or at home, has met the problem that most of the timing devices available on the market are not repetitive but merely time an interval from when the button is pressed after which they operate a set of contacts and they have to be reset before they will go through the cycle again. All of which means that they are not of any use for continuous slide show operation. Fortunately it is not difficult to build a repetitive timer at a reasonable cost.

The circuit described here is very simple, and is one of the many variations of the simple astable multivibrator; no relay driver was found to be needed making the finished design very economic on components.

The projector for which the prototype was designed to be used, was a Kodak Carousel which required to have a set of contacts made together for about a quarter of a second to cause the slide mechanism to operate. This contact is made by means of the relay contacts when the relay is activated in the circuit. The relay needs

# SLIDE PROJECTOR TIMER

BY C. G. GAMMANS

to be a 6-9V type with a coil resistance of at least 185 ohms and one set of normally open contacts.

## CIRCUIT

The complete circuit diagram of the Slide Projector Timer is shown in Fig. 1 and is seen to be a simple astable multivibrator, of variable frequency and mark/space ratio, loaded with relay RLA. Only the "space" part of the periodic time of the cycle is variable.

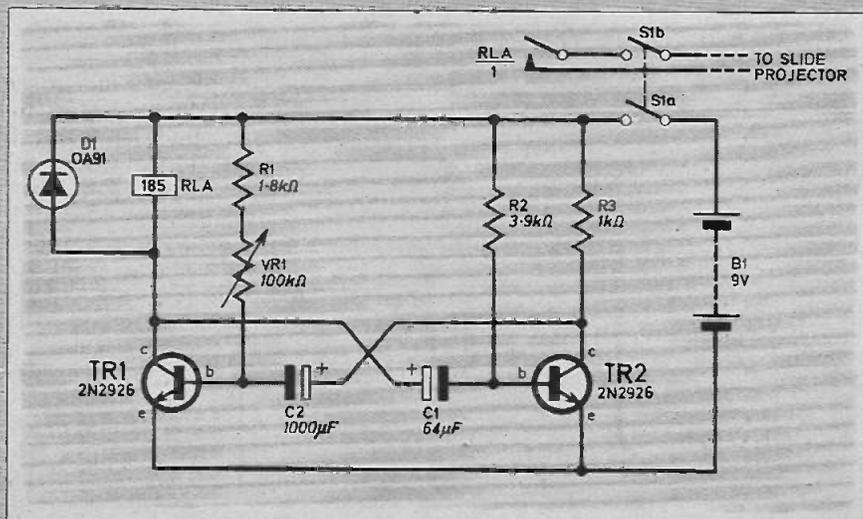


Fig. 1. The complete circuit diagram of the Slide Projector Timer.

The projector, to operate, uses the fixed timing interval i.e. the "mark" and this is set at the required 0.25 seconds by the "mark" timing components R2 and C1.

The "space" part of the multivibrator cycle i.e. time between relay contact "makes", is variable by adjusting VR1 which, together with C2 and R1 forms the timing components. Adjusting VR1 allows the time between "makes" of the relay contacts to be adjusted from one second to 20 seconds. Increasing VR1 increases the time interval between "makes" and thus between slide changes.

When S1 is switched to the on position, TR1 turns on hard (saturates) with TR2 off (not conducting) and virtually the whole supply appears across the relay coil causing the relay contacts to close for 0.25 seconds. After this time, TR2 switches on and TR1 off—astable action—and the relay contacts open and remain open for a time determined by VR1 setting. After this set time interval the cycle is repeated until turned off at S1.

To hold a slide in position for longer than that available from the unit, S1 should be switched off for as long as required. Longer delays may be obtained by increasing the values of C2 and/or VR1.

The unit will run for many hours powered by a PP3 battery.

## CONSTRUCTION

The prototype unit was built on a piece of 0.1in matrix Veroboard size 18 holes by 26 strips. The layout of the components on the top-side of the board is shown in Fig. 2; there are no breaks in the copper strips on the underside.

Commence construction by drilling the fixing hole at location P11 and then mount and solder the link wires, resistors and capacitors as shown.

Next construct the aluminium case to the dimensions given in Fig 3, and assemble the components VR1, RLA, S1 and B1 as indicated. Now solder flying leads of sufficient length to the component board. The transistors should now be soldered in position and a heatshunt used to prevent thermal damage.

Secure the component board in position in the case with 4BA nut bolt and spacer and then wire up the flying leads to the other components as detailed in Fig. 3. Finally, solder the output lead from one set of normally open contacts and S1b, and pass out through the case via a rubber grommet. The length of this lead will depend on the desired distance of the unit from the projector. If desired, this lead can be made detachable by using a two pin plug and socket.

## TESTING

Check out the circuit for wrong/omitted connections, solder bridges between copper strips, transistor connections and diode and capacitor polarities. If satisfied, turn VR1 fully anti-clockwise and switch on with projector not connected. The relay should click over once every second or so. Turning VR1 clockwise should increase the time between clicks; the fully clockwise position should produce one click every 20 seconds or so. If this does not happen, recheck for faults.

If all is well, the lid may be screwed in place. A piece of foam plastic glued to the inside lid will hold B1 in place.

## IN USE

Locate the slide change contacts in the remote operating box of the slide projector and connect the two wires from the timer unit in parallel with the slide change contacts.

Switch on the slide projector and set it up as you would normally then switch on the Slide Projector Timer. Set the slide changing speed, then switch off the slide timer and reset the slide cassette to the first slide required. Switch on the Slide Projector Timer when you wish the show to begin. If during a display you want to hold the show at the slide on the screen, then it is necessary to switch off the timer.

If the magazine of the projector is one of the round types, then with the timer running, the show will go on until you switch off. ▣

## Components . . . .

### Resistors

R1 1.8k $\Omega$

R2 3.9k $\Omega$

R3 1k $\Omega$

All  $\frac{1}{2}$ W carbon 10% SEE

### Potentiometer

VR1 100k $\Omega$  carbon lin.

### Capacitors

C1 64 $\mu$ F elect. 9V

C2 1000 $\mu$ F elect. 9V

### Semiconductors

TR1 2N2926G npn silicon

TR2 2N2926G npn silicon

D1 OA91. 1N4148 or similar

### Miscellaneous

RLA Any 6-9V relay with coil resistance 185 $\Omega$  or greater and one set of normally open contacts

B1 9V PP3

S1 d.p.s.t. toggle or slide  
Veroboard, 18 holes x 26 strips 0.1in. matrix;  
battery clip; aluminium for case; two core  
cable for connecting unit to projector; knob.

**SHOP  
TALK**

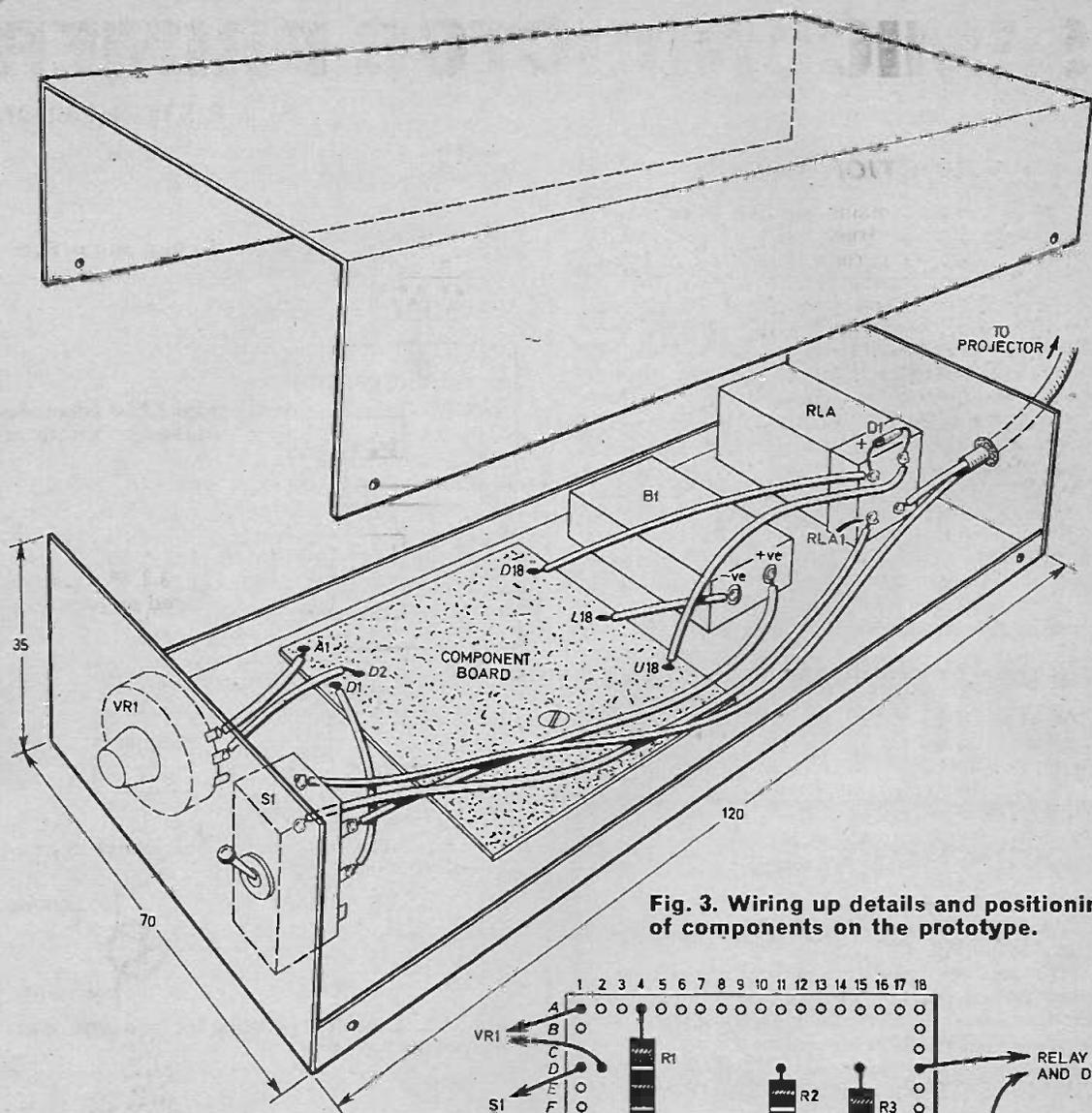
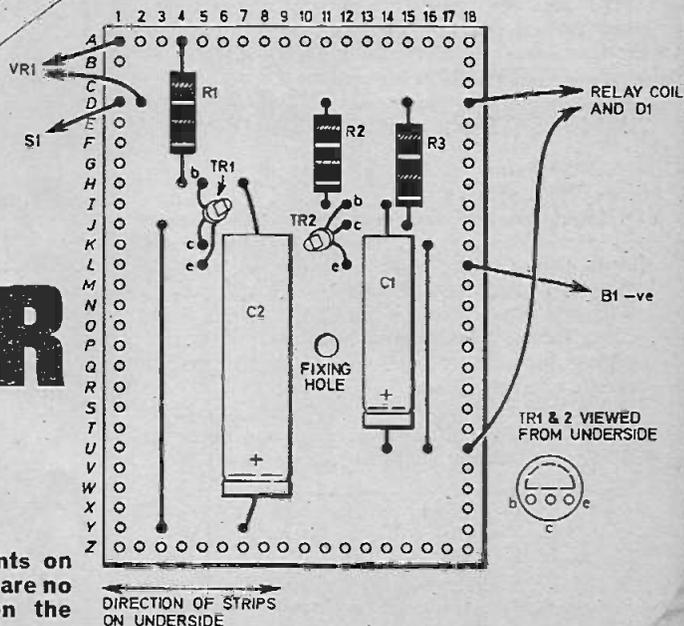


Fig. 3. Wiring up details and positioning of components on the prototype.

# SLIDE PROJECTOR TIMER

Fig. 2. The layout of the components on the topside of the Veroboard. There are no breaks along the copper strips on the underside.



# SEMICONDUCTOR PRIMER

By A.P. STEPHENSON

## 3 ■ PN JUNCTION ACTION

"p" material contains positive holes which can move around freely within the crystal. These can be considered as "little white balls" which possess a positive charge.

"n" material contains electrons, which can be treated as "little black balls". If these two materials are joined (in a special way) a pn junction is formed, Fig. 3.1.

Assume a battery is connected as in Fig. 3.2. No current flows because the holes and electrons are simply pulled away from the junction, leaving an area in between which is an insulator (because there are no charges left).

Now consider Fig. 3.3. This time, the holes and electrons are pulled across the junction, and a steady current flows round the circuit. The directional arrows are in opposite directions but the effect is additive since holes are +ve and electrons -ve.

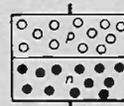


Fig. 3.1. Schematic of a pn junction.

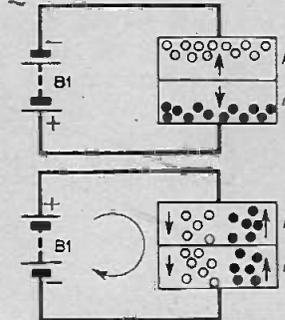


Fig. 3.2. A reversed biased pn junction.

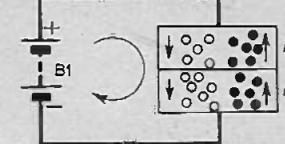


Fig. 3.3. A forward biased pn junction.

## 4 ■ CONSTRUCTION OF A TRANSISTOR

A transistor comprises two pn junctions forming a "sandwich". There are two ways of forming such a sandwich: (a) pnp (b) npn. These are illustrated in Fig. 4.1.

