

An exciting hobby.... for everyone

# everyday electronics

MAR. 74  
20p



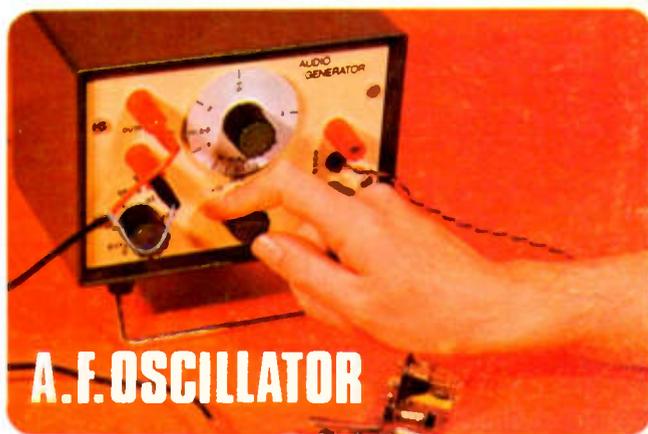
**MPH!**  
ADJUSTABLE  
**SPEED GUARD**



**PLANT PROPAGATOR**

**FREE** INSIDE...

**INTEGRATED CIRCUIT  
DATA CHART**



**A.F. OSCILLATOR**

# NEW EDU-KIT MAJOR

COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT.

BUILD THESE PROJECTS WITHOUT  
SOLDERING IRON OR SOLDER.



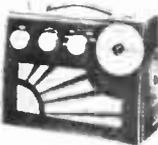
★ 4 Transistor Earpiece Radio ★ Signal Tracer ★ Signal Injector ★ Transistor Tester NPN/PNP ★ 4 Transistor Push Pull Amplifier ★ 5 Transistor Push Pull Amplifier ★ 7 Transistor Loudspeaker Radio MW/LW ★ 5 Transistor Short Wave Radio ★ Electronic Metronome ★ Electronic Noise Generator ★ Batteryless Crystal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

★ 24 Resistors ★ 21 Capacitors ★ 10 Transistors ★ 3½ loudspeakers ★ Mica Baseboard ★ 3 12-way connectors ★ 2 Volume controls ★ 2 Slider Switches ★ 1 Tuning Condenser ★ 3 Knobs ★ Ready Wound MW/LW/SW Coils ★ Ferrite Rod ★ 6½ yards of wire ★ 1 yard of sleeving, etc. ★ Parts price list and plans 50p (FREE with parts).

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

## 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 30p (FREE with parts).  
**Total Building Costs** **£8.50** P P & Ins. 52p.  
(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 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" x 5½" x 2½" approx.  
Parts price list and Plans 15p. Free with parts.

**Total Building Costs** **£2.73** P 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.

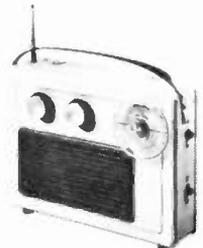
**Total Building Costs** **£4.08** P P & Ins. 31p.  
(Overseas P & P £1.85) (+ 10% VAT 40p)

## 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. 6 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 4in. 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)

## NEW ROAMER NINE WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors. 9 Tunable wavebands as 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 9½" x 7" x 2½" approx. Parts Price list and Plans 30p (FREE with parts)

**Total Building Costs** **£6.95** P P & Ins. 44p.  
(Overseas P & P £1.85p) (+ 10% VAT 69p)

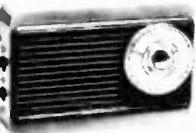
## POCKET FIVE

3 Tunable wavebands. M.W./L.W. and Trawler Band. 7 stages, 5 transistors and 2 diodes. supersensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 5½" x 1½" x 3½" 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)



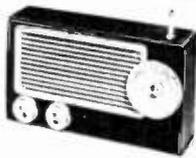
## TRANSONA FIVE

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 5½ x 2½in. 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.

## "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" 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 5½ x 2½in. 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

61a HIGH STREET, BEDFORD, MK40 1SA Tel. 0234 52367  
Reg. no. 788372

I enclose £..... for.....

Name.....

Address.....

(Dept. E.E.28.)

# everyday electronics

VOL. 3 NO. 3

MARCH 1974

## FREE INSIDE

INTEGRATED CIRCUIT DATA CHART

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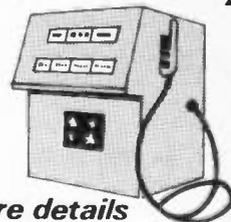
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Another aid to Fuel Economy

**TRANSISTOR  
ASSISTED  
IGNITION**



See Page 147 for more details

# CRESCENT RADIO LTD

11 & 40 MAYES ROAD, LONDON N22 6TL 888 3206

10% VAT TO BE ADDED TO ALL GOODS & CARRIAGE PRICES

**7" x 4" LOUDSPEAKER**  
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: 38,000. Max. Free range: 90Hz to 12kHz. Power handling: 5W. Unobtainable. Price: £1.60. 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-phone listening amplifier. The power pack enables this unit to work from the standard mains.

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

**"CRESCENT" DIGITAL CLOCK KIT**

24 Hour Mins Digital Clock Kit We Supply:  
★ A complete set of components  
★ A complete set of easy to follow instructions  
★ Printed circuits 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 £5.50 plus 5p P.&P.

**"CRESCENT" CATALOGUE**

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

**MINI LOUDSPEAKERS**  
2 1/2" (57mm) 400hm — 50p each  
2 1/2" (57mm) 800hm — 50p each  
Please include 5p. P. & P. up to 3 Mini-Loudspeakers

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## COMPONENTS AND HI FI FOR THE HOME CONSTRUCTOR

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13 SOUTH MALL, EDMONTON, N.9 803 1685



**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 1/2v 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 2 1/2". OUR PRICE — £2.75p + 10p. P. & P. Same model suitably wired for the Philips Cassette — £3.00 + 10p. P. & P.

**"CRESCENT" 100 WATT R.M.S. ALL PURPOSE AMPLIFIER U. BUILD IT**

We supply the three modules for you to build this Disco-Group-P.A. amplifier into the cabinet of your choice.

**★ THE POWER AMP MODULE TP 100W**  
170W, r.m.s. eq. wave 300W instantaneous peak into 8 ohm (180W into 16 ohm). £14.28, carr. 45p.

**★ THE PRE-AMP MODULE**  
Four control pre-amp Vol, Bass, Treble, Middle controls. Designed to drive most amplifiers using F.E.T. first stage. £3.96 carr. 25p.

**★ THE POWER SUPPLY MODULE P5100**  
Is supplied complete with the mains transformer. £9.66, 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

**TRI-VOLT CAR CONVERTER**

Enables you to work your Transistor Radio, Amplifier or Cassette etc. from the 12 volt car supply positive or negative earth. This converter supplies 6, 7 1/2 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.



**POTENTIOMETERS**  
All types 1" and less diameter.  
**SINGLES DUAL**  
5K Log or 5K  
10K Lin Less 10K  
25K Switch 25K Less  
50K 50K 40p-  
100K 12p ea. 100K Switch  
250K Double 250K 40p-  
500K Pole 500K each  
1M Switch 1M  
2M Switch 2M  
24p ea.  
Up to 3 Pots. Please add 5p. 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  
27/A 12v 17M/A 700 Ω  
21/A 12v 28M/A 430 Ω  
12/A 6v 33M/A 185 Ω  
80p each.  
Please include 5p P. & P up to 3 Relays.



**"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.

**MAINS TRANSFORMER**

Fused Primary 240V. Secondary 220V @ 50mA. 6.3V @ 1A. This transformer is made to a very high standard and is a small size: 2 1/2" x 2 1/2" x 2 1/2" plus 15p P. & P.



**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 L/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 STYL**  
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 Dust Bug £1.20  
Parastatic Disc Preener 45p  
Anistatic Fluid 20p  
Dust Bug Spares (Brush & Roller) 15p  
Prices inc VAT and Post.

**CASSETTE TAPES**  
Audio-Magnetics C60  
3 10 20  
£1.00 | £1.90 | £3.20 | £6.30  
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**  
Goldring G800 £6.00  
Orbit NM22 £4.00  
Shure 75/6 £6.00  
Sonotone 9TAHC (Dia) £2.00  
Sonotone 8T4A (Dia) £1.50  
Ronnnette 105 (Dia) £1.25

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



Approx. Size 8 1/2" x 2 3/4" x 6 1/4"

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**



## KITS FOR PREVIOUS PROJECTS

Unless otherwise stated, kits contain electronic parts only. The case and special items can be obtained locally. Also batteries are not included. Kits may be returned for refund if construction has not been started. We reserve the right to substitute components should deliveries be protracted so as to avoid in-stock delay.

**If reprint of data is required add 10p HOME SENTINEL.** Ward off the unwanted intruder! No elaborate setting up or wiring required. Kit of parts \$4-35.

**"SWAP" INDICATOR.** Press your button first and your opponent is blocked also suitable for Quiz games and reaction testing. Kit of parts \$1-10.

**RECORD PLAYER.** Good quality at a reasonable price - good enough for classical records and pop. Kit of parts \$6-10.

**WINDSCREEN WIPER CONTROL.** Wet dirty road Drizzle Fog Mistrained screen Scraping wipers - combat these with add-on wiper control. Kit of parts \$2-50.

**FUZZ BOX.** Add wild and interesting effects to guitar playing with this solid state Fuzz box. Kit of parts \$2-50.

**PHOTOGRAPHIC COLOUR TEMPERATURE METER.** Must for colour photographer get the colours right gives quick indication of filters necessary for correction in any light. Can be used with natural or studio lighting. Kit of parts \$2-50.

**ASTRON M.W. RADIO.** A simple M.W. reflex circuit receiver - easy to build. Kit \$2-50.

**REMOTE TEMPERATURE COMPARATOR.** Measures small temperature changes in liquids or gasses (fish tank, photographic solution, thermostatically controlled rooms etc). Kit \$5-25.

**RAIN WARNING ALARM.** Keep your washing dry with this automatic alarm device. Kit \$2-50.

**WAA WAA PEDAL.** Add excitement and sound vibration to your music. Kit \$3-50.

**ELECTRO LAUGH.** Laughter simulator also useful electronic alarm. Kit of parts \$2-50.

**SOIL MOISTURE METER.** Many plants are killed through over-watering - this meter measures soil moisture at root depth probes can be left permanently in the ground - indicator remotely housed could monitor several plants. Kit \$3-50.

**SIGNAL INJECTOR.** A useful pocket instrument for fault finding in radios and amplifiers. Kit \$1-10.

**BABY ALARM.** Keep a check on the kids this device will give you peace of mind as you watch T.V. Kit \$4-40.

**SIMPLE CALCULATOR.** Teaching aid for multiplication - can be used for quick checks. Kit \$3-10.

**POWER SUPPLY UNIT.** Just right for testing low voltage circuits - a simple stabilised supply providing 0-16 volts D.C. continuously variable. Kit \$5-50.

**METAL LOCATOR.** A simple easy to construct self-contained metal locator - giving a meter indication of buried metal. Kit \$5-00.

**AUDIO TONE GENERATOR.** Makes electronic music covers range from 50 - 20000 Hz. Specifically designed for use with tape recorder. Kit \$3-25.

**LIGHT TO SOUND CONVERTER.** Produces an audio tone - the frequency of which is dependent on the light level. Kit \$2-15.

**SHAVEN INVERTER.** Provides 240v 50hz from 12 volt car battery - gives approx. 10 watts which is enough for most shavers. Kit \$4-35.

**ELECTRONIC METRONOME.** Electronic Metronome with pulse frequency continuously variable from 40 - 225 beats per minute. Kit \$3-15.

**THROUGH LENS LIGHT METER.** A simple light meter for use with single lens reflex camera. Kit \$4-25.

**MEDIUM AND LONG WAVE RADIO TUNER.** A simple radio tuner for use with almost any amplifier. Kit \$3-25.

**INFRA RED BURGLAR ALARM.** Uses an invisible, reflected beam to detect intruders when beam is intercepted - a power output is switched on for up to one minute. Kit \$4-35.

**CASSETTE TAPE POWER SUPPLIES.** Two units to power a cassette tape player or recorder on from the mains. Price \$2-50. Two from the car battery. Price \$1-40.

**REACTOMATIC.** A reaction testing game that can also be a quiz answering indicator. Kit \$3-30.

**ELECTRONIC MOUSE TRAP.** A humane mouse trap - catches them alive so that you can release them in their home. Kit \$3-25.

**TRANSISTOR TESTER.** A rapid tester for checking most transistors - tests transistors in an oscillator circuit and gives audible indication of goodness. Kit \$2-15.

**BIT SAVER.** Prolongs life of soldering iron bit prevents pitting. Kit \$1-95.

**ICE WARNING DEVICE.** A device that can be set to indicate 'ice' conditions or similar temperature levels. Kit \$1-55.

**AUDIO COLOUR UNIT.** Add a colour dimension to your audio equipment. This unit will modulate three lamps in accord with Bass middle and treble notes of any music. Kit of parts \$7-50.

**U.H.F. T.V. AERIAL.** A simple aerial for U.H.F. reception of your band could improve your reception immensely. Kit \$1-65.

**DAMP LOCATOR.** Easily carried in your pocket this little unit gives visible indication of damp. Kit \$1-25.

**ENLARGER & EXPOSURE METER.** For D.I.Y. photographer \$5-00.

**EGG TIMER.** Simple timer with audible warning. \$4-15.

## THYRISTOR LIGHT DIMMER

Domestic model for any lamp up to 250 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price \$2-95. Industrial model 5 amp. module with control knob not on switch plate \$3-30.



Standard 1c any fuse plug and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. \$2-50 plus 25p P. & 1



## ELECTRONIC IGNITION

### TEACH IN '74

A new beginners series started with the October issue of this magazine, we will be supplying all the parts for this. The initial kit covering all component required for the first 6 months is available post and VAT included - price \$7. A special feature about our version of this kit is the 4 1/2" x 3" meter 0-100uA meter. As the author says, a large meter is so much easier to read than a small one.

### MIGHTY MIDGET

Probably the thinnest possible radio as described in Practical Wireless, January '73. All electronic parts \$2-20 post paid



## CONTROL DRILL SPEEDS

### DRILL CONTROLLER NEW IKW MODEL

Electrically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger tip control. Kit includes all parts, case, everything and full instructions - \$1-95 plus 15p post and insurance. Made up model also available. \$2-95 plus 25p post & p

### RADIO STETHOSCOPE

Easiest way to fault find - traces signal from aerial to speaker when signal stops you've found the fault. Use it on Radio, TV amplifier, anything - complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. \$3-50. Twin stethoscope instead of earpiece 85p extra post and ins. 20p.

## SPEED GUARD PLANT PROPAGATOR A.F. OSCILLATOR

To receive parts for these and other feature projects, send the quoted approximate amounts and any cash adjustment can be made later.

### GOOD COMPANION

We can now offer these again in a new version using Ferranti ZN414 and Mullard AF Modules 112. Excellent two wood cabinet. Cabinet size approx. 11in wide x 8in high x 3in. Complete assembly instructions \$5-75 plus 25p post and ins.

### STANDARD WAFER SWITCHES

Standard size 1 1/2" wafer - silver-plated 5-amp contact, standard 1" spindle - 2" long with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	44p	44p							
2 poles	44p	77p							
3 poles	44p	77p							
4 poles	44p	77p							
5 poles	44p	77p							
6 poles	44p	77p							
7 poles	44p	77p							
8 poles	44p	77p							
9 poles	44p	77p							
10 poles	44p	77p							
11 poles	44p	77p							
12 poles	44p	77p							

### SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in x 18in \$1-60. 12in x 10in \$1-21.

### MULLARD UNILEX STEREO SYSTEM

There is no doubt that it is a good system, we believe that for the money it is without comparison. We demonstrate this at our Tamworth Road depot. Prices of the individual items for this:

1 Unilex Amplifier	Ref. EP.9000	\$1-60
1 Unilex Amplifier	Ref. EP.9001	\$1-60
1 Unilex Pre-Amp	Ref. EP.9001	\$1-95
1 Unilex Power Unit	Ref. EP.9002	\$2-53
1 Control panel kit with spun aluminium faced knobs		\$3-30

Or the complete outfit - \$11-30 post paid. Pair of 15 ohm speakers made by E.M.I. are also available if required, price \$3-30 the pair. No extra postage if ordered with the above, otherwise add 25p.

## J. BULL (ELECTRICAL) LTD.

(Dept. E.E.), 7 Park Street, Croydon CRO 1YD

Callers to: 162 3 Tamworth Road, CROYDON.



## KITS FOR PREVIOUS PROJECTS CONT. FROM LEFT HAND COL.

**NEON NOVELTY.** Interesting modern ornamental kit \$1-65.

**INDICATOR AUDIBLE WARNING.** Add this audible warning device to car indicators or dash panel warning lights and your attention will be instantly drawn to the warning lamp kit. \$1-50.

**FIGHT LIGHT SWITCH.** A simple control to dim a lamp. Kit \$1-10.

**GENERAL PURPOSE AMPLIFIER.** An audio amplifier of reasonable quality for use with radio tuners and audio oscillators, record decks electric guitars, etc. Kit \$4-00.

**HOME INTERCOM.** Keep in touch with this simple, easily connected good quality two way intercom. Kit \$4-00.

**FLASHING LIGHT METRONOME.** For use in the musical field and the laboratory where an audible not on click could get lost or become annoying. Kit \$1-40.

**MIMI ORGAN.** A three octave, stylus operated organ neatly and simply constructed on a printed circuit board. Kit \$4-75.

**RAIN ALARM II.** Sounds an audible alarm as soon as the first rain drops fall. Kit \$2-00.

**CASSETTE AMPLIFIER.** Boosts the output from cassette tape recorders and transistor radios. Kit \$4-50.

**AUDIO SIGNAL MIXER.** Where you want to mix speech and music, and to fade them in and out to tape - enthusiast should be without this. Kit \$3-90.

**AUTO FAN.** A thermostatic control for car engine fan, gives quicker warming up time, etc. Kit \$3-55.

**SLAVE FLASH.** Photos taken with a single flash have a "flat" appearance - a second flash correctly positioned overcomes this. This unit enables a second (or third) flash to be automatically triggered. Kit \$1-25.

**ELECTRONIC DOORBELL.** Not in fact a bell but an electronic circuit that produces an unusual sound when the button is pressed. Kit \$4-00.

**WAA WAA.** Add another sound dimension to your guitar or organ. Kit \$1-50.

**I.C. RADIO.** A simple personal radio using a special I.C., is small, easy to build, yet gives excellent results. Kit \$3-10.

**AQUARIUM THERMOSTAT.** A very sensitive electronic thermostat. Can also be used for other applications requiring fine control of temperature. Kit \$3-85.

**TRAIN CONTROLLER.** With most control there is considerable loss of power on low speeds - this unit overcomes this problem and makes slow speed realistic. Kit \$3-15.

**3 GANG TUNING CONDENSERS.** 500pF each section ideal for transmitter or communications receiver. \$1-95.

**STEREO HEADPHONE ADAPTER.** Enables one or two sets of stereo headphones to be used with an amplifier. \$1-85.

**4 BAND TRF RECEIVER.** Receives amateur, shipping and normal medium wavebands. \$3-95.

**GAS ALARM.** A simple alarm detects gas, vapours and smoke. \$2-99.

**3 BY 3 GAME.** Adds fun to any game which uses dice, or is novel game for two players. \$2-10.

**AUTO-WATERING FOR PLANTS \$2-80.**

**TREMELO UNIT \$2-10.**

**BABY SWATCH ALARM \$2-00.**

**OUR 1974 CATALOGUE LISTING HUNDREDS OF BARGAINS. NOW AVAILABLE. PRICE 30p. POST PAID.**

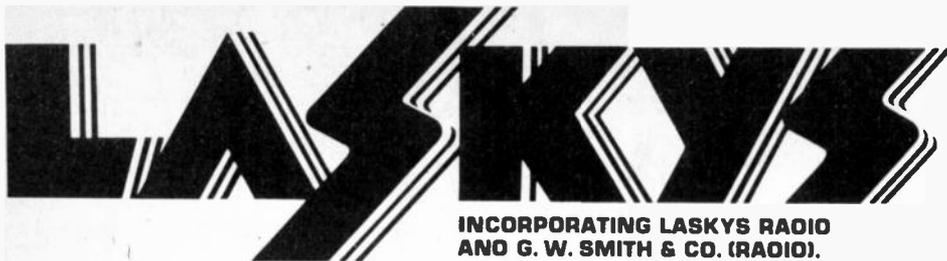
**RECORD PLAYBACK HEADS (TRUVOX)**

Individual prices of these are:  
2 track record playback heads 50p each  
4 track record playback heads 75p each.  
Erase heads are also available separately...  
2 track 33p 4 track 55p

**RESETTABLE FUSE**  
How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at 1¢ per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Only £1-10 each or £12 per dozen, specify 5, 10 or 15 amp - simply fit in place of switch.

**HEATERS AND ELEMENTS**  
Tangential Heater Unit, 2KW, price \$2-75 plus 40p post, etc. Tangential Heater Unit, 3KW, price \$3-85 plus 40p post, etc. Control Switch for above 44p each. 300 watt Heat and Light Lamp, price 99p plus 25p post. 5KW Blower Heater, price \$19-10. 1000 watt Heat and Light Tube (Mullard) with special holder and terry clips, price \$2-20 plus 30p post. 2000 watt Mouldable Metal Chad Element, 8 ft. long - \$1-10. Radiant Cooker Rings, 2000 watt, 83p each 1000 watt Fire Spirals, 22p each. 750 watt Flat Elements, 83p each. Black Heat Element Metal Chad 900 watt 14" x 11" - 83p each. Oven Element Metal Chad, 2000 watt, "W" shaped, 14 1/2" long x 9" wide 83p each.

**NEED A SPECIAL SWITCH**  
Double Leaf Contact. Very slight pressure closes both contacts. 8p each 10 for 80p. Plastic pushrod suitable for operating. 6p each. 10 for 54p.



**INCORPORATING LASKYS RADIO  
AND G. W. SMITH & CO. (RADIO).**

**AUDIOTRONIC Model ATM1**

Top value 10,000  $\mu$ pr pocket multi-meter. Ranges - 0/10/50/250/1,000 volt AC and DC. DC current 0.1mA/100mA. Resistance 0/150k ohms. Decibels -10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.



**OUR PRICE £2.95** P&P 15p

**AUDIOTRONIC Model ATM5**

Jewel movement, extrinsically moulded case with advance ohms adjustment. Ranges: 0.3/15/150/300/1200V AC, 1250V DC, 300/600V DC, 5000  $\mu$ pr, 0.300 uA/0.300mA DC. Resistance:  $\times 10$  to  $\times 100$ . -10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.



**OUR PRICE £3.50** P&P 15p

**MODEL TE200**

20,000  $\mu$ pr. Mirror scale, overload protection. 0/5/25/250/1000V DC, 0/10/50/250/1000V AC, 0.5/50A/10A. Resistance: 20 to +82dB.



**OUR PRICE £4.95** P&P 15p

**MODEL U437 MULTIMETER**

10,000  $\mu$ pr. A first class instrument manufactured in USSR to the highest standards. Ranges: 2.5/10/50/250/500/1000V DC, 2.5/10/50/250/500/1000V AC, DC current 1000  $\mu$ A/1/10/100mA/1A. Resistance 300 ohms. Complete with batteries, test leads, instructions and a sturdy steel carrying case.



