An exciting hobby.... for everyone

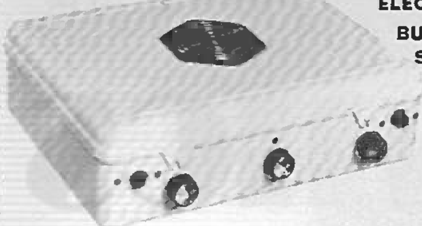
everyday electronics

NOV. 73
15 p.

EXTRA INSIDE

8 PAGE SUPPLEMENT ON CONSTRUCTIONAL METHODS

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.

Complete with parts price list & plans.

Total Building Costs £7·23 P P & Ins. 44p. (Overseas P & P £1·85p.)
(+ 10% VAT 72p)

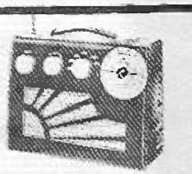
NEW ROAMER NINE

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" × 7" × 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)

ROAMER TEN



with VHF including aircraft. 10 Transistors. 9 Tunable Wavebands, MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Stations also Aircraft Band. Built in Ferrite Road 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. Fine tone moving coil speaker. 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" × 7" × 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" × 5½" × 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, 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.
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)

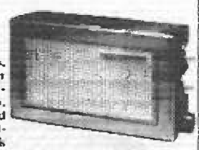
"EDU-KIT"

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 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 ¼" 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)

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" × 1½" × 3½" approx. Plans and parts price list 15p. (Free with parts).

Total Building Costs £2·28 P P & Ins. 24p (Overseas P & P 1·25p)
(+ 10% VAT 22p)

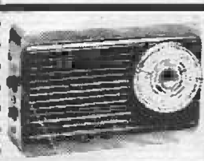
ROAMER EIGHT Mk 1

NOW WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Fine tone moving coil speaker. 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 × 7 × 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)

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. 25p (Overseas P & P 1·25p)
(+ 10% VAT 25p)

ROAMER SIX

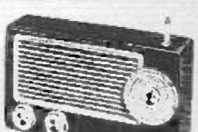
Case and looks as Trans-Eight

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 × 5½ × 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)

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 × 5½ × 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)

Please add 10% for VAT INC. P&P

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Reg. no. 788372

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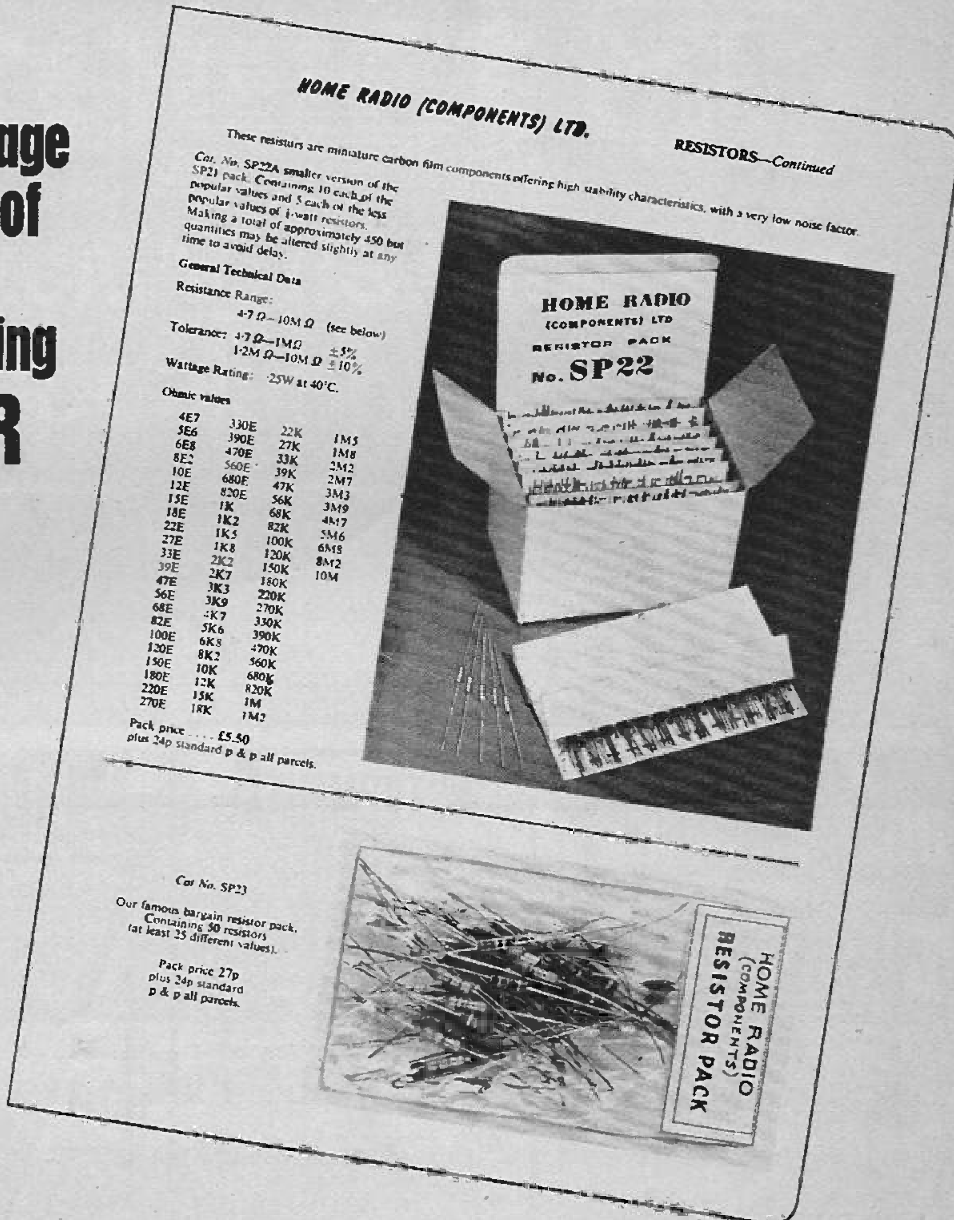
Among the 240 pages of the famous HOME RADIO COMPONENTS Catalogue, are seven pages listing Resistors . . . .

Here is a page showing 2 of our unique money saving RESISTOR PACKS



HOME RADIO (COMPONENTS) LTD. — RESISTORS—*Continued*

These resistors are miniature carbon film components offering high stability characteristics, with a very low noise factor.

Cat. No. SP22A smaller version of the SP21 pack. Containing 10 each of the popular values and 5 each of the less popular values of ¼-watt resistors. Making a total of approximately 450 but quantities may be altered slightly at any time to avoid delay.

General Technical Data

Resistance Range:
4·7 Ω – 10M Ω (see below)

Tolerance: 4·7 Ω—1M Ω ±5%
1·2M Ω—10M Ω ±10%

Wattage Rating: ·25W at 40°C.