The three wires connected are named as follows:

The base is the middle layer connection.

The emitter is one of the ends.

The collector is the other end.

The symbols for the two kinds of transistor are given in Fig. 4.2.

The emitter arrow points in direction of conventional current, i.e. positive to negative. Emitter arrow is INWARDS for pnp. Emitter arrow is OUTWARDS for npn.

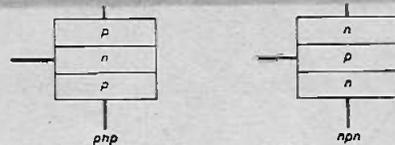


Fig. 4.1. Schematic sandwich construction of transistors.

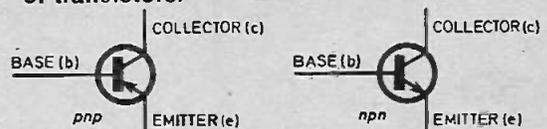


Fig. 4.2. Circuit symbols for pnp and npn transistor types.

## 5 ■ THE "TWO DIODES" CONCEPT

A transistor is basically two pn-junction diodes back to back, Fig. 5.1.

Assume the middle connection (the base) is left "up in the air", no current can flow due to the opposing effect of the two diodes, Fig. 5.2.

Suppose the base is now returned, via a resistor, to the collector rail. The bottom diode is now forward biased and the top diode is still reverse biased, which is the correct way to operate all transistors.

Note that in both cases the bottom diode is forward biased and is therefore dropping about 0.6 volts (assuming a silicon transistor).

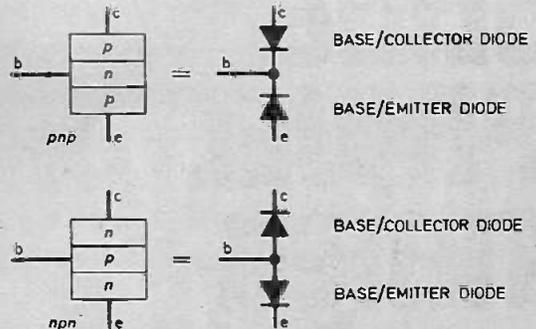


Fig. 5.1 The back to back diode representation of a transistor.

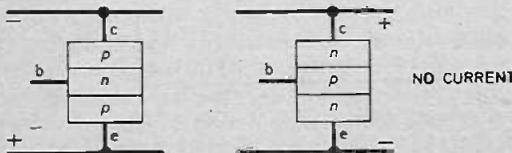
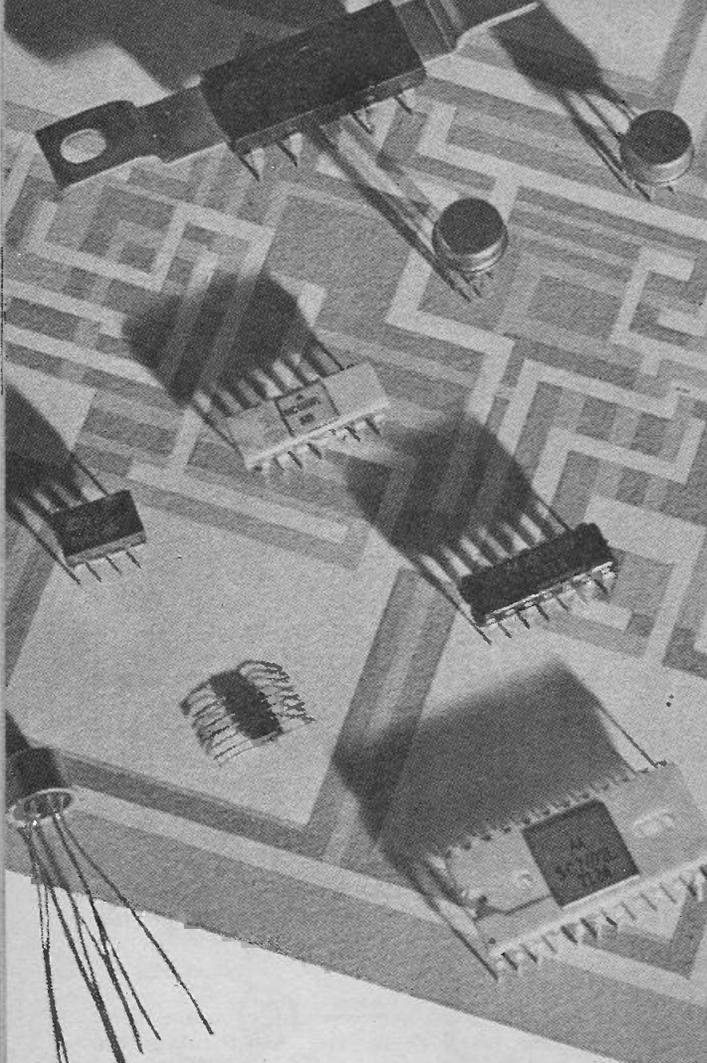


Fig. 5.2 (left). No current flows under these conditions.



**T**HE replacement of the thermionic valve by the transistor and the field effect transistor enabled the size of electronic equipment to be reduced by a very large factor. The development of integrated circuits during the 1960's has enabled a further large reduction in the size of equipment to be effected.

An integrated circuit can contain large numbers of diodes, transistors, field effect transistors, resistors and capacitors formed by a photographic technique, on a single minute silicon chip. Integrated circuits are often called monolithic circuits because they are formed on a single piece of silicon.

### **SOME APPLICATIONS**

The replacement of numerous discrete components by a small integrated circuit confers a number of advantages. The reduction in size is important and useful in most applications, but in some fields it is essential.

For example, it is easy to incorporate a thousand transistors and other components on a very small silicon chip; the resulting integrated circuit can be used in a wrist watch employing a quartz crystal electronic oscillator to provide an accuracy of about one minute per year or less (12 seconds per year in the case of the Omega "Megaquartz"). A circuit with a thousand separate (or "discrete") components could not possibly be incorporated into a miniature wrist watch.

### **SPACE RESEARCH**

Another field where integrated circuits have proved to be of vital importance is that of space research. The reduction in weight and volume achieved by the use of these components instead of separate transistors has made the modern sophisticated signalling and control systems possible. Satellites can now be equipped with miniature computers containing numerous integrated circuits.

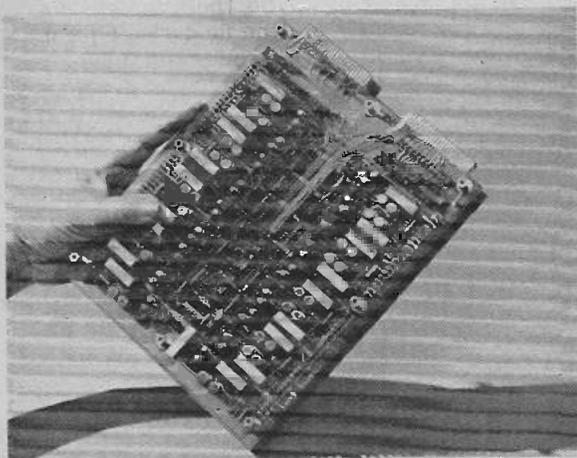
The modern computer employs very large numbers of integrated circuits so that an enormous number of components can be connected together in a relatively small space. This has enabled much more powerful computing systems to be made than would have been practicable with discrete components.

### **ADVANTAGES**

The advantages achieved by the use of integrated circuits are not limited to the saving in space thereby obtained. In the manufacture of an integrated circuit all of the internal connections are automatically made by the photographic techniques used in production. In these days of extremely high labour costs, this enables a great saving to be made on the manufacturing costs.

# **Introduction to INTEGRATED CIRCUITS 1**

By **J. B. DANCE** M.Sc.



An example of the use of integrated circuits for a computer core memory.

The price of many of the cheaper integrated circuits is about the same as that of about three cheap transistors. Many types of integrated circuits are available for less than £1, even though they contain some hundreds or thousands of separate components. The cost of designing and setting up the equipment used to manufacture integrated circuits is very high, but once the equipment has been set up, the cost of producing each additional component is very low.

The price of any one type of integrated circuit is therefore dependent more on the expected demand for that component rather than on the complexity of the device concerned. Indeed, most integrated circuits employ more components than a similar circuit using discrete devices, partly because additional components can be added with only a very small rise in the manufacturing cost.

## DISADVANTAGES

There are two main disadvantages in the use of integrated circuits instead of discrete devices, but these disadvantages tend to apply only in certain specific applications.

In general, circuits which must operate at extremely high frequencies employ discrete components, since it is difficult to manufacture integrated circuits which can operate at some thousands of megahertz.

The other disadvantage is that when one has mass produced, cheap integrated circuits available, one cannot alter the internal design of the integrated circuit to suit one's particular application. In other words, one loses some of the versatility of circuit design when one replaces discrete components with integrated circuits. Nevertheless, this very loss of versatility implies that the circuit designer is relieved of much of the detailed design work of individual stages.

In general, each type of integrated circuit is normally produced for a fairly definite type of

application for which it can be sold in large numbers. It is uneconomical to produce integrated circuits which will not be sold in very large numbers. Some types are designed for audio amplification applications, others for use in television receivers and others for the counting of electrical pulses, but some comprise a high gain amplifier which can be used in a fairly wide variety of applications.

## EARLY HISTORY

Various attempts were made to miniaturise circuits during the last war, but the first type of device which one might really call an integrated circuit was developed in 1958 by Texas Instruments Ltd. This consisted of a number of resistors and transistors which were produced by diffusing impurity elements into a single chip of silicon.

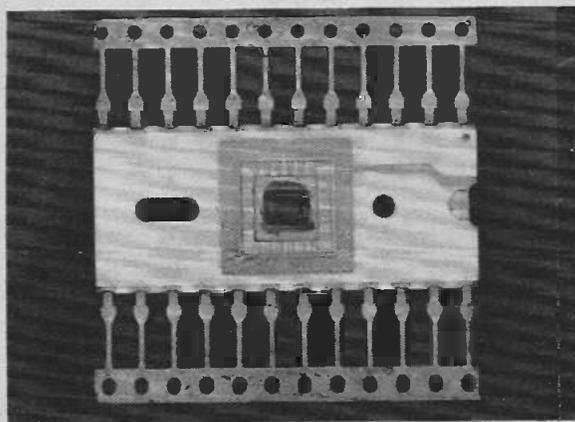
Many types of integrated circuits were developed in the early 1960's. The well known silicon planar process developed by the Fairchild Company in 1960 provided a great boost to the industry, since it is the process by which almost all modern integrated circuits are produced.

The first types of integrated circuits were used mainly in the military and computer fields, but their use has spread and one can now find them in the radio and television fields where costs are most competitive. It is generally cheaper to employ a mass produced miniature integrated circuit than to pay labour charges for people to wire up and test discrete circuits.

## APPEARANCE

A transistor normally has three connections, and seldom more than four. Most integrated circuits need more connections than this owing to their complexity. However, the first integrated circuits were produced by various transistor manufacturers and they naturally fitted their products into the type of cases they had been using for transistors.

An integrated circuit before encapsulation.



One type of integrated circuit employs the normal TO-5 type of transistor encapsulation, but there are typically six or eight leads coming out of the base instead of the three or four of the normal transistor. The leads are arranged in a circle. Such integrated circuits can dissipate only about one watt of power. Some high power integrated circuits employ the diamond shaped TO-3 type of encapsulation (as used for many high power transistors), but there may be a number of connecting wires arranged in a circle coming from the base of the device.

One of the most common types of encapsulation used for integrated circuits at the present time is the dual-in-line package (see Fig. 1). This usually consists of a rectangular plastic or ceramic package with two separate rows of connection pins, one row being fitted on each side of the package. Some types of dual-in-line integrated circuits have eight pins (two lines of four pins each), but the most common



A small part of the production area for 7400 J.C.s at ITT Semiconductors.

types of integrated circuit have 14 pins (two lines of 7 pins each). Types with 16 pins are common (for example, certain types of counters), whilst some types of dual-in-line integrated circuits have still more connections.

Some types of integrated circuit are available both in the TO-5 type of encapsulation and as dual-in-line devices. The latter are usually very slightly cheaper than the same devices in a TO-5 type of encapsulation.

## SOCKETS

A transistor is normally soldered directly into the circuit in which it is to be used. Integrated circuits can also be soldered directly if a suitable circuit board is employed, but it is not easy to unsolder and change devices having a large number of connections. It is therefore common practice to use integrated circuits in suitable

sockets. This also avoids possible damage to the integrated circuit by the voltage spikes occurring on an unearthened soldering iron or by overheating during soldering by an inexperienced person.

Sockets are available for integrated circuits having the TO-5 type of encapsulation and also for those employing the dual-in-line encapsulation. In the latter case, sockets are available with 8, 14 and 16 connections and possibly for other numbers also. An integrated circuit with 8 connections, can, incidentally, be fitted into a dual-in-line socket which has 8, 14 or 16 connections.