**OUR PRICE £4.95** P&P 25p

**MODEL TH12**

20,000  $\mu$ pr. Overload protection. Slide switch selector. 0/10/25/50/150/1000V DC, 0/10/50/250/1000V AC, 0/500A/25/250mA DC, 0/3k/30k/300k/3 Megohms. -20 to +0.5k.



**OUR PRICE £5.95** P&P 15p

**HIDKI MODEL 720X VOM**

A versatile, accurate measuring instrument. 20,000  $\mu$ pr. 0/5/25/100/500/1000V DC, 0/10/50/250/1000V AC, 0-20k/2 Megohms.



**OUR PRICE £5.97** P&P 20p

**TMK MODEL TW50K**

46k ranges, mirror scale. 50kV AC, 500V/1A DC. DC Volt: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volt: 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50/100/250/500/1000V AC, 2.5/5/10/25/50/100/250/500V DC. Accuracy 4%. Size 283 x 84 x 36mm. Complete with carrying case, leads and fuses.



**OUR PRICE £10.50** P&P 20p

**MODEL C7000EN**

Giant 8" mirror scale, 20,000  $\mu$ pr. 0/0.25/1/2.5/10/50/250/1000V DC, 0/500V AC, 0/500A/10A/100/500mA/10A. DC, 0/2k/200k/20 Meg. -20 to +50dB.



**OUR PRICE £13.95** P&P 35p

**U4323 MULTIMETER**

20,000  $\mu$ pr. Sample unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/1000V DC, 2.5/10/15/250/1000V AC, 0.05/0.5/5/50/500mA DC. Resistance 5/50/500 ohms/5/10/100k ohms/1Meg. Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.



**OUR PRICE £7.00** P&P 20p

**MODEL TE300**

30,000  $\mu$ pr. Mirror scale. Overload protection. 0/0.6/3/15/30/300/1200V DC, 0/6/30/120/600/1200V AC, 0.300A/6mA/60mA/300mA/600mA. 0/3k/50k/800k/8 Meg ohms. -20 to +83dB.



**OUR PRICE £7.50** P&P 15p

**U4324 MULTIMETER**

High sensitivity, overload protected. Ranges: 20,000  $\mu$ pr. 0.6/1.2/3/12/30/60/120/600V DC, 0.6/3/15/60/150/300/600/900V AC. Current: 0.00/0.6/6/60/600mA/3A DC. Resistance: 25/500 ohms/0.5/5/50/500k ohms/5 Megohms. Decibels: -10 to +12dB. Size 167 x 63mm. Supplied complete with test leads, spare diode and instructions.



**OUR PRICE £8.00** P&P 20p

**U435 MULTIMETER**

20,000  $\mu$ pr. Overload protected. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC, 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC, 0.3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.



**OUR PRICE £8.75** P&P 20p

**U4312 MULTIMETER**

Extremely sturdy instrument for general electrical use. 667  $\mu$ pr. Ranges: 0/1.5/7.5/30/60/150/300/600/900V DC & 75mV/0.1/0.3/1.5/7.5/30/60/150/300/600/900V AC, 0/300A/1.5/6/15/150/600/1A/1.5/5/6A DC, 0/1/5/15/1A AC, 1.5/6A AC, 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.



**OUR PRICE £9.75** P&P 25p

**U91 Clamp VOLT AMMETER**

For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current 10/25/100/250/500A. Accuracy 4%. Size 283 x 84 x 36mm. Complete with carrying case, leads and fuses.



**OUR PRICE £10.50** P&P 20p

**MODEL C7000EN**

Giant 8" mirror scale, 20,000  $\mu$ pr. 0/0.25/1/2.5/10/50/250/1000V DC, 0/500V AC, 0/500A/10A/100/500mA/10A. DC, 0/2k/200k/20 Meg. -20 to +50dB.



**OUR PRICE £13.95** P&P 35p

**MODEL 500**

30,000  $\mu$ pr with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC, 0/2.5/10/25/100/250/500/1000V AC, 0.05/0.5/5/50/500mA DC, 0.5/50A/5/50/500mA, 12A DC, 0/60k/8 Meg ohms.



**OUR PRICE £10.95** Carr. paid

**KAMODEN 360 MULTIMETER**

High sensitivity DC 100k ohm/V AC 10k ohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC, 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100k ohms/10/100M ohms. Decibels: -20 to +82dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with test leads etc.



**OUR PRICE £13.95** P&P 25p

**HIDKI MODEL 700X**

100,000  $\mu$ pr. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC, 0.6/3/15/60/150/300/600/1200V AC, 15/300A/3/6/30/60/150/300A/5/6/12A DC, 25/200k/2k/20k ohms. -20 to +83dB.



**OUR PRICE £14.95** P&P 20p

**KAMODEN HM720B FET VOM**

Input impedance 10 Megohms. Ranges: 0/25/125/625/1000V DC, 0/2.5/10/50/250/1000V AC, 0/25uA/2.5/25/250 mA DC, 0/5k/50k/500k/5M 500 Megohms.



**OUR PRICE £14.95** P&P 30p

**TMK MODEL 117 FET ELECTRONIC VOLT METER**

Battery operated. 11 Meg input, 26 ranges. 0/1.5/7.5/30/60/150/300/600/900V DC & 75mV/0.1/0.3/1.5/7.5/30/60/150/300/600/900V AC, 0/300A/1.5/6/15/150/600/1A/1.5/5/6A DC, 0/1/5/15/1A AC, 1.5/6A AC, 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with leads and instructions.



**OUR PRICE £17.50** P&P 20p

**KAMODEN 72200 Multitester**

High sensitivity. 200,000  $\mu$ pr. Overload protected. Mirror scale. Ranges: -0/0.00/3/30/120/600/1200V DC, 0/3/12/60/120/600/1200V AC, 0/50uA/1.2mA/100mA/600mA/12A DC, 0/12A AC, -20 to +83dB, 0/2k/200k/20 Meg/50k ohms.



**OUR PRICE £16.95** P&P 30p

**370WTW MULTIMETER**

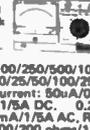
Features AC current ranges. 20,000  $\mu$ pr. 0/0.5/2.5/10/50/250/500/1000V DC, 0/2.5/10/25/100/250/500/1000V AC, 0/500A/1/10/100mA/10A/100/500mA/10A. DC, 0/5k/50k/500k/5 Meg/50 Meg. Decibels: -20 to +82dB.



**OUR PRICE £17.50** P&P 25p

**U4317 MULTIMETER**

High sensitivity instrument for field and laboratory work. Knife edge pointer. 85mm. mirror scale. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000V DC, 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1.5A DC, 0.25/0.5/1/5/10/50/250mA/1.5A AC, Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: -5 to +10dB. Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.



**OUR PRICE £15.00** P&P 20p

**TE40 HIGH SENSITIVITY AC VOLT METER**

10 Meg input. 10 ranges: 0.001/0.03/0.1/0.3/1/3/10/30/100/300V RMS. Scale: -1.2MHz. -40 to +50dB supplied brand new complete with leads and instructions.



**OUR PRICE £17.50** P&P 25p

**TE65 VALVE VOLTMETER**

26 ranges. DC volts 1.5-1500V. AC volts 1.5-1500V. Resistance up to 1000 Megohms. 200/240V AC operation. Complete with probe and instructions.



**OUR PRICE £17.50** Additional probe available RF £2.12, HV £2.60

**TMK LAB TESTER**

100,000  $\mu$ pr. 6 1/2" scale. Buzzer short circuit switch. Sensitivity 100,000  $\mu$ pr DC, 5kV/1 AC. DC V: 0/0.2/5/10/50/250/1000V AC, 3/10/50/250/500/1000V DC, current 10/100uA/10/100/1000mA/2.5/10A. Resistance: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: -10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 90mm.



**OUR PRICE £19.95** P&P 25p

**MODEL U4311 Sub-standard Multi-range Volt-Ammeter**

Sensitivity 333 Ohms/Volt AC and DC. Accuracy 0.5%. DC, 1% AC. Scale length: 165mm. 0/380/750uA/1.5/3/7.5/15/30/75/150/300/150/300/750mA/1.5/3/7.5A DC, 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificate.



**OUR PRICE £49.00** P&P 50p

**LB3 TRANSISTOR TESTER**

Tests IGO and B. PNP/NPN. Operates from 9V battery. Complete with all instructions etc.



**OUR PRICE £3.95** P&P 20p

**LB4 TRANSISTOR TESTER**

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.



**OUR PRICE £4.50** P&P 20p

**U4341 MULTIMETER TRANSISTOR TESTER**

27 ranges. 16,700  $\mu$ pr. Overload protected. Ranges: 0.3/1.5/8/30/60/150/300/600V DC, 1.5/7.5/30/150/300/750V AC. Current: 0.05/0.5/5/60/600mA DC, 0.3/3/30/300mA AC. Resistance: 0.05/0.5/2/20/200k ohms/2 Megohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.



**OUR PRICE £10.50** P&P 20p

**KAMODEN HM350 TRANSISTOR TESTER**

High quality instrument to test reverse leak current and DC current. Features: 4" square identification factor of PNP, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.



**OUR PRICE £12.50** P&P 30p

**S100TR MULTIMETER - TRANSISTOR TESTER**

100,000  $\mu$ pr. Mirror scale. Overload protection. 0/0.1/2/0.6/3/12/30/120/600V DC, 0.6/3/30/120/600V AC, 0/12/600uA/12/300mA/12A DC, 0/10k/1 Meg/100 Meg. -20 to +50dB, 0.01-0.2 MFD. Transistor tester measures Alpha, Beta and ICG etc. Complete with instructions, batteries and leads.



**OUR PRICE £14.95** P&P 25p

**Model 449A In Circuit TRANSISTOR TESTER**

Checks true AC. Beta in/out. Checks ICG. Checks diodes in/out. Checks SCR etc. 100 Meg. 0.2-500V. ICO 0-240 V AC operation.



**OUR PRICE £17.50** P&P 25p

**KAMODEN HMG500 insulation resistance tester**

Range 0-1000 Megohms. 500V Battery operated. Wide range clear meter 4" x 4". Complete with deluxe carrying case, batteries and instructions.



**OUR PRICE £19.95** P&P 30p

**TE16A TRANSISTORISED SIGNAL GENERATOR**

5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 148 x 148 x 92mm. Complete with instructions and leads.



**OUR PRICE £8.97** P&P 25p

**TE22 SINE SQUARE WAVE AUDIO GENERATOR**

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedance 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.



**OUR PRICE £17.50** P&P 37p

**ARF 300 AF/RF SIGNAL GENERATOR**

All transistorised compact fully portable. AF sine wave 18Hz to 220 kHz. AF square wave 18Hz to 100kHz. Output Square/Sine wave 10V. P.P. RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.



**OUR PRICE £29.95** P&P 50p

**ALL PRICES EXCLUDE VAT**

# NEW

INCORPORATING LASKY'S RADIO  
AND G. W. SMITH & CO. (RADIO).

Send s.a.e. for 8 page list of  
Semi-Conductors & Valves

## NEW SINCLAIR PROJECT 80 HI-FI MODULES & PACKAGES

240 Power Amplifier.....	£5.45
280 Power Amplifier.....	£5.95
Stereo 80 Pre-Amplifier.....	£11.95
Active Filter Unit.....	£6.95
Project 80S.....	£26.95
P26 Power Supply.....	£4.98
P28 Power Supply.....	£7.98
2 x 240/Stereo 80/P26.....	£25.00
2 x 280/Stereo 80/P28.....	£27.75
2 x 240/Stereo 80/P28.....	£30.45
Transformer for P26.....	£4.05
POST & PACKING 35p each	

**AT201 Oscade  
ATTENUATOR**  
Frequency range 0-  
200kHz. Attenuator  
0-111dB, 0.1dB  
steps. Impedance 600 ohms. Input  
power maximum 30dBm. Size: 180 x  
90 x 65mm.

**OUR PRICE £12.50** P&P 37p

**BELCO Sine Square Wave  
CR OSCILLATOR**  
Sine 18 x 200,000Hz  
Square 18 x 20,000  
Hz. Maximum out-  
put +10dB (10k  
ohms) Operates  
from internal batteries. Attractive two  
tone case. Size: 180 x 127 x 50mm

**OUR PRICE £17.50** P&P 17p

**SWR METER MODEL SWR3**  
Handy SWR meter for  
transmitter antenna alignment,  
with built-in field  
strength meter. Accuracy  
5%. Impedance 52 $\Omega$  Indicator  
100uA DC. Full  
scale 5 section collapsible  
antenna. Size 145 x 50 x  
60mm.

**OUR PRICE £4.25** P&P 26p

**MODEL TE15  
GRID DIP METER**  
Transistorized. Operates  
as Grid Dip.  
Oscillator, Absorption  
Wave Meter and  
Oscillating Detector.  
Frequency range  
440kHz-280MHz  
in six coils. 500uA  
meter. 9V battery  
operation. Size:  
180 x 80 x 40mm.

**OUR PRICE £15.00** P&P 20p

**BYOS Vernier TUNING DIAL**  
App. 7:1 ratio planetary  
drive vernier dial. Log  
scale 0-180 degrees.  
Blank scales 1  
Dial size 128 x 76mm. Overall size  
190 x 117 x 41mm, deep including  
knob and coupling. 1/2" diam. shaft

**OUR PRICE £1.62** P&P 15p

**YAMABISHI VARIABLE  
VOLTAGE TRANSFORMERS**  
Excellent quality at low cost.  
All models—Input 230V 50/60Hz.  
Variable output 0-260V  
MODEL S280 GENERAL PURPOSE  
BENCH MOUNTING

1A	£8.75	30p
2.5A	£10.00	36p
5A	£14.70	37p
8A	£26.50	57p
10A	£28.10	75p
12A	£28.50	102p
20A	£72.50	126p
25A	£72.50	130p
40A	£103.10	150p

MODEL S2608  
2.5A £8.75 30p  
1A £10.00 35p

**POWER RHEOSTATS**  
High quality ceramic  
construction. Windings  
embedded in  
vitreous enamel.  
Heavy duty brush  
wiper. Continuous  
rating. Wide range  
available ex-stock.  
Single hole fitting. 1/2" diameter shafts.  
Bulk quantities available.

25 WATT 10/25/50/100/250/500/  
1000 Ohms. £1.15 P&P 10p

50 WATT 10/25/50/100/250/500/  
1000/2500/5000 Ohms.  
£1.62 P&P 10p

100 WATT 1/5/10/25/50/100/250/  
500/1000/2500 Ohms.  
£2.34 P&P 15p

**RUH6 Reflex Horn Speaker**  
Built-in driver  
unit. Impedance  
16 ohms. Power  
rating 10W.  
Response 380-  
7000Hz. Size  
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Weather and  
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200uA	£3.30		
500uA	£3.25		
50-0-500uA	£3.35		
100-0-100uA	£3.30		
1mA	£3.20		
5mA	£3.20		
10mA	£3.20		
50mA	£3.20		
100mA	£3.20		
500mA	£3.20	20V DC	£3.20
1A DC	£3.20	300V DC	£3.20
5A DC	£3.20	15V AC	£3.30
10A DC	£3.20	300V AC	£3.30
5V DC	£3.20	VU Meter	£3.45



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50uA	£3.75		
100uA	£3.70		
200uA	£3.65		
500uA	£3.45		
50-0-500uA	£3.75		
100-0-100uA	£3.70		
1mA	£3.40		
5mA	£3.40		
10mA	£3.40		
50mA	£3.40	10V DC	£3.40
100mA	£3.40	20V DC	£3.40
500mA	£3.40	50V DC	£3.40
1A DC	£3.40	300V DC	£3.40
5A DC	£3.40	15V AC	£3.85
10A DC	£3.40	300V AC	£3.85
5V DC	£3.40	VU Meter	£3.85



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Size: 86 x 78mm

50uA	£4.10		
100uA	£3.45		
200uA	£3.35		
500uA	£3.35		
50-0-500uA	£3.45		
100-0-100uA	£3.40		
500-0-500uA	£2.85		
1mA	£2.85		
5mA	£2.85		
10mA	£2.85		
50mA	£2.85		
100mA	£2.85		
500mA	£2.85	50V AC	£3.10
1A DC	£2.85	150V AC	£3.10
5A DC	£2.85	300V AC	£3.10
10A DC	£2.85	500V AC	£3.10
15A DC	£2.85	S Meter 1mA	£3.15
20A DC	£2.85	VU Meter	£4.10
30A DC	£3.10	1A AC	£2.85
50A DC	£3.20	5A AC	£2.85
5V DC	£2.85	10A AC	£2.85
10V DC	£2.85	20A AC	£2.85
20V DC	£2.85	30A AC	£2.85
50V DC	£2.85	50A AC	£2.85
150V DC	£2.85	100A AC	£2.85
300V DC	£2.85	200A AC	£2.85
18V AC	£3.10	500A AC	£2.85



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Size: 100 x 80mm

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500uA	£4.10		
50-0-500uA	£4.35		
100-0-100uA	£4.30		
1mA	£3.85		
1A DC	£3.85		
5A DC	£3.85		
20V DC	£3.95		
50V DC	£3.95	300V AC	£4.00
300V DC	£3.95	VU Meter	£4.75



## CLEAR PLASTIC MODEL 45P

Size: 50 x 50mm

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100uA	£2.75		
200uA	£2.75		
500uA	£2.70		
50-0-500uA	£2.90		
100-0-100uA	£2.75		
500-0-500uA	£2.65		
1mA	£2.65		
5mA	£2.65		
10mA	£2.65		
50mA	£2.65	300V AC	£2.70
100mA	£2.65	S Meter 1mA	£2.75
500mA	£2.65	VU Meter	£3.00
1A DC	£2.65	1A AC	£2.65
5A DC	£2.65	5A AC	£2.65
10V DC	£2.65	10A AC	£2.65
20V DC	£2.65	20A AC	£2.65
50V DC	£2.65	30A AC	£2.65
15V AC	£2.70	30A AC	£2.65



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500uA	£3.50		
50-0-500uA	£3.95		
100-0-100uA	£3.95		
1mA	£3.50		
300V AC	£3.50		
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50V DC	£8.55	5V/50V DC	£7.70
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50V DC	£8.55	1A/15A DC	£7.70



## CLEAR PLASTIC MODEL 38P

Size: 42 x 42mm

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200uA	£2.65		
500uA	£2.50		
50-0-500uA	£2.75		
100-0-100uA	£2.65		
500-0-500uA	£2.50		
1mA	£2.50		
1-0-1mA	£2.50		
2mA	£2.50		
5mA	£2.50		
10mA	£2.50		
50mA	£2.50		
100mA	£2.50	15V DC	£2.50
200mA	£2.50	20V DC	£2.50
300mA	£2.50	50V DC	£2.50
500mA	£2.50	100V DC	£2.50
750mA	£2.50	150V DC	£2.50
1A DC	£2.50	300V DC	£2.50
2A DC	£2.50	500V DC	£2.50
5A DC	£2.50	15V AC	£2.55
10A DC	£2.50	50V AC	£2.55
15A DC	£2.50	150V AC	£2.55
20A DC	£2.50	300V AC	£2.55
30A DC	£2.50	500V AC	£2.55
10V DC	£2.50	S Meter 1mA	£2.55
10V DC	£2.50	VU Meter	£2.90



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Size: 80 x 60mm

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100uA	£3.30		
500uA	£2.90		
50-0-500uA	£3.35		
100-0-100uA	£3.25		
1mA	£2.75		
5mA	£2.75		
10mA	£2.75		
50mA	£2.75		
100mA	£2.75		
500mA	£2.75		
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300V AC	£2.85	30A AC	£2.75



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200uA	£4.45		
500uA	£4.30		
50-0-500uA	£4.70		
100-0-100uA	£4.45		
500-0-500uA	£4.30		
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1-0-1mA	£4.30		
5mA	£4.30		
10mA	£4.30		
50mA	£4.30		
100mA	£4.30	300V DC	£4.30
500mA	£4.30	15V AC	£4.35
1A DC	£4.30	300V AC	£4.35
5A DC	£4.30	S Meter 1mA	£4.30
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50V DC	£4.30	20A AC	£4.30
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200uA	£3.00		
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50-0-500uA	£3.10		
100-0-100uA	£3.05		
1mA	£2.85		
5mA	£2.85		
10mA	£2.85		
50mA	£2.85		
100mA	£2.85		
500mA	£2.85	10V DC	£2.85
1A DC	£2.85	50V DC	£2.85
5A DC	£2.85	300V DC	£2.85
10A DC	£2.85	15V AC	£3.00
1A DC	£2.85	300V AC	£3.00
5V DC	£2.85	VU Meter	£3.20



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Size: 80 x 80mm

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100uA	£3.30		
500uA	£3.00		
50-0-500uA	£3.35		
100-0-100uA	£3.30		
500-0-500uA	£2.85		
1mA	£2.85		
1-0-1mA	£2.85		
5mA	£2.85		
10mA	£2.85		
50mA	£2.85		
100mA	£2.85		
500mA	£2.85		
1A DC	£2.85		
2A DC	£2.85		
5A DC	£2.85		
15A DC	£2.85		
50A DC	£2.85		
5V DC	£2.85		
10V DC	£2.85		
50V DC	£2.85		
150V DC	£2.85		
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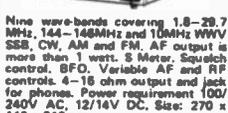
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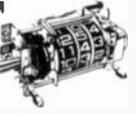
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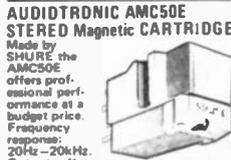
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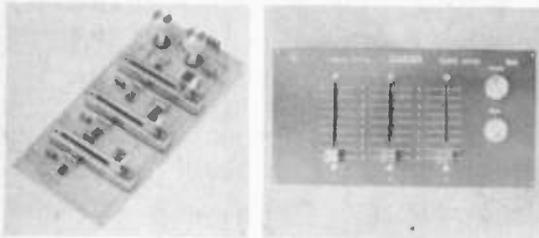


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# Amplify your interest in Electronics!

Now you can take an even greater and wider interest in electronics with the help of PRACTICAL ELECTRONICS, Everyday Electronics' associate magazine.

An authoritative pace-setter in the field of applied electronics, PRACTICAL ELECTRONICS is widely read by professional technicians and engineers as well as students who all find it an invaluable source of information relating to both practical and theoretical matters.

## Don't miss this New beginner's series

### **First steps in Circuit Design**

Starting in April This important new series will enable even the novice to start learning how to design circuits from scratch. This additional ability will double the enjoyment to be derived from the exciting hobby of electronics.

## Also one of the projects in the April issue...

### **Liquid Crystal Alarm Clock**

Mains operated clock with an attractive liquid crystal display - the very latest in readout systems. An exciting project for the more experienced constructor.

## Special pull-out feature

### **Camera Electronics**

A special survey of electronic aids found in commercially available automatic and semi-automatic cameras. Well worth looking into!

**PRACTICAL  
ELECTRONICS**

## April issue out mid-March\*

25p

Place a regular order for Practical Electronics and Everyday Electronics every month with your newsagent!

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

# 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.

### The 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.

### Features of the Sinclair Cambridge

- \* Uniquely handy package.  $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$ , weight  $3\frac{1}{2}$  oz.
- \* Standard keyboard. All you need for complex calculations.
- \* Clear-last-entry feature.
- \* Fully-floating decimal point.
- \* Algebraic logic.
- \* Four operators (+, -, x, ÷), with constant on all four.
- \* Constant acts as last entry in a calculation.
- \* Constant and algebraic logic combine to act as a limited memory, allowing complex calculations on a calculator costing less than £30.
- \* Calculates to 8 significant digits, with exponent range from  $10^{-20}$  to  $10^{79}$ .
- \* Clear, bright 8-digit display.
- \* Operates for weeks on four U16-type batteries. (MN 2400 recommended.)