Ohmic values

4E7	330E	22K	1M5
5E6	390E	27K	1M8
6E8	470E	33K	2M2
8E2	560E	39K	2M7
10E	680E	47K	3M3
12E	820E	56K	3M9
15E	1K	68K	4M7
18E	1K2	82K	5M6
22E	1K5	100K	6M8
27E	1K8	120K	8M2
33E	2K2	150K	10M
39E	2K7	180K	
47E	3K3	220K	
56E	3K9	270K	
68E	4K7	330K	
82E	5K6	390K	
100E	6K8	470K	
120E	8K2	560K	
150E	10K	680K	
180E	12K	820K	
220E	15K	1M	
270E	18K	1M2	

Pack price £5.50
plus 24p standard p & p all parcels.

Cat No. SP23

Our famous bargain resistor pack. Containing 50 resistors (at least 25 different values).

Pack price 27p
plus 24p standard
p & p all parcels.

**The Famous Home Radio Components Catalogue lists 6,800 items – 1,770 of them illustrated*

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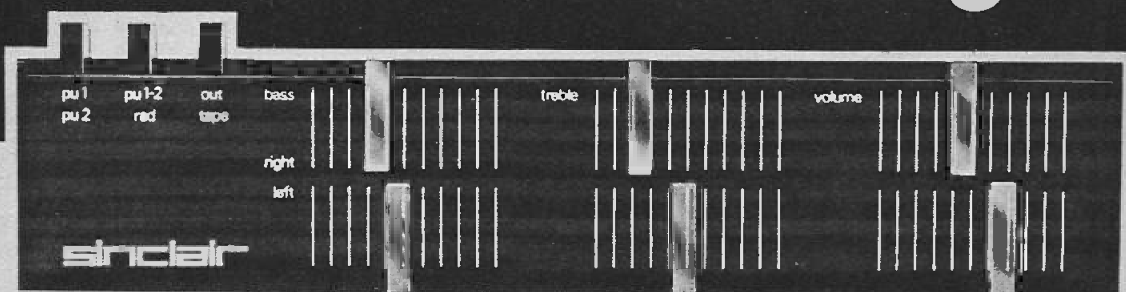
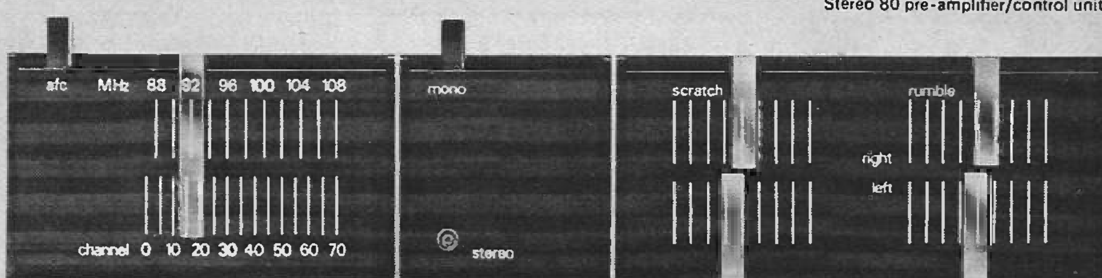
now...

Project 80

...exciting new thinking in modular hi-fi design

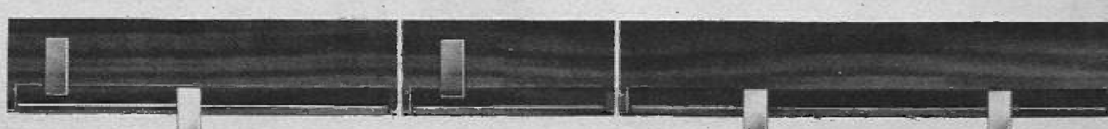


Stereo 80 pre-amplifier/control unit



Project 80 tuner Stereo decoder Project 80 Active Filter Unit (AFU)

the slimmest, most elegant hi-fi modules ever made



Living with hi-fi takes on new meaning now that Project 80 is here. These amazing new modules mark a brilliant technical advance all round; their size and presentation bring exciting new opportunities to install systems in ways hitherto only dreamed about but never before made practical. You can build a Project 80 system virtually anywhere and it is unbelievably simple to install and connect up. Everything that could possibly be wanted in a top quality do-it-yourself domestic hi-fi system will be found in Project 80 – compactness, elegantly ultra-modern styling, ease of fixing and operation, new control methods, and above all superb performance. New as well as popular established ideas on installation are featured on page four of this announcement to provide just a few examples of the system's fantastic versatility.

sinclair

INTERNATIONAL AUDIO FAIR STAND C 8

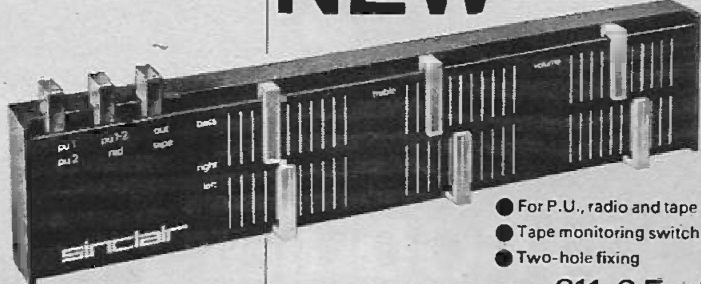
Project 80 new modules

Stereo 80 pre-amplifier and control unit

As with other Project 80 units, the Stereo 80 is mounted by means of two bolts fixed at the rear which pass through holes drilled in the wood or plastic on which modules are to be mounted. *All the electronics are contained within the ¾" deep front panel!* Connecting leads are taken away similarly out of sight. Each channel in the Stereo 80 has its own independent tone and volume controls operated by sliders. This enables exceptionally good environmental matching to be obtained. Provision is made for magnetic and ceramic pick-ups, radio and tape in and out. A virtual earth input stage forms part of the up-dated circuitry of the Stereo 80 to ensure the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

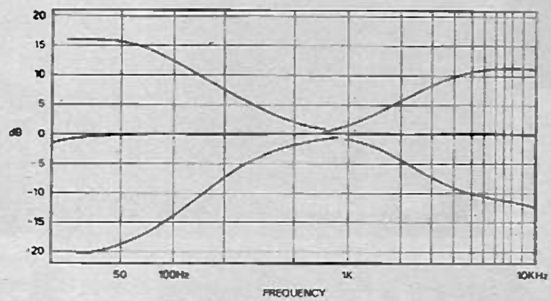
TECHNICAL SPECIFICATIONS
Size – 260×50×20mm (10¼×2×¾ins)
Finish – Black, with white markings
Inputs – Mag. P.U. 3mV RIAA corrected; Ceramic P.U. 300 mV
Radio 300 mV; Tape 30 mV
S/N ratio – 60db
Frequency range – 20Hz to 15KHz ± 1dB; 10Hz to 25KHz ± 3dB
Power requirements – 20 to 35 volts
Outputs – 100mV + AB monitoring for tape
Controls – Press button for tape, radio and P.U. selection Volume.
Bass + 12dB to – 14dB at 100Hz; Treble + 11dB to – 12dB at 10KHz

NEW



- For P.U., radio and tape
- Tape monitoring switch
- Two-hole fixing

R.R.P. £11.95 + £1·19 V.A.T.