Great care should be taken when one is inserting and removing dual-in-line integrated circuits into or from their sockets, since the pins can be badly bent (even if reasonable care is taken) when the integrated circuit fits tightly into a new socket. If one attempts to remove an integrated circuit of the dual-in-line type from

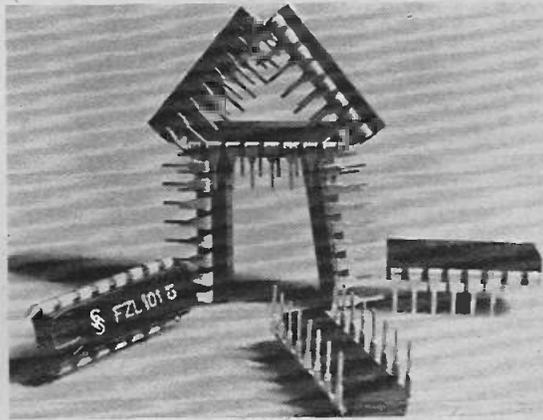


Fig. 1. Dual-in-line packages, these examples have 16 pins.

its socket and it does not come out easily, a thin, small screwdriver slipped under the device will greatly assist in removing it without any damage. If, however, the pins of the device are bent, they should be carefully straightened or "dressed" with pliers and/or forceps.

## TYPES

Integrated circuits are employed for so many purposes that it is possible only to give some general indications of some of the more common types of application in this article. Audio amplifiers will be considered in most detail, since they are the type of integrated circuit which is most likely to be of interest to the amateur enthusiast.

The first types of integrated circuit to be developed were digital types which operate by the switching of transistors in them. These tran-

sistors are either fully conducting or switched off at any one time; any states of partial conduction do not occur for more than a very short time.

Digital integrated circuits became commercially available in large numbers around 1964. They are widely used in computers and for complex logic applications. They can be used in counting circuits. Metal oxide semiconductor techniques (M.O.S.T.s) are much used in digital applications with integrated circuits, since very economical devices can be produced. However, they are not yet widely used in other types of circuit.

Digital integrated circuits can be employed in industrial logic control. As an extremely simple example, one may employ a digital logic circuit to ensure that a machine will operate only if the cooling water is flowing or if an air-blower is switched on and if there are enough metal parts at the input and if a bath is within certain temperature limits.

The amateur enthusiast may meet digital integrated circuits in calculators, but such projects are fairly complex. In general, the average amateur will be more interested in other types of integrated circuit, so the digital types will not be discussed further here.

## LINEAR INTEGRATED CIRCUITS

In linear circuits the currents and voltages can have any values between certain limits, the output being in some way related to the applied input. Suitable linear integrated circuits offer the designer ready made high gain amplifiers, etc.

They were initially rather expensive and designers were not familiar with them; they have therefore been used in large numbers only during the past five years or so. The price of linear integrated circuits has fallen rapidly and they may become cheaper still as time passes and more of them are used.

## OPERATIONAL AMPLIFIERS

Operational amplifiers were originally high gain amplifiers using discrete components. They were mainly used to carry out mathematical operations (such as subtraction, integration, etc.) in analogue computers—hence their name. They are coupled so that they can handle steady signals (even signals of zero frequency) as well as alternating inputs.

Operational amplifiers are now produced as integrated circuits. They have a multitude of applications and the properties of the circuits in which they are used can be greatly altered by using various resistors and capacitors in the input and feedback circuits of the amplifiers.

General purpose operational amplifiers form a natural field for the use of integrated circuits.



Pre-testing of integrated circuits at Mullard's. Silicon slices are being electrically checked.

Some thousands of types of operational amplifier are now available.

## THE "709"

The first type of general purpose operational amplifier to be produced in quantity was the Fairchild  $\mu$ A709. This type is now available from many manufacturers. For example, Texas Instruments market it under the type number SN72709, Motorola under the number MC1709, National Semiconductor under the number LM709, Newmarket Transistors as LIC709 and Mullard-Philips as the TAA521, etc. Some manufacturers offer two type 709 amplifiers in a single 14 pin dual-in-line package; one example is the Motorola MC1437 and MC1537 dual amplifiers.

A transistor of a certain type number from one manufacturer will satisfactorily replace a transistor of the same number produced by another manufacturer. However, in the case of integrated circuits, one cannot necessarily replace one device by an equivalent device of another manufacturer. This is due to the complexity of the circuits and the impossibility of specifying all of the parameters of a device in a data sheet. However, expert circuit designers take such factors into account.

Next month we shall be looking at some particular linear integrated circuits.



# SHOP TALK

By Mike Kenward

WE are beginning to receive a number of letters from readers complaining about long delays in the supply of components from retailers. Unfortunately these delays are often unavoidable and are due to the manufacturers not being able to supply the retailers. Quite often the retailer can find no alternative supply and cannot obtain a definite commitment on when he will receive the goods.

A recent instance of this problem was experienced in this office. We were trying to obtain some low value, high wattage resistors for a future project and one supplier quoted 63 to 64 weeks delivery—some time in 1975!

## Emergency Lighting Unit

The basically very simple *Emergency Lighting Unit* could be very useful indeed both for supplying light and of course for charging car batteries which are bound to be stretched to the limit supplying power during emergencies. If the petrol shortage gets worse it may be worth using the car battery for lighting most of the time—however we will be looking at petrol economy, so watch out for some petrol saving devices.

Getting back to the components needed for the lighting unit, provided a battery is available, most of the components are straightforward with some alternatives being given in the text. The relay may take a bit of looking for, but almost any 12V or less type will work provided the contacts are rated at 5 amps—the coil resistance does not matter too much and there are a number of different types with coils of about 200 ohms that should suit.

Unfortunately the case we show is not available but most suppliers sell a range of cases and any one that is big enough will do.

## Power Supply Unit

The first of the *EE Test Gear Five*, the *Power Supply Unit* will be of immediate interest to the more serious constructor and, as with all the instruments in this series is a very useful and "professional" piece of equipment. Most of the parts will be readily

available, the transformer and the 10 ohm potentiometer should be available from the larger suppliers. Miniature switches were used on the prototype but these are expensive and normal toggle types are suitable.

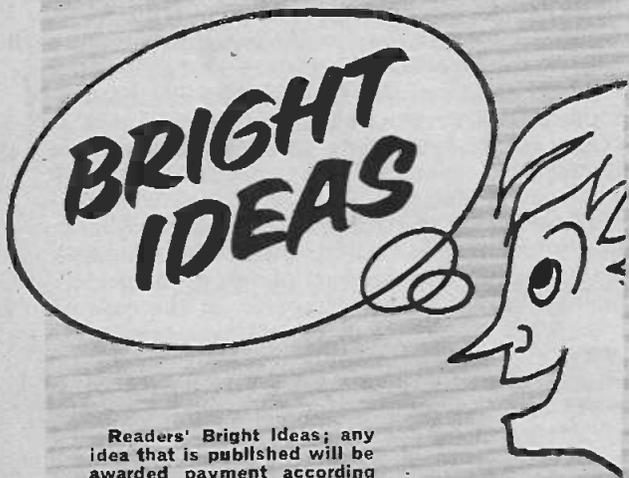
The cases used for the *Test Gear Five* are made by Olsen Electronics Ltd. and are available from them for £3.45 including postage, packing and V.A.T.

The case used is a type 25A with louvres; this case is very well made and very strong, it also gives a good appearance to the finished unit. Cases are available in light green, dark green, blue and silver grey and front panels in light green, cream or white. Our prototypes used dark green cases and cream front panels and look very smart (see front cover). Olsen are at 5 Long Street, London E.2.

The knobs used on the front panel are available from Re-an Products, Burnham Road, Dartford, Kent.

## Slide Projector Timer

Relays and cases are items that are often discussed in this article and this once again applies with the *Slide Projector Timer*. In fact the relay can be almost any type that will work on 9 volts and most suppliers should be able to find something to suit. Virtually the same words can be used when referring to the case, there are a number of types available and any that is big enough will do.



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

A handy tool I have made to extract integrated circuits and other components from circuit boards without damage. It is made from 3mm brass rod which will spring back when released, the rod is bent into an inverted "V" shape and about 10mm is bent inwards at each end and then filed down to a taper keeping the bottom as horizontal as possible.

The tapered ends are inserted under each end of the integrated circuit and a slight pressure is applied to the sides of the brass rod, heat is then applied to the pins on the underside of the circuit board and as the solder melts the integrated circuit will lift out because of the tapered prongs.

R. Linklater,  
Aldershot, Hants.

Instead of using enamel paint as a p.c. board resist I used nail varnish which has several advantages.

- (1) It takes less time to dry.
- (2) It is difficult to remove the paint while wet if a mistake is made, but with nail varnish it dries quickly and can be removed with the special remover.

S. Bailey,  
Leicester.



# POWER SUPPLY UNIT



Stabilised variable voltage from 0-20V with current limit control up to 0.5A.

A power supply is a key component in any electronic circuit. Although one may use batteries in a finished project, they are not flexible enough to provide variable voltages needed while designing and testing a new circuit. Additionally, this unit supplies power for other instruments in the E.E. Test Gear Five series.

This unit has been designed to satisfy the essential requirements of a home constructor's workshop at a reasonable cost. It provides a stable, well regulated, low ripple output, and incorporates a variable current limit. The voltage may be continually varied from zero to 20V, and the current limit set within the range 50mA to 0.5A. The output current or voltage is indicated on a meter. Limiting the supply current at 0.5A protects the unit from damage arising from a short circuit.

## DESIGN PRINCIPLES

The block diagram, Fig. 1, outlines the basic principles of the circuit.

The power source provides a rectified, smoothed, d.c. voltage to the other circuit blocks. The Zener diodes provide a 30V source for the

Approximate cost of components including V.A.T.

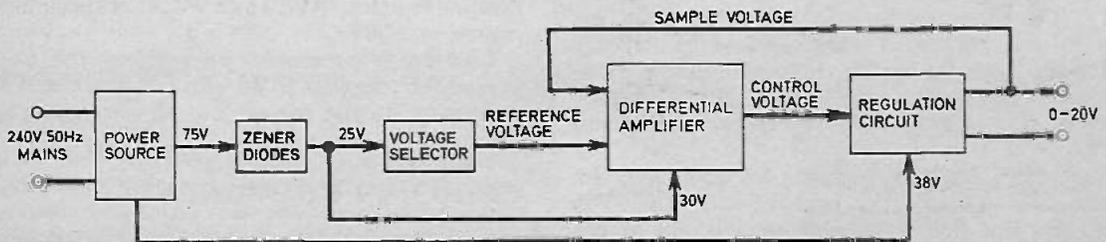
£7.80 plus case

differential amplifier, and a 25V source for the voltage selector. The 25V source covers the range from -3.3V to +22V to ensure that the output voltage will swing from zero to 20V.

The differential amplifier compares the voltage from the voltage selector with the voltage at the output of the supply. The signal which appears at the output of the differential amplifier is proportional to the difference between the two inputs and this signal controls the regulation circuit which in turn controls the output voltage.

This feedback loop will force the output voltage of the supply towards the voltage set at the voltage selector. This circuit arrangement produces a supply having good regulation and low ripple, while allowing the output voltage to be set at any desired level between zero and 20V.

Fig. 1. Block diagram of the Power Supply Unit.



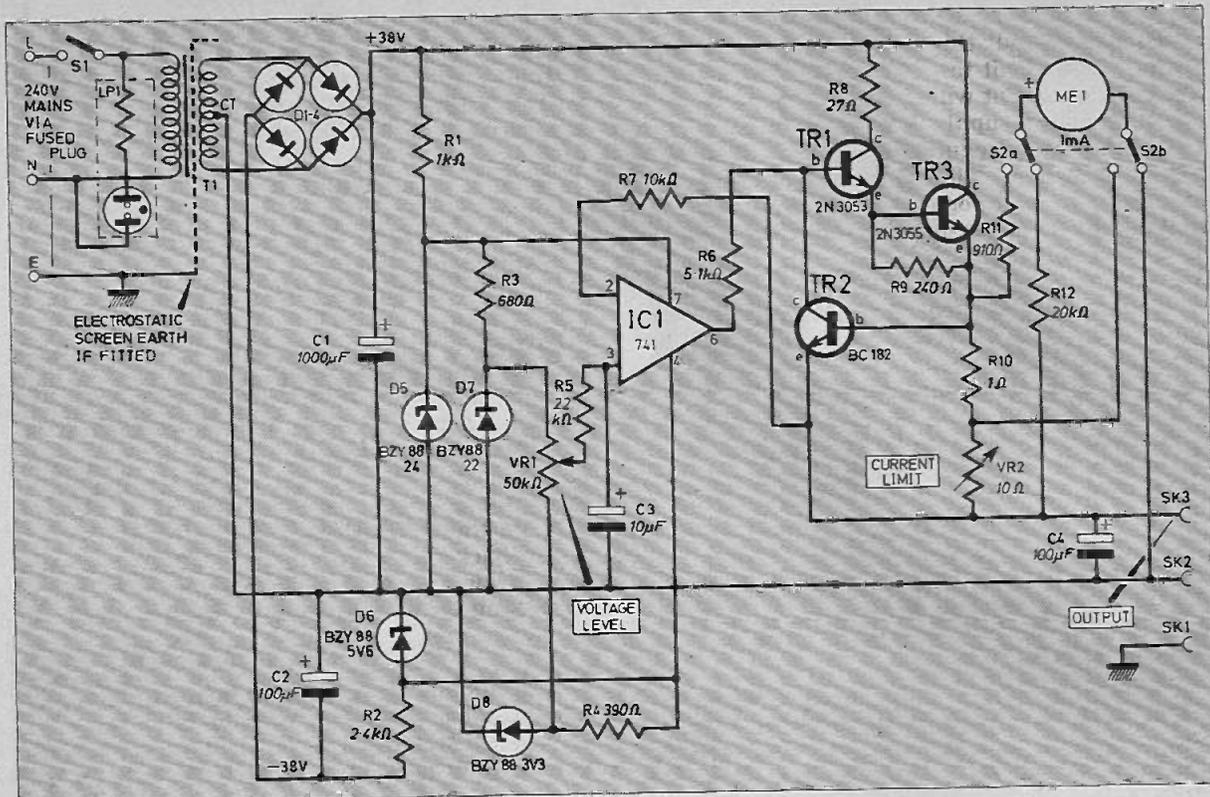


Fig. 2. The complete circuit diagram of the Power Supply Unit.