# A complete kit!

The kit comes to you packaged in a heavy-duty polystyrene container. It contains all you need to assemble your Sinclair Cambridge. Assembly time is about 3 hours.

**Contents:**

1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



**This valuable book – free!**

If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

But if you want to get even more out of it, you can go one step further and learn how to unlock the full potential of this piece of electronic technology.



How? It's all explained in this unique booklet, written by a leading calculator design consultant. In its fact-packed 32 pages it explains, step by step, how you can use the Sinclair Cambridge to carry out complex calculations.

# sinclair

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Everyday Electronics, March 1974

**Why only Sinclair can make you this offer**

The reason's simple: only Sinclair – Europe's largest electronic calculator manufacturer – have the necessary combination of skills and scale.

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But that in itself wouldn't be enough. Sinclair also have a very long experience of producing and marketing electronic kits. You may have used one, and you've almost certainly heard of them – the Sinclair Project 60 stereo modules.

It seemed only logical to combine the knowledge of do-it-yourself kits with the knowledge of small calculator technology.

And you benefit!

**Take advantage of this money-back, no-risks offer today**

The Sinclair Cambridge is fully guaranteed. Return your kit within 10 days, and we'll refund your money without question. All parts are tested and checked before despatch – and we guarantee a correctly-assembled calculator for one year.

Simply fill in the preferential order form below and slip it in the post today.

**Price in kit form: £24.95 + £2.50 VAT. (Total: £27.45)**

**Price fully built: £29.95 + £3.00 VAT. (Total: £32.95)**

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Please send me

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# everyday electronics

## CLASS DISTINCTION

Things aren't always what they appear to be. This certainly applies in the case of electronic circuits. For example, when trying to classify projects into "simple" or "complex" just what criteria does one apply? A cursory inspection of a circuit diagram and a count of the components does not necessarily provide a true guide, especially where integrated circuits (i.c.'s) are included.

Clearly there are two different methods by which an electronic project can be "weighed." One is by considering, in its entirety, the electronic system involved. This provides an instructive insight into the fundamental principles upon which the project is based, and certainly is a rewarding exercise for the serious student.

The second method relies upon consideration of the purely material form of the project, and is based essentially upon the number and nature of the components employed. For the general constructor this is the more realistic yardstick to adopt. The degree of complexity in actual building terms is, after all, the most important factor he is concerned with, apart from cost.

But, in the end, is there any significant difference between these two methods of project appraisal, it might be asked. Well the difference is very real. And it is increasing by leaps and bounds thanks to the wider use of integrated circuits. More circuit complexity in fundamental design, but without corresponding increase in constructional work. It may seem impossible, but it is really true.

As a case in point, take a look at this month's *Speed Guard*. In purely electronic terms the system employed is of a reasonably complex nature, and the diagrams may be a little off-putting to the less experienced. But further inspection reveals that the complexity lies mainly within the two i.c.'s. These components (complete circuits or building blocks in their own right) can be viewed quite simply as black boxes. Their internal operation can be taken for granted. To the constructor they are just other components.

The more theoretically minded may shrink from this pragmatic approach. But it makes sense for the average person who wants to utilise and enjoy electronics in the fullest manner possible.

*Fred Bennett*

*Our April issue will be published on Friday, March 15*

EDITOR F. E. Bennett ● ASSISTANT EDITOR M. Kenward ● B. W. Terrell B.Sc.  
ART EDITOR J. D. Pountney ● P. A. Loates ● K. A. Woodruff  
ADVERTISEMENT MANAGER D. W. B. Tilleard

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# AUDIO FREQUENCY OSCILLATOR

Features variable output level and frequency continuously variable from 10 to 10,000Hz.

**P**RACTICAL construction projects often involve checking out various parts of the circuit to see if they are working properly. An Audio Frequency Oscillator and a pair of earphones can be used for testing circuits for amplification. Although the oscillator described in this article is very simple to build, it gives a very useful range of frequency and voltage. It uses any supply voltage between 18 and 30 volts, its output being virtually unaffected by the voltage of the supply. The *Power Supply Unit* described in last month's issue provides a suitable source. The unit employs an integrated circuit which gives a simple, but high quality oscillator.

## THE INTEGRATED CIRCUIT

The integrated circuit comprises a high gain amplifier with two inputs; pin 2 is a negative feedback input and pin 3 is a signal input, the negative feedback controls the gain. The principle of this amplifier is illustrated in Fig. 1.

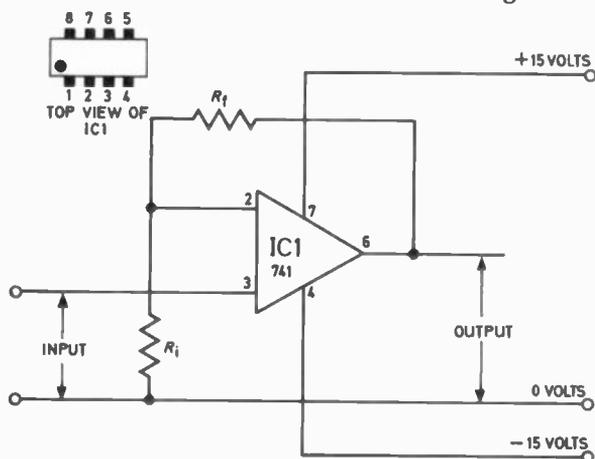
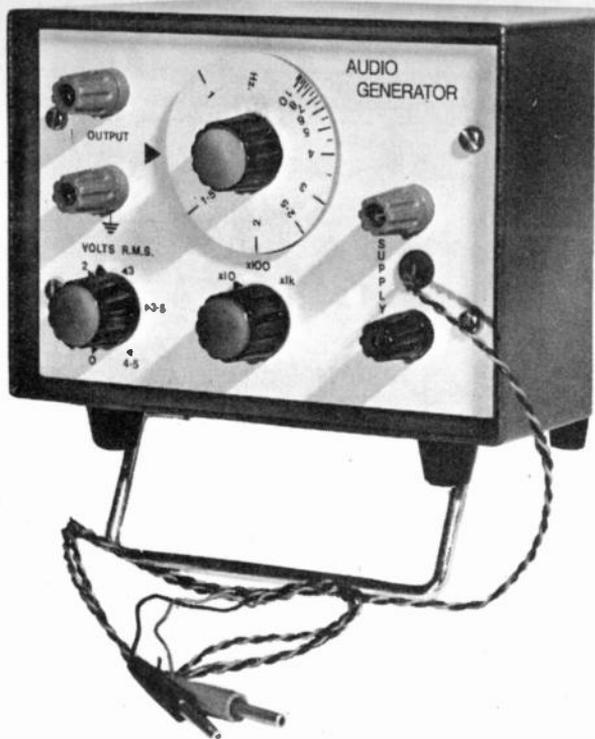


Fig. 1. A fundamental configuration for the 741 when used as an amplifier.



The ratio of resistors  $R_f$  and  $R_i$  sets the gain which may have any value from 2 to 100, according to the formula:

$$\text{Gain} = 1 + \frac{R_f}{R_i}$$

Note:  $R_i$  must always be greater than 500 ohms.

If both  $R_i$  and  $R_f$  were 1 kilohm, then the gain would be 2. However, if  $R_f$  was increased to 100 kilohm then the gain would be 101. By this means the integrated circuit may be used in a variety of different circuits requiring an amplifier. On no account should any connection be made to pins 1 and 5 as they are connected internally.

## THE OSCILLATOR

The complete circuit diagram of the oscillator which incorporates the integrated circuit is shown in Fig. 2. This particular oscillator is called a *Wien Bridge Oscillator*. The ratio of  $R_4$  and thermistor  $R_{TH1}$  in series with  $R_5$  determines the gain according to the above formula.

The thermistor  $R_{TH1}$  is a vital component, without which the oscillator will not function. The thermistor in this circuit stabilises the out-



**Approximate cost  
of components  
including V.A.T.**

**£6.60 plus case**

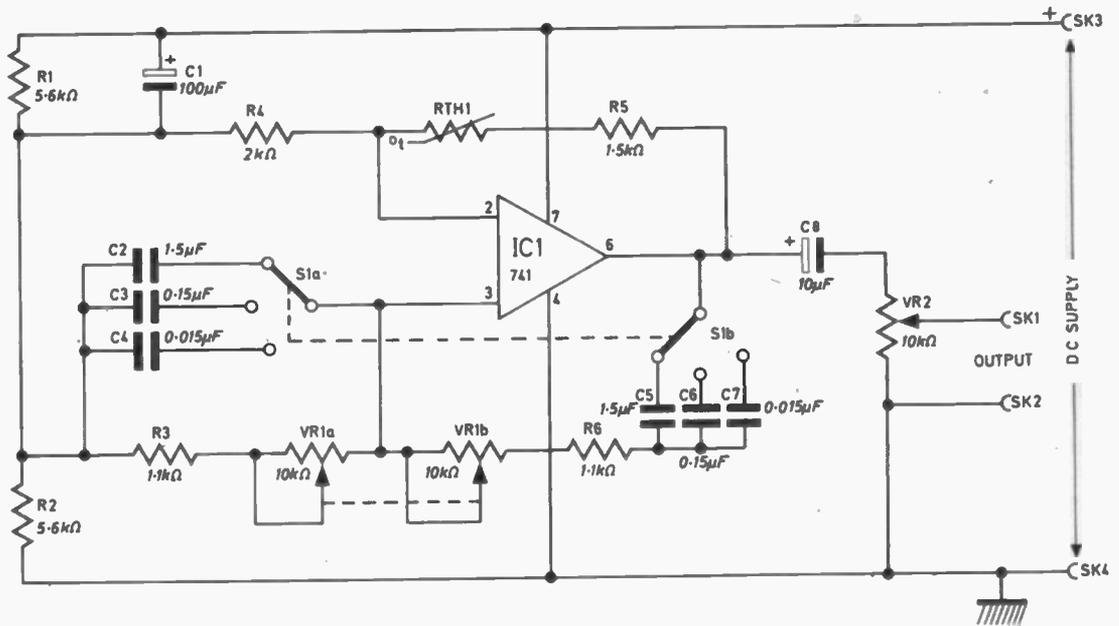


Fig. 2. The complete circuit diagram of the Audio Frequency Oscillator.

put oscillation, exchanging it for a resistor produces a distorted output signal.

With S1 in the x10 position the feedback from the output through C5, R6 and the twin gang potentiometer VR1 to pin 3 of the integrated circuit produces oscillation. With this network positive feedback occurs at one frequency only. The frequency corresponding to the minimum setting of VR1 is given by the formula below.

$$\text{Frequency} = \frac{1}{2\pi C_5 R_6}$$

This is the higher frequency, 100Hz, on this range of the switch S1.

When VR1 is turned to its maximum resistance, the minimum frequency is given by

$$\text{Frequency} = \frac{1}{2\pi C_5 (R_6 + VR_1)}$$

giving 10Hz.

On the other two ranges, (a) x100, (b) x1000 the minimum and maximum frequencies are (a) 100Hz and 1000Hz, (b) 1000Hz and 10,000Hz respectively.

Incorporating R1, C1 and R2 into the circuit enables the oscillator to work from a single supply, and so makes it possible to use the *Power Supply Unit* described in last month's issue. When using the latter to supply power to the Audio Frequency Oscillator be sure to connect the *negative* terminal to earth.

The oscillator output is coupled via C8 to potentiometer VR2 which adjusts the signal output from zero to about 4.5V r.m.s.

## Components....

### Resistors

- R1 5.6kΩ
  - R2 5.6kΩ
  - R3 1.1kΩ
  - R4 2kΩ
  - R5 1.5kΩ
  - R6 1.1kΩ
- All ¼W ±10% carbon

### Potentiometers

- VR1 10kΩ ± 10kΩ twin ganged semi-precision eg. Colvern CLR 4049/15 or /18
- VR2 10kΩ linear

### Capacitors

- C1 100μF 25V elect.
  - C2 1.5μF
  - C3 0.15μF
  - C4 0.015μF
  - C5 1.5μF
  - C6 0.15μF
  - C7 0.015μF
  - C8 10μF 25V elect.
- } 2% or 5%

### Miscellaneous

- RTH1 thermistor type R54
- IC1 741 differential operational amplifier 8 pin d.i.l.
- S1 two-pole three-way rotary
- SK1, 2, 3, 4 screw terminal/socket, one black, one green, two red (4 off) Veroboard 0.1in. matrix 24 strips × 44 holes; Veropins (6 off); 8 pin d.i.l. socket; knobs (3 off); aluminium sheet for dial; rubber grommet; 6BA nuts, bolts, washers and stand-off pillars.

SEE  
**SHOP  
TALK**

## CONSTRUCTION DETAILS

The prototype Audio Frequency Oscillator was housed in an identical instrument case to that used for the *Power Supply Unit* featured in *EVERYDAY ELECTRONICS* last month.

The unit is to be built on 0.1in. matrix Veroboard and Veropins are used for flying lead connections. The layout of the components on the top side of the board and the breaks in the copper strips on the underside of the board are shown in Fig. 3.

Make the breaks on the underside of the board and drill the two fixing holes as detailed and then insert and solder the Veropins as indicated.

It can be seen that an 8 pin d.i.l. socket is used for IC1 thus eliminating contact of the soldering iron with the integrated circuit and avoiding the risk of thermal damage. The use of a socket also simplifies replacement should the need arise. The i.c. should not be in the socket when the latter is being soldered in position.

Now position and solder the i.c. holder, resistors, capacitors and thermistor as indicated in Fig. 3. Next prepare the front panel as indicated in Fig. 4 and secure all the panel mounted components in position as shown. Now wire up to the component board.

The two leads emerging from the front panel and labelled "supply leads" should be about 75cm long and be terminated in banana plugs or spade terminals, one red and one black if being powered by the *Power Supply Unit*, or suitable battery connectors. Power supply to other

units may be obtained from the terminals SK3 and SK4. If a number of units are connected in this fashion the system could interact and oscillate, so one must watch for this fault and if in doubt connect each unit *directly* to the *Power Supply Unit*.

Now insert IC1 in its socket, taking note of polarity—indicated by an indentation near pin 1 and then secure the component board to the inside base of case by means of two 6BA nuts, bolts and stand-off pillars.

## CALIBRATION

To make the dial for the frequency selector, cut a 55mm diameter disc from a piece of thin gauge aluminium and drill a 7mm diameter hole at its centre. Now glue a control knob at the centre of the disc aligning with the hole.

A full-size drawing of the frequency scale is shown in Fig. 5; this should be cut-out or copied and glued to the disc, the dial is then complete.

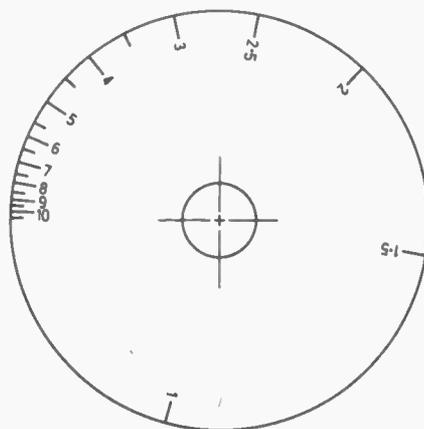
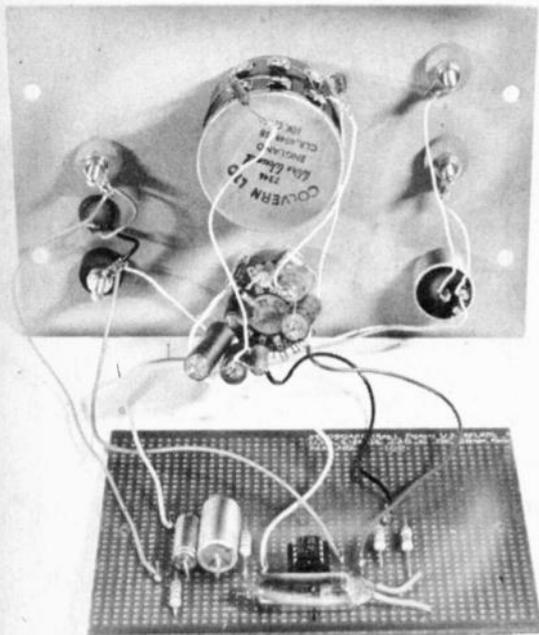


Fig. 5. Full-sized dial details.

Now mark the front panel with an arrow head pointing towards VR1 spindle at about 32mm from the latter, see Fig. 6. Turn VR1 fully anti-clockwise, place the dial assembly on VR1 spindle and align the "1" on the dial with the



Photograph of the completed component board and front panel.

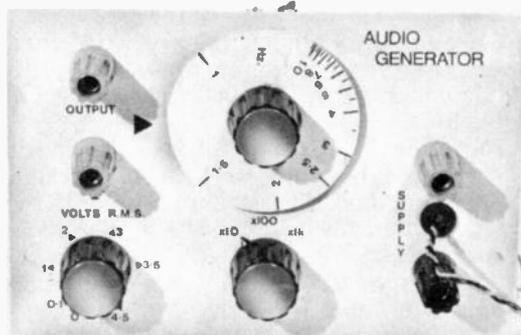


Fig. 6. Details of front panel labelling.

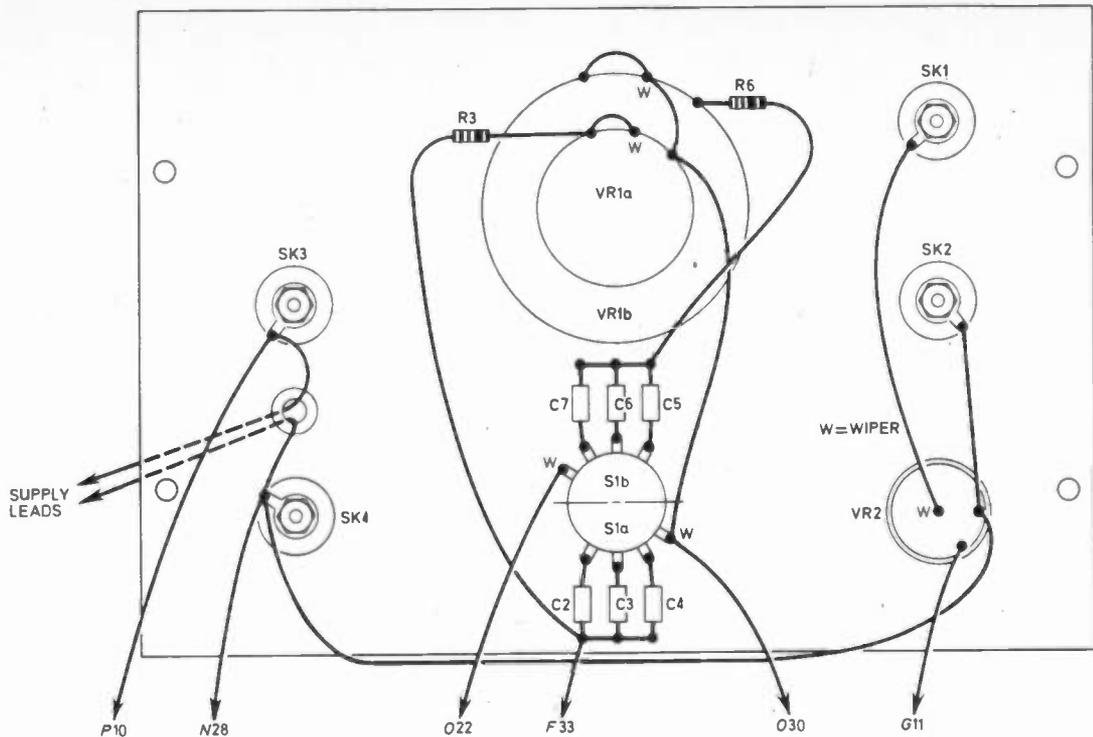


Fig. 4 (above). Wiring up details on the rear of the front panel.

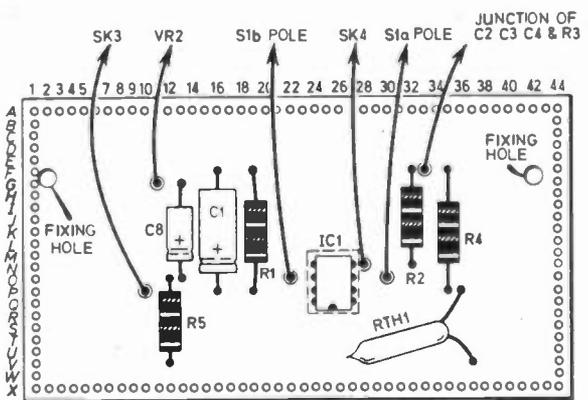
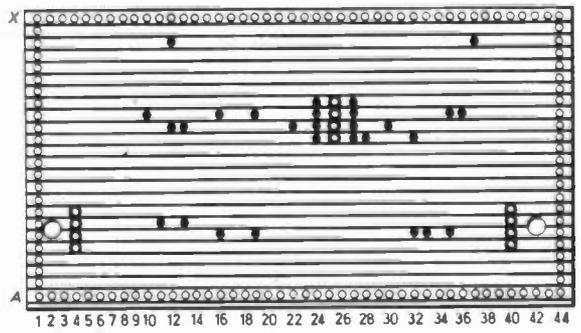


Fig. 3 (left). The layout of the components on the topside of the Veroboard, and the breaks along the copper strips to be made on the underside.

© = VEROPINS



# AUDIO FREQUENCY OSCILLATOR

arrow. At this position secure the dial assembly to VR1 spindle.

The calibration details for the output voltage level control are given in Table 1. Mark a zero in the approximate position to that shown around the control knob in Fig. 6 and then use a protractor to mark off the various levels, in a clockwise direction, according to Table 1.

Table 1: Output level calibration.

Angle of rotation (degrees of arc)	Output voltage level (volts r.m.s.)
0	0
6.6	0.1
66.6	1
133.2	2
199.8	3
233	3.5
300	4.5

These markings, as all the others on the front panel are best done with Letraset as on the prototype; this gives a very neat and professional appearance.

Turn VR2 fully anticlockwise and place the knob on the spindle; rotate the knob so that its pointer is aligned with the "0" of the scale and secure the knob in this position.

The three positions of the switch S1 and other markings should now be made, using Letraset, to complete the project.

### TESTING THE OSCILLATOR

First check the wiring very carefully against the wiring up diagram of Fig. 4. Tick each wire and connection off on the diagram as you check it. Secondly, check each solder joint to see that it is clean and shiny and that the solder has run onto the component wire properly.

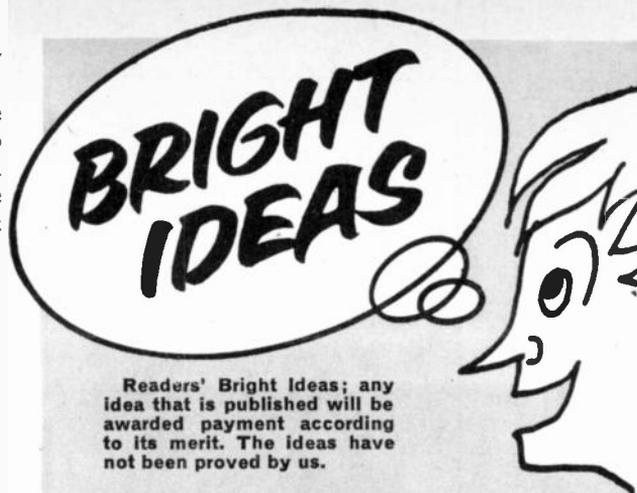
Check that all the Veropins have been soldered in position—a push fit is not enough. Finally, make sure that the integrated circuit is in the socket the right way round.