Project 80 FM tuner smaller, more efficient

A truly remarkable tuner in every way – its unbelievably compact size – its original circuitry – its dependable performance – all this in a boldly designed modern case measuring 85×50×20mm (3⅓×2×¾ins). Greater adaptability (and possibly financial convenience) results from the tuner and stereo decoder section being made available separately.

TECHNICAL SPECIFICATIONS
Size – 85×50×20mm (approx. 3⅓×2×¾ins)
Tuning range – 87 to 108 MHz
Detector – I.C. balanced coincidence, for good A.M. rejection
AFC – Switchable, with thermistor control to prevent from drift
One 26 transistor I.C.
Twin dual varicap tuning
Distortion – 0·3% at 1 KHz for 75KHz deviation
Ceramic filter in I.F. section
Aerial impedance – 75 Ω or 240-300 Ω
Sensitivity – 4 microvolts for 30dB quieting
Power requirements – 12 to 45 volts

NEW

- AFC switch
- Twin dual varicap tuning
- 4-hole ceramic filter
- Slider tuning

R.R.P. £11.95 + £1·19 V.A.T.

Project 80 stereo decoder

Making the Project 80 decoder separate from the F.M. tuner gives the constructor a wider choice of systems as well as saving money in cases where stereo reception may not be required. This unit gives a 40dB channel separation with an output of 150mV per channel. The gallium arsenide light emitting beacon automatically lights up to show when a stereo transmission is tuned in. Designed essentially as an integral part of Project 80 systems, this multiplex stereo demodulator may be used in many cases with existing single channel frequency modulated tuners to provide stereo reception.
Size – 47×50×20mm (1⅞×2×¾ins)
One 19 transistor I.C.

NEW

- Solid-state stereo indicating beacon
- Readily adaptable for use with other tuners

R.R.P. £7.45 + 0·74p V.A.T.

new constructional techniques

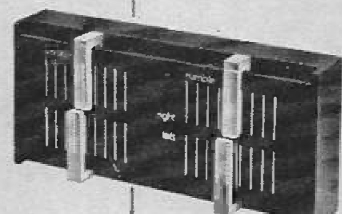
. . .and again Sinclair leads the world

1962 Micro-miniature power amp small enough to stand on a 10p. piece. Slimline pocket receiver smaller than a 20 cigarette pack
1963 Micro-6 receiver, smaller than a matchbox
1964 Pocket F.M. receiver; PWM amp.
1965 Z.12 power amplifier module; PZ.3 power supply
1966 Stereo 25 pre-amp/control unit
1967 Micromatic; Q.14 loudspeaker; the first Neoteric
1968 IC.10, the first ever integrated circuit for constructors use
1969 Q.16 – improved version of Q.14· Systems 2000 and 3000; Project 60 launched
1970 IC.12 Project 605
1971 Project 60 stereo FM tuner. Z.50 PZ 8
1972 Improvements to Project 60 with Z.50 MK.2 and PZ.8 Mk.3 The Executive Calculator; Digital multi-meter· Q.30 speaker·
1973 Cambridge Calculator
PROJECT 80 LAUNCHED
. . . and next ?

Project 80 active filter unit

This efficiently designed unit makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape. As with Stereo 80, separate controls are applied to each channel thereby making it easier to obtain ideal stereo balance in any kind of indoor environment.

TECHNICAL SPECIFICATIONS
Size – 108×50×20mm (4¼ × 2 × ¾ins)
Voltage gain – minus 0·2dB
Frequency response – 36Hz to 22KHz, controls minimum
Distortion – at 1KHz – 0·03% using 30V supply
HF cut off (scratch) – 22KHz to 5·5KHz, 12dB/oct. slope
L.F. cut off (rumble) – 28dB at 20Hz, 9dB/oct. slope



NEW

- For scratch and rumble control
- Transistorised active circuitry

R.R.P. £6.95 + 0·69p V.A.T.

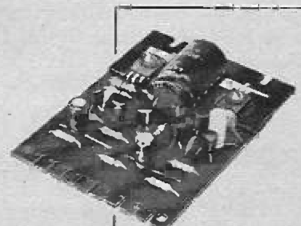
Z.40 & Z.60 power amplifiers
totally short-circuit proof

Either of these entirely new power amplifiers is intended for use in Project 80 installations although, of course, they are readily adaptable to an even wider range of applications. Both Z.40 and Z.60 incorporate built-in protection against shortcircuiting and risk of damage arising from mis-use is greatly reduced. Comprehensive instructions are supplied with each of the modules.

Z.40 Technical Specifications
Size – 55×80×20mm
(2⅛ × 3⅛ × ¾ins) 9 transistors
Input sensitivity – 100mV
Output – 15 watts RMS continuous into 8 Ω (35V). 30 watts music power into 4 Ω (30V)
Frequency response – 10Hz–100KHz ± 1dB
Signal to noise ratio – 64dB
Distortion – at 10 watts into 8 Ω less than 0.1%
Power requirements – 12-35 volts

Z 60 Technical Specifications
Size – 55×98×20mm
(2⅛ × 3⅞ × ¾ins) 12 transistors
Input sensitivity – 100-250mV
Output – 25 watts RMS into 8 Ω (45V). 50 watts music power into 4 Ω (50V)
Distortion – typically 0·03%
Frequency response – 10Hz to more than 200KHz ± 1dB
Signal to noise ratio – better than 70dB
Built-in protection against transient overload and short circuit
Load impedance – 4 Ω min; max. safe on open circuit

NEW



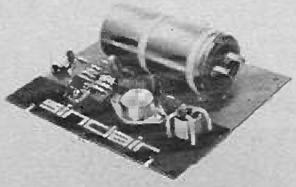
Z.40
R.R.P. £5.45 + 0·54p V.A.T.

Z.60
R.R.P. £6.95 + 0·69p V.A.T.

Sinclair power supply units PZ.8

the worlds most advanced unit in its class

Stabilised power supply unit. Re-entrant current limiting makes damage from overload or even direct shorting impossible, a principle never before inorporated in a commercially available constructor module. Normal working voltage (adjustable) 45V.
R.R.P. £7.98+0.79p V.A.T.
Without mains transformer
PZ.5 30V unstabilised
R.R.P. £4.98+0.49p V.A.T.
PZ.6 35V. stabilised
R.R.P. £7.98+0.79p V.A.T.