## CIRCUITRY

The circuit diagram for the Power Supply Unit is shown in Fig. 2. The power source comprises a 25-0-25V transformer, a diode bridge (D1-D4), and capacitors C1 and C2, an arrangement which gives two voltage sources, 38V being produced across each capacitor.

The Zener diodes give 30V across D5 and D6 to supply the differential amplifier, and a more accurate supply of 25V across D7 and D8 for the voltage selector. Resistors R1 to R4 limit the current through the Zener diodes.

The potentiometer VR1 acts as a voltage selector, while the differential amplifier IC1 consists of a 741 and ancillary components. Components R5 and C3 form a filter to reduce noise. Resistor R6 increases the output impedance of the 741, which is normally 75 ohms and R7 is a current limiting resistor, through which the output voltage is sampled.

The regulator circuit consists of TR1, R8, R9 and TR3 connected as a darlington pair. This may be considered as one transistor with very high gain. Because of this the darlington transistor has a low base current with high collector current, so the arrangement reduces the drain on the 741.

When the sample voltage drops below the reference voltage, the output on the 741 rises, and this increases the base current of the darlington pair. The collector/emitter voltage of

TR3 falls and the output voltage increases until the sample voltage is the same as the reference voltage. If the output voltage is greater than the reference voltage, the effect is reversed.

The output voltage will always take up the potential of the reference voltage.

Components TR2, R10 and VR2 form the current control and current limit. With VR2 set to zero ohms, and with 0.5A flowing through R7, the voltage drop across R7 amounts to 0.5V. This is sufficient to turn on transistor TR2 and bring the base of TR1 to the output potential. This cuts off TR1, and hence TR3, so the output current is limited to 0.5A.

By increasing the resistance between base and emitter of TR2, with VR2, the current limit may be reduced to below 50mA.

The meter circuit has been designed for a meter having 1mA full scale deflection and an internal resistance of 105 ohms. Voltage is measured directly across the output via the 20 kilohm resistor, R12, so that full scale deflection represents 20V.

Current is measured by reading the voltage across R11, so that 0.5A current gives half scale deflection on the meter.

## CHOOSING COMPONENTS

In the prototype it was decided to use an inexpensive 50V, centre tapped, half-ampere

transformer, and this allowed the prototype Power Supply Unit to reach its specified voltage and current output with normal mains supply.

If the mains supply falls appreciably below 240V, the poor regulation of an inexpensive transformer may affect the output. If it is intended to make regular use of the unit near to its limits, a better quality transformer should be considered.

A half-amp diode bridge package with reverse voltage of 100V is used to provide rectification. Four diodes in a bridge arrangement could be used as an alternative, provided that they are each rated at half-amp, and have a reverse voltage of at least 40V.

Transistor TR2 is a BC182, but any small, silicon npn transistor having a maximum  $V_{ce}$  greater than 50V may be used in this position.

All resistors used are  $\frac{1}{4}$  watt types or greater. The capacitors are all electrolytic and it is important to ensure that you use capacitors with working voltages equal to or greater than the values given.

## METER

The meter must give full scale deflection for 10mA or less. If this current is called  $I_{fsd}$  and the resistance of the meter is called  $R_m$ , then the product,  $I_{fsd} \times R_m$  must be less than one volt.

To choose resistors R11 and R12 the formula

$$R_s = \frac{V_{fsd}}{I_{fsd}} - R_m$$

was used where  $R_s$  is the series

resistance, see Fig. 3.

Output voltage is measured via R12 and  $V_{fsd}$  is 20V. Output current is measured across R10 and via R11, and  $V_{fsd}$  is one volt.

$$\text{So, } R11 = \frac{1}{I_{fsd}} - R_m \text{ and } R12 = \frac{I_{fsd}}{20} - R_m$$

The closest resistance in the list of preferred values should be chosen.

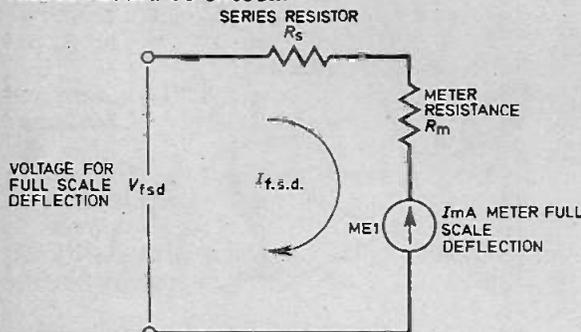


Fig. 3. Current flow in the meter circuit.

## CONSTRUCTION

The prototype Power Supply Unit was housed in a commercially available steel cabinet with removable front and rear panels but any robust case available will do as long as it is metallic.

Components are mounted on the case parts

itself and on a piece of 0.1in plain matrix board. Veropins are used to anchor some components on the top side of the board and insulated wire to make the interconnections on the underside of the board.

The top and underside of the component board are shown in Fig. 4. Begin by drilling the four fixing holes near to each corner and then insert the Veropins as indicated.

Next insert the integrated circuit holder and then position and solder the bridge rectifier, resistors and capacitors, paying special attention to polarities, and then wire up the underside as shown keeping the connecting wires as short as possible. The transistors and diodes should be soldered in position next and a heatsink, such as a pair of pliers, should be used when doing so otherwise heat from the soldering iron may damage these components.

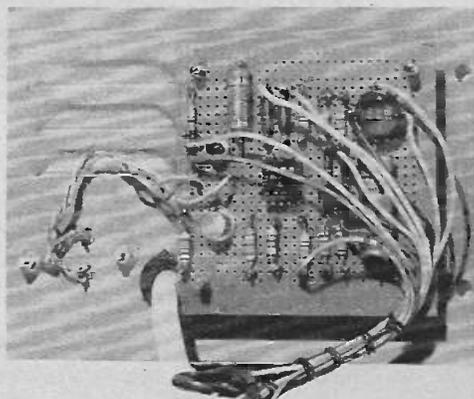
The back panel should be prepared next and the power transistor TR3 mounted in place. Insulating bushes and mica washer **must** be used. Now mount the component board to the back panel with four 4BA nuts, bolts and stand-off spacers and then wire the board to TR3. The back panel acts as a heatsink for TR3.

The next step is to cut and drill the front panel to take the components ME1, VR1, VR2, S1, S2, LP1 and the three terminal connectors SK1, SK2 and SK3 as shown in Fig. 4, and then secure these components in position.

The smoothing capacitor C1 should now be fixed to T1 by means of the capacitor clip as shown in Fig. 6. This assembly should now be placed in position inside the case and suitable holes marked and drilled in the case base through which the transformer can be secured with 4BA nuts and bolts.

Place the front and rear panels on the work bench with T1 between them and wire up according to Figs. 4 and 5. The three core mains cable should be fed in through the panel via a rubber grommet; the other end should terminate in a fused mains plug.

Thoroughly check out your wiring before finally assembling in the metal case.



Photograph of completed component board.

# POWER SUPPLY UNIT

**e e e**  
TEST GEAR FIVE

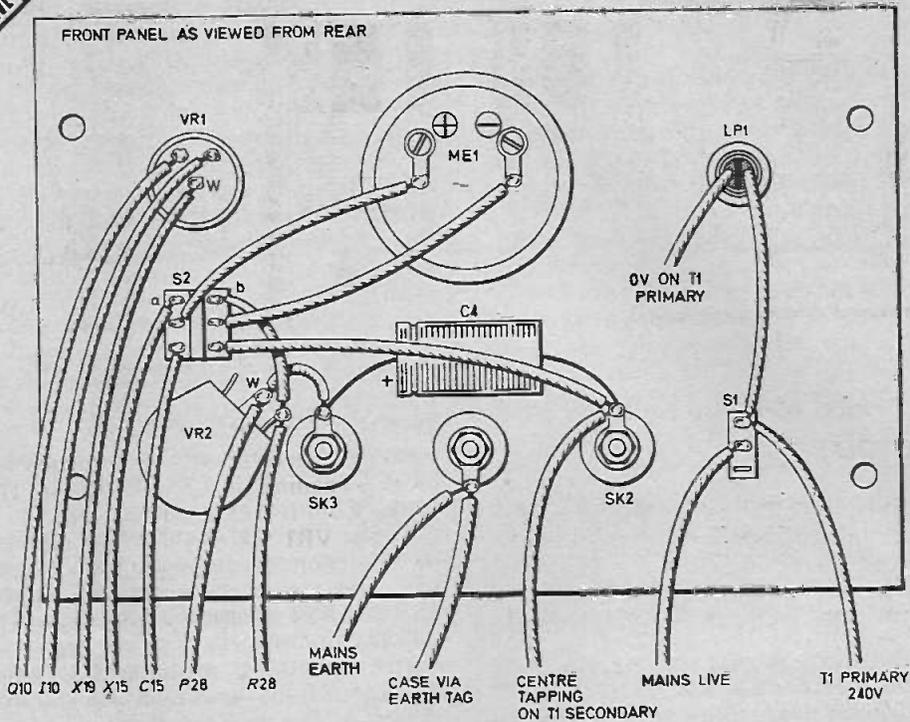


Fig. 5. Component positioning and wiring up on the front panel.

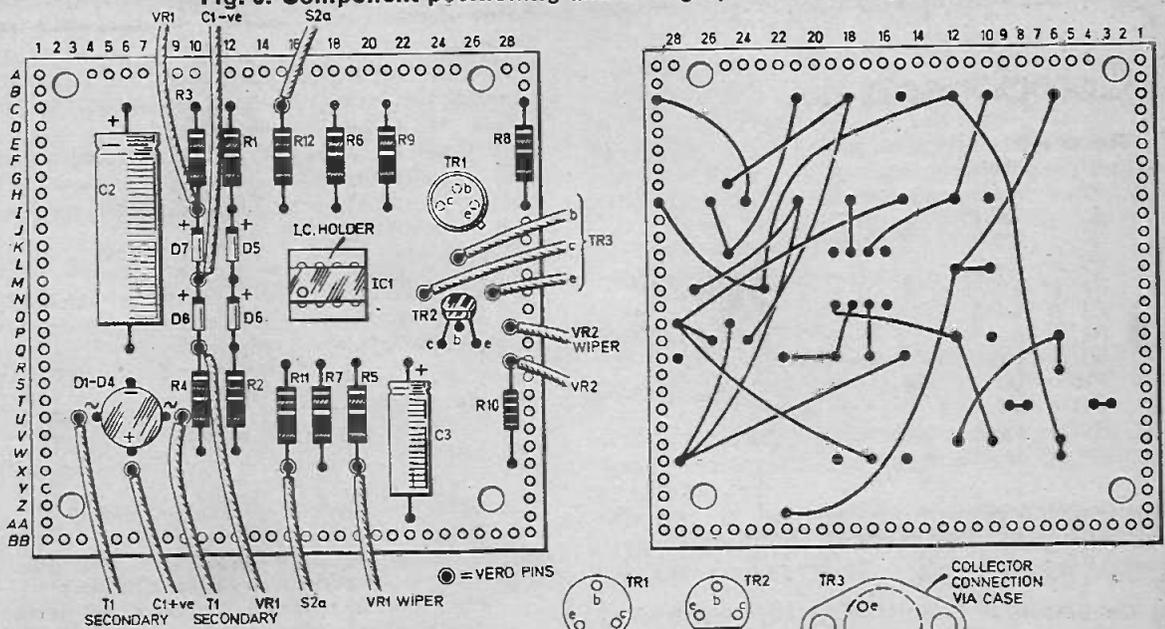


Fig. 4. The layout of the components on the top side of the board, and interconnections on underside.

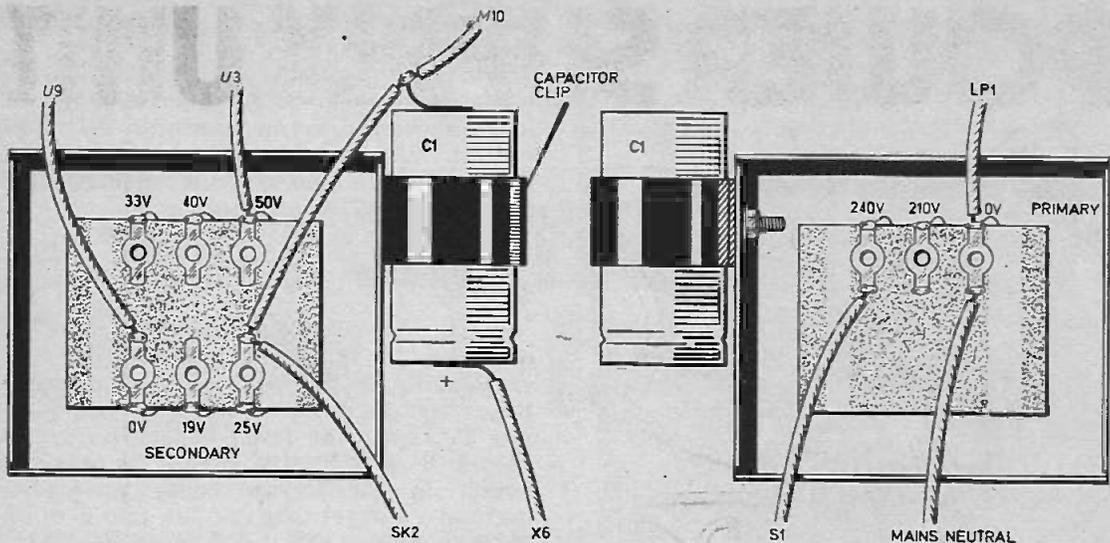


Fig. 6. Wiring up details on primary and secondary windings of T1.