The power supply for the Audio Frequency Oscillator can be either batteries eg. two PP9 batteries in series, or use can be made of the *Power Supply Unit* described last month.

Whichever power supply system is used, connect to the Audio Frequency Oscillator and connect a high impedance set of earphones across the output sockets, SK1 and SK2.

Turning the frequency selector dial in a clockwise direction should increase the pitch of the tone heard in the earphones; switching S1 in a clockwise direction should also increase the pitch.

If VR2 is turned in a clockwise direction, the volume should increase for all range and dial settings. □



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

An inexpensive and attractive indicator lamp can be fitted into an aluminium or plastic panel by simply drilling a hole of about 3mm diameter and filling it with clear epoxy adhesive.

The front of the hole is covered with insulating tape before it is filled with the transparent adhesive such as Devcon Five Minute Epoxy. When this has hardened the tape is removed, leaving the finished "lens" flush with the panel and almost invisible until illuminated by a neon or filament bulb from behind. If desired the lamp can be embedded in the epoxy.

P. Albericci, Stockport, Cheshire.

When building electronic devices on Veroboard or printed circuit board, it is often necessary to leave the item for several weeks in an unfinished state due to lack of components etc.

During this time, the board which was initially bright and clean loses its clean appearance and sometimes becomes so tarnished (oxidation) that it is impossible to solder in any other parts until the board has been cleaned.

Since cleaning is difficult and dangerous, in so far as delicate components are concerned, I have found it convenient to use an aerosol of hair laquer to lightly cover the copper strips on the underside of the board.

Most brands of laquer if sprayed on thinly are sufficient to prevent oxidation of the copper, but do not prevent solder adhering, and a good sound soldered joint can be made.

C. Taylor, Ripley, Derbys.

### PLEASE TAKE NOTE

A potential construction hazard with the *Power Supply Unit* featured in last month's issue has been brought to our attention.

With the type of transformer used in the prototype, where the windings are terminated on tags fixed to the front and rear of the transformer, it is possible to obtain a dangerous short circuit if the transformer is not positioned very carefully so as to provide adequate clearance between itself and the front and rear panel mounted components when the latter are bolted in position.

To avoid this, use a transformer with its connections taken to a tag panel on the top of the transformer or omit the neon indicator and mount the on/off switch in its place.

Values for R1 and R3 were shown correctly on Fig. 2, not in the components list.

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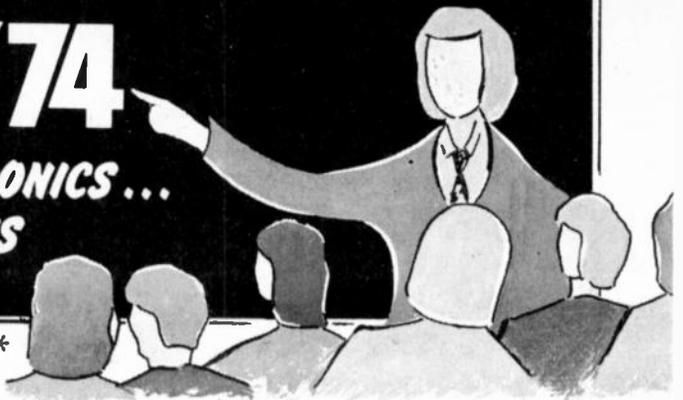
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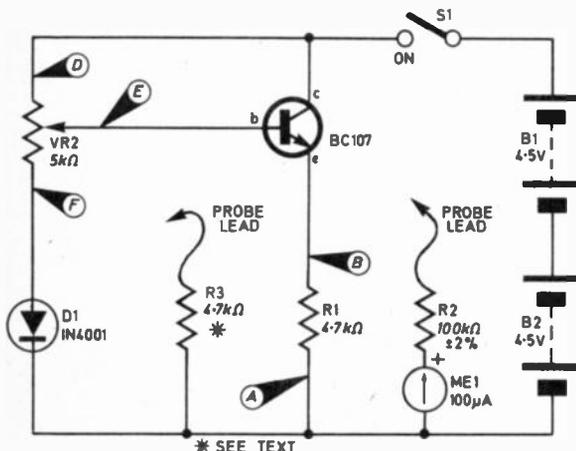
## LESSON 6 Basic Circuits

**T**HIS month we investigate some very useful circuits that are often used as parts of larger systems. Each circuit has a well defined function and a thorough study of each one will amply repay the time spent. Each circuit is treated essentially from an experimental point of view and can be built on the Tutor Board using the existing range of components.

The operation of each circuit is investigated and verified by actual measurements using the Tutor Board system. **Future articles in the Teach-In '74 series may involve the purchase of certain additional components and these will be announced at least one month in advance of the actual requirement so that readers can obtain the necessary items in time.**

### EMITTER FOLLOWER

Our first circuit, the emitter follower, is aptly named as it is really a single transistor stage in which the voltage at the emitter (output) point follows any changes that occur at the base



**Fig. 6.1. Basic emitter follower.**

\* North Staffordshire Polytechnic (Any communications arising from the Teach-In '74 series must be addressed to Everyday Electronics, Fleetway House, Farringdon Street, London E.C.4.)

(input). Fig. 6.1 illustrates the basic arrangement that we shall use.

The base voltage of TR1 (BC107) can be varied by means of VR2 (5 kilohm). When the slider of the potentiometer is turned to point F the voltage fed to the transistor is just the diode forward voltage of approximately 0.6 volts. This is about the same as the emitter-base voltage of a conducting transistor and so TR1 will be on the verge of conduction. If VR2 is turned in a clockwise direction the base voltage, measured with respect to battery negative point A, will increase from 0.6 volts to 9 volts. If we assume that the emitter-base voltage of TR1 is constant at 0.6 volts the increase in base voltage must be accompanied by the flow of emitter current so that an equal voltage drop appears across the 4.7 kilohm emitter resistor, R1.

For example if VR2 was set to give a base voltage of 5.3 volts the voltage across the emitter resistor would be 4.7 volts and the emitter current would be 1 mA. If the base voltage is varied by means of VR2 the emitter voltage will follow the changes produced at the base and it is this action which gives the circuit its name. As far as changes in voltage are concerned the voltage gain, or amplification, of this circuit is unity. Voltage gain is defined as the output voltage change divided by the input voltage change. Note that the base and emitter voltages are always offset by about 0.6 volt even though the gain is unity.

What value can there be in using such a circuit if the gain is only unity? To seek the answer it will be convenient to test the circuit out in a simple experiment.

### TEST CIRCUIT

Arrange the components on the Tutor-Board to match the schematic of Fig. 6.1. (By now you should be getting used to this transformation of the theoretical schematic diagram into an

actual experimental arrangement of components. If you are still experiencing some difficulty it will help to plan the layout on paper first, try to plan a layout yourself and then compare it with Fig. 6.3. Also build the 0-10V voltmeter circuit and connect the negative side to point A.

Using the (red) probe lead for the positive side of the voltmeter measure the voltages  $V_{E,A}$  and  $V_{B,A}$ , for two different settings of VR2. Verify that your circuit behaves as described above. At this stage it is possible to check both the input-output offset, the "following" action and the voltage gain.

## SECOND PROBE

For the next part of the test, one end of a second 4.7 kilohm resistor should be connected to point A and the other end should be joined to the spare (black) voltmeter probe lead. This lead is required so that the resistor can be connected to either the base or the emitter of the transistor whilst observing the meter reading. First, set VR2 to make  $V_{B,A} = 5$  volts and then make a temporary connection with the resistor probe lead first to E and then to B. The voltmeter connection must be left unchanged so that the value of  $V_{B,A}$  can be taken for each position of the resistor probe lead.

When the resistor is across EA the voltage  $V_{B,A}$  will drop due to the loading of the 5 kilohm potentiometer by the extra 4.7 kilohm resistor. However when the resistor is connected at the emitter, the voltage  $V_{B,A}$  will barely change and it may be difficult to detect any movement of the meter pointer.

## VOLTAGE GENERATOR

The emitter follower output terminal behaves as a nearly perfect voltage generator having a very low effective internal resistance since any tendency for the emitter voltage to change will be counteracted by a change in emitter current. The emitter voltage will only alter if the base voltage changes and since the additional 4.7 kilohm resistor at the emitter only doubles the already small base current the base voltage will be almost constant.

The transistor supplies the extra current required by the added 4.7 kilohm resistor and 99 per cent (or more) of this extra current flows from the battery via the collector and emitter leads. The increase in base current, to account for the remaining 1 per cent (say), has negligible effect on the base voltage. In fact, using these typical percentages the extra base current is seen to be approximately the current that would be required by a resistance of about 470 kilohm connected across EA. Thus any additional load resistance at the emitter appears transformed by the factor  $(1 + \beta)$ , or  $(1 + h_{FE})$  when considered from the base.

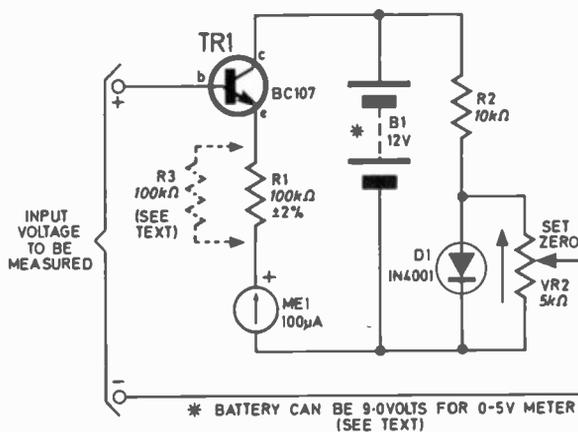


Fig. 6.2. Emitter follower used as a voltmeter.

## ISOLATION

The emitter follower thus behaves as a buffer or isolating stage and can be used to supply voltages to relatively low resistance loads without incurring any excessive loading effects on the input source. In many applications the base of the emitter follower is connected directly to the source if a suitable "d.c. bias" voltage level exists. Fig. 6.2 illustrates a circuit example in which the emitter follower is used to make an electronic voltmeter that takes less than  $1\mu\text{A}$  from the source at full scale deflection.

The battery voltage for the emitter follower must be greater than the maximum voltage to be measured, which, in this case is 10 volts. The 5 kilohm potentiometer allows a fraction of the diode voltage drop to be used to compensate for the  $V_{be}$  offset and can be set to give a zero meter reading with the input leads shorted. The compensation is only approximate since the value of  $V_{be}$  will change slightly over the  $100\mu\text{A}$  range of meter current.

The 5 kilohm potentiometer is rotated in the direction shown by the arrow until the pointer just begins to move from its zero position. The circuit can be operated at 9V, using the two 4.5 volt batteries of Tutor Board, to make a 0 to 5 volt electronic meter by connecting a second 100 kilohm  $\pm 5$  per cent resistor in parallel with the 100 kilohm  $\pm 2$  per cent meter resistor, see Fig. 6.5.

Try using this electronic meter to measure the voltage of a previously charged  $1000\mu\text{F}$  capacitor. If the capacitor is momentarily connected across one battery it will charge up to 4.5 volts. This voltage can then be observed using the electronic meter. Avoid touching the capacitor or voltmeter leads as moist skin will provide a discharge path. If the capacitor has good insulation it may take at least an hour for the capacitor to fully discharge due to the very small input current required to operate the meter. (If the  $h_{FE}$  of your BC107 is, say,

400 the base current would be approximately  $0.25\mu\text{A}$  for a 5 volt full scale reading. This corresponds to an effective input resistance of 20 megohms and a discharge time constant of 20,000 seconds!

### BISTABLE CIRCUIT

The bistable circuit derives its name from the fact that two distinct stable operating conditions exist (bistable=two stable states). A typical circuit is shown in Fig. 6.4 and can be built on the Tutor Board for experimental purposes. The circuit is symmetrical in that the components on one side of the circuit are the mirror image of those on the other side excepting the battery and switch. Each of the two possible states requires one transistor to be on whilst the other is off.

To indicate the state of the transistors we are using the 6V lamps as "collector load" resistors. If the on transistor is made to pass sufficient current the lamp will light and this then indicates the on state for that transistor. The circuit can be made to change from one stable state

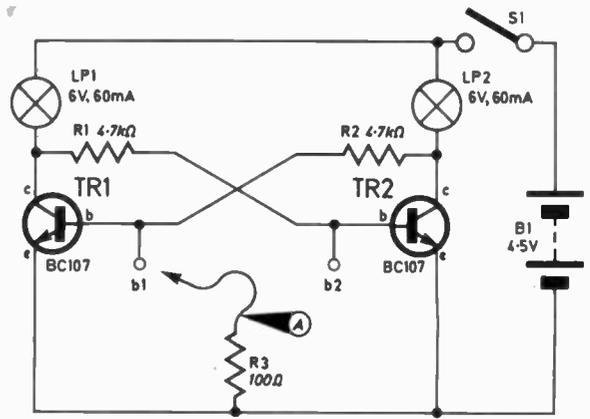


Fig. 6.4. Basic bistable circuit.

to the other by creating a suitable disturbance. To illustrate this process wire up the circuit on the Tutor Board, check all connections and then close the switch S1.

Only one of the two lamps should light. Using one of the probe leads connected to point A,

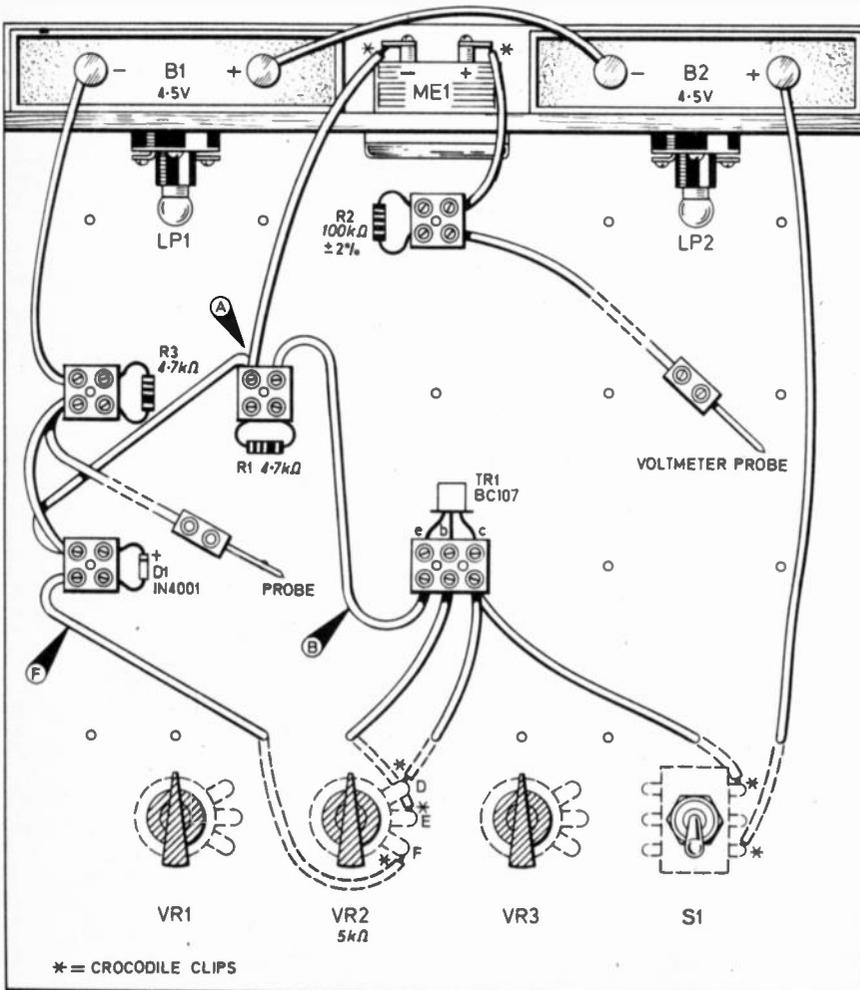


Fig. 6.3. Layout and wiring on the Tutor Board for the circuit shown in Fig. 6.1.

touch the base lead (b1 or b2) of the on transistor briefly. The circuit should change state and the previously off lamp should now be lighted. The circuit can be made to switch back and forth by touching the probe on points b1 and b2 in turn. Note that the circuit will only change state if the probe is connected to the base of the on transistor. This switching action can be compared with the action of a domestic light switch which has two stable positions and must be pushed in the correct direction if the toggle is to move to its alternative position.

It is not difficult to see how the circuit works. If TR1 is assumed to be on, with the resistor values used the transistor must be saturated and hence its  $V_{ce}$  will be about 200mV. This is insufficient to allow TR2 to turn on and so negligible current flow occurs in this transistor. Because of this, the base of TR1 is effectively connected via the lamp (cold resistance) and the 4.7 kilohm to +4.5 volts which gives a base current of about 1mA. This ensures that TR1 is held saturated. The probe simply "shorts" the base/emitter junction of the on transistor

with 100 ohms and turns it off. The cross coupling to the other transistor base causes this transistor to switch to the on state.

More complex versions of this circuit are widely used in logic or digital systems, such as data processing or computing equipment, and are often made in the form of an integrated circuit. The basic behaviour is however very similar to that described above.

### SCHMITT TRIGGER

The Schmitt trigger circuit, illustrated in Fig. 6.6, is similar to the bistable but the switching action depends on the voltage applied at the input,  $V_{in}$ . Only one transistor is on at any time but the state of the circuit can be controlled by changing  $V_{in}$ .

Build the circuit on the Tutor Board and carefully check all wiring. Set VR2 so that  $V_{in}$  is zero (slider E to end F) and set the control VR1 so that the emitters of TR1 and TR2 are joined together (slider B to end A). In this position the potentiometer simply acts as a 100 ohm resistor

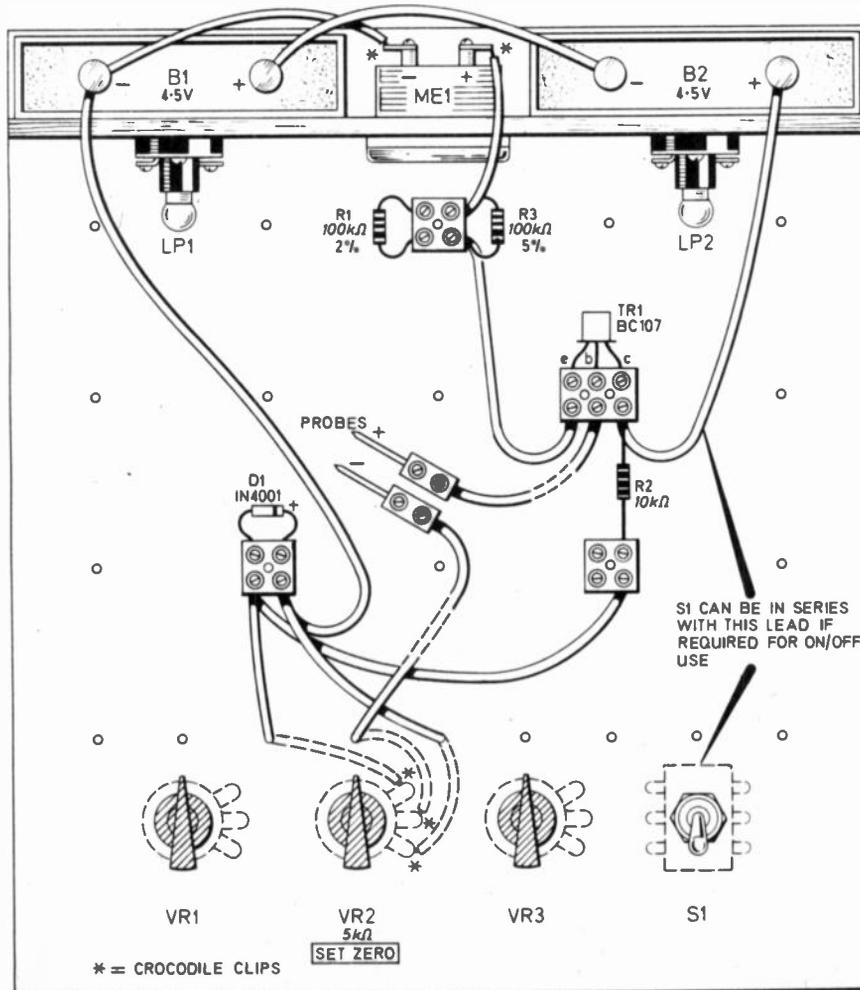


Fig. 6.5. Tutor Board layout and wiring for Fig. 6.2.

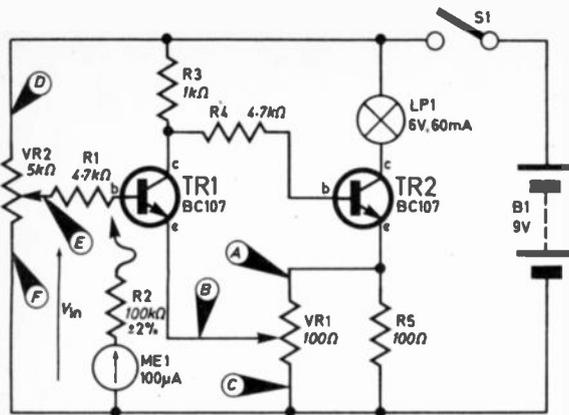


Fig. 6.6. Basic Schmitt trigger circuit.

in parallel with R5, also 100 ohms, to give an effective emitter resistance of 50 ohms. Operate the switch S1 and check that the lamp LP1 lights.

Transistor TR1 will be off since the current in TR2 produces a voltage drop across the effective emitter resistance (50 ohms) which makes point A positive with respect to C. Since  $V_{in}$  is set to zero, the voltage  $V_{AC}$  appears as a reverse bias across the base-emitter junction of TR1. Note that TR2 derives its base current via R3 and R4.

The usual 0-10V voltmeter circuit should be used to measure the voltages at the various points in the circuit, to verify the above statements. Make a list of all the voltages so that they can be compared with other readings, taken at the same points later on. Table 6.1 illustrates one way of setting out the information derived from these measurements.

## SWITCHING

To demonstrate the switching action of the circuit hold the voltmeter (positive) lead to point E at the end of R1 and slowly rotate VR2 in a clockwise direction. The voltmeter should indicate the rising input voltage  $V_{in}$ . At about 3.5 volts the lamp LP1 will suddenly turn off and the meter reading will fall to approximately 3.2 volts. In this state TR1 is on and TR2 is off. Without disturbing the setting of VR1 measure the voltages at the points mentioned in Table 6.1 and record your results in the right hand column. A comparison of the "before and after" readings at each point will verify that the transistors have in fact changed states.

Reconnect the voltmeter to point E and slowly rotate VR2 anticlockwise towards its initial position. The lamp will remain off until  $V_{in}$  reaches a voltage of about +1.2 volts at which level the circuit returns to its former condition with LP1 and TR2 on and TR1 off.