Recommended Project 80 applications

System	The Units to use	Units cost
Simple battery record player	Z.40	£5.45 +54p V.A.T.
Mains powered record player	Z.40, PZ.5	£10.43 +£1.04 V.A.T.
30W. RMS continuous sine wave stereo amp.	2× Z.40s, Stereo 80; PZ.6	£30.83 +£3.08 V.A.T.
50W (8 Ω) RMS continuous sine wave de luxe stereo	2× Z.60s, Stereo 80; PZ.8	£33.83 +£3.38 V.A.T.
amplifier Indoor P.A.	Z.60, PZ.8	£14.93 +£1.49 V.A.T.
Car Radio	F.M. tuner, Z.40	£16.40 +£1.64 V.A.T.

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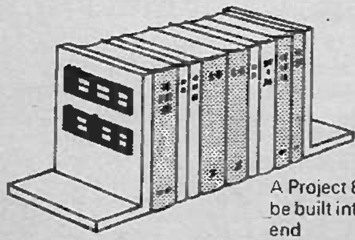
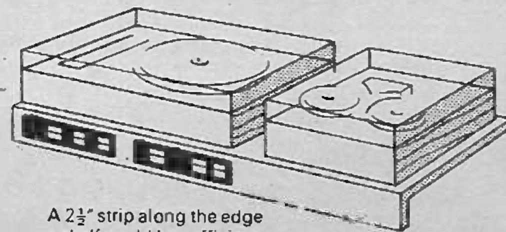
From Sinclair the worlds most advanced hi-fi modules

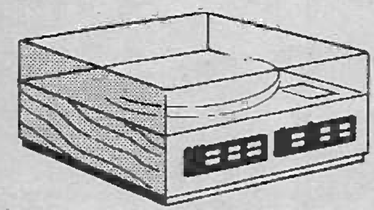
Sinclair Project 80 the ultra-modern non-obtrusive hi-fi



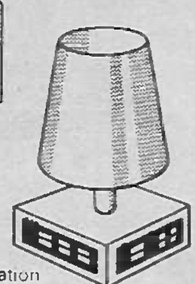
A Project 80 system could be built into a book-shelf end



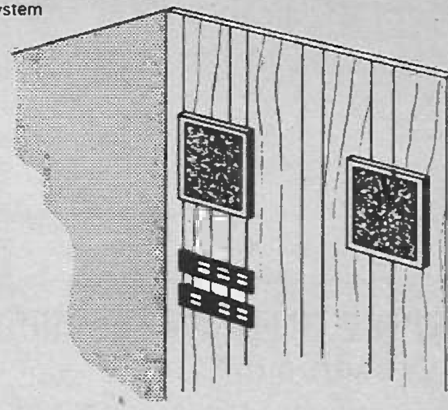
A 2½" strip along the edge a shelf could be sufficient to contain a complete system



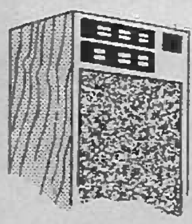
The modules mount very easily onto a playing plinth



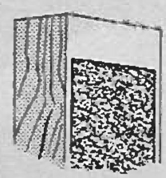
A novel application would be to build around the base of a lampshade



Two Sinclair Q.16 loudspeakers suitably positioned together with Project 80 could be mounted on to a false wall.



Project 80 could be easily mounted onto a loudspeaker cabinet



When you have seen for yourself how fantastically slim and cleverly designed these modules are, further ways will suggest themselves in which they can become a pleasing part of your particular domestic environment.

To SINCLAIR RADIONICS LTD. ST. IVES, HUNTINGDON PE17 4HJ

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Should any defect arise in normal use, we will service it without charge. For damage arising from mis-use a small charge (typically £1.00) will be made.

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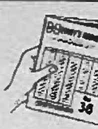
INTEGRATED CIRCUITS
F.E.T.—LIGHT DEVICES



More Devices
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New Ranges
This is a must for all Semi-conductor Users (ask for booklet No. 36)

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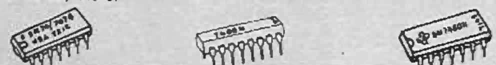
INTEGRATED CIRCUITS

VERY IMPORTANT. ONLY branded I.C's are to the FULL manufacturers specifications. ALL others are not. Henry's sell *only* branded Integrated Circuits . . . From TEXAS . . . I.T.T. . . . FAIRCHILD . . . SIGNETICS. So why buy alternatives or under spec. devices when you can purchase the genuine article from us—ex stock . . . need we say more!