## CHECKING OUT

Set VR1 fully anti-clockwise and VR2 fully clockwise, S2 to the voltage mode and then plug into the mains and switch on at S1. The neon indicator lamp should light. Now turn VR1 in a clockwise direction and the meter needle should move across the scale, reading 20 volts with VR1 in the fully clockwise position. Turn VR1 back to read zero volts and switch off.

Connect a 12 volt bulb, six watts or less—i.e. the bulb takes 0.5A or less—across the output

terminals SK2 and SK3. Now turn VR1 clockwise until a reading of 12 volts shows; the intensity of the bulb increases from zero.

Leave VR1 set at this level and switch S2 to the current monitoring mode, and take the reading from the *lower* scale, it should be 0.5A. Turn VR2 in an anticlockwise direction and the intensity of the bulb should decrease showing that the current through the bulb is being limited to the value shown on the meter.

With VR2 set to limit at about 250mA (0.25A), switch S2 back to the voltage mode, the meter

## Components....

### Resistors

R1	680Ω
R2	2.4kΩ
R3	390Ω
R4	390Ω
R5	22kΩ
R6	5.1kΩ
R7	10kΩ
R8	27Ω
R9	240Ω
R10	1Ω
R11	910Ω
R12	20kΩ
All ½W carbon ± 5%	

### Potentiometers

VR1	50kΩ linear carbon
VR2	10Ω linear

### Capacitors

C1	1000μF	40V	elect.
C2	100μF	40V	elect.
C3	10μF	25V	elect.
C4	100μF	25V	elect.

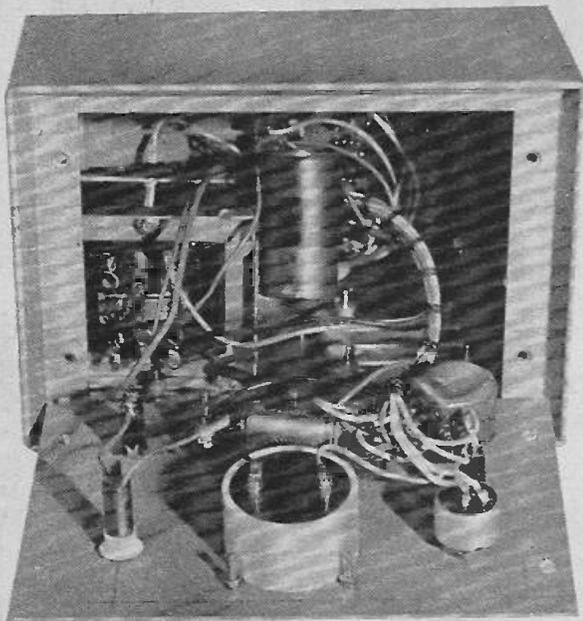
SEE  
**SHOP  
TALK**

### Semiconductors

TR1	2N3053 silicon	npn
TR2	BC182 silicon	npn or similar
TR3	2N3055 silicon	npn
D1-D4	½A 100 P.I.V. bridge rectifier	or equivalent
D5	BZY88/24	400mW Zener
D6	BZY88/5V6	400mW Zener
D7	BZY88/22	400mW Zener
D8	BZY88/3V3	400mW Zener
IC1	741 differential operational amplifier,	8-pin d.i.l.

### Miscellaneous

T1	240V primary 25-0-25 0.5A secondary
ME1	1mA d.c. meter type S.E.W. MR38P or similar
LP1	panel mounting mains neon with built-in resistor
S1	mains on/off slide or toggle
S2	d.p.d.t. toggle or slide
SK1, 2, 3	insulated screw terminals, black green red (1 off each colour)
Plain matrix board 0.1in. 28 x 28 holes; Veropins; capacitor clip to suit C1; mica washer and insulating bushes for TR3; 4BA nuts bolts and washers and four 4BA stand-off spacers; length of three-cored mains cable. Case, metal approx. 165x115x115mm.	



Photograph of completed unit and front panel, removed.

reading, now from the top scale, should still be at 12 volts.

If a lower wattage bulb is used, say three watts, i.e. current consumption of 0.25A, then in the above test, turning down the current limit control, VR2, would have no effect on the intensity of the bulb until the current is limited to less than 0.25A.

## USING

When using the Power Supply Unit to power a device, the maximum current likely to be required by the device should be estimated and the current limit control set to this value. In this way damage to the device is kept to a minimum should there be a fault. Even if there is a short circuit in the device being powered, the maximum current that can flow into it will have been limited by VR2.

There is a third terminal, SK1 connected to earth, so it is possible to earth either side of the power supply output as required.

It is recommended that when in use all connections to the output sockets be made and checked before switching on the unit. □



## ...Counter Intelligence

BY PAUL YOUNG

*A retailer discusses component supply matters.*

**M**ANY who take up electronics as a hobby, become "hooked on it" if you will forgive the argot. However, when you consider that there are so many less useful or interesting things that could claim your money and attention, this must count in its favour. If you do reach that stage, you will probably find you are placing regular weekly or monthly orders with your suppliers. In which case, I would suggest that you approach them, with the idea of opening an account. I don't think the mail order firms, would raise any objections.

Of course it would be wisest not to broach the subject, until you have been one of their "cash customers" for a few months. This will give them confidence, and they will also be able to assess your value to them as a client. They may want references, this is usual procedure, but I am sure you will know plenty of people who will vouch for you.

It helps considerably, if your referees have a status, such as, bank manager, doctor, vicar, or school teacher. You may have the

payment card of a completed hire purchase transaction, this is often acceptable evidence of your credit worthiness.

### Advantages

Consider the advantages of a monthly account. You can order at will, either by post or telephone, and just one cheque or postal order at the end of each month will settle your debt, (this in itself can show quite a saving in the cost of cheques and postal orders). In our company (due perhaps to my enthusiasm) we went overboard for this scheme.

I had an Answerphone installed on a special ex-directory line, (thus enabling our customers to place orders at any time during the 24 hours). Apart from the convenience, it meant that they could use the telephone at the reduced rates. I also provided them with order forms and pre-paid envelopes.

### 'C' for Charlie

For the benefit of the telephone users, I sent them a letter, telling

them what to do, and what to avoid. I even sent them a copy of the international air alphabet. I think you know the type of thing. I believe it started in World War 1, with "C for Charlie," "D for Don", "B for beer" etc. Now it is much more sophisticated, and to give you a small sample, "G" "H" "I" "K", would become "golf" "hotel" "Lima" "kilo."

### Miss-understanding

When I first introduced it, it led to an amusing incident. The excellent young lady, who runs the whole scheme in her spare time takes the orders off the telephone machine each morning.

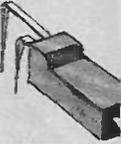
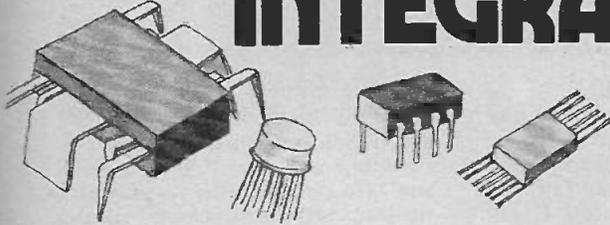
This particular morning, she came to me in great consternation, "Ere this bloke must be orf his chump, 'E wants to order a hotel an' a golf course!" I quickly told the poppet that we were not going into the real estate business, and explained to her, how it came about. Since then all has been plain sailing.

Finally, if any of my fellow sufferers (I mean of course component retailers) would like any advice on running these accounts, just contact me, and, as they say in the *Times* personal column, they will learn something to their advantage, to say nothing of their customers.

# FREE

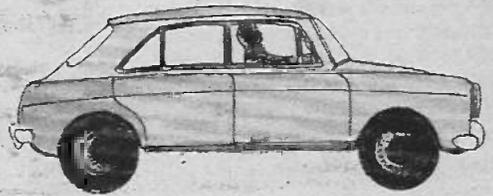
# Inside... NEXT MONTH'S ISSUE

## INTEGRATED CIRCUIT DATA CHART

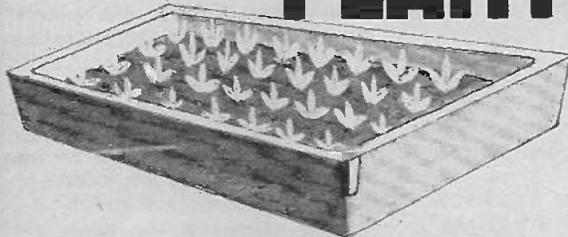


## SPEED GUARD

An audible warning is sounded when a pre-set speed is exceeded. An aid to save fuel and to speed limit observance.



## PLANT PROPAGATOR

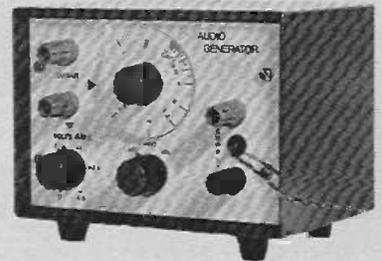


Get your seedlings off to a good start with this temperature controlled soil warmer.

## A.F OSCILLATOR



The second unit in our Test Gear Five series provides a sine wave output of up to 4.5 volts r.m.s. between 10Hz and 10kHz.



*Subject to the current national industrial situation at the time of going to press*

# everyday electronics

MARCH ISSUE ON SALE FRIDAY, FEBRUARY 15

NEW PRICE 20p.

# Ruminations

By Sensor

## Watts to do!

In the midst of the energy crisis there seems little to be cheerful about; the prospect of cold homes, long bus queues in snow filled streets and a bowl of cold gruel for supper, scarcely gladdens the heart.

But the electronics man can feel smug if not snug in the knowledge that the transistor circuits can run on a small battery for many hours. When the power is "on" the whole family can gather round the hot soldering iron while construction of the latest project continues and thus avoid any waste of heat.

I remember warming my hands on the valves of a radar set, during a power crisis many years

ago, and a keen fisherman I knew put this waste heat to good use in rather unusual circumstances. One of the women in the factory had bought some bacon during a lunchtime shopping trip and had discovered that it contained some maggots. She was quite justifiably complaining to her workmates about this unhappy state of affairs when the fisherman overheard her remarks. He paid her for the bacon and put it into a piece of equipment for the afternoon where it was kept at an ideal temperature for the maximum production of fat maggots! I felt that this incident represented a variation on the "one man's meat is another man's poison" theme.

## Waste Not

The early computers used a considerable amount of power but most of it was dissipated in heat. It was usual to fit refrigeration equipment to all but the smallest computer in order to

keep the temperature down to within the operating limits of the components and to avoid the operators having to work stripped to the waist.

Even at a more humble level the domestic radio and television produced an appreciable amount of heat; my father used to raise boxes of tomato seedlings on top of the television very successfully but if you try it be very careful when watering them (see next month's propagator article—ed.).

I have often felt that man is guilty of a prodigious waste of heat which is pushed out into the atmosphere, poured into rivers and into the sea with no real attempt to extract the energy which has been put into it at such cost. It has been cheaper to throw away heat than to try to conserve it but the trend towards dearer fuel must change all that. Unfortunately we cannot get back all that has been lost over the years; the best that we can do is to put our house in order now, before it is too late.



applied polarity then you can still use an electrolytic but you must make sure that the a.c. component of the signal does not cause the capacitor's "ripple current rating" to be exceeded. With small signal coupling capacitors (between stages) this is not likely to be a problem but it could be in the case of power supply smoothing.

You must however remember that most electrolytics are "leaky" and this would preclude their use in some circuits.

## Capacitor Voltage

Why do capacitors have a voltage rating? Is it very important and can you use devices having different ratings from those specified?

Any capacitor—when boiled down to its fundamental principle of operation is made up of a number of electrodes separated from each other by a very thin insulator—known as a dielectric. This can be plastic (polyester or polystyrene) ceramic, paper, air or a chemical electrolytic. Any insulating substance can prevent d.c. current flow but only when the voltage across it is limited to below its breakdown voltage; this is dependant on its nature and its thickness. Breakdown occurs

by a spark jumping across between the electrodes and through the dielectric. Not only can this permanently damage the capacitor but it can ruin the operation of the circuit.

The voltage rating for a capacitor is the maximum voltage (whether d.c. or peak a.c.) that you can apply across the device before this breakdown occurs. Sometimes there are differences in level between the peak a.c. value and d.c. value for a given capacitor. Obviously is is a very important parameter. You can, however, *always* use a capacitor having a higher voltage rating than is specified in a components list.

## Electrolytic Capacitors

Are there any rules that limit the use of electrolytic capacitors in a circuit?

Provided one side of the capacitor is *always* positive with respect to the other then you can use an electrolytic. Even if you have an alternating voltage on one side provided it is set off by a d.c. level so that the peak a.c. levels do not reverse the

**PRACTICAL ELECTRONICS**

**MARCH ISSUE**

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Improve the performance of your car with the SCORPIO MK. 2 IGNITION SYSTEM—for 6V and 12V systems

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# Bags of electronic success from Josty Kit and more and more people stock them!



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Experienced engineers have produced the wide range of Josty Kits from the finest materials and components. With circuit boards incorporating the latest developments. Assembly of even the complicated circuits has never been simpler. So you put them together quicker and right first time. And now even more people are stocking them. Just look at the list. If there isn't a stockist near you, there are mail order services so nobody gets left out. Every Josty Kit carries a one year guarantee for all parts and for the correct function of the assembled kit.