What caused the circuit to change over? With  $V_{in}$  set to zero we know that TR1 is reverse biased by about 3 volts and so  $V_{in}$  must be

Table 6.1:  
Schmitt Trigger Circuit Voltage Levels

(1) Test Point	(2) Voltages Note (c)	(3) Voltages Note (d)
(Typical values)		
TR1 base	0 V	
TR1 collector	+8.0 V	
TR1 emitter	+3.0 V	
TR2 base	+3.6 V	
TR2 collector	+3.2 V	
TR2 emitter	+3.0 V	
Battery terminals	+9.0 V	

### Notes

- All voltage readings taken with 0-10V voltmeter circuit, with respect to battery negative (C).
- VR2 set for maximum "feedback".
- Column (2) relates to  $V_{in}=0$ .
- Column (3) to be used for voltage readings measured, as per text, when circuit has just switched over.

raised to slightly more than this level before TR1 can conduct. Once TR1 starts to conduct its collector current produces a voltage drop across R3 which lowers the base voltage of TR2. The emitter voltage of TR2 "follows" the change at the base, just as in the emitter follower circuit, and as a result TR1 turns further on since the reverse bias voltage  $V_{AC}$  is now less than the previous 3.0 volts. This process is regenerative and a rapid change over occurs. The increase in the base current of TR1 causes the voltage at point E to fall slightly.

To restore the initial circuit conditions it is necessary to reduce  $V_{in}$  to the point at which TR1 starts to turn off. Since the on current in TR1 is much less than that for TR2 and LP1, the voltage "threshold" at which the circuit restores to normal is much lower than the previous switching threshold at 3.5V. Note that the lower on current in TR1 is mainly due to the use of a 1 kilohm collector load whereas the load for TR2 is about 100 ohms due to the lamp (hot) resistance. Readers will probably have realised by now that the potentiometer VR1 determines the amount of reverse bias fed back from TR2 to the base-emitter junction of TR1. The experiment can be repeated with VR1 set mid way to give 50 per cent of the feedback voltage used in the first tests i.e. about 1.5 volts. The switching thresholds for this setting should be approximately +2.0 volts (lamp turns off) and +1.1 volts (lamp turns on).

## ACTION SUMMARY

The behaviour of the Schmitt trigger is summarised in Fig. 6.7 where the arrows indicate the direction of the various voltage or current changes. The "width" of the loop represents

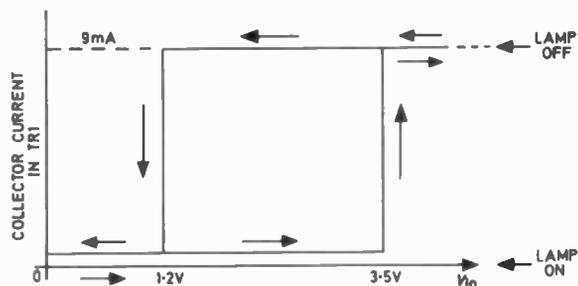


Fig. 6.7. Summary of Schmitt trigger action.

the voltage difference between the two thresholds and is sometimes called backlash or hysteresis. Reducing the setting of VR1 to give less feedback mainly affects the right hand threshold.

The diagram illustrates an important feature of Schmitt trigger circuits namely that when  $V_{in}$  is between the thresholds, the circuit can be in either state. Which state occurs in practice depends on the "previous history" of  $V_{in}$  and this feature is a simple form of memory. The bistable circuit also exhibits a similar property and is widely used in digital systems such as computers for this reason.

The "block diagram" of Fig. 6.8 shows how a triangular shaped input voltage waveform can be connected to a rectangular pulse waveform by using a Schmitt trigger circuit as a voltage dependent switch.

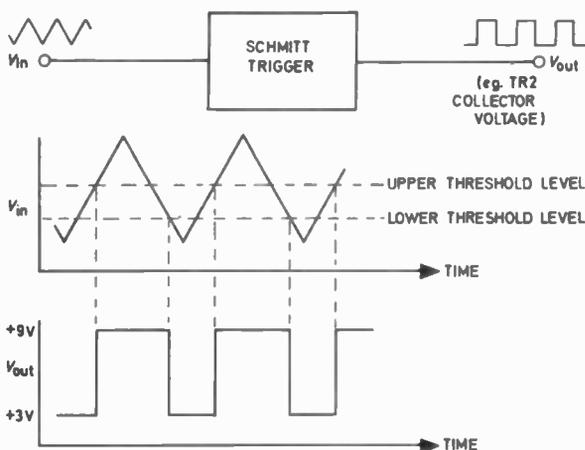


Fig. 6.8. Typical application of Schmitt trigger.

Note: Some readers may find this month's work more difficult than that given in previous parts of the Teach-In '74 series. Do not try to rush the experiments; make sure that you understand each test before proceeding to the next stage. This is a good time to review all the work that has been presented so far. Concentrate on any topics that you find difficult and your efforts will be well worth while.

Why not write to us and let us know how you are getting on?

Next month we shall examine the operation of two more circuits known as the monostable and astable multivibrator.

## Ruminations

By Mrs. Sensor

### Sockets

Sensor is swotting and has asked me to stand-in for him. I wondered what to say, my experience of electronics has receded into the dim and distant past, the breathtaking new inventions of my time are now the exhibits of the museums and I am lost in the modern world of transistors, integrated circuits and the like. No, my best idea is to speak as the beneficiary of years of d.i.y. electronics from the days of our first "hand-built" television set in our first home, to the present time of piped music for the "beef-on-the-hoof" in the farm buildings.

The t.v. was unique, requiring a good six square feet of floor

space, everything visible and handy to repair in times of need. I think I do remember the cabinet, some light-oak faced board and a few sticks of 1 inch by 1 inch tucked away in the spare room. Yes, it helped to make quite a reasonable book-case eventually. Our son's arrival necessitated the encapsulation of the t.v. and it was surprising what a big sitting-room we had.

Eight years in the one house saw a marvellous transformation, I could stand anywhere in any room and plug in my vacuum without taking a single step. In the garage the story was the same, he could drill, solder, use his lathe, light up all corners and warm himself by the electric fire, all at one and the same time. But alas, came the day when there was no more space for sockets so we moved to a brand-new house where each room was provided with one socket, excepting the lounge which had two, one at each end.

### Dangerous Wires

There followed the years of the home-built radiogram, the electronic organ (never completed) and the radio transmission to all rooms. During that time a funny thing happened, I discovered that there were two d.i.y. enthusiasts in the house and the smaller of the two had very peculiar ideas about my height, there were dozens of gracefully draped wires all around the house, all at jugular vein height as far as I was concerned. But those days are in the past now, he can Sellotape his wires to the ceiling without recourse to steps.

The skirting of our second house filled up over the years and reading the house-agents blurb when we put it up for sale, one had the impression of lots of misprints regarding power points.

Now a third domain, crying out for attention. I thought the two-foot thick walls might have been a deterrent but no, here we go again.



WITH, we hope, the worst part of the winter behind us we can start looking forward to the spring and perhaps to a more settled industrial situation and fewer shortages. Perhaps by the time this is published we will be able to obtain "normal" amounts of petrol once again, however, it is unlikely that we will ever get it at the old price. This fact alone makes the *Speed Guard* a worthwhile project, plus the fact that it could save an endorsement by drawing your immediate attention to excess speed within any limit.

### Speed Guard

The *Speed Guard* is the first project we have published that uses more than one integrated circuit and is probably near the limit of complexity for an EE project! Provided some care is

taken when handling the i.c.s, and that sockets are used to hold them, most constructors should have little difficulty with construction of this project.

The 555 i.c. is available under a number of different codes—see wall chart—but is usually listed by suppliers as the 555. The type used in the *Speed Guard* is an 8 pin dual-in-line package and it will be easier to follow our layout if this type is obtained—the 7400 is a 14 pin dual-in-line package.

A 35 ohm or greater impedance speaker should be used (up to about 80 ohms) and a number of quite small types are available from various suppliers. It is also a good idea to include a 1 amp line fuse in the supply and a holder for this is available from car accessory shops. Ask for a line fuse holder as used for car radios.

### Audio Frequency Oscillator

Some components used in the *Audio Frequency Oscillator* are, as far as we can tell, only available from one supplier. Electro-value, 28 St Judes Road, Englefield Green, Egham, Surrey can supply the R54 thermistor, Home Radio can supply the Colvern twin gang potentiometer ( $\pm 2$  per cent tolerance).

The Wima capacitors are recommended as these are  $\pm 5$  per cent tolerance, if you have difficulty getting these, Combined Electronic Services, Spare Sales Department, 604 Purley Way, Waddon, Croydon CR9 4DR can supply at 22p each for  $1.5\mu\text{F}$ , 12p each for the other values, plus V.A.T., a 40p handling charge is added to each order. As

mentioned last month the Olsen case type 25A with louvres is available for £3.45 including postage packing and V.A.T. from Olsen Electronics Ltd., 5 Long Street, London E.2.

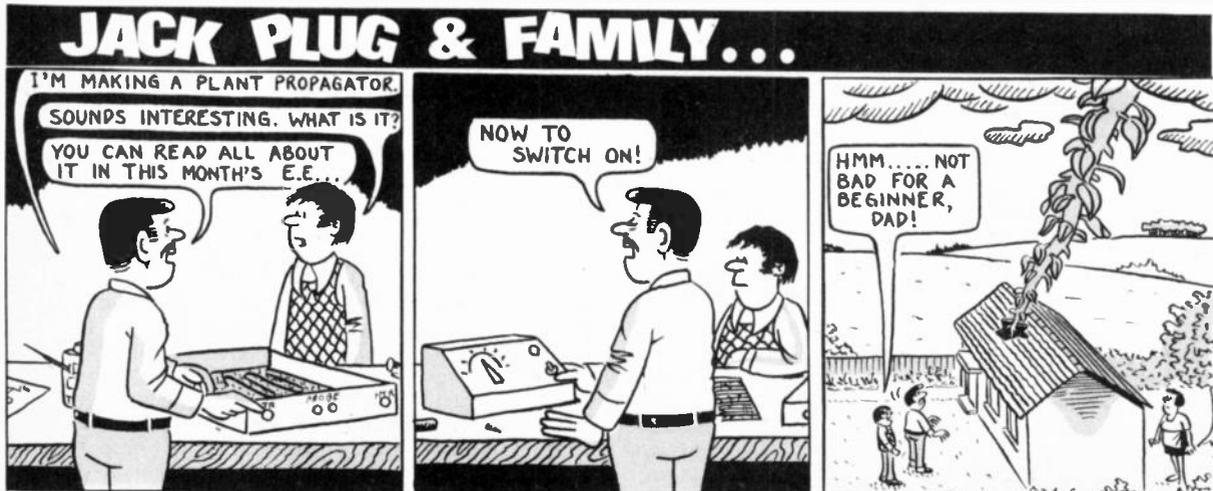
Also last month we stated that the knobs were available from Re-An Products, Burnham Road, Dartford, Kent. This is not in fact the case although Re-An do make similar knobs and a skirt with indicator line is available. The knobs are type R62 with black skirts with indicator, they cost 14p each plus 20p post and packing, plus V.A.T. on total. Top cap colours available are red, blue, green, yellow and black—state your requirements with the order.

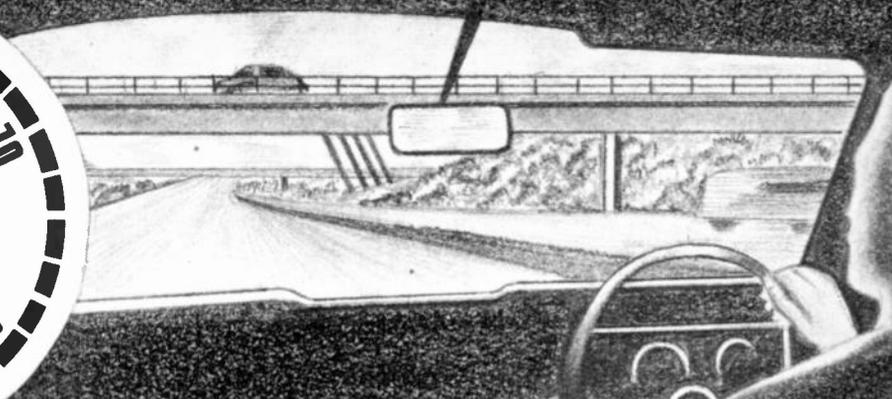
The actual knobs on the prototype units are made by Elma and are available from Farnell Electronic Components Ltd., Canal Road, Leeds LS12 2TU but they cost in the region of 35p each plus a 25p small order surcharge—for orders under £5. The large knobs are 70-21- $\frac{1}{4}$  inch, top caps are 1450-21, pointers 1451-21, small knobs 70-14- $\frac{1}{4}$  inch, caps 1450-14 and the pointers 1451-14. Top caps are used for all knobs, pointers for most—the tuning dial does not have a pointer.

### Plant Propagator

All the electronic components for the *Plant Propagator* should be readily available—the heater wire may have to be obtained by buying a small bar element, they are fairly cheap.

There are a variety of seed trays available from hardware shops and flower shops but do not get one so big that the heater cannot heat all the soil.





BY MIKE HUGHES

# SPEED GUARD

**Gives an audible tone when preset speed limit is exceeded.**

**D**URING times of fuel shortage this device is a useful aid to fuel economy for the motorist. Under normal conditions it can be extremely useful to the driver who constantly uses motorways and runs the risk of accidentally exceeding the 70 miles per hour speed limit—or as it is now during the fuel crisis, 50 miles per hour.

The device works from a signal picked up off a spark-plug lead and uses this to sense the rate of revolution of the engine—which is directly related to the car's speed when in top gear.

When a certain rate of revolution (set by a preset control within the Speed Guard) is exceeded, a small loudspeaker produces a shrill and uncomfortable wail inside the car's saloon. This warning cannot be ignored and the only way to stop the noise is to reduce speed.

## ENGINE SPEEDS

In theory any speed can be set ranging from a few miles per hour up to 70 or more; however, because the device is working from the engine's revolutions, it is a little inconvenient to set it for speeds less than 40 miles per hour because it could trigger when accelerating away in low gear. Obviously the minimum effective speed for which it can be used will depend upon the gear ratio range of the vehicle and whether or not you are a "quick off the mark" driver.

To some extent rapid acceleration is just as much a fuel waster as high speed driving hence a warning of excessive revs in low gear might be a useful reminder to some drivers.

As an example of the "tripping" speeds in different gears the author had the prototype

installed in a Zephyr 4 with the alarm set to sound at 50 miles per hour in top gear. The maximum speeds that could be obtained in lower gears without the alarm going off were approximately: 1st gear—12 m.p.h.; 2nd gear—20 m.p.h.; 3rd gear—35 m.p.h.; Top gear—50 m.p.h.

In practice there is a slight delay before the unit switches in therefore a short duration of excess speed will not affect the alarm (about 2 seconds) but there is a penalty at the other end; because of hysteresis in the electronic triggering of the alarm, the driver must reduce his speed to about 15 per cent less than the trigger speed to shut off the alarm. There is, thus, a built in incentive to keep a steady speed just below the maximum set.

With the prototype unit the speed is set by an infinitely variable knob on the front panel and this is convenient for experimental purposes; however it is possible—for those of weak will—to cheat the alarm by manually increasing the setting of speed. Those who fall into this category ought to use a preset control that is lockable and only adjustable with a screwdriver.

## CIRCUIT THEORY

Not only is the project useful from its application but it contains some interesting circuitry which—on the face of it—is quite complex for the beginner but nevertheless is very straight-



**Approximate cost of components including V.A.T.**

**£3.60 plus case**

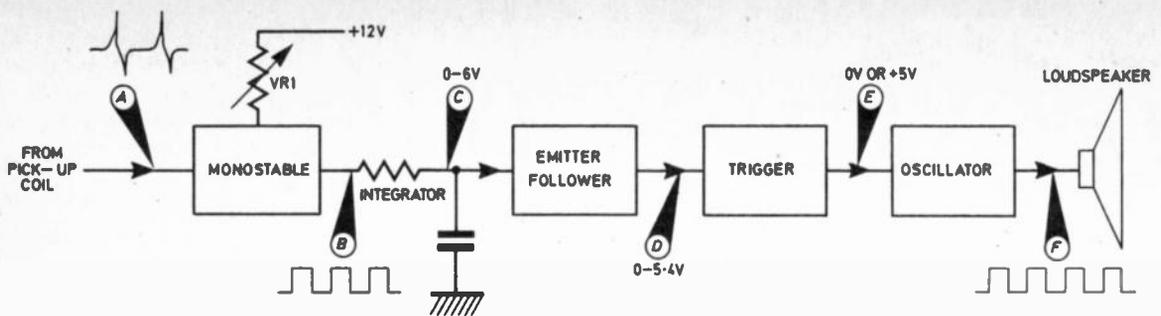


Fig. 1. Block diagram of the Speed Guard. Waveform at point F only occurs if speed exceeds preset maximum.

forward to make because use is made of integrated circuits.

The complete system is shown in Fig. 1 in block schematic form. Engine revolution pick-up is effected by about six turns of insulated wire round one of the spark-plug leads. Every time this plug sparks, a very fast pulse is fed into the unit (signal A). When the pulse goes in a negative direction it triggers a monostable circuit which produces a positive going pulse of fixed time duration; this duration can be preset by VR1 which forms the speed setting control.

At slow engine revs the mark/space ratio of this signal will be small (signal B) but as the speed increases the amount of time this signal is at 0V will reduce while the time at the positive level will remain the same; the mark space ratio thus increases. This signal is fed to a simple capacitor charge/discharge circuit, called an integrator, and depending on the respective mark/space ratio the capacitor will receive an average higher or lower charge, shown as a voltage which can be in the range of 0 to about +6V.

To prevent any following circuitry affecting the controlled discharge rate of the capacitor, the voltage that is built up across it—as speed

increases—is fed to a high input resistance current amplifier (an emitter follower) the output of which is shown as a similar range of voltage swing (signal D). This voltage is used to trip a Schmitt Trigger that operates on an input voltage of about 2V in the upwards going direction and reverts at a level of about 1.8V. The output of the trigger will thus be in one of two possible states (a) +5V if the signal D is above +2V and (b) 0V if D is below 1.8V. The signal E from the trigger is used to switch an oscillator on and off and the latter drives the loudspeaker.

If the speed set control VR1 is fixed at some level, and the car's speed increases above this equivalent setting, the circuit is designed so that the voltage at D exceeds 2V and the output from the trigger point E goes to +5V which switches on the oscillator.

It takes a couple of seconds for the integrator to give a steady output at each speed hence there is a short delay before the alarm sounds. When the car's speed decreases there is again a short delay in the integrator but the voltage at D has to fall below 1.8V before the trigger reverts and switches off the oscillator. This is how the built in penalty comes about.

## Components . . . .

### Resistors

R1	470k $\Omega$
R2	1k $\Omega$
R3	22k $\Omega$
R4	10k $\Omega$
R5	1k $\Omega$
R6	470 $\Omega$
R7	2.7k $\Omega$
R8	2.7k $\Omega$
R9	120 $\Omega$ $\frac{1}{2}$ W
R10	100 $\Omega$ $\frac{1}{2}$ W

All  $\pm 10\%$   $\frac{1}{2}$ W carbon unless stated otherwise

### Capacitors

C1	680pF polystyrene
C2	0.22 $\mu$ F (see text)
C3	47 $\mu$ F elect. 12V
C4	0.1 $\mu$ F
C5	0.1 $\mu$ F
C6	1000 $\mu$ F elect. 6V
C7	2.2 $\mu$ F polvester or elect. 10V

SEE  
**SHOP  
TALK**

### Semiconductors

TR1	BC108 npn silicon
D1	1N4148
D2	1N4148
D3	1N4148
IC1	NE555 or MC1455
IC2	SN7400

### Miscellaneous

VR1	100k $\Omega$ linear carbon potentiometer
LS1	50mm diameter with coil impedance greater than 35 ohms
SK1	coaxial socket
PL1	coaxial plug
FS1	1A line fuse and holder
Veroboard	0.1in. matrix 40 holes x 19 strips; i.c. sockets 8 pin d.i.l. and 14 pin d.i.l. (1 off each); tag post; rubber grommet; knob; grille for loudspeaker; metal case.

## CIRCUIT OPERATION

The complete circuit diagram of the Speed Guard is shown in Fig. 2 and might look rather unfamiliar to many readers; this is because of the fact that integrated circuits are used. The alphabetically designated points of Fig. 1 are repeated in Fig. 2 to help the reader.

The monostable is made from a very versatile integrated circuit known as the 555 shown as IC1. It draws its power through pins 1 (0V) and 8 (+12V). Note that this is desirable to connect pin 4 to +12V as well. It is triggered by a negative going signal into pin 2 and this is provided by the coupling circuitry from the pick up coil.

Diodes D1 and D2 are there to prevent any very high induced voltages in the coil damaging IC1. The output from the monostable is taken from pin 3 at the bottom end of its output load resistor, R2. The monostable's dwell time is set by VR1, R4 and C2 (a note about the capacitor later).

Components R3 and C3 form the simple integrator circuit already mentioned and this is directly coupled to the base of TR1 connected as an emitter follower.

The integrated circuit IC2 is a standard SN7400 transistor transistor logic (t.t.l.) NAND gate—in fact there are four gates. This device is normally found in logic circuits and is used in an unusual fashion in this application.

The two left hand gates are cross coupled with R6 to form a very simple Schmitt Trigger. It is essential to use D3 in one of the input lines otherwise the circuit will not trigger reliably.

The value of R6 is quite critical because it sets the hysteresis of the trigger; reduce its value and there will be a larger gap between the upwards and downwards triggering levels.

The remaining two gates in the package are capacitively cross coupled with C4 and C5 to make a free running (astable) multivibrator operating at a high audio frequency.

The oscillator will only work when the input at pin 12 is at +5V and this is obtained from the output of the trigger.

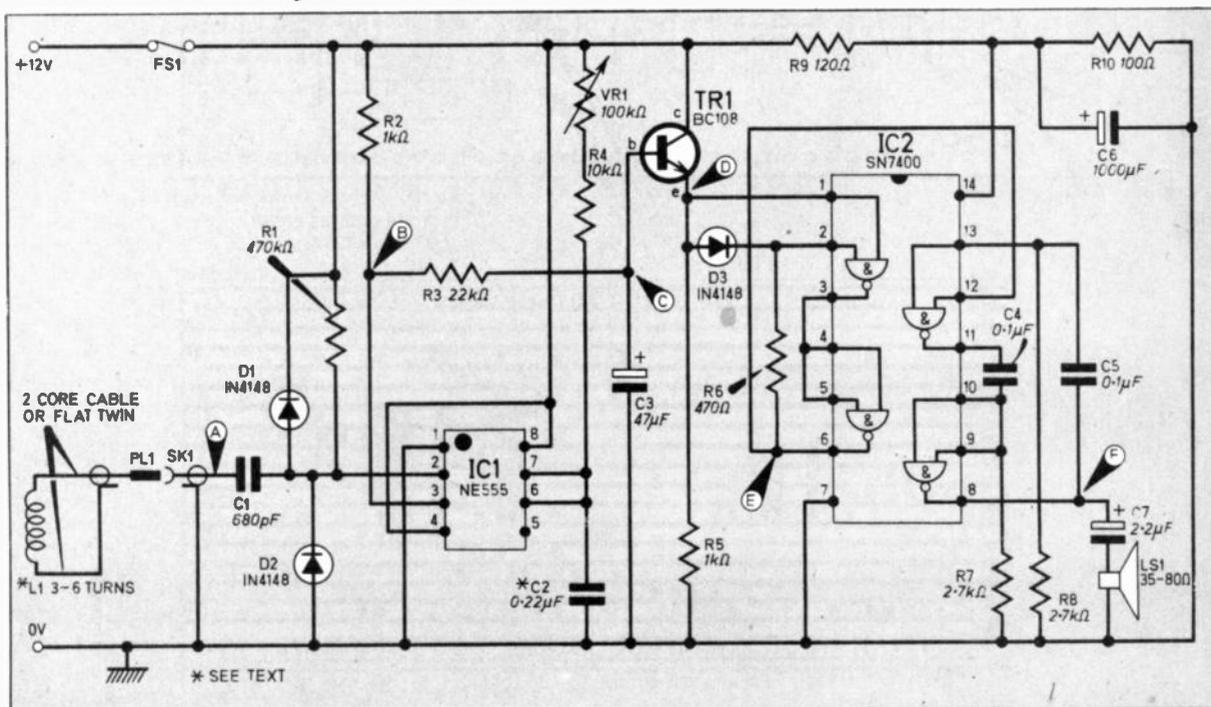
It is important to note that IC2 requires a power supply of +5V and this is obtained from the potential divide action of R9 and R10 in association with the reservoir capacitor C6. These two resistors must be of at least half-watt rating.