Type	1/11 £ p	12/29 £ p	30/99 £ p
SN7400N	0·20	0·18	0·16
SN7401N	0·20	0·18	0·16
SN7401AN	0·38	0·38	0·33
SN7402N	0·20	0·18	0·16
SN7403N	0·20	0·18	0·16
SN7403AN	0·38	0·38	0·33
SN7404N	0·24	0·21	0·18
SN7405N	0·20	0·18	0·16
SN7405AN	0·44	0·44	0·38
SN7406N	0·40	0·38	0·35
SN7407N	0·40	0·38	0·35
SN7408N	0·25	0·22	0·19
SN7409N	0·38	0·33	0·28
SN7409AN	0·44	0·44	0·38
SN7410N	0·20	0·18	0·16
SN7411N	0·25	0·23	0·21
SN7412N	0·30	0·28	0·25
SN7412AN	0·38	0·38	0·33
SN7413N	0·30	0·27	0·25
SN7414N	0·72	0·72	0·63
SN7416N	0·30	0·27	0·25
SN7417N	0·30	0·27	0·25
SN7420N	0·20	0·18	0·16
SN7422N	0·28	0·28	0·25
SN7422AN	0·38	0·38	0·33
SN7423N	0·37	0·34	0·32
SN7425N	0·37	0·37	0·32
SN7427N	0·37	0·37	0·32
SN7428N	0·43	0·43	0·37
SN7430N	0·20	0·18	0·16
SN7432N	0·37	0·37	0·32
SN7433N	0·43	0·43	0·38
SN7433AN	0·57	0·57	0·50
SN7437N	0·43	0·43	0·37
SN7438N	0·43	0·43	0·37
SN7438AN	0·57	0·57	0·50
SN7440N	0·20	0·18	0·16
SN7441AN	0·85	0·79	0·73
SN7442N	0·85	0·79	0·73
SN7443N	1·50	1·27	1·13
SN7444N	1·50	1·27	1·13
SN7445N	2·16	2·16	1·89
SN7446N	2·16	2·16	1·89
SN7447AN	1·80	1·80	1·57
SN7448N	1·50	1·27	1·13
SN7450N	0·20	0·18	0·16
SN7451N	0·20	0·18	0·16
SN7453N	0·20	0·18	0·16
SN7454N	0·20	0·18	0·16
SN7460N	0·20	0·18	0·16
SN7470N	0·33	0·30	0·27
SN7472N	0·38	0·38	0·34
SN7473N	0·44	0·41	0·37
SN7474N	0·48	0·48	0·42
SN7475N	0·59	0·55	0·51
SN7476N	0·45	0·36	0·32
SN7480N	0·80	0·70	0·50
SN7481N	1·25	1·10	0·95
SN7482N	0·87	0·80	0·72
SN7483N	1·20	1·10	1·00
SN7485N	1·87	1·87	1·63
SN7486N	0·50	0·50	0·44
SN7489N	4·32	4·32	3·78
SN7490N	0·75	0·70	0·63
SN7491AN	1·10	1·00	0·90
SN7492N	0·75	0·70	0·63
SN7493N	0·75	0·70	0·63
SN7494N	0·85	0·80	0·75
SN7495N	0·85	0·80	0·75
SN7496N	1·00	0·90	0·83
SN74100N	2·16	1·89	1·89
SN74104N	0·60	0·53	0·45
SN74105N	0·60	0·53	0·45
SN74107N	0·51	0·51	0·45
SN74110N	0·57	0·57	0·50
SN74111N	0·86	0·86	0·75
SN74116N	2·16	2·16	1·89
SN74118N	1·00	0·90	0·83
SN74119N	1·92	1·92	1·68
SN74120N	1·05	1·05	0·92
SN74121N	0·57	0·57	0·50
SN74122N	0·80	0·80	0·70
SN74123N	1·44	1·44	1·26
SN74125N	0·69	0·69	0·60
SN74126N	0·69	0·69	0·60
SN74132N	0·72	0·72	0·63
SN74136N	0·63	0·63	0·55
SN74141N	1·00	0·90	0·80
SN74142N	2·88	2·88	2·52
SN74145N	1·44	1·44	1·26
SN74147N	2·30	2·30	1·83
SN74148N	2·01	2·01	1·63
SN74150N	2·30	2·30	2·01
SN74151N	1·15	1·15	1·00
SN74153N	1·09	1·09	0·95
SN74154N	2·30	2·30	2·01
SN74155N	1·15	1·15	1·00
SN74156N	1·09	1·09	1·00
SN74157N	1·09	1·09	0·95
SN74159N	2·44	2·44	2·14
SN74160N	1·58	1·58	1·38
SN74161N	1·58	1·58	1·38
SN74162N	1·58	1·58	1·38
SN74163N	1·58	1·58	1·38
SN74164N	2·01	2·01	1·76
SN74165N	2·01	2·01	1·76
SN74166N	2·16	2·16	1·89
SN74167N	4·10	4·10	3·59
SN74170N	2·88	2·88	2·52
SN74172N	5·76	5·76	5·04
SN74173N	1·66	1·66	1·45
SN74174N	1·80	1·80	1·57
SN74175N	1·29	1·29	1·13
SN74176N	1·44	1·44	1·26
SN74177N	1·44	1·44	1·26
SN74180N	1·44	1·44	1·26
SN74181N	5·18	5·18	4·53
SN74182N	1·44	1·44	1·26
SN74184N	2·16	2·16	1·89
SN74185AN	2·16	2·16	1·89
SN74188N	6·48	6·48	5·67
SN74190N	2·30	2·30	2·01
SN74191N	2·30	2·30	2·01
SN74192N	2·30	2·30	2·01
SN74193N	2·30	2·30	2·01
SN74194N	1·72	1·72	1·51
SN74195N	1·44	1·44	1·26
SN74196N	1·58	1·58	1·38
SN74197N	1·58	1·58	1·38
SN74198N	3·16	3·16	2·77
SN74199N	2·88	2·88	2·52

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ACY39	65p
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AD161	39p
AD162	39p
AF117	20p
AF118	50p
AF139	33p
AF186	40p
AF239	44p
ASY27	30p
BA115	10p
BAX13	5p
BC107	12p
BC108	12p
BC109	12p
BC109C	14p
BC113	16p
BC147	12p
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BCY71	20p
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OA81	10p
OA200	8p
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OC77	55p
OC81	28p
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2N3714	1·60
2N3771	1·75
2N3773	2·25
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2N3819	35p
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40250	45p
40361	45p
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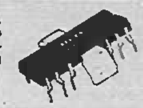
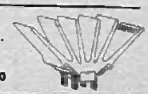
40408	50p
40486	75p
40636	1·00
40430	85p

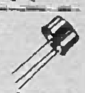
TBA800 5 WATT I.C.
Suitable alternative to SL403D. 5/30 volt operated. 8/16 ohm 5 watt output.
With circuits and data £1·50



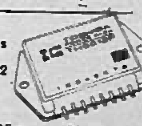
Sinclair IC12
with circuits and data. 6 watt IC with printed circuit board 28 volt operated £1·80



ZN414 IC
Integrated circuit radio as featured by many magazines (PW Jan. 73 Reprint Ref. No. 19 for 10p) £1·20



Toshiba Power and Preamplifier modules
TH9013P 20 watt Power amplifier 22-0-22 or single 45 volts operated £4·57
TG9014P Stereo on two channel preamplifier. £1·50
(circuit book No. 42 price 10p)



Ultrasonic Transducers
Operate at 40Khz up to 100 yds. Ideal remote switching and signalling. Complete with data transmitter and receiver new I.C. circuits.
Per pair £5·90

3015F 7 SEG.
I.C. size complete with data price £2 each or 4 for £7
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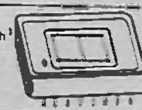

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100 ......42p
500 ......39p
1000 ......34p

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25 ......12p ea
100 ......10p
500 ...... 9p
1000 ...... 8p

AF117
25 ......15p ea
100 ......13p
500 ......12p
1000 ......10p

OC35
25 ......46p ea
100 ......42p
500 ......38p
1000 ......34p

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400 m/w BZY88/BZX83. From 3·3 volt – 33 volts 10p each

1·3 watts 5% Miniature Tubulars IN4700 series. From 3·3 volt – 33 volt 18p each.

10 watts. Stnd Mounting, ZS series 6-8 volts – 100 volts 5% 40p each.