### JOSTY KIT RETAIL PRICE LIST

Model No.	Description	Total RRP inc. V.A.T.
AF20	Mono Transistor Amplifier	5.28
AF25	Mixer	3.96
AF30	Mono Transistor Pre-Amplifier	2.87
AF35	Emitter Amplifier	2.50
AF80	Small 0.5 W Amplifier for Microphone	4.65
AF305	Intercom	8.28
AF310	Mono Amplifier (for Stereo use two)	6.50
M160	Multivibrator	1.88
M1302	Transistor Tester	9.30
M191	Vu-Meter	5.01
M192	Stereo Balance Meter	5.47
LF380	Quadrophonic Device	12.50
AT60	Psychedelic Light Control, Single Channel	8.58
AT65	Psychedelic Light Control, 3 Channel	16.00
AT25	Window Wiper Robot	6.40
AT30	Photo Cell Switching Unit	6.27
AT50	400W Triac Light Dimmer Speed Control	5.28
AT55	2.200W Triac Light Dimmer Speed Control	7.59
AT5	Automatic Light Control	2.84
GU330	Tremolo Unit for Guitars, etc.	8.25
HF61	Diode Detector	3.66
HF65	Frequency Modulated FM Transmitter	2.97
HF75	FM Transistor Receiver	3.16
HF310	FM Tuner Unit	17.39
HF325	De-Luxe FM Tuner Unit	26.53
HF330	Stereo Decoder for use with HF310 or HF325	10.95
GP310	Stereo Pre-Amp to use with 2, AF310	23.39
GP312	Basis Circuit Board	12.60
GP304	Basis Circuit Board	5.44
HF380	Aerial Amplifier for LW to VHF	5.54
HF395	Broadband Aerial Amplifier	1.94
NT10	Power Supply 100mA/9V Stabilised, 12V Unstabilised	6.76
NT300	Professional Stabilised Power Supply	13.76
NT305	Voltage Converter	4.95
NT315	Power Supply 240V a.c. to 4.5 - 15V d.c. 500mA	10.52
AE1	Output Stage 100mW	1.65
AE2	Pre-amplifier	1.26
AE3	Diode-receiver	2.00
AE4	Flasher	1.09
AE5	Astable Multivibrator	1.05
AE6	Monostable Multivibrator	1.02
AE7	RC Generator	1.06
AE8	Bassfilter	0.99
AE9	Treblefilter	0.99
AE10	CCIR - filter	0.99



AT65 Psychedelic Light Control. 400 watts on each of three channels. Treble, medium and bass.



AT30 Photo-cell amplifier. Use for burglar alarm, counter, door opener, etc.

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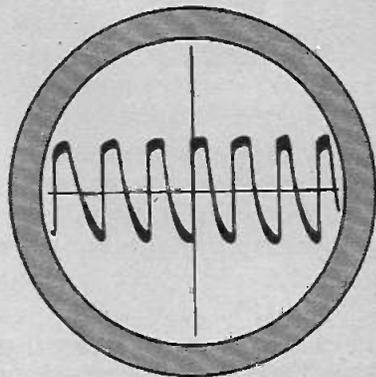
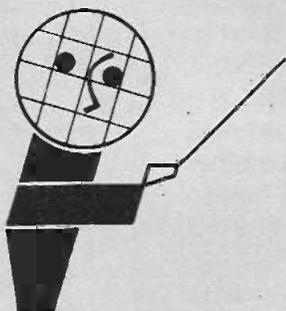
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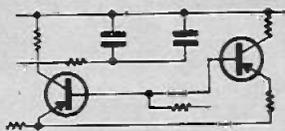
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# DEMO CIRCUITS

12

By MIKE HUGHES

## The AND Gate

**T**HIS month's circuit is shown in Fig. 12.1 and you would be excused if you felt, at first glance, that it was so simple it hardly warranted a special article to describe its function.

However, it is a most important circuit and crops up over and over again—usually hidden away within a more involved system. Because of its simplicity and the fact that it is seldom described in detail when embodied within a more complicated circuit we felt that we had better do the honours to the diode AND gate.

To understand its function, imagine you are in a car on a gated mountain road; it is impossible for you to progress along the road unless someone opens the gate—your progress is under the control of a third party!

Conversely, the third party could deliberately impede your passage by refusing to open the gate. This is a direct comparison with this month's circuit which has the same effect on electrical signals as the mountain gate had on the car. This is how the circuit gets its name.

### EXPERIMENT

To see this effect wire up the circuit of Fig. 12.1 and connect point *B*, with a temporary lead, to the +4.5V rail. Connect a meter, set to volts, between point *C* and ground and then alternately connect point *A* to +4.5V and then to ground with a flying lead.

By varying the voltage at *A* in this manner you are simulating a square wave and you will see that the voltage measurement at the output, point *C*, follows the waveform you are putting in at *A*. When *A* is connected to ground do not expect to see zero volts at point *C* because you must remember there are forward voltage drops across the diodes to consider. By keeping input *B* connected to +4.5V you are, in effect opening the gate to allow the signals from *A* to pass through.

Now connect point *B* to ground and you will find that the output *C* drops to nearly zero and stays there irrespective of any signal you apply at *A*—grounding point *B* shuts the gate.

You may have noticed that while doing this

you can have the gate open by leaving input *B* disconnected; you can therefore consider this to be a "spring loaded" gate which—in the absence of any positive action to keep it closed (grounding point *B*)—will always swing open.

### CIRCUIT ACTION

Let's see why this effect takes place. We shall assume that we are using "digital" signals at inputs *A* and *B*; this means that the voltages we supply will be either the full supply voltage (+4.5V) or ground (0V).

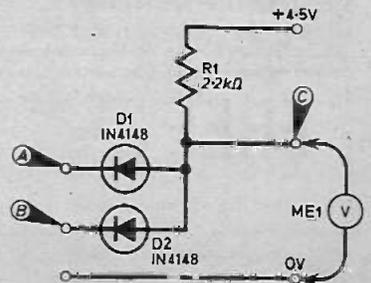
Imagine that both inputs are shorted to ground; both the diodes *D1* and *D2* will be forward biased and current will flow down *R1* and through the diodes and we will get a voltage at *C* that corresponds to the forward voltage drop of the silicon diodes (about 600mV).

Leave *B* connected to ground and imagine *A* connected to +4.5V. The voltage at *A* is more positive than the voltage at *C* so *D1* will be reverse biased and hence will not conduct; *D2*, on the other hand, is still forward biased and the output will stay at nearly zero. Reverse the connections between *A* and *B* (so that *B* is now going to +4.5V with *A* to ground) and you have exactly the same set of circumstances as before—the voltage at *C* stays low.

If, however, both *A* and *B* are connected to +4.5V (or, for that matter, are left disconnected) no current can flow through *R1*—except for the minute amount taken by the meter—and the voltage at *C* will rise to about +4.5V.

Fig. 12.1. The basic AND gate and the truth table

INPUTS		OUTPUT
A	B	C
0V	0V	0V
+4.5V	0V	0V
0V	+4.5V	0V
+4.5V	+4.5V	+4.5V



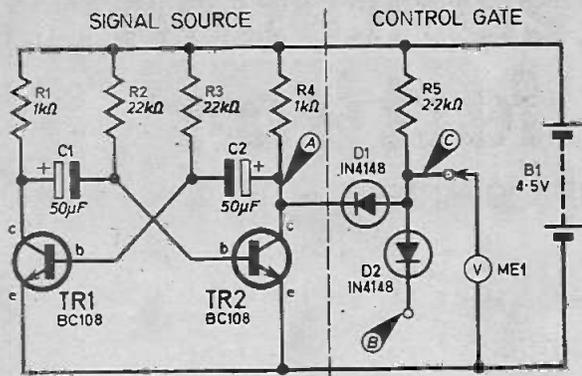


Fig. 12.2. Test circuit for the gate

Notice that we have described every possible permutation of applying either 0V or +4.5V to both inputs—four possibilities in all—and in only one of these possibilities did the output go to +4.5V. This occurred when both *A* and *B* were connected to +4.5V—strictly speaking we should not consider any cases of the inputs being disconnected.

Because the output will go to a high voltage only when both outputs are connected to a high voltage shows us why the gate is called an AND gate. It takes *A* and *B* to be at high levels to make *C* go to a high level!

### TRUTH TABLE

The combinations of the input conditions and the resulting output conditions can best be seen in the form of a table—Fig. 12.1. This is called a truth table. Imagine column *A* as being a signal and column *B* a control voltage. You can see that the voltages applied to *A* appear at the output when *B* is +4.5V but the input signal is inhibited from appearing at the output when *B* is at 0V; +4.5V at *B* opens the gate while 0V closes it!

## DIGITAL GENERATOR

As an extension of the experiment you can generate a real electronic digital waveform for input *A* by using a slow running astable multivibrator as shown in Fig. 12.2. Check with the voltmeter that you are getting a repetitive waveform at point *A* and then measure what you get at output *C* when *B* is firstly connected to +4.5V and then to ground.

You might think that connecting point *B* to ground in some way stops the multivibrator operating; this is not so and you can check this by returning the voltmeter to point *A*. The two diodes are acting as a control gate for the multivibrator's signal.

## ALARM

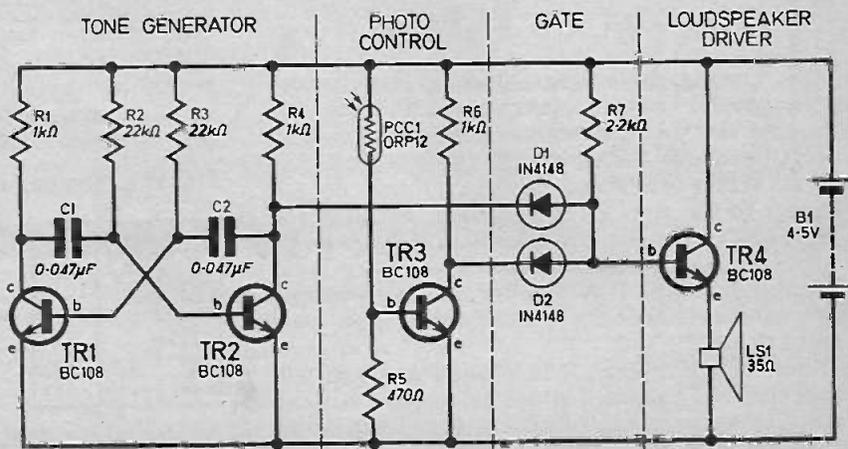
Finally, and to remove the need for mechanical intervention, we can use an electronic signal as the control. A simple circuit is shown in Fig. 12.3. Basically we have a multivibrator operating at an audio frequency and a photocell driving a transistor as a control source.

When the photocell is dark, the voltage at the collector of TR3 is high and this effectively applies +4.5V to input *B*—the signal from the audio source can thus pass through the gate into the loudspeaker driver and we hear an audio tone. When light falls on the cell base current passes into TR3 and the voltage at its collector falls virtually to zero; this closes the gate and the audio tone stops.

If you had this circuit set up with a torch beam illuminating the cell there would be no tone from the loudspeaker until the light beam was interrupted—perhaps by someone walking through a door—and then you get an audible alarm.

Next part: The series resonant filter

Fig. 12.3. Simple electronic circuit to demonstrate the function of the AND gate



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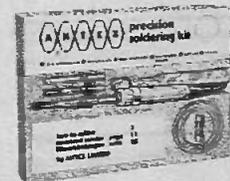
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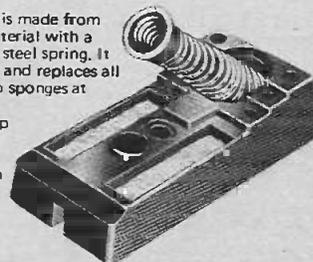
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# DOWN TO EARTH

By GEORGE HYLTON

"Why is it that you don't get a shock if you touch the neutral terminal of the mains? After all, this terminal is negative half the time and positive half the time, so if you don't get a shock when it's negative then you should get one when it's positive. Also, why is it that if you connect a voltmeter between the neutral and earth terminals you get a small voltage reading?"

An enquiring mind is a great thing, and can lead to important discoveries. Benjamin Franklin, flying his kite in a thunderstorm, proved that thunderclouds are electrically charged and so gained evidence that lightning is electrical.

The next chap to try the experiment discovered that it could be dangerous. He was electrocuted. Which is by way of saying, please don't play about with the mains.

Even if what you do *should* be safe, in theory, as in this case, there's no guarantee that it *will* be safe in practice. Electrical wiring in the house has been known to have the polarities reversed, the earth connection omitted, and so on.

## BRITISH SYSTEM

For the benefit of foreign readers whose mains system may be different from ours, the standard British house wiring system provides 240V, 50Hz outlets at sockets which take three-pin plugs.

One pin is connected to the local, domestic earth (often a metal water pipe where it enters the ground). Another is the neutral side of the mains, earthed at the power station or distribution transformer. The third is the live or non-earthly side of the mains. The system is shown in Fig 1, which is simplified in that it glosses over the fact that the distribution cables are usually made to carry more than one "phase" and so have more than two conductors, but the general idea is correct.

In order to receive a shock from the mains, it is necessary to connect your body between the

live and neutral terminals, directly or *indirectly*.

## DIRECT AND INDIRECT

A direct connection is what you get if you touch the "live" terminal with, say, one finger and the "neutral" with another. This is not pleasant. In particular, if the two fingers are on different hands, the resulting arm-to-arm current passes through your heart, which is a pretty good way of killing yourself.