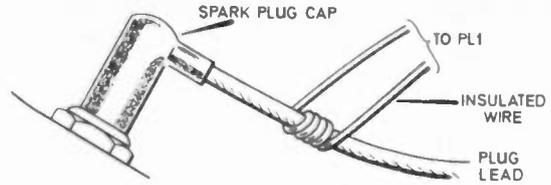
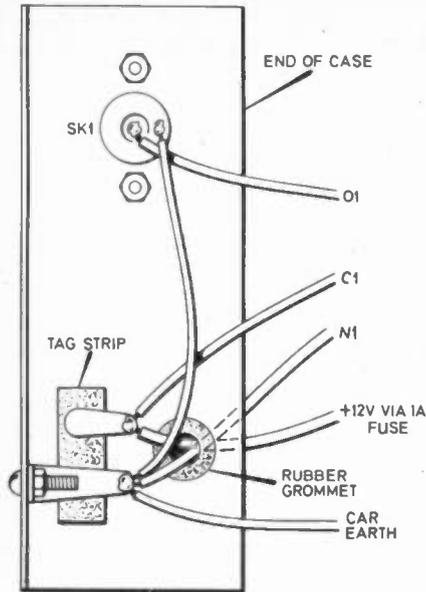
Drive to the loudspeaker is taken from the output of the oscillator at pin 8 through the coupling capacitor C7. Under no circumstances should a loudspeaker of less than 35 ohms be used otherwise the integrated circuit could be permanently damaged. To be safe it is preferable to use a miniature 75 ohm device. Provided this advice is adhered to the integrated circuit is quite capable of producing a high amplitude "squeal" without any further form of amplification.

## CONSTRUCTION

In the prototype, the circuit board and associated components were mounted in an aluminium case that can be screwed under the dashboard. Although a coaxial plug and socket is used to accept the lead from the pick-up coil,

Fig. 2. The complete circuit diagram of the Speed Guard.



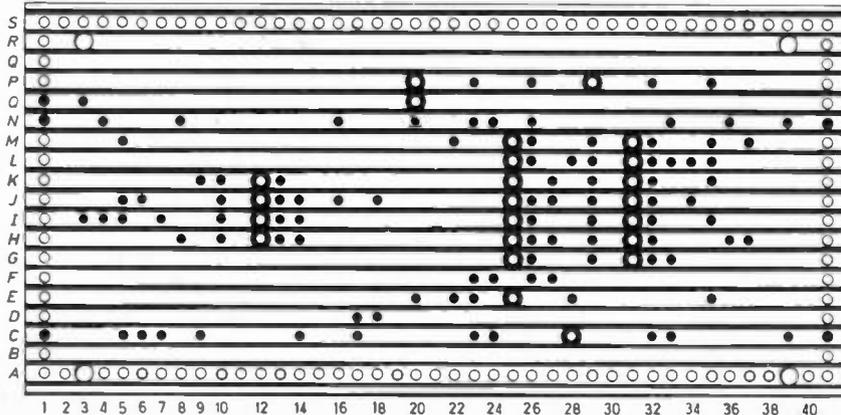


Shows the method of wrapping the pick-up coil around the spark plug lead.

# SPEED GUARD

Fig. 4 (left). Wiring details in the case.

Fig. 3 (below). The layout of the components on the Veroboard and regions to be removed on the underside.



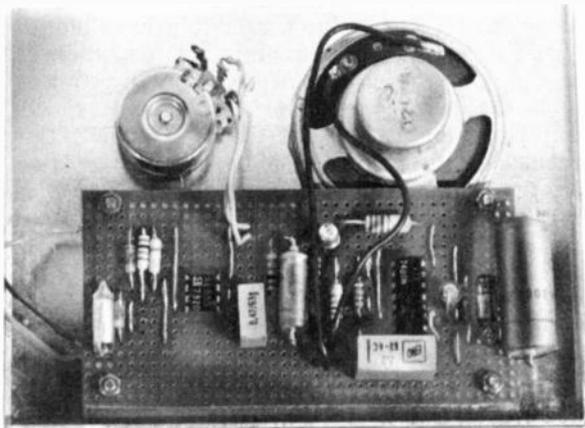
do not use screened cable for the lead. The internal capacity of the cable can, in some instances, shunt the induced signal to ground. Capacitor C7 was a polyester type in the prototype but an electrolytic will do just as well, but take note of its polarity.

The prototype Speed Guard was built on a piece of 0.1in matrix Veroboard size 19 strips by 40 holes. The layout of the components on the topside of the board and breaks in the copper strips on the underside are shown in Fig. 3.

Begin construction by making the necessary breaks along the copper strips as detailed and then drill the four fixing holes, one near each corner as shown.

Now position and solder the i.c. holders and link wires followed by the resistors and capacitors. With the aid of a heatshunt, solder in position the diodes and transistor.

Next secure VR1 and LS1 with speaker grille in place as indicated below. Fix the rubber grommet, coaxial socket SK1 and earthing tag in position and wire up all the components and component board as shown.



Photograph of the component board.

### CONNECTING TO CAR

Although primarily designed for a negative earth 12V system, the unit can be converted to positive earth by returning the positive rail to the earthing tag inside the box and connecting the flying power input leads to the car's electrical system accordingly. The circuit is not suitable for 6V systems.

Ideally the live power lead should come from a point that is automatically switched on when the ignition switch is turned thus the circuit is only active whenever the engine is running. The twin wire running to the pick-up coil should avoid as much of the other car wiring as possible—to avoid stray pick up of other signals—and in particular should be kept as far away as possible from other plug leads or the centre h.t. lead into the distributor. Working off the plug signal, removes any problem with four or six cylinder engines—a spark pulse is produced for

every second revolution of the engine (assuming four-stroke action).

Obviously different cars have a vast range of revolutions for given road speeds. Some cars may naturally rev too high for accurate adjustment of VR1. If that is the case C2 should be reduced in value to 0.1 $\mu$ F.

### TESTING

When the unit is first installed it can be quickly tested for function at tick over revs by increasing the value of VR1 to maximum while maintaining a constant engine speed. At some setting the oscillator tone will be heard in the loudspeaker. Reduce the value of VR1 slightly and the sound will stop but will then be found to start again if the throttle is opened slightly. Be prepared for the slight delay in response—as already mentioned.

To set the unit for a pre-set speed (say 50 m.p.h.) drive as steadily as possible at 50 m.p.h. on the open road with VR1 set at **minimum** resistance and slowly increase its value until the alarm just triggers. Reduce speed to about 45 m.p.h. and the tone should stop; increase speed and it should trigger again at 50 m.p.h.

It should be stated that the unit is sensitive to temperature variations and the exact triggering speed could vary by up to 10 per cent in extremes of temperature; however, if the electronics are kept inside the saloon most cars reach a normal temperature within a few minutes of running and the error associated with temperature variation should not be excessive.

### PICK-UP COIL

Some experimentation might be worthwhile deciding on the best number of turns for the pick-up coil; for the prototype six turns were found to be ample but the number and position of them will depend on the efficiency of the ignition coil and the points.

If the car is badly tuned or misfiring there could be errors associated with this monitoring method but there again one object of the project is to effect fuel economy and first and foremost—to this end—is a correctly tuned engine!  $\square$



Photograph of the completed unit.

It is a well-known fact that plants grow much better if their climate is stable and without the wide temperature fluctuations that can occur in this country. It would therefore seem sensible to provide some form of temperature control, especially when trying to raise seeds.

There are many plant propagators on the market but although these reduce the severity of the temperature fluctuations they do not remove them completely. With this simple heating system a fairly constant temperature can be maintained and more successful seed raising should follow.

### TEMPERATURE CONTROL CIRCUITRY

The control circuitry is shown in Fig. 1. The heart of the whole device is a glass bead thermistor RTH1. As the temperature increases the resistance of the thermistor decreases and so the potential at the base of TR1 increases. When this value is greater than the potential at the base of TR2 then the current that is drawn by R2 passes through TR1 instead of TR2. This causes R3 to bias off TR3 which in turn switches off TR4 and consequently the heater.

As the thermistor cools down TR2 takes over and so the heater is switched on again. This

process will keep the propagator at a fairly constant temperature, the temperature being set by VR1 which determines the potential at which the two transistors TR1 and TR2 reverse rolls. With the values chosen quite a large temperature variation can be covered and this can be set to suit the particular plant types being cultivated.

The whole device runs off a 12 volt 1 amp (approx.) d.c. supply and, as this is a comparator type circuit, there is no need for elaborate stabilisation. Therefore the power supply shown in Fig. 1 is suitable for this device.

### HEATER

There are many heating elements readily available on the market that are suitable for this device but they all require adaption for use in a low voltage circuit. Insulation is not really of much importance in the heater as it is operated at such a low voltage.

Two elements that immediately spring to mind are the wire from an electric bar fire and a piece of electric blanket heater wire. The bar fire wire has the advantage that to provide a 1 amp heater current a reasonably long length of wire is required, but it is uninsulated, whereas the blanket wire is insulated and only requires about half the current for the same heat, its equivalent length is thus about half too; this means that it would need to heat twice the area. The fire wire also has the advantage that it is readily available and for this reason was chosen. The system is adaptable to most heaters.

A length of wire of approximate resistance 12 ohms should be unwound from a 1 kilowatt fire-bar (approx 1.7 metres). This should then be placed in the pattern shown in Fig. 2 on top of a layer of peat and small pebbles (it may be easier

**Approximate cost of components including V.A.T. £5.00 plus tray heater and case**

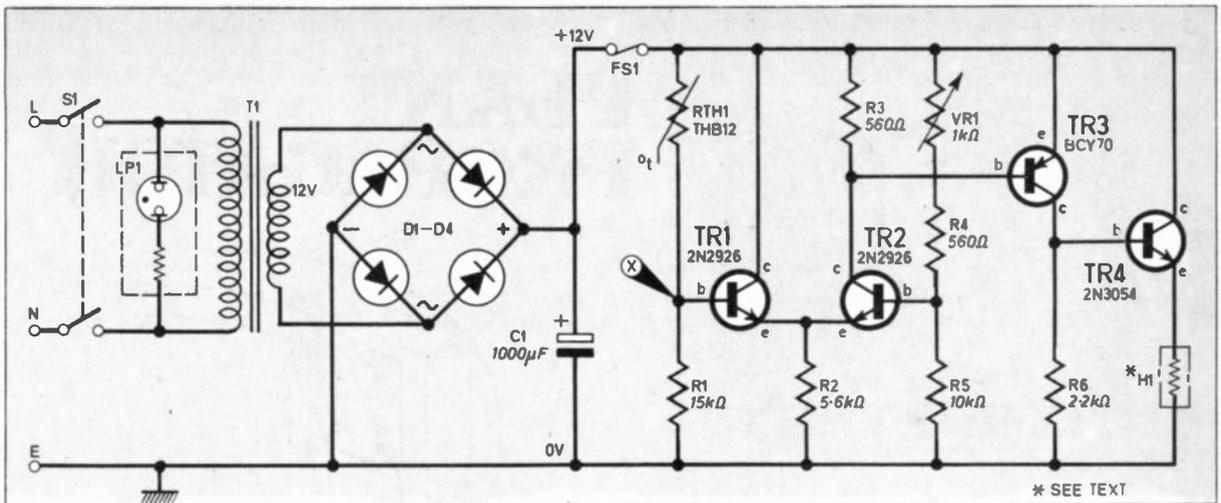


# PLANT PROPAGATOR

By D.T. GOODWIN B.Sc.

A temperature controlled heated tray for raising seeds.





**Fig. 1** Circuit diagram of the Plant Propagator. The components to the left of FS1 form the power supply, those to the right the control circuitry.

to straighten the wire before attempting this). The two ends of the wire are then soldered to two terminals mounted on the side of the seed tray, and the heater is then ready for use.

### MOUNTING THE PROBE

The thermistor probe should be mounted as near the centre of the tray as possible to ensure an overall reading, it should also be placed central with respect to the heating wires. The thermistor is held in a terminal block with two wires going to two terminals on the side of the tray. It is best to try and insulate this sensor from the possible effects of watering, etc.

### CONSTRUCTION

All the electronics (apart from the thermistor, heater, transformer and rectifier) can be mounted on a piece of 0.15 inch matrix Vero-board. The layout is shown in Fig. 3. This can then, together with the transformer, be mounted in the control box. The box can be any metal or plastic case that is large enough to house all the components. If a metal case is used this should be earthed with a three-core mains lead and fused three-pin plug—a 1 amp fuse is adequate.

### SETTING UP AND CALIBRATION

To set up the device simply connect the four wires from the control box to the seed tray and switch on, setting the required temperature with VR1. To calibrate it simply place a thermometer in the soil around about the centre of the tray (taking care not to disturb the thermistor) and read off the temperature for certain settings of the pot after allowing time for the soil to warm up. It is helpful to put a voltmeter across the heater when setting up and calibrating so that the temperature at which the heater switches off can easily be seen.

With the components shown a temperature range of about 60 degrees F to 100 degrees F should be attainable although the upper figure is dependent on the efficiency of the heater and on losses through the propagator. □

## Components....

### Resistors

- R1 15k $\Omega$
- R2 5.6k $\Omega$
- R3 560 $\Omega$
- R4 560 $\Omega$
- R5 10k $\Omega$
- R6 2.2k $\Omega$

All  $\frac{1}{4}$ W  $\pm 10\%$  carbon

### Capacitor

- C1 1,000 $\mu$ F elect. 15V

### Semiconductors

- TR1 2N2926 (orange) silicon npn
- TR2 2N2926 (orange) silicon npn
- TR3 BCY70 silicon pnp
- TR4 2N3054 silicon npn
- D1-D4 Any 50 p.i.v., 1.5 amp (or greater) bridge rectifier

### Miscellaneous

- S1 d.p.d.t. mains toggle switch
- T1 240V primary 12V, 1.5A secondary transformer
- FS1 1 amp fuse and holder
- RTH1 THB12 bead type thermistor (Henry's Radio)
- VR1 1k $\Omega$  carbon potentiometer
- H1 heating element—see text
- LP1 panel mounting neon indicator with built in resistor.

Vero-board 25 holes  $\times$  16 strips  $\times$  0.15 inch matrix, aluminium for TR4 heatsink, approx 70mm  $\times$  35mm  $\times$  22s.w.g., connecting wire, case, knob for VR1, plant tray, connecting terminals for tray (4 off), 2 way connector block.

SEE  
**SHOP  
TALK**

# PLANT PROPAGATOR

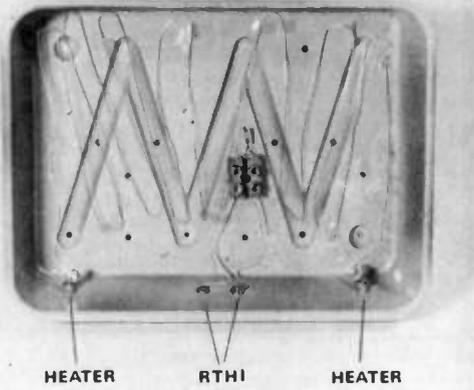


Fig. 2. Seed tray layout and wiring.

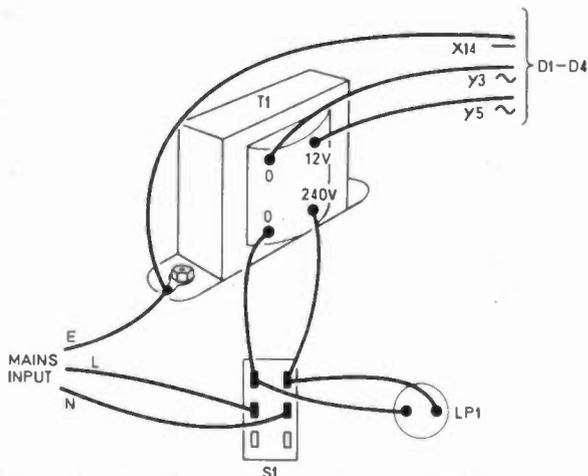
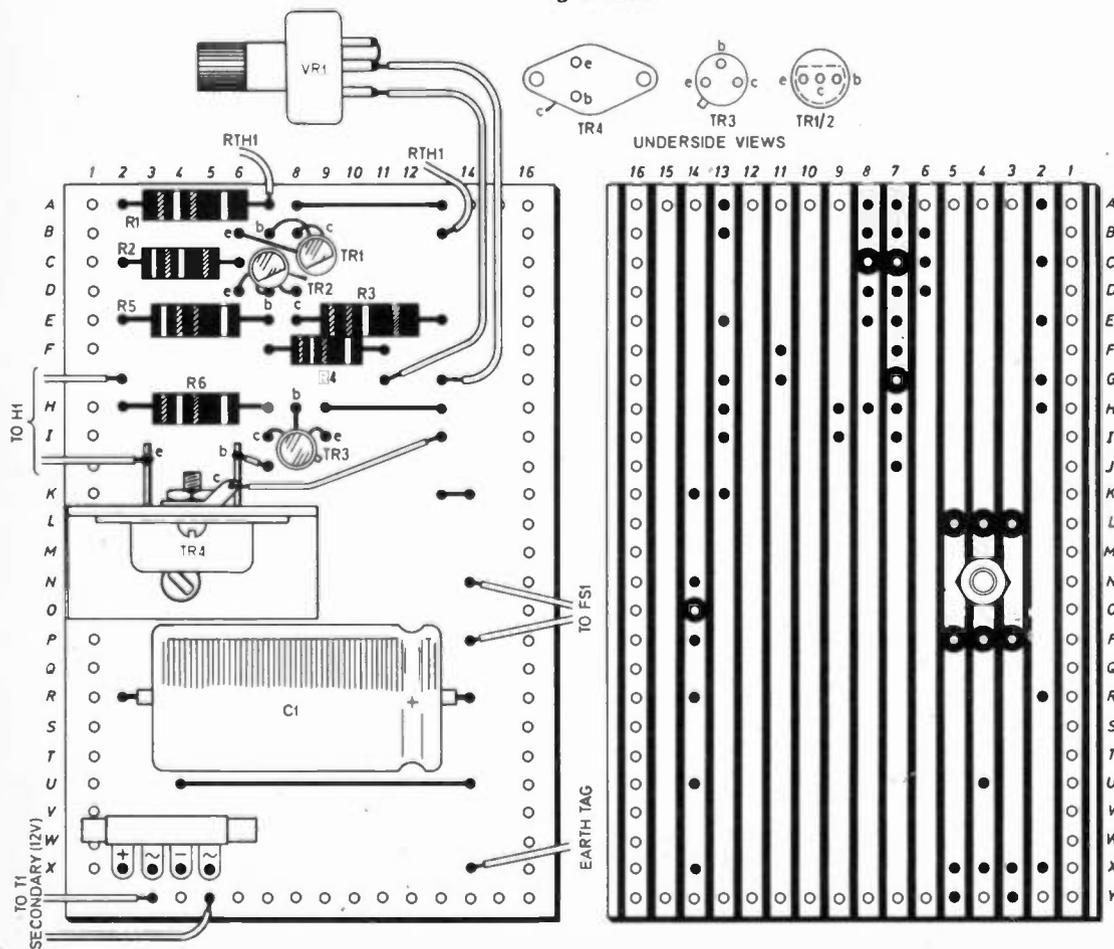


Fig. 3. Veroboard layout and wiring (below) and transformer connections (above). TR4 is mounted on a small heat sink made from a strip of aluminium bent at one end with holes drilled to clear the emitter and base leads and for the mounting screws.



# SEMICONDUCTOR PRIMER

By A. P. STEPHENSON

## 6 ■ CORRECT TRANSISTOR SUPPLY POLARITIES

### PROBLEM

In each circuit shown, (Fig. 6.1 a—i), state if collector current is flowing or not.

Also state, in one sentence, the guiding points which directed your answers.

collector end.  
must obey the conventional current direction and the base resistor must be returned to the  
The correct collector supply rail polarity  
(f) = no (g) = no (h) = no (i) = no  
(a) = yes (b) = no (c) = yes (d) = yes (e) = no

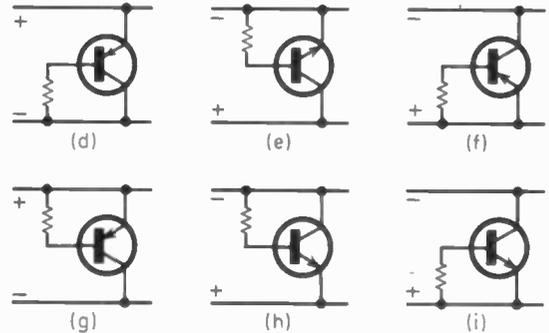
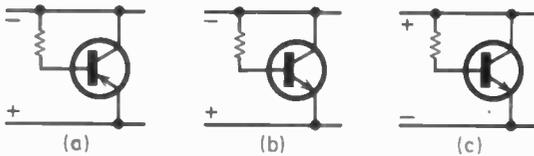


Fig. 6.1. Collector current will flow in only some of these configurations.

## 7 ■ HOW A TRANSISTOR AMPLIFIES

Consider the following arrangements, (Fig. 7.1). Note the arrows are showing *electron* flow. The base material is *p* type and is made *very thin*.

With no forward bias on base (switch open) no current flows at all, because the two diodes are back to back.

With forward bias on base (switch closed) electrons in the emitter are pulled into the base, forming base current. But any electron reaching the base is FAR MORE LIKELY TO TRAVEL ON TO THE COLLECTOR, SINCE IT IS AT A HIGHER POSITIVE POTENTIAL THAN THE BASE.

Thus only a few electrons turn "left", most of them carry straight on.

Thus, switching on a *small* base current has

released a *large* collector current.

The transistor is therefore a **current amplifier!**

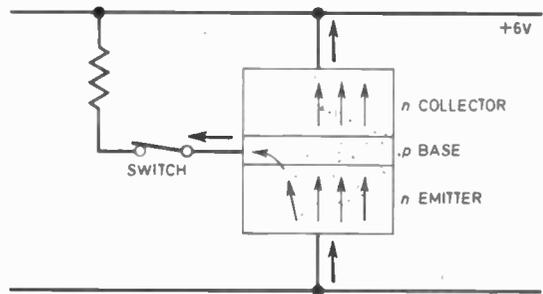


Fig. 7.1. Electron flow in an *n*pn transistor.

## 8 ■ THE THREE CURRENTS IN A TRANSISTOR

The following equation describes the distribution of currents in a transistor.