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1 amp series IN4001 to IN4007 From 6p ea
1·5 amp PL4001 to PL4007 From 8p ea
3 amp PL7001/IN5400 From 14p ea
Send for full list 36

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702C (T05)	75p
709C (T05)	39p
709C (D.I.L.)	39p
723C (T099)	90p
723C (D.I.L.)	90p
728C (D.I.L.)	45p
728C (T099)	45p
741C (T05)	50p
741C (D.I.L.)	50p
747C (T099)	£1·0p
748C (D.I.L.)	61p

Semi-Conductor QUANTITY DISCOUNTS
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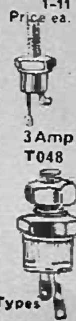
TRIACS – Stnd. mounting with accessories

Type	P.I.V.	1-11 Price ea.
3 AMP RANGE		
SC35A	100v	80p
SC35B	200v	85p
SC35D	400v	90p
SC35E	500v	£1·20
6 AMP RANGE		
SC40A	100v	90p
SC40B	200v	95p
SC40D	400v	£1·20
SC40E	500v	£1·50
10 AMP RANGE		
SC45A	100v	£1·05
SC45B	200v	£1·15
SC45D	400v	£1·45
SC45E	500v	£1·85
15 AMP RANGE		
SC50A	100v	£1·45
SC50B	200v	£1·65
SC50D	400v	£1·95
SC50E	500v	£2·25



3 Amp T048

TRIACS – Additional Types
40430 TRIAC (T066) 85p
40669 TRIAC (Plastic) 90p
40486 TRIAC (T05) 75p

NEW RANGES
BRIDGE RECTIFIERS
FEATURES SMALL SIZE AND LOW COST Sizes are approx.

250M/A QUARTER AMP
B025/05 50 PIV 16p
B025/10 100 PIV 18p
¼ x ¼ x ½" dia.

½ AMP 1-11 Pricing

Type	P.I.V.	Price ea.
B05/05	50v	20p
B05/10	100v	22p
B05/20	200v	23p
B05/40	400v	25p
B05/60	600v	27p

½H x ½L x $\frac{3}{16}$" dia.

1 AMP P.I.V.

B1/05	50v	25p
B1/10	100v	25p
B1/20	200v	28p
B1/60	600v	30p

½H x ½L x $\frac{3}{16}$" dia.

1 AMP P.I.V.

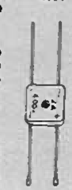
W005	50v	29p
W01	100v	30p
W02	200v	32p
W06	600v	35p

⅜ x ⅜" Tubular

2 AMPS P.I.V.

B2/05	50v	35p
B2/10	100v	40p
B2/20	200v	45p
B2/60	600v	50p
B2/100	1000v	55p

½H x ½L x $\frac{3}{16}$" dia.



4 AMPS P.I.V.

B4/100	100v	55p
B4/200	200v	59p
B4/400	400v	65p
B4/600	600v	75p
B4/800	800v	£1·00

½H x ½L x $\frac{3}{16}$" dia.

6 AMPS P.I.V.

B6/05	50v	65p
B6/10	100v	70p
B6/20	200v	80p
B6/40	400v	90p
B6/6x0	600v	£1·00

½H x ½L x $\frac{3}{16}$" dia.

SILICON CONTROLLED RECTIFIERS

Type	P.I.V	1-11
ONE AMP (T05)		
CRS 1/05AF	50v	30p
CRS 1/10AF	100v	30p
CRS 1/20AF	200v	35p
CRS 1/40AF	400v	45p
CRS 1/60AF	600v	55p
THREE AMP (T048)		
CRS 3/05AF	50v	40p
CRS 3/10AF	100v	40p
CRS 3/20AF	200v	45p
CRS 3/40AF	400v	55p
CRS 3/60AF	600v	65p
FIVE AMP		
CRS 5/400	400v	60p
SEVEN AMP (T048)		
CRS 7/100	100v	60p
CRS 7/200	200v	67p
CRS 7/400	400v	85p
CRS 7/600	600v	95p

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	4000	23·10
EAGLE	TSA149	25·10
	TSA151	34·85
	AA2	30·80
	AA4	42·45
	AA6	55·95
HOWLAND WEST	DA1000	22·45
HENELEC TEXAN	Kit	28·50
HENELEC TEXAN	Built	35·00
NIKKO	TRM300	25·95
	TRM400	32·50
PIONEER	SA500A	34·25
ROTEL	RA 211	32·65
	RA311	41·15
	RA611	60·80
	RA810	75·75
	RA1210	92·50
SINCLAIR	2000	22·95
	3000	28·95
TANDBERG	TA300	66·10
TELETON	SAQ206B	22·50
	SAQ307	22·50
	GA202	28·50

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(carr./packing 50p)

AKAI	AT550	80·50
	AT580	94·50
AMSTRAD	3000	23·55
EAGLE	AA8	40·50
	TST152	29·45
HENELEC Stereo Kit		21·00
HENELEC Stereo Built		24·95
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PIONEER	TX500A	48·75
ROTEL	RT222	32·65
	RT322	43·75
	RT622	65·40
SINCLAIR	2000	26·95
	3000	26·95
TELETON	GT202	30·50

DECODERS / SYNTHESIZERS
(carr. etc. 30p)

DYNACO QUADRATOR		16·90
EAGLE	AA10	12·00
	AA26	16·35
TATE 1	Chassis	7·95
TATE 3	Chassis	15·75
TATE 4	Chassis	19·95
TATE 7	Boxed	25·95

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Recommended pairs 8 ohms (Carr. / Packing £1·50 pair)

RANK DOMUS		
150		25·95 pr
175		33·75 pr
250		53·75 pr
MARSDEN HALL		
110	10 watt	22·50 pr.
150	15 watt	27·50 pr.
200	20 watt	34·50 pr.
DYNACO		
A10	20-60 watts	43·00 pr.
A25	20-60 watts	69·00 pr.
A35	20-60 watts	79·00 pr.
WHARFEDALE		
Denton 2	18 watt	27·20 pr.
Linton 2	20 watt	32·15 pr.
Melton II	25 watts	51·80 pr.
Triton	25 watt	40·80 pr.
LEAK		
150	18 watt	32·65 pr.
250	18 watt	44·30 pr.
CELESTION		
120	20 watt	37·80 pr.
COUNTY	25 watt	33·60 pr.
15	30 watt	50·40 pr.
44	44 watt	81·20 pr.

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	N2203	16·60
	N2211	19·95
Sanyo	M1101	13·90
	M1102	12·95

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(carr. etc. 15p)

SHURE		M44G	4·20
M3Dm	3·20	M75/6/11B	6·75
M44.7	3·95	M75 EDII	8·50
M44E	4·25	M75 EJII	7·95
M55E	4·95	M75GII	7·25
GOLDRING			
G850	2·85	G800SE	10·00
G800	3·95	G820	6·70
G800H	3·95	G820E	10·00
G800E	5·95	G820SE	13·35
ADC			
Q36	10·70	Q30	5·90
Q32	8·70		
GRADO			
FTR	5·25	FTE	8·25
F3E	11·25	F2	18·75
EMPIRE		999TEX	14·95
		999REX	3·70
		999QUX	4·80
		999XEX	8·50
RONNETTE		SM500/7	4·60
		SM500/5	4·60
		SM500/E	6·95

STEREO COMPACTS
Complete with Speakers (c./p. £1·25)