The indirect connection is nearly as bad. It happens when you touch the "live" terminal only, but when your body is also in some way connected to the earth.

Since the mains "neutral" is also connected to earth, the circuit is complete and you get a shock. With 240V to drive the current, the earth connection to your body needn't be very good. Standing on a concrete floor in leather-soled shoes may provide a low enough resistance for a lethal shock, while most homes contain a wealth of earthed objects such as water pipes, taps, gas pipes, central heating radiators and so on.

## NO SHOCK

I know: I haven't answered the questions yet. Well, the answer to the first one can be seen from

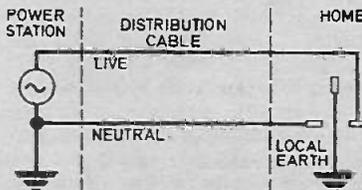


Fig. 1 Domestic mains supply from power station.

Fig. 1. Touching the "neutral" alone, even if you are earthed, doesn't permit current to flow between "live" and "neutral", via your body, so, no shock. The polarity of the voltage at the neutral terminal swings positive and negative with respect to the live terminal but it's always the same as that of the earth terminal, since both neutral and earth are connected to the earth, one at the power station and the other at the local water pipe or whatever.

Since both these terminals are earthed, there can be no voltage difference between them. Or can there? Yes, there can, because they are not connected to the earth at the same place: the earth connections may be miles apart.

## VOLTAGE DROP

This leads to the answer to the other question, which is, really: how can there be a voltage difference between two terminals, each earthed? In Fig. 1, the cable between power station and home is shown as having no resistance. But real cables, however thick, do have some resistance. Since a mains distribution cable may be carrying thousands of amperes even a few thousandths of an ohm resistance can cause an appreciable voltage drop.

In the case of the neutral side of the cable, this voltage drop is earthed at the power station but not at the home end. The home end can therefore be a few volts above local earth potential, and this is one cause of the small voltage which our reader measured between local earth and neutral terminals.



"Better check your construction of that indicator audible warning—it's just failed the noise test."

REMEMBER  
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# Readers Letters

## P.C. Construction

Wishing to construct the *Train Controller* as described in *EVERYDAY ELECTRONICS* Vol. 2 No. 9 September, '73, I decided to have a go at making my own printed circuit as per instructions in Vol. 2 No. 6. June '73. I'm afraid that I have lost count of the number of chemists that I called on to try and get the ferric chloride and have come to the conclusion that there must be an easier way to carry out this project. One chemist told me that there was no such animal as ferric chloride in powder or crystal form and that it existed only in liquid form. In the end I managed to purchase a do-it-yourself kit (in which the f.c. was a liquid) but as I would like to be able to purchase the necessary chemicals separately I would welcome your comments generally.

I note that in the process of etching on copper that nitric acid is used. Although more care would have to be exercised when using acids it might prove easier to obtain and I would enquire if this is a suitable alternative.

By the way, I feel that the estimated cost of £3.15 for the cost of parts for the controller was a bit conservative. I purchased most of the bits and pieces from Henry's Radio, and the balance from a component shop in Brighton, and they came to a lot more than £3.15. If A. J. Dunn managed to build his for £3.15 then he was very lucky.

I look forward to receiving your reply and thank you for providing such an interesting mag. each month.

N. C. Langridge,  
Littlehampton, Surrey

G. F. Milward of 369 Alum Rock Road, Birmingham B8 3DR can supply 1/2lb packs of ferric chloride (in crystal form) for 50p including post and packing. A dilute solution of nitric acid can

be used provided the resist can withstand it—nail varnish is quite good!

The price for the controller was obtained by pricing components from suppliers catalogues. One of our advertisers is supplying a kit of parts for the same price.

## Soldering Competition

Many thanks for your letter dated September, 1973 and your kind congratulations accompanying a most attractive and useful runner-up prize

The competition has given me great pleasure and I would like to say that I wholeheartedly agree with the final order selected by the judges for the first prize. They obviously gave the competition considerable thought.

May I also take this opportunity to congratulate you on your very fine publication, which I always find most interesting, stimulating and educational.

J. W. Berry,  
Bury St. Edmunds.

Many thanks for the safe receipt of my prize from the recent soldering competition in *EVERYDAY ELECTRONICS*.

Congratulations are really all due to *EVERYDAY ELECTRONICS* which I have taken ever since the first issue. Before this, I did not have the vaguest idea about electronics or soldering.

Being a middle aged spinster with no male friends or relatives connected in any way with electronics I have learned all I do know on the subject through your pages. It is the lucid way in which processes are explained, together with the detailed diagrams and clear photographs, which I have found so easy to follow, which has enabled me to learn as much as I have. (To my wondering surprise.)

The excellent book about soldering is just what I needed and is going to be so useful. I didn't have a wire stripper either, so that also will be very acceptable, even though I have acquired the knack of stripping with side cutters!

Incidentally, I have never ever won any kind of prize in my life before. Maybe electronics has brought some luck at last!

Thank you again for the gifts and for an excellent magazine, and for the happy hours that will ensue from both.

Connie Wade  
Leeds.

## Price

As a schoolboy I am rather annoyed at the letter in the December *E.E.* which said that your projects are within the scope of the pocket money of the schoolboy enthusiast. This is not true. The average schoolboy only gets at the least 30p pocket money which is hardly enough for your projects. I have made one of your projects which the approximate cost was 45p (*Neon Novelty* with two lamps). It cost me a total of 105p which I could only afford because it was Easter.

David Hooton,  
Rushden, Northants.

## Spiders At Work

Re. your December issue *Ruminations*, spiders are used by man to spin their webs to suit our purposes. Selected spiders are made to spin a thread onto special frames, which are then stored until needed to be used as graticules (crosswires) in certain optical instruments. An example of this application was shown on BBC's "Animal Magic" some weeks ago, when a spider was shown working for man at the York factory of Vickers Instruments, the "end" result being used in the repair of a theodolite.

C. Long,  
Leeds.

Please note: we can only answer readers letters concerning published articles, not commercial equipment or modifications to circuits. Please include an s.a.e. for a reply.

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 500-10, 200-25, 100-50, 9p; 1000-10, 500-25, 200-50, 11p; 2000-10, 1000-25,  
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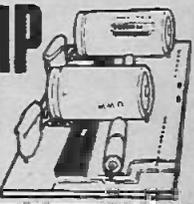
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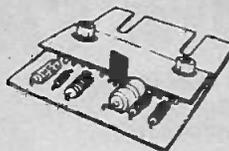
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200uA	£2.40	£2.50	—	£3.05	£4.05	—	—	—	£2.70	£3.00	£3.30	£3.40	—
500uA	£2.25	£2.45	£2.65	£2.75	£3.90	£2.70	£3.05	£3.70	£2.55	£2.95	£3.15	£3.20	—
50-0-50uA	£2.50	£2.65	£3.05	£3.15	£4.25	£3.05	£3.40	£3.95	£2.80	£3.05	£3.40	£3.60	£6.40
100-0-100uA	£2.40	£2.50	£2.95	£3.10	£4.05	£3.00	£3.30	£3.90	£2.75	£3.00	£3.35	£3.50	—
500-0-500uA	£2.25	£2.40	—	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
1mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	£3.20	—
1-0-1mA	£2.25	—	—	—	£3.90	£2.60	—	—	—	—	—	—	—
2mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
5mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
10mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
20mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
50mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
100mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
150mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
200mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
300mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
500mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
750mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
1A DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	—	£5.95
2A DC	£2.25	—	—	—	—	£2.60	—	—	—	—	—	—	—
5A DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	—	£5.95
10A DC	£2.25	—	—	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
15A DC	£2.25	—	—	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
20A DC	£2.25	—	—	£2.60	—	—	—	—	—	—	—	—	—
30A DC	—	—	—	£2.80	£3.95	£2.60	—	—	—	—	—	—	—
50A DC	—	—	—	£2.90	—	£2.60	—	—	—	—	—	—	—
3V DC	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
5V DC	—	—	—	£2.60	—	£2.60	—	—	£2.60	£2.90	£3.10	—	£5.95
10V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	£5.95
15V DC	£2.25	—	—	—	—	—	—	—	—	—	—	—	£5.95
20V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	—	£2.90	£3.10	—	£5.95
50V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	—	£5.95
100V DC	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
150V DC	£2.25	—	—	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
300V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	—	£5.95
500V DC	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
750V DC	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
15V AC	£2.30	£2.45	£2.60	£2.80	£2.95	—	—	—	£2.70	£3.00	£3.30	—	—
30V AC	—	—	—	—	—	£2.65	—	—	—	—	—	—	—
50V AC	£2.30	—	—	£2.80	—	£2.65	—	—	—	—	—	—	—
150V AC	£2.30	—	—	£2.80	—	£2.65	—	—	—	—	—	—	—
300V AC	£2.30	£2.45	£2.60	£2.80	£3.95	£2.65	£3.00	£3.70	£2.70	£3.00	£3.30	£3.25	—
500V AC	£2.30	—	—	£2.80	—	£2.65	—	—	—	—	—	—	—
S Meter 1mA	£2.30	£2.50	£2.60	£2.85	£3.90	—	—	—	—	—	—	—	—
VU Meter	£2.65	£2.70	£3.60	£3.70	£4.55	£3.65	£3.70	£4.30	£2.90	£3.15	£3.50	£3.85	—
1A AC	—	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
5A AC	—	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
10A AC	—	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
20A AC	—	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
30A AC	—	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
50A AC	—	—	—	—	—	£2.60	—	—	—	—	—	—	—
50mA AC	—	—	—	£2.60	—	—	—	—	—	—	—	—	—
100mA AC	—	—	—	£2.60	—	—	—	—	—	—	—	—	—
200mA AC	—	—	—	£2.60	—	—	—	—	—	—	—	—	—
500mA AC	—	—	—	£2.60	—	£2.60	—	—	—	—	—	—	—
50mV DC	—	—	—	—	—	—	—	—	£2.90	—	—	—	—
100mV DC	—	—	—	—	—	—	—	—	£2.90	—	—	—	—
500mA/5A DC	—	—	—	—	—	—	—	—	—	—	—	—	£7.00
1/15A DC	—	—	—	—	—	—	—	—	—	—	—	—	£7.00
5/15V DC	—	—	—	—	—	—	—	—	—	—	—	—	£7.00
5/50V DC	—	—	—	—	—	—	—	—	—	—	—	—	£7.00

**SEW PANEL METERS—SIZES AND FIXING INFORMATION**

	Front	Panel Hole	Fixing		Front	Panel Hole	Fixing
Model 38P	42 x 42mm	32mm dia.	4 studs	Model SW100	100 x 80mm	65mm dia.	4 studs
Model 45P	50 x 50mm	38mm dia.	4 studs	Model SD460	59 x 46mm	38mm dia.	4 studs
Model 52P	60 x 60mm	48mm dia.	4 studs	Model SD640	85 x 64mm	45mm dia.	4 studs
Model 65P	86 x 78mm	57mm dia.	4 studs	Model SD830	110 x 83mm	58mm dia.	4 studs
Model 85P	120 x 110mm	98mm dia.	4 studs	Model PE70	90 x 34mm	70 x 31mm	2 holes
Model 65	80 x 80mm	64mm dia.	4 studs	Model ED107	Size: 100 x 90 x 150mm high	including terminals.	
Model S80	80 x 80mm	65mm dia.	4 studs				



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Reduce tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Size: 450 x 205 x 79mm. AC 220/240V



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Instant recording and playing. Piano key controls. Automatic level control. Built-in speaker. Complete with remote control microphone, carrying case and shoulder strap.

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**AUDIOTRONIC AHP8-0 8 Track Stereo Tape Deck**

Can be used with most hi-fi amplifiers. Push button track selector, & illuminated track indicators. Attractive cabinet with black and silver trim. Output level 750mV, 220/240V A.C.

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**SPECIAL BARGAIN !! STEREO SOUND SPEAKERS**

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size 365 x 225 x 190mm. 8 ohms. 8 watts RMS, 15 watts peak. Complete with Din lead.

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5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated trigger running 20-2000 sweeps from 0.2µsec to 100 milli-sec/cm. Free running time base 50Hz-1MHz. Built-in time base. Calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual.



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Light weight head-phones with padded ear pieces. 4/16 ohms. 20-20,000Hz. Complete with 6' lead and plug.