**Emitter current = base current + collector current**

or in symbols,

$$I_e = I_b + I_c$$

These currents flow as indicated in Fig. 8.1.

If the  $I_c$  is 5mA and  $h_{fe}$  is 100, the base current  $I_b = \frac{5}{100} \text{mA} = 0.05 \text{mA}$ . The emitter current  $= I_b + I_c = 0.05 + 5$ .

Therefore, emitter current = 5.05mA.

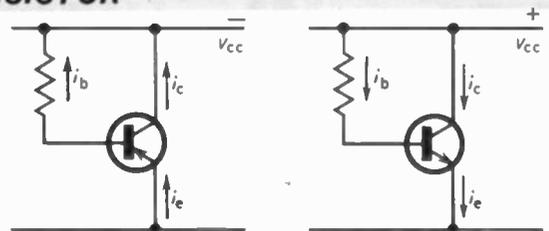
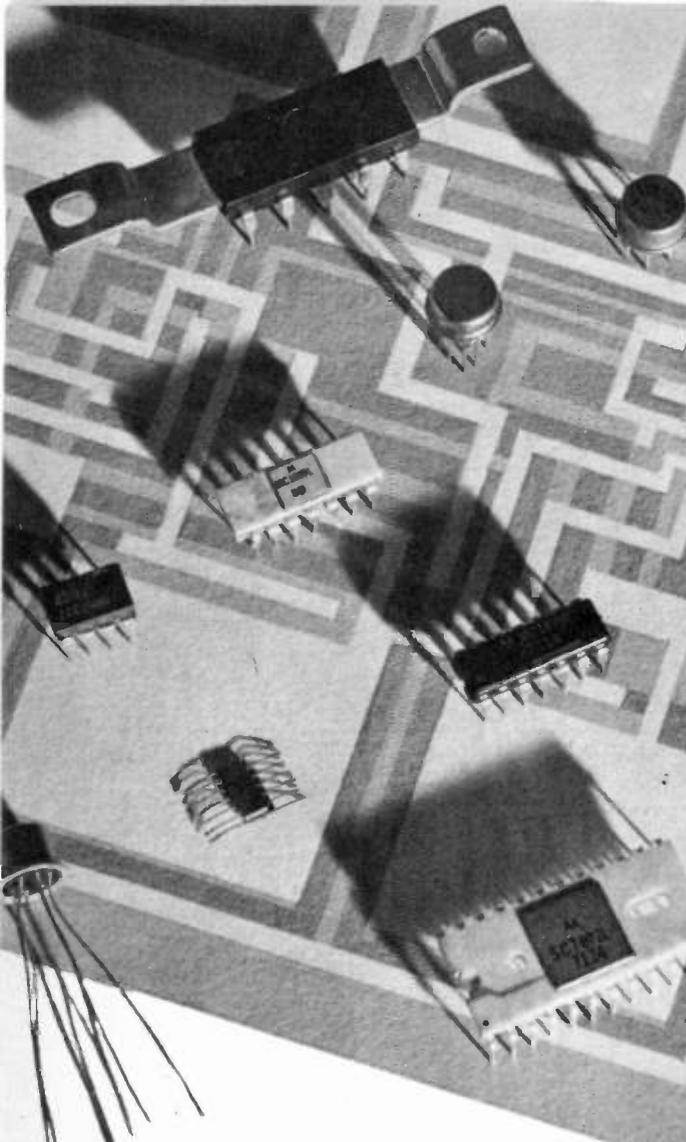


Fig. 8.1. Current flow in *p*np and *n*pn transistors.



LAST month we looked at integrated circuits in general, this month we take a look at some i.c.s of particular interest to amateurs.

## AUDIO AMPLIFIERS

Many amateur enthusiasts make audio amplifiers from discrete components. Others may purchase ready made circuit boards containing a fully constructed audio amplifier suitable for their application. However, during the past few years more and more integrated circuit audio amplifiers have become available. They are ideal for the amateur constructor, being compact devices priced at about £3 or less. They are basically operational amplifiers which incorporate as many of the components as possible inside the integrated circuit.

At very low power levels (up to about 0.1 watt), integrated circuit audio amplifiers can be made on a minute silicon chip. At somewhat higher power levels (up to a few watts) the silicon chip must be specially mounted on a heat sink or on a piece of metal which protrudes from the body of the integrated circuit and which can be bolted to a heat sink. At still higher powers it is common practice to employ an integrated circuit pre-amplifier which drives an output stage employing discrete components.

At very low power levels integrated circuit audio amplifiers may employ output stages which operate in class A. The power supply current is then independent of the signal level. At somewhat higher power levels, class B operation is employed and the power dissipation then increases with signal level. Pulse width modulation techniques appear very suitable for use with integrated circuit audio amplifiers, since the power dissipated is low. However, this type of audio amplifier has not come into general use.

Almost all integrated circuit audio amplifiers require various external components, mainly capacitors. It is not possible to incorporate the large value capacitors required for use in audio amplifiers in a micro-miniature silicon chip of an integrated circuit and they must therefore be connected externally. Some types of thick-film hybrid circuits are available in which sub-miniature capacitors are mounted inside the package.

## AMPLIFIER I.C.S.

We will now consider an audio amplifier which is much used by the amateur constructor, the SN76013 which is the same device as the Super IC12. This device can supply up to about 6 watts of power into an 8 ohm speaker.

The SN76013 is shown on the Integrated Circuit Data Chart presented free with this issue. It can be seen that a finned aluminium heat sink is fitted onto the back of the integrated circuit module. There are twelve con-

# Introduction to INTEGRATED CIRCUITS 2

By J.B.DANCE M.Sc.

necting pins arranged in a dual-in-line configuration with a gap of two pins in the centre of each of the two lines of pins.

## CIRCUIT

The internal circuit of the SN76013 is quite complex and it is not necessary to understand its operation in order to use this amplifier, but the following brief notes may interest some of the more experienced readers.

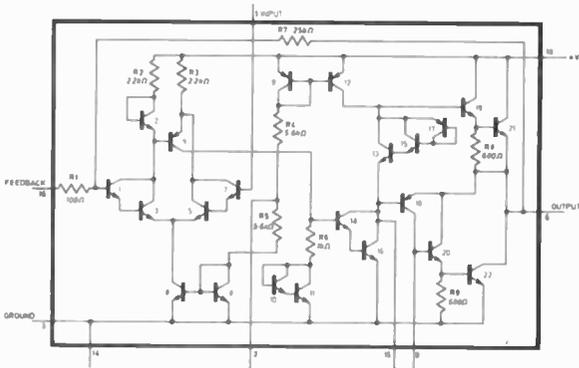


Fig. 2. Circuitry of the SN76013.

Transistors TR1 and TR3, Fig. 2, form a Darlington amplifier which, together with the Darlington amplifier TR5 and TR7, forms a differential long-tailed pair input stage. Transistor TR4 (biased by TR8) forms the constant current source for the long-tailed pair.

The differential output from the long-tailed pair stage is fed to the emitter-base junction of TR6 and the output from the latter is fed to the Darlington pair TR14 and TR16, TR12 acts as a constant current load to this pair. Transistors TR19, TR21, TR18, TR20 and TR22 are connected in a conventional quasi-complementary class AB output stage.

Overall negative feedback is taken through R7 to the input of pin 16. In the external circuit a resistor is also used to apply more negative feedback from the output to pin 16.

A simple circuit with typical component values for use with the SN76013 is shown on the chart.

## OUTPUT POWER

The power output obtainable from the SN76013 depends on the speaker impedance and the power supply voltage. The maximum permissible power supply voltage is 28V and the minimum recommended 8V. The maximum output power for a 28V supply is obtained with a 6 ohm load and is about 7.6 watts. The output power falls to 6 watts with an 8 ohm speaker and to 4.7 watts for a 15 ohm speaker, both with a 28V supply. These maximum power levels can be obtained with a 30mV input signal.

The sensitivity of the SN76013 is adequate for use with a high output crystal pick-up or a ceramic record player cartridge, even when one allows for the fact that an input of 250mV is required to overcome the losses in the frequency compensation circuits between the pick-up and the input of the amplifier.

## SL402D and SL403D

The Plessey type SL402D and SL403D audio amplifiers are somewhat smaller than the Texas SN76013, but they must be fitted to a heat sink. The SL402D can provide an output of up to 2.5W and the SL403D an output of up to 3.5W. They are used as class AB amplifiers.

The shape of these amplifiers is shown on the chart. It can be seen that a 10-pin dual-in-line encapsulation is employed with brackets designed for bolting to an external heat sink.

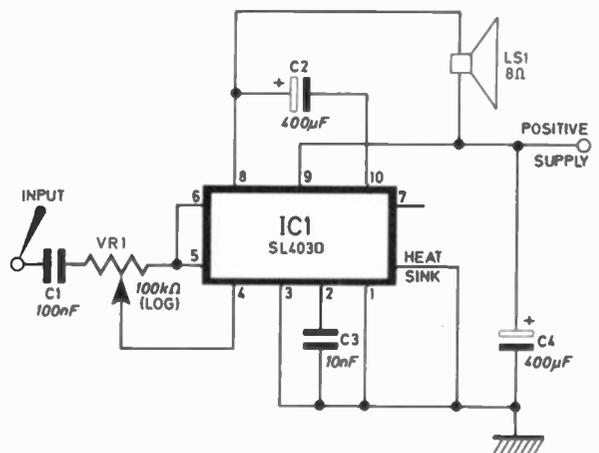
An interesting feature of these amplifiers is the use of an internal silicon controlled rectifier to protect the unit against short circuiting of the output. If such a short occurs, the power supply must be momentarily interrupted to reset the silicon controlled rectifier. The maximum operating supply voltage for the SL402D is 14V and for the SL403D 18V.

The simplest type of circuit used with these amplifiers is shown in Fig. 3. Only four capacitors and a potentiometer (the volume control) are required.

## THE LM380N

Another integrated circuit audio amplifier which is ideally suitable for the amateur constructor is the National Semiconductor type LM380N. It has been designed so that a minimum number of external components are required and can provide 2W into an 8 ohm loudspeaker when operated from an 18V supply.

Fig. 3. Simple circuit employing an SL403D amplifier.



The LM380N device has thermal overload protection; that is, an internal circuit is included which will prevent damage from occurring if the components on the internal silicon chip become too hot. In addition, the LM380N includes short circuit protection; it will not therefore be damaged if the output is accidentally shorted to ground.

This audio amplifier has a 14-pin dual-in-line encapsulation with the connections shown on the chart. If the input signal is fed to pin 2, the output voltage will be in phase with the input. However, the input signal may be fed to the inverting input at pin 6, in which case the output signal will be 180 degrees out of phase with the input.

The LM380N includes internal feedback resistors which ensure that it has a fixed voltage gain of 50 (or 34db). Although this fixed gain reduces the versatility of the device somewhat, it does enable it to be used with a minimum number of external components and makes it more attractive for many purposes.

The LM380N can dissipate up to about 1.3W without any heat sink. If one wishes to operate it at its maximum power level for an appreciable time, pins 3, 4 and 5 and pins 10, 11 and 12 should be soldered to external heat sinks.

The circuit of a complete audio amplifier using the LM380N is shown in Fig. 4; it is outstanding for its simplicity. The components R1 and C2 (shown dotted) increase the stability at high frequencies. The minimum recommended operating voltage is 8V and the absolute maximum operating voltage 22V; however, it is wise to regard 18V as the upper limit to prevent possible damage to the device during voltage surges.

When the input is fed to pin 2, the other input at pin 6 may be left unconnected, but sometimes it is better to return it to earth either directly or through a capacitor or resistor. When the input is fed to pin 6, pin 2 should be returned

to earth in one of these ways.

If the average input potential is the same as that of the negative line, no capacitor need be placed in series with the input. The input impedance is 150 kilohms.

If a mains power pack is used to supply a LM380N, any hum on the power supply line tends to appear at the output. This hum can be reduced by a very large factor (about 40db) by connecting a capacitor of about 5 $\mu$ F from pin 1 to ground.

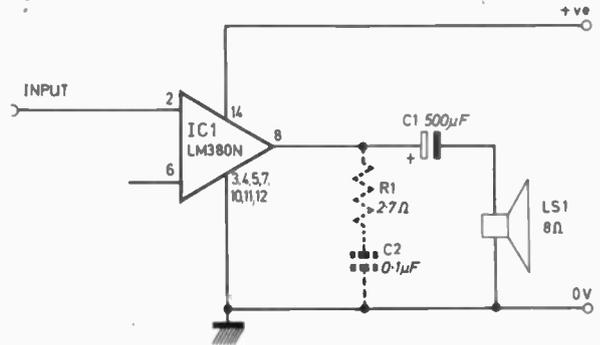


Fig. 4. Circuit using an LM380N.

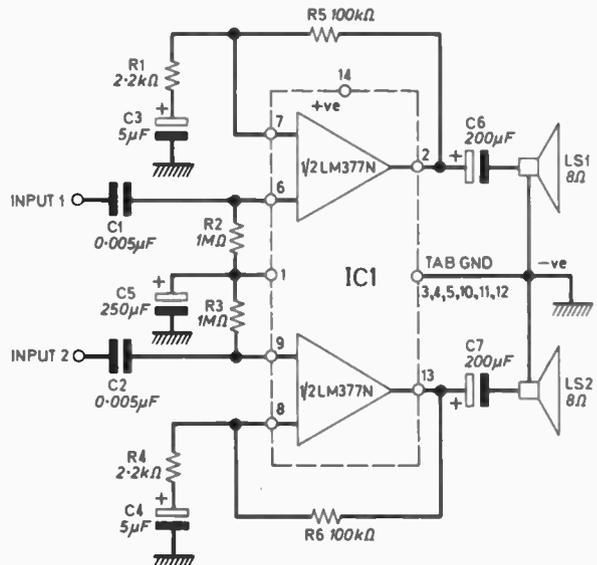
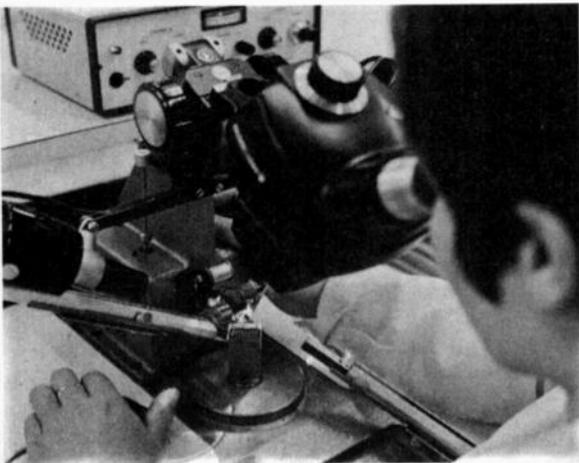
### DUAL POWER AMPLIFIER

The National Semiconductor LM377N is a 14-pin dual-in-line device which contains two separate high gain audio power amplifiers in a single encapsulation. Each amplifier will provide an output of up to at least 2W (typically 2.5W) into an 8 or 16 ohm loudspeaker.

This device is intended mainly for use in stereo radio receivers, stereo record players, tape recorders, etc. Both amplifiers are fully protected against accidental short circuiting of

Fig. 5. Circuit of a stereo amplifier using an LM377N.

Photograph showing an integrated circuit being connected to the package pins.



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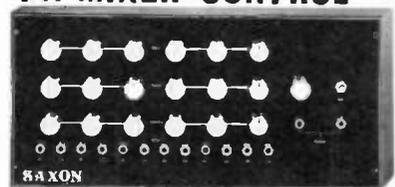
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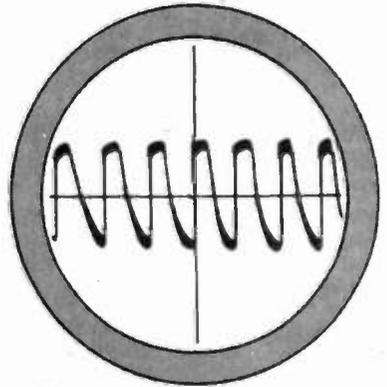
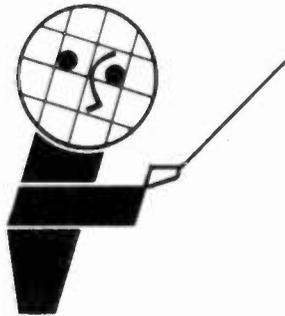
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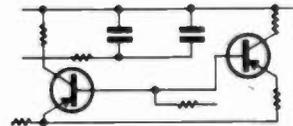
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its output and, in addition, against overheating of the silicon chip.

The minimum recommended supply voltage is 10V and the absolute maximum permissible supply voltage 26V. Under no signal conditions the device requires about 15mA, but this rises to about 1A at high power levels.

The amplifiers have a high input impedance (3 megohms). The gain is set by the values of two external resistors.

The connections of the LM377N are unfortunately shown incorrectly on the chart, the base should be C. A single device of this type can be used in the circuit of Fig. 5 as the power amplifier stages of a stereo system. The gain is equal to  $R5/R1 = R6/R4 = 45$ .

The bias supply from pin 1 must be used to supply both of the inputs at pins 6 and 9. In Fig. 5 this bias is applied via R2 and R3 to the respective amplifiers.

The LM377N can also be used as the driver stage in high power audio amplifiers if it is employed to feed two suitable high power output stages.

## THE TBA800

Another well-known integrated circuit audio amplifier is the SGS-Ates type TBA800; it can feed up to 5W of power into a 16 ohm loudspeaker when the circuit is operated from a 24V supply.

The TBA800 is encapsulated in a plastic case which has its connecting pins in the quad-in-line configuration. Quad-in-line devices are like dual-in-line ones, but alternate pins are bent so that they are at different distances from the body of the device. Thus when one looks at one end of the device, one sees four separate lines of pins; hence the name quad-in-line.

In addition to its connecting pins, the TBA800 has two metal tabs at the centre of each side of the device. These cooling tabs (which should be connected to the negative line) enable the device to provide up to 2.5W of power to an 8 or 16 ohm loudspeaker without any additional heat sink. If a TBA800 is to be used at a higher power level for more than a very short time, the metal tabs should be connected to an external heat sink. They may, for example, be soldered to the copper of a printed circuit board.

## TBA810S and TBA810AS

The SGS-Ates TBA810S has the same type of encapsulation as the TBA800, but is a lower voltage, higher current device. It can drive up to 7W into a 4 ohm loudspeaker when a 16V supply is used and the cooling tabs are connected to a suitable heat sink.

The TBA810S is especially suitable for use in car radio receivers, since it can provide up to 4.5W into a 4 ohm loudspeaker when it is operated from a 12V car supply.

The TBA810AS is electrically similar to the TBA810S, but it has flat tabs with a hole drilled in each so that an external heat sink can be bolted to the tab.

A typical circuit for the TBA810S or TBA810AS is shown in Fig. 6. The minimum supply voltage is 4V and the absolute maximum 20V.

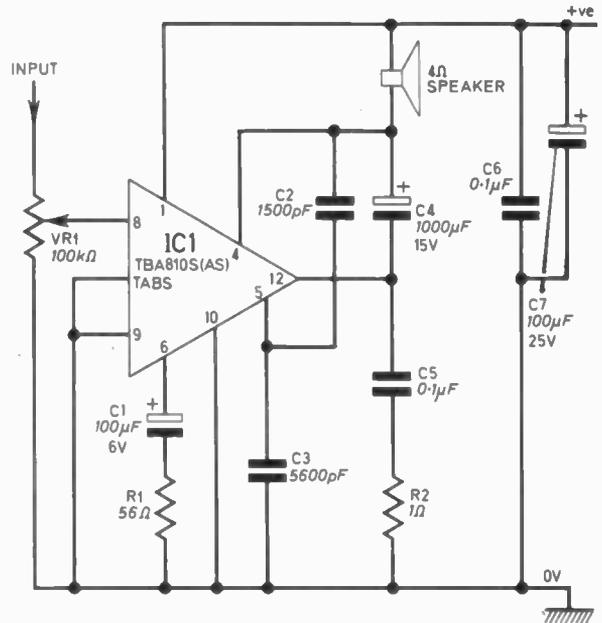


Fig. 6. Circuit for use with the TBA810S.

It should be noted that the TBA800 is suitable for 16 ohm loudspeakers, since it is a relatively high voltage device, whereas the high current output available from the TBA810 devices renders them more suitable for 4 ohm loudspeakers.

## HIGHER POWER DEVICES

SGS-Ates will soon offer a type TCA940 amplifier which can drive a 4 ohm loudspeaker at the 10W level when fed from an 18V supply. The company have also developed a 20W amplifier which is expected to be produced in the fairly near future.

## DIODE PROTECTION

If the power supply is accidentally applied to an integrated circuit audio amplifier with a reversed polarity, the device will normally be destroyed within a few milliseconds. Constructors are therefore advised to put a diode in the positive supply line, since this diode will prevent appreciable reverse current from flowing if the supply is accidentally connected with the wrong polarity. Obviously the diode must be connected the correct way round and must be able to pass

a continuous current equal to the maximum current passed by the device.

The diode may be removed after the initial experiments if there is no longer any possibility of the power supply being applied with the wrong polarity.

## **RF/IF AMPLIFIERS**

Radio and intermediate frequency amplifiers using integrated circuits are now becoming more common. In general integrated circuits for high frequency amplification employ several transistors per stage. It is not easy to incorporate tuned circuits in a silicon chip and therefore possible alternatives are being investigated.

Many types of high frequency amplifier are available, such as the RCA type CA3053 and the Plessey type SL612. The Mullard TAD100 unit can be used in amplitude modulated radio receivers for handling the signal from the mixer-oscillator stage up to the audio driver stage when used with suitable external components.

Various manufacturers have designed integrated circuits for use in v.h.f. receivers. For example, the Signetics N511A is a 14-pin dual-in-line circuit which enables only one coil with a single winding to be used in the f.m. limiter and detector stages of a receiver. It can also be employed in television sound channels and in communication receivers, etc.

## **THE ZN414**

The ZN414 is one of the most interesting integrated circuits for the amateur constructor. It contains ten transistors in a miniature transistor-like case with three connecting leads.

When the ZN414 is connected to a ferrite aerial, a tuning capacitor, a bias resistor, two capacitors and a 1.3V battery, it provides a signal which can drive a magnetic earpiece. Full constructional details of such a receiver were given in the September 1973 issue of this journal and the device will therefore not be discussed in detail here.

The ZN414 can also be used as an i.f. amplifier in a.m. superheterodyne receivers. Further details are available in a booklet published by Ferranti Ltd., Gem Mill, Chadderton, Oldham, Lancs.

## **OTHER RADIO DEVICES**

The TBA651 is an integrated circuit which is used to carry out the whole of the radio and intermediate frequency processes in a medium/long wave superheterodyne receiver.

The device combines the functions of r.f. amplifier, oscillator, mixer, i.f. amplifier and automatic gain control. It has been designed for use in both car radios and in high quality receivers.

The TBA651 will operate from supply voltages between 4.5V and 18V, consuming only 11.5mA. The device is encapsulated in a 16-pin quad-in-line case.

Another well-known device is the TAA661B f.m./i.f. amplifier and detector which is suitable for use in television sound and in f.m. receivers. The use of this device enables the detector transformer to be eliminated, whilst the output signal can be used to drive an audio amplifier directly. Detector alignment is carried out by the adjustment of a single coil—a point which should appeal to the amateur constructor.