Fidelity	UA3	39·90
Sanyo	G2601KL	125·50
Sanyo	G2615N	71·50
Sanyo	GXT4520KL	103·50
Sanyo	GXT4730KL	97·50
Philips	GF908	99·65
Philips	RH802	159·95
Philips	RF836	57·20
Philips	GF826	41·75
Philips	RH811/RH421	84·95
Philips	RF839	55·95
Philips	GF829	39·95
Philips	GF815	47·75
Philips	GF808	65·75
Philips	RH814/RH411	93·50
Philips	GF603	19·95

8 TRACK STEREO HOME UNITS
(carr/packing 70p)

Amereex ACR301 48·00
(with MW/FM stereo radio)

PORTABLE TV BATTERY/MAINS
(c./p. £1·00)

Elizabeth T9	9"	43·50
Crown 9TV	9"	46·50
Elizabethan T12	12"	43·95
Teleton TW12	12"	46·95
Sanyo 10T150	12"	49·95

CASSETTE PLAYER
FOR CAR – HOME AND AROUND

Actually the price far belies the quality of the superb player. It is of beautiful quality both in sound and looks. Features wind, rewind, volume and tone controls. Speaker is very good indeed. Comes complete with earphone, batteries. Full guarantee. Optional adaptor to run off car or mains.

CAR CIGAR LIGHTER PLUG-IN ADAPTOR £1.95
MAINS ADAPTOR £1.95

DOLBY / NRU
(carr./packing 30p)

Teleton	SNR100D	29·50
Philips	N6720	15·00

Teac AN60/AN80/AN180 stocked

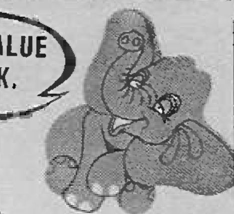
RECORD DECK PACKAGES
(carr./packing 75p) *Less cart.—rest with

(HL)	SP25 III/800 or H	15·95
(M)	SP25 III/M756S	19·45
(HL)	AP76/G800	25·55
(M)	AP76/M756S	29·10
(HL)	GL75 P/C	33·50
(HL)	GL75 P/C G800	36·65
(HL)	GL75 P/C G800E	39·15
(HL)	MP60 (TRD1) G800	15·80
	HT70 (TPDI) G800	19·50
	*Pioneer PL12D	31·75
	*Thorens TD165	43·80
	Thorens TD160C	50·80
RANK DOMUS	BD200	43·60
	BA400	55·95

BATTERY / MAINS CASSETTE
(carr. etc. 35p)

Wien	RT452	13·65
Amerex	AC101	12·00
Elizabethan	LZ315	12·25
Amerex	AC104	16·00
Philips	N2204	20·75
	N2205	29·50
PYE	9115	27·75
	9118	21·20
Hitachi	TRQ291	27·50
Sanyo	M2000G	23·25
	MR4010	28·95
	M4000G	49·90
BASF	CC9201	37·25
Hitachi	TRQ2335	49·50

BEST VALUE IN U.K.



BATTERY / MAINS RADIO CASSETTE RECORDERS
(carr. etc. 30p)

Amerex	ACR200	22·00
	ACR201	30·00
Elizabethan	LZ416	27·25
	LZ516	29·10
BASF	CC9301	50·75
Philips	RR322	28·75
	RR413	33·90
	RR712	48·30
Sanyo	M4141	39·50
	M2400W	31·50
	M2400FG	31·50
	M4400FC	62·50
Grundig	C250	47·95
Hitachi	TRK1240E	29·50
	TRS1161	35·00
	KCT1210L	33·50

STEREO RECORDER DECKS
(carr./packing 50p)

Cassette		
Philips	N2506	44·50
	N2510	£87·10
Pye	9145	44·50
Tandberg	TCD300	112·00
Akai	CS30D	50·65
	CS33D Dolby	62·50
	GXC36D	65·15
	GXC40D	57·40
	GXC38D Dolby	81·45
	GXC46D Dolby	83·55
	GXC45D	92·85
TEAC	A250/A350—A450	Stocked
Reel to Reel		
Akai	4000DS	62·50
Tandberg	3321X/3341X	107·70

Large range Akai/Tandberg/Revox/Teac stocked.

STEREO PHONES
(carr./packing 20p)

AKAI		TTC	
ASE11	4·75	G3000	6·60
ASE20	7·30	G2222	5·95
ASE22	8·25	LOW COST	
DULCI		MD802	1·95
SH650D	2·25	MD806	3·75
SH850GX	3·95	PIONEER	
SH1300VS	5·25	SE20A	5·90
AKG		SE30A	9·45
K60	8·25	SE50	6·35
ROTEL		SEL20	7·90
RH630	4·85	SEL25	11·15
RH700	6·75	SEL40	12·99
SENHEISSER		ACCESSORIES	
HD414	11·25	H1012/JB3	
WHARFEDALE		Junction Box	1·40
DD1	8·95	JB3DE Din	
ISODYN	15·00	Junction Box	1·60
KOSS		JB11D De Luxe	
K6	9·95	Junction Box	1·95
K6/LC	11·25	0250 Phone	
K711	7·95	Switch	4·75
KRD711	7·95	CONTROL BOXES	
HV1	17·50	G1301	
K0727B	12·45	(two phones)	2·62
K0747	15·95	G1305	
PRO4AA	21·95	Controller	2·15
PRO5LC	23·95	FF17 2-pairs	
HOWLAND WEST		(Sliders)	6·25
CIS200	2·75	Koss T4A	4·20
CIS250	5·25	T5A	4·95
CIS1000	7·50	T10A	8·50
CIS2000	15·25	HW Mk.III Controller	6·90

8 Track

Akai	CR81D	53·60
	CR80DSS	93·65

STEREO RECORDERS
(carr./packing 70p)

Akai	1721L	67·20
Cassette		
Akai	GXC40	67·20
	GXC46	89·95
Philips	N2400/RH411	63·75
	N2401/RH411	74·50
	N2401S/RH411	79·95
	N2405/RH401	49·50
	N2510	88·75
8 Track		
Akai	CR81	66·20

STEREO TUNER AMPLIFIERS
(carr./packing 75p)

Akai	AA8030	92·50
Goodmans Module 80		58·20
Goodmans Module 90		75·75
Goodmans One/Ten		88·50
Pioneer	SX525	90·75
	SX626	124·75
Rotel	RX150A	41·95
	RX200A	53·95
	RX400A	64·95
	RX600A	90·00
	RX800	114·50
	RX154A	78·30
Tandberg	TR200MPX	85·15
	TR1000MPX	125·35
	TR1010MPX	135·75
Teleton	TSF55	57·20