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Packed with transistors, diodes, capacitors and resistors—COMPLIMENT VALUE £1.50. 3 for ONLY 55p + p + p 50p

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BA5	4"	2½"	2"	41p
BA6	3"	2"	1"	34p
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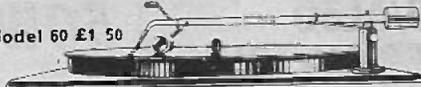
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104 For model CN240 3/16" 39p  
1100 For model CCN240 3/32" 38p  
1101 For model CCN240 3/8" 38p  
1102 For model CCN240 1" 38p  
1020 For model G240 3/32" 38p  
1021 For model G240 1/8" 38p  
1022 For model G240 3/16" 38p  
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C4	75	1½ W Resistors mixed preferred values	0.55
C5	5	Pieces assorted Ferrite Rods	0.55
C6	2	Tuning Gangs, MW/LW VHF	0.55
C7	1	Pack Wire 50 metres assorted colours	0.55
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C 9	3	Micro Switches	0.55
C10	15	Assorted Pots & Pre-Set	0.55
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## PLUGS AND SOCKETS

**SOCKETS**  
PS 35 DIN 2 Pin (Speaker) 0.08  
PS 36 DIN 3 Pin 0.10  
PS 37 DIN 5 Pin 180° 0.10  
PS 38 DIN 5 Pin 240° 0.10  
PS 39 Jack 2.5mm Switched 0.09  
PS 40 Jack 3.5mm Switched 0.10  
PS 41 Jack 1" Switched 0.17  
PS 42 Jack Stereo Switched 0.26  
PS 43 Phono Single 0.06  
PS 44 Phono Double 0.10  
PS 45 Car Aerial 0.09  
PS 46 Co-Axial Surface 0.09  
PS 47 Co-Axial Flush 0.14

## INLINE SOCKETS

PS 21 D.I.N. 2 Pin (Speaker) 0.13  
PS 22 D.I.N. 3 Pin 0.17  
PS 23 D.I.N. 5 Pin 180° 0.17  
PS 24 D.I.N. 5 Pin 240° 0.17  
PS 25 Jack 2.5mm Plastic 0.10  
PS 26 Jack 3.5mm Plastic 0.12  
PS 27 Jack 1" Plastic 0.24  
PS 28 Jack 1" Screened 0.28  
PS 29 Jack Stereo Plastic 0.22  
PS 30 Jack Stereo Screened 0.28  
PS 31 Phono Screened 0.14  
PS 32 Car Aerial 0.15  
PS 33 Co-Axial 0.17

## PLUGS

PS 1 D.I.N. 2 Pin (Speaker) 0.11  
PS 2 D.I.N. 3 Pin 0.12  
PS 3 D.I.N. 4 Pin 0.14  
PS 4 D.I.N. 5 Pin 180° 0.15  
PS 5 D.I.N. 5 Pin 240° 0.15  
PS 6 D.I.N. 6 Pin 0.15  
PS 7 S.I.N. 7 Pin 0.15  
PS 8 Jack 2.5mm Screened 0.12  
PS 9 Jack 3.5mm Plastic 0.09  
PS 10 Jack 3.5mm Screened 0.12  
PS 11 Jack 1" Plastic 0.13  
PS 12 Jack 1" Screened 0.18  
PS 13 Jack Stereo Screened 0.29  
PS 14 Phono 0.06  
PS 15 Car Aerial 0.15  
PS 16 Co-Axial 0.10

## CABLES

CP 1 Single Lapped Screen 0.06  
CP 2 Twin Common Screen 0.08  
CP 3 Stereo Screened 0.08  
CP 4 Four Core Common Screen 0.23  
CP 5 Four Core Individually Screened 0.30  
CP 6 Microphone Fully Braided Cable 0.10  
CP 7 Three Core Mains Cable 0.07  
CP 8 Twin Oval Mains Cable 0.06  
CP 9 Speaker Cable 0.04  
CP 10 Low Loss Co-Axial 0.10

## CARBON POTENTIOMETERS

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VC 1 Single Less Switch 0.14  
VC 2 Single D.P. Switch 0.28  
VC 3 Tandem Less Switch 0.44  
VC 4 1K Lin Less Switch 0.14  
VC 5 100K Log anti-Log 0.44

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0.1 watt 0.06 each  
100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4.7M

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8 Books comprising  
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BP11 Practical Transistor Novelty Circuits 40p  
BP9 Universal Gram-Motor Speed Indicator 8p  
BP3 How to make FM & TV Aerials, Bands 1, 2 and 3 18p  
BP4 Radio Servicing for Amateurs 20p  
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BP6 Transistor Circuits Manual No.1 15p  
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BP5 Tested Shortwave Receiver Circuits using MAT's 30p  
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## CARTRIDGES

ACOS GP91-18C 200mV at 1.2cm/sec £1.16  
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The E12 Range of Carbon Film Resistors, 1/8th watt available in PAKS of 50 pieces, assorted into the following groups:—  
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R3 50 Mixed 10K ohms-82K ohms 40p  
R4 50 Mixed 100K ohms-1 Meg. ohms 40p  
THESE ARE UNBEATABLE PRICES—LESS THAN 1p EACH INCL. V.A.T.

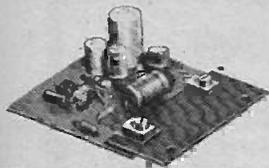
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C80, 32p C90, 41p C120, 52p

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### AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0.25%
LOAD IMPEDANCE		8 - 16Ω
INPUT IMPEDANCE	f = 1KHz	100 kΩ
FREQUENCY RESPONSE 3dB	Po = 2 WATTS	50 Hz - 25KHz
SENSITIVITY for RATED O/P	Vs = 25V, RL = 8Ω f = 1KHz	75mV. RMS
DIMENSIONS		3" x 2 1/2" x 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL = 8Ω f = 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

#### AUDIO AMPLIFIER MODULES

AL 10. 3 watts RMS	£2.19
AL 20. 5 watts RMS	£2.59
AL 30. 10 watts RMS	£3.01

#### POWER SUPPLIES

PS 12. (Use with AL10 & AL20)	88p
RPM 80. (Use with also AL30 & AL50)	£3.25

FRONT PANELS SP 12 with Knobs	£1.10
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#### PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20)	£4.85
PA 100. (Use with AL30 & AL50)	£13.15

#### TRANSFORMERS

T461 (Use with AL10)	£1.38 P & P 15p
T638 (Use with AL20)	£1.93 P & P 15p
BMT80 (Use with AL30 & AL50)	£2.15 P & P 25p

#### PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from the associated power supplies. There are two stereo inputs, one has been designed for use with Ceramic cartridges while the auxiliary input will suit most Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm x 84mm x 35mm.

Frequency response—  
20Hz - 50KHz (±3dB)  
Bass control—  
±12dB at 60Hz  
Trebble control—  
±14dB at 14KHz  
\*Input 1. Impedance  
1 Meg. ohm  
Sensitivity 300mV  
†Input 2. Impedance  
30 K ohms  
Sensitivity 4mV

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### The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls.

Transformer, Power supply and Power amps.

Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet.

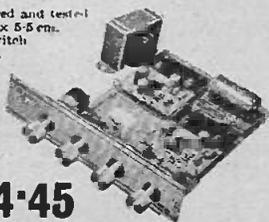
Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25KHz.

Input 2 (Aux.) 4mV into 30K. Harmonic

distortion. Bass control ±12dB at 60Hz typically 0.25% at 1 watt.

Treble con. ±14dB at 14kHz.

£14.45



### 50W pk 25w (RMS)

0.1% DISTORTION!  
HI-FI AUDIO AMPLIFIER

### THE AL50

★ Frequency Response 15Hz to 100,000—1dB.

★ Load—3, 4, 8 or 16 ohms.

★ Distortion—better than -1% at 1 KHz.

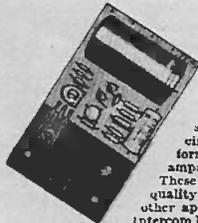
★ Signal to noise ratio 80dB.

ONLY  
£3.58 each

★ Supply voltage 10-35 Volts.

★ Overall size 63mm 105mm x 13mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and ALSO was conceived to fill the need for all your A.F. amplification needs.  
FULLY BUILT TESTED - GUARANTEED.



### STABILISED POWER MODULE SPM80

SPM80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest component and circuit techniques incorporating complete short circuit protection. With the addition of the Main Transformer MT80, the unit will provide outputs of up to 1.5 amps at 35 volts. Size: 62mm x 105mm x 30mm.

These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Discos Systems, Public Address-Intercom Units, etc. Handbook available 10p PRICE £3.25

TRANSFORMER BMT80 £2.15 p. & p. 28p

### STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stage. Three switched stereo inputs, and rumble and scratch filters are features of the PA100 which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

#### SPECIFICATION

Frequency Response—  
20Hz - 20KHz ± 1dB  
better than 0.1%  
Harmonic distortion  
Inputs: 1. Tape Head  
2. Radio, Tuner  
3. Magnetic P.U.  
1.5 mV into 50K Ω  
1.5 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. input—  
equalised to RIA curve within ± 1dB from 20Hz to 20KHz.

Bass Control  
± 15dB at 20 KHz

Treble Control  
± 15dB at 20 KHz

Filters: Rumble (High Pass)  
100Hz

Scratch (Low Pass)  
8KHz

Signal/Noise Ratio  
better than -65dB

Input overload  
± 26dB

Supply  
+ 35 volts at 20mA

Dimensions  
292mm x 82mm x 35mm

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1  
SPM80, 1 BMT80 & 1 PA100 ONLY £25.30 FREE p. & p.

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# BI-PAK

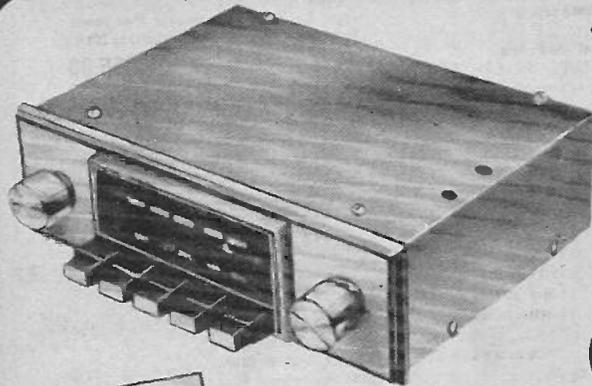
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# R T V C



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### BUILD YOUR OWN TOURIST PUSH BUTTON CAR RADIO

Technical specification:

- 1.) Output 2.5 watts R.M.S. into 8 ohms. For 12 volt operation on negative or positive earth.
- 2.) Integrated circuit output stage, pre built three stage IF Module.

Controls Volume, manual tuning and five push buttons for station selection, illuminated tuning scale covering full medium and long wave bands.

Size Chassis 7 ins. wide, 2 ins. high and 4  $\frac{1}{2}$  ins. deep approx.

**NOTE:** The ability to solder on a printed circuitboard is necessary to complete this kit successfully. Circuit diagram and comprehensive instructions 55p. free with kit.

### Car Radio Kit

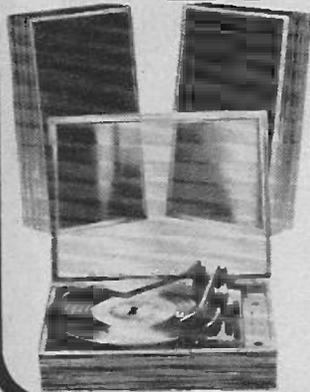
**£6.60 + 55p. postage & packing.**

Speaker including baffle and fixing strips  
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Recommended Car Aerial - fully retractable and locking.

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## QUALITY SOUND FOR LESS THAN £19.00

Stereo 21 easy to assemble audio system kit. - no soldering required. Includes:-

BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.

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Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.

For the technically minded:-

Specifications:

Input sensitivity 600mV; Aux. input sensitivity 120mV; Power

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Stereo headphone socket with automatic speaker cutout.

Provision for auxiliary inputs - radio, tape, etc., and outputs for

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15  $\frac{1}{2}$ " x 8" x 4". Complete deck and cover in closed position

approx. 15  $\frac{1}{2}$ " x 12" x 6". Complete only **£18.45.**

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Specially selected pair of stereo headphones with individual

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\*Mixer employing F.E.T. (Field Effect Transistor). \*Solid State Circuitry. \*Attractive Styling.

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Technical specification.

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Two Duo Type II matched speakers -

Enclosure size approx. 17" x 10 1/2" x 6 1/2" in simulated teak. Drive unit 13" x 8" with parasitic tweeter.

**Complete System £49-00**

**£65-00**

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Viscount III amplifier (As System I)

Garrard SP.25 Mk III deck (As System I)

Two Duo Type III matched speakers -

Enclosure size approx. 23 1/2" x 11 1/2" x 9 1/2".

Finished in teak veneer. Drive units approx.

13 1/2" x 8 1/2" with 3 1/2" HF speaker. Max. power

20 watts, 8 ohms. Freq. range 20Hz to 20kHz.

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Garrard SP25 Mk. III with		
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total **£56-20**

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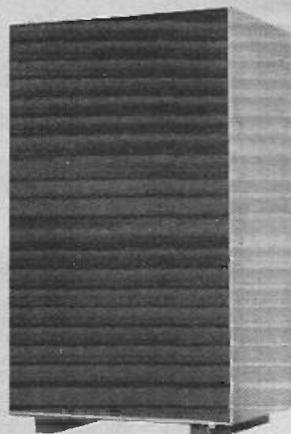
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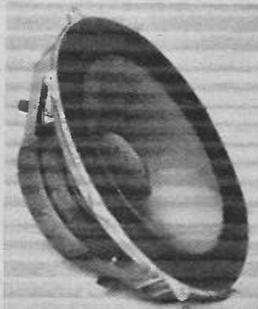
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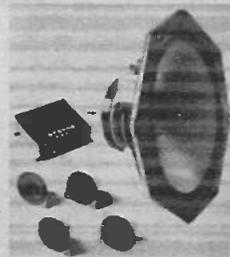
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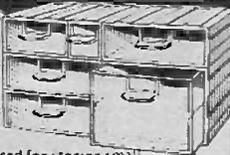
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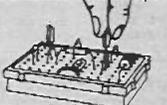
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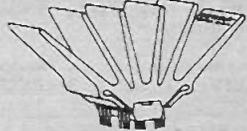
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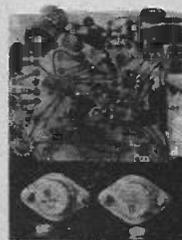
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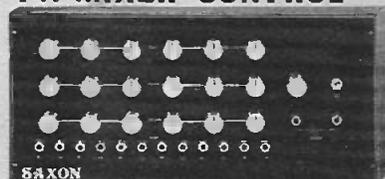
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