The TDA1200 is a recently developed device for use as an f.m. radio i.f. system. It is a complex integrated circuit which includes f.m. amplification and detection, inter-channel muting for silent tuning, automatic frequency control, delayed automatic gain control, switching of a stereo decoder and driving a field strength meter.

This 16-pin dual-in-line device is suitable for use in high fidelity car radio and communication receivers.

Many other integrated circuits for radio and television use have come onto the market within the last few years. They will enable the cost of consumer devices to be kept lower than they otherwise would have been by minimising labour costs.

The Signetics integrated circuits types NE560B, NE561B and NE562B enable complete f.m. i.f. strips (including the demodulator) to be constructed without any inductors. They employ circuits known as phase locked loops.

## **VOLTAGE REGULATORS**

Another important use of integrated circuits is for voltage regulation in power supplies. One merely connects the circuit to the output of a smoothed power supply in order to obtain a highly regulated output with an extremely low hum level. These voltage regulators are themselves ideal for use in the very stable power supplies required to drive some types of integrated circuit.

## **TIMER**

A timer integrated circuit recently introduced by the Signetics Company is particularly versatile. It can be used to obtain delays of microseconds to hours and the delay is almost independent of the supply voltage. The type number is NE555V for the dual-in-line 8-lead package.

Integrated circuits have made a very great impact on a wide variety of circuits, only a few of which have been mentioned in this article. The rapid fall of prices during the last few years make them components which can really appeal to the amateur experimenter as well as to the professional engineer. □

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# DOWN TO EARTH

By GEORGE HYLTON

"Transistor data always gives current amplification, never voltage amplification. Yet in practical circuits it is voltage gain which matters. Can the voltage gain be derived from the current gain?"

The reason why no information about voltage gain is given in the transistor makers data is that you don't need it. Or, rather, it's assumed by the makers that you already have it, in your head.

Show a competent transistor circuit designer the audio amplifier of Fig. 1, and ask him what is the voltage gain. After about ten seconds, he'll say, "About 120", and he'll be right.

You can do it, too. The magic formula is: multiply the d.c. voltage drop across the collector load resistance (in kilohms) by 40. This is the voltage gain. In Fig. 1, the voltage drop across the 1 kilohm emitter resistor is 1 volt, so the emitter current is 1 milliamp. The collector current must be nearly the same, so the drop across the 3 kilohm collector load R3 is 3V. Gain is  $3 \times 40 = 120$ .

## COMPLICATIONS

We don't propose to go into the rather complicated reasons for this very simple relationship. The important thing is that it is true of all bipolar transistors, whether *npn*, *nnp*, silicon or germanium.

It's also true that it's only an approximation, and gives accurate results only when the transistor is used in normal circuits with only a few volts across the load resistance.

What's 'normal'? Well, Fig. 1 is normal, assuming that TR1 is an ordinary small signal audio transistor such as BC108 or 2N2926. But if the supply voltage were 50V and the drop across R3 were 30V the gain would not be 1200, as predicted by the formula, but a lot less.

One has to be sensible, too. In Fig. 1 there's no external load resistance, only R3. If you short the output terminals (giving an external load of 0 ohms!) there can be no output voltage. So the external load, if used, matters, and will reduce the output and voltage gain.

If an external load of 3 kilohms were connected (i.e., equal to R3), then the a.c. part of the output current would divide itself equally between the two loads and the output and gain would be halved. (This implies that R3 and the external load are in parallel to the signal current.

That is so, because the two loads are tied together at one end by the output capacitor and at the other by the power supply.

In practice, the external load (let's call it  $R_L$ ) may not be equal to R3. To find the gain for any value of  $R_L$ , first use the magic formula for the gain with no load then multiply the answer by  $R_L/(R_L + R3)$ .

## MULTI STAGE

In a multi-stage amplifier (Fig. 2), the "external load" on the first stage is the input impedance of the second stage. In practical circuits, this input impedance is so much smaller than the collector load resistance of the previous stage that to all intents and purposes the whole of the a.c. current from TR1 goes into the base of TR2. It is then amplified  $h_{fe2}$  times ( $h_{fe2}$  = current amplification factor of TR2) before passing through the final (3 kilohm) load resistance to set up the output voltage.

To calculate the overall gain we need to know the a.c. collector current of TR1 rather than its a.c. collector voltage. There is another magic formula which gives you the a.c. collector current:  $40 \cdot I_{c1} \cdot V_{in}$ , where  $I_{c1}$  is the number of milliamps of d.c. collector current of TR1. This leads to an expression for the overall voltage gain.

Voltage gain =  $40 I_{c1} h_{fe2} R_{L2}$   
 where  $R_{L2}$  is the final load in kilohms (in, Fig. 2, 3 kilohms).  
 If  $h_{fe2} = 100$  and  $I_{c1} = 100 \mu A$  or  $0.1 \text{ mA}$ , the overall gain is:  $40 \cdot 0.1 \cdot 100 \cdot 3 = 1200$ .

Like the previous formulae, this is an approximation (and errs on the side of optimism).

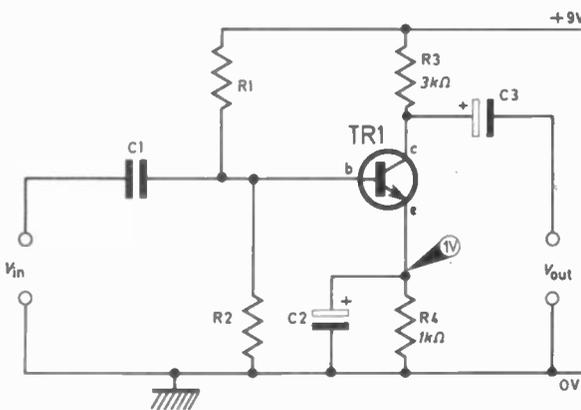


Fig. 1. Single stage amplifier

Everyday Electronics, March 1974

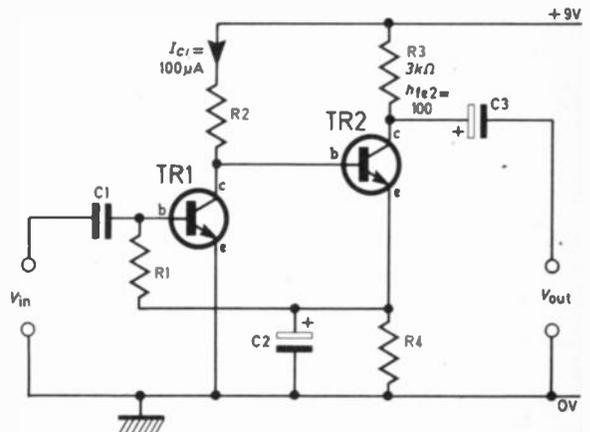


Fig. 2. Two stage amplifier

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# Readers Letters

## I.C.'s and valves

I have a complete set of EVERYDAY ELECTRONICS and I am pleased with it although I would like to see a general broadening of your horizons in other fields past and future; in this I am referring to the lack of projects using integrated circuits and valves and also the lack of explanation of these devices.

Perhaps such devices could be explained in the next term of Teach-In '74. Also could you start a sound-effects series, in particular an "electronic echo". On the whole I like this magazine.

R. Leyland Zlitrm,  
Auckland,  
Australia.

You will be pleased to see that we are using integrated circuits in two of our constructional projects this month.

Detailed explanations of the functioning within the i.c. package however are not given and as a rule the i.c. will be treated as a black-box whose overall performance and operation only are described. The reason for this should be made clear in the series Introduction to Integrated Cir-

cuits which started last month.

At the other end of the line. i.e. valves, we cannot envisage using valves in any E.E. projects—although it is not an impossibility.

Your idea for a sound effects series has been noted and we shall be looking into this in the future.

## Veroboard

I have recently started reading your magazine, and wish to build some of the projects detailed. However, as a raw beginner, only knowing the basic theory learned at school, I wonder if you would explain to me Veroboard diagrams as I do not understand what copper strips should be removed, and which ones left in place. Also how do you remove the copper.

D. Nicholson,  
Cardiff.

Constructional projects built on Veroboard usually show two views of the board, one from the topside showing component positions and a view of the underside showing the copper strips.

The copper strips are shown as

white strips on a black background. Breaks are shown along the strips as white holes on a black background and these breaks can be made by using a "spot-face cutter" a tool made for this job, or a small drill bit of diameter larger than the width of the copper strip.

Other information given on the underside view is the solder point of a component or flying lead to the copper strip; this is indicated by a black dot along the strip.

## Inverter

I have been a regular reader of your magazine for some time now, and at present intending to build a d.c. to a.c. inverter as described in one of your earlier issues. However, I would like to build it so that the output would be around 240 volts 50 cycles and about 100 watts minimum (from 12 volt car battery).

As I am a newcomer to electronics through your magazine, I feel confident that you will be able to advise me as to where I might be able to obtain instructions to build such an inverter, or if possible how to modify your published design to meet the output required.

J. Henderson,  
Ayrshire.

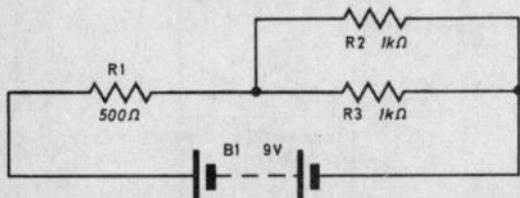
The inverter you refer to was published in the July 1972 issue of E.E. and cannot be modified easily to obtain the required power output.

However, a 100 watt inverter was featured in Practical Electronics February 1973.

## What do you know?

### OHMS LAW

1. What would you expect the potential difference across a 3.9-kilohm resistor to be if 150 microamps were flowing through it.
2. What current would flow in R3 in Fig. 1.



3. What wattage resistors would you use for those shown in Fig. 1.

4. If R3 in Fig. 1 is removed what effect would it have on the current flow in R1.

### ANSWERS

1.  $V = IR = 3.9 \times 150 = 0.585V$ .
2. Total circuit resistance =  $1k\Omega$ , total circuit current =  $\frac{1 \times 10^3}{9} = 9mA$ . Therefore current flow in R3 =  $4.5mA$ .
3. Dissipation in  $R1 = I^2 R = (9 \times 10^{-3})^2 \times 500 = 0.0405W$ . Hence  $\frac{1}{2}W$  or  $\frac{1}{4}W$  resistors are quite adequate. Since R2 and R3 are higher resistance and are passing less current their dissipation will be lower and once again  $\frac{1}{2}W$  or  $\frac{1}{4}W$  resistors will suit.
4. If R3 were removed the overall circuit resistance would become  $1.5k\Omega$  and current would be  $\frac{1.5 \times 10^3}{9} = 5mA$ . Therefore current flow in R1 would drop from  $9mA$  to  $5mA$ .

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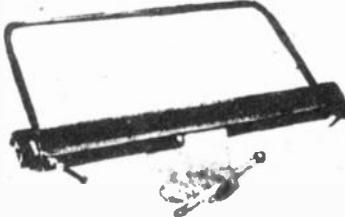
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UIC100	-12 x 7430	0-55	UIC56	-8 x 7470	0-55	UIC100	-5 x 74100	0-55
UIC101	-12 x 7440	0-55	UIC57	-8 x 7471	0-55	UIC101	-5 x 74101	0-55
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UIC103	-12 x 7442	0-55	UIC59	-8 x 7473	0-55	UIC103	-5 x 74103	0-55
UIC104	-5 x 7443	0-55	UIC60	-8 x 7474	0-55	UIC104	-5 x 74104	0-55
UIC105	-5 x 7444	0-55	UIC61	-8 x 7475	0-55	UIC105	-5 x 74105	0-55
UIC106	-5 x 7445	0-55	UIC62	-5 x 7480	0-55	UIC106	-5 x 74106	0-55
UIC107	-5 x 7446	0-55	UIC63	-5 x 7481	0-55	UIC107	-5 x 74107	0-55
UIC108	-5 x 7447	0-55	UIC64	-5 x 7482	0-55	UIC108	-5 x 74108	0-55
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0-70	1-54	1-00	0-39	0-41	0-54	0-54	0-63
0-83	1-76	400	0-48	0-52	0-62	0-62	0-74
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0-83	200	0-06	0-10	0-07	0-16	0-22
0-27	400	0-07	0-15	0-08	0-22	0-30
0-41	600	0-08	0-18	0-11	0-26	0-38
0-50	800	0-11	0-19	0-12	0-28	0-41
0-61	1000	0-12	0-28	0-16	0-33	0-51
0-70	1200	0-12	0-28	0-16	0-33	0-51
0-76						

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Viscount III amplifier (As System I)  
Garrard SP. 25 (As System I)  
Two Duo Type IIIA matched speakers - Enclosure size approx. 31" x 13" x 11 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.

**Complete System £69.00**

**PRICES: SYSTEM 1**

Viscount III R 102 amplifier	£24.20	-£1 p & p
2 Duo Type II speakers	£14.00	+£2.20 p & p
Garrard SP25 with MAG. cartridge de luxe plinth and hinged cover	£21.00	-£1.75 p & p.

total £59.20

Available complete for only **£51.00 + £3.50 p. & p.**

**PRICES: SYSTEM 2**

Viscount R 102 amplifier	£24.20	+£1 p & p
2 Duo Type III A speakers	£39.00	+£4.00 p & p
Garrard SP25 with MAG. cartridge de luxe plinth and hinged cover	£21.00	-£1.75 p & p.

total £84.20

Available complete for only **£69.00 + £4 p. & p.**

## STEREO 21



## 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.

Two 8" x 5" speakers with cabinets.  
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 output 2.7 watts per channel; Output impedance 8-15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs - radio, tape, etc., and outputs for taping discs. **Overall Dimensions.** Speakers approx. 15 1/2" x 8" x 4". Complete deck and cover in closed position approx. 15 1/2" x 12" x 6". Complete only **£18.95**

Extras if required.

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## DISCO AMPLIFIER

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Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).

Inputs \*5 Electrically Mixed Inputs. \*3 Individual Mixing controls. \*Separate bass and treble controls common to all 5 inputs.  
\*Mixer employing F.E.T. (Field Effect Transistors). \*Solid State Circuitry. \*Attractive Styling.

**INPUT SENSITIVITIES**

1) Crystal Mic or Guitar 9mV. 2) Moving coil Mic or Guitar 8mV. 3), 4), 5) Medium output equipment (Gram, Tuner, Monitor, Organ, etc.) - all 250mV sensitivity.

AC Mains 240V. operation.  
Size approx. 12 1/2" x 6" x 3 1/2" ins

**£13.50 + 60p.**  
postage & packing.



## 8 TRACK CARTRIDGE PLAYER\*

Elegant self selector push button player for use with your own stereo system. Compatible with Viscount III system, the Stereo 21 and the Unisound module.

Technical specification.

Mains input. 240V. Output sensitivity 125mV

Comparable unit sold elsewhere at £24.00 approx.

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## BUILD YOUR OWN STEREO AMPLIFIER\*

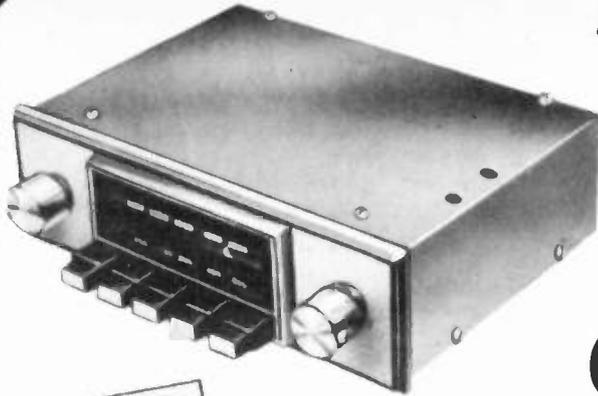
For the man who wants to design his own stereo - here's your chance to start, with Unisound - pre-amp, power amplifier and control panel. No soldering - just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum.

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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  $\frac{5}{8}$  ins. deep approx.

# Remember! one of the Top Ten Accessory Awards from Motor magazine **PUSH BUTTON\* CAR RADIO KIT**

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

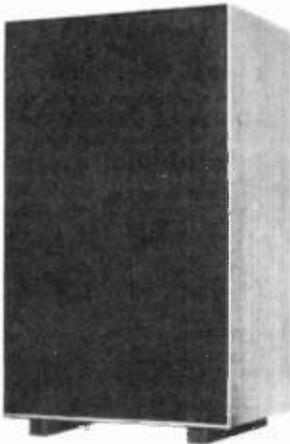
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Hand built - 15" diameter bass with 3" voice coil.  
 - two 5" diameter Mid Range units.

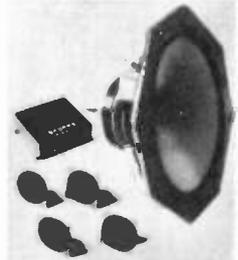
- two 3  $\frac{1}{2}$ " HF. units, plus matching crossover panel with two variable potentiometers for mid and high frequency adjustment.

#### Powder Handling

Continuous rating 35 W rms., Peak power rating 70 W.

Frequency Response 20 Hz 20,000 Hz.

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15" 14A/780. Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS, and is treated to give a smooth frequency response. Resonance 30 Hz. flux density 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3" voice coil.

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8N7403N	0.20	0.18	0.16	8N7454N	0.20	0.18	0.16	8N74150N	2.30	2.30	2.01
8N7403AN	0.38	0.38	0.33	8N7460N	0.20	0.18	0.16	8N74151N	1.15	1.15	1.00
8N7404N	0.24	0.21	0.18	8N7470N	0.33	0.30	0.27	8N74153N	1.09	1.09	0.95
8N7405N	0.20	0.18	0.16	8N7472N	0.38	0.38	0.34	8N74154N	2.30	2.30	2.01
8N7405AN	0.44	0.44	0.38	8N7473N	1.44	1.41	1.37	8N74155N	1.38	1.15	1.00
8N7406N	0.28	0.28	0.25	8N7485N	0.48	0.48	0.42	8N74156N	1.09	1.09	1.00
8N7407N	0.40	0.38	0.35	8N7475N	0.69	0.65	0.61	8N74157N	1.09	1.09	0.95
8N7408N	0.25	0.22	0.19	8N7476N	0.45	0.38	0.32	8N74158N	2.44	2.44	2.14
8N7409N	0.33	0.33	0.28	8N7480N	0.80	0.70	0.50	8N74160N	1.58	1.58	1.38
8N7409AN	0.44	0.44	0.38	8N7481N	1.25	1.10	0.95	8N74161N	1.58	1.58	1.38
8N7410N	0.20	0.18	0.16	8N7482N	0.87	0.80	0.72	8N74162N	1.58	1.58	1.38
8N7411N	0.25	0.23	0.21	8N7483N	1.20	1.10	1.00	8N74163N	1.58	1.58	1.38
8N7412N	0.28	0.28	0.25	8N7484N	0.48	0.48	0.42	8N74164N	2.01	2.01	1.76
8N7413AN	0.38	0.38	0.33	8N7486N	0.50	0.50	0.44	8N74165N	2.01	2.01	1.76
8N7413N	0.30	0.27	0.25	8N7489N	4.32	4.32	3.78	8N74166N	2.16	2.16	1.89
8N7414AN	0.72	0.72	0.63	8N7490N	0.75	0.70	0.63	8N74167N	0.75	0.40	0.39
8N7414N	0.30	0.27	0.25	8N7491AN	1.10	1.00	0.90	8N74170N	2.88	2.88	2.52
8N7417N	0.30	0.27	0.25	8N7492N	0.78	0.70	0.63	8N74172N	0.78	0.78	0.54
8N7420N	0.20	0.18	0.16	8N7493N	0.75	0.70	0.63	8N74173N	1.58	1.58	1.38
8N7422N	0.20	0.18	0.16	8N7494N	0.85	0.80	0.75	8N74174N	1.80	1.80	1.57
8N7422AN	0.38	0.38	0.33	8N7495N	0.85	0.80	0.75	8N74175N	1.29	1.29	1.13
8N7423N	0.37	0.34	0.32	8N7496N	1.00	0.90	0.83	8N74176N	1.44	1.44	1.26
8N7425N	0.37	0.37	0.32	8N74100N	2.18	1.89	1.89	8N74177N	1.44	1.44	1.26
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8N7432N	0.37	0.37	0.32	8N74110N	0.57	0.57	0.50	8N74184N	2.16	2.16	1.89
8N7433N	0.43	0.43	0.38	8N74111N	0.86	0.86	0.75	8N74185AN	2.16	2.16	1.89
8N7433AN	0.57	0.57	0.50	8N74118N	2.16	2.16	1.89	8N74188N	0.48	0.48	0.42
8N7437N	0.43	0.43	0.37	8N74118N	1.00	0.90	0.83	8N74190N	2.30	2.30	2.01
8N7438N	0.43	0.43	0.37	8N74119N	1.92	1.92	1.68	8N74191N	2.30	2.30	2.01
8N7438AN	0.57	0.57	0.50	8N74120N	1.05	1.05	0.92	8N74192N	2.30	2.30	2.01
8N7440N	0.20	0.18	0.16	8N74121N	0.57	0.57	0.50	8N74193N	2.30	2.30	2.01
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8N7442N	0.85	0.79	0.73	8N74123N	1.44	1.44	1.26	8N74195N	1.44	1.44	1.26
8N7443N	1.50	1.27	1.13	8N74125N	0.69	0.69	0.60	8N74196N	1.58	1.58	1.38
8N7444N	1.50	1.27	1.13	8N74126N	0.69	0.69	0.60	8N74197N	1.58	1.58	1.38
8N7445N	2.18	2.18	1.89	8N74132N	0.72	0.72	0.63	8N74198N	3.18	3.18	2.77
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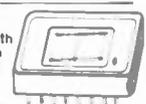
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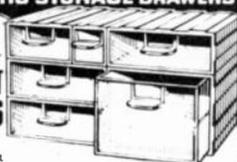
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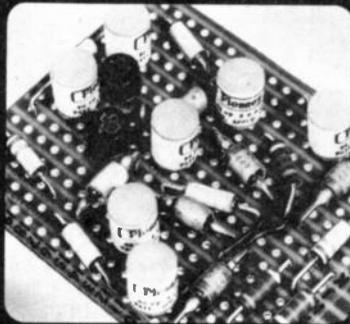
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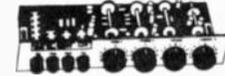
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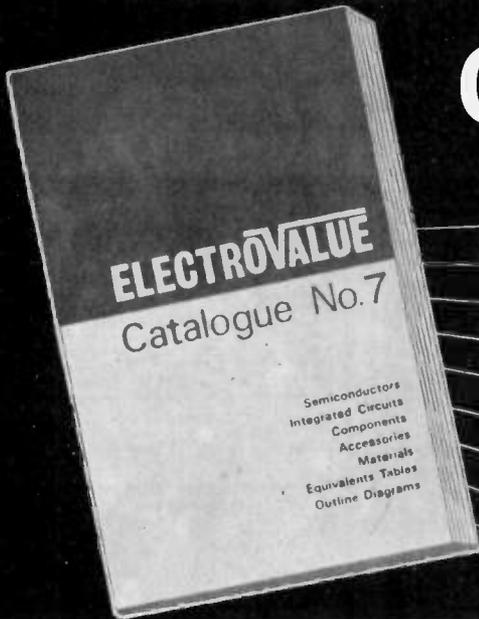
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22	—	—	—	—	—	8p	8p	8p
47	8p	—	8p	8p	8p	8p	10p	13p
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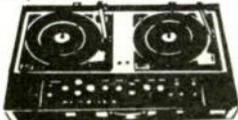


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