8 TRACK PLAYER DECKS
(carr./packing 35p)

Elizabathan	8/LZ1	13·40
McDonald/BSR	TD8S	12·75
	TD83V	15·25

IN CAR ENTERTAINMENT

CAR RADIOS (carr/packing 35p)
MW/LW Complete with speakers

SHIRA Touring	7·00
SHIRAMATIC	9·00
PHILIPS RN270	13·65
PHILIPS RP305	17·40
PYE 2644	26·75
PYE 2062	18·25
COURIER MC101	10·95
COURIER PC51	14·75
SHARP ATR 933	12·45
SHARP AR 947	18·60

STEREO CASSETTE (carr/packg 35p)
Complete with Speakers

SHIRA NA300	18·50
SHIRA CP401	23·75
PHILIPS N2607	26·40
R/MOBILE 302CS	32·00
PYE 2252	24·75
PYE 2253	28·45
HANIMAX HC6010	36·90
SELMAR (Plus MW/LW Radio)	38·95

STEREO 8 TRACK (carr/packg 35p)
Complete with speakers

SHIRA ST805	15·00
WALTHAM TRE 1500	21·00

8 TRACK WITH MW/LW RADIO (carr/packg 35p)
Complete with speakers

SHIRA ST1000	25·70
SHIRA ST2000	31·50

MW/STEREO FM (carr/packg 35p)
Complete with Speakers

SHARP CAR RADIO AR953	36·50
LEAR JET 277 (Plus 8 Track)	42·65

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YATES ELECTRONICS
(FLITWICK) LTD

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

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

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

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

PLEASE ADD 10% VAT

RESISTORS
½W Iskra high stability carbon film—very low noise—capless construction.
⅓W Mullard CR25 carbon film—very small body size 7·5 x 2·5 mm.
⅓W 2% ELECTROSIL TR5.

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7 Ω–2·2M Ω	E24	1p	0·8p
½	10%	3·3M Ω–10M Ω	E12	1p	0·8p
⅓	2%	10 Ω–1M Ω	E24	3·5p	3p
⅓	10%	1 Ω–3·9 Ω	E12	1p	0·8p
⅓	5%	4·7 Ω–1M Ω	E12	1p	0·8p
4	10%	1 Ω–10 Ω	E12	6p	5·5p

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

DEVELOPMENT PACK
0·5 watt 5% Iskra resistors 5 off each value 4·7 Ω to 1M Ω.
E12 pack 325 resistors £2·40. E24 pack 650 resistors £4·70.

POTENTIOMETERS
Carbon track 5k Ω to 2M Ω, log or linear (log ½W, lin ¼W).
Single, 12p. Dual gang (stereo), 40p. Single D.P. switch, 24p.

SKELETON PRESET POTENTIOMETERS
Linear: 100, 250, 500 Ω and decades to 5M Ω. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, 5p each. Miniature 0·25W, 7p each.

TRANSISTORS

AC107	15p	AF126	20p	BF115	25p	OC42	12p	2N3707	12p
AC126	12p	AF139	32p	BF173	20p	OC44	12p	2N3708	10p
AC127	15p	AF178	32p	BF177	28p	OC45	12p	2N3709	11p
AC128	15p	AF180	40p	BF178	32p	OC70	12p	2N3710	11p
AC131	12p	AF181	40p	BF179	32p	OC71	12p	2N3711	11p
AC132	12p	BC107	12p	BF180	32p	OC72	12p	2N3819	32p
AC176	15p	BC108	12p	BF181	32p	OC81	12p	2N4062	12p
AC187	22p	BC109	12p	BF194	14p	OC82D	12p	2N4286	20p
AC188	22p	BC147	12p	BF195	14p	2N2646	60p	2N4289	20p
AD140	50p	BC148	12p	BF197	15p	2N2904	20p	40360	35p
AD149	45p	BC149	12p	BF200	32p	2N2926	10p	40361	35p
AD161	33p	BC157	14p	BFY50	20p	2N3054	58p	40362	40p
AD162	36p	BC158	14p	BFY51	20p	2N3055	60p	40408	40p
AF114	20p	BC159	14p	BFY52	20p	2N3702	13p	ZTX108	15p
AF115	20p	BC187	22p	BUY105	225p	2N3703	12p	ZTX300	15p
AF116	20p	BD131	75p	OC26	45p	2N3704	13p	ZTX302	20p
AF117	20p	BD132	75p	OC28	50p	2N3705	12p	ZTX500	15p
AF118	38p	BD133	75p	OC35	50p	2N3706	11p	ZXT503	20p

ZENER DIODES
400mW 5% 3·3V to 30V, 12p.

WIRE WOUND POTS. 3W, 10, 25, 50 Ω and decades to 100k Ω, 35p.

DIODES

RECTIFIER				SIGNAL	
BY127	1250V	1A	12p	OA85	7p
1N4001	50V	1A	7p	OA90	5p
1N4002	100V	1A	8p	OA91	5p
1N4004	400V	1A	8p	OA202	7p
1N4006	600V	1A	10p	1N4148	5p
1N4007	1000V	1A	10p	BA114	8p

BRUSHED ALUMINIUM PANELS
12in x 6in, 25p; 12in x 2½in, 10p; 9in x 2in, 7p

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

THERMISTORS

VA1055S	15p
VA1066S	15p
VA1077	15p
R53	£1·35

THYRISTORS

2N5060	50V	0·8A	30p
2N5064	200V	0·8A	47p
106F	50V	4A	40p
106D	400V	4A	55p

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

MULLARD POLYESTER CAPACITORS C280 SERIES
250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, 3p. 0·033μF, 0·047μF, 0·068μF, 3½p. 0·1μF, 4p. 0·15μF, 0·22μF, 5p. 0·33μF, 6½p. 0·47μF, 8½p. 0·68μF, 11p. 1·0μF, 13p. 1·5μF, 20p. 2·2μF, 24p.

MYLAR FILM CAPACITORS 100V
0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, 2½p. 0·04μF, 0·05μF, 0·068μF, 0·1μF, 3½p.

CERAMIC DISC CAPACITORS
100pF to 10,000pF, 2p each.

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

SOLID TANTALUM BEAD CAPACITORS — 12p

0·1μF	35V	2·2μF	35V	22μF	16V
0·22μF	35V	4·7μF	35V	33μF	10V
0·47μF	35V	6·8μF	25V	47μF	6·3V
1·0μF	35V	10μF	25V	100μF	3V

VEROBOARD

	0.1	0.15
2½ x 3¾	22p	16p
2½ x 5	24p	24p
3¾ x 3¾	24p	24p
3¾ x 5	27p	27p
17 x 2½	75p	57½p
17 x 3¾	100p	78p
17 x 5 (plain)	—	82p
17 x 3¾ (plain)	—	60p
17 x 2½ (plain)	—	42p
2½ x 5 (plain)	—	12p
2½ x 3¾ (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2·5mm insulated	8p
Standard insulated	12p	3·5mm insulated	8p
Stereo screened	35p	3·5mm screened	13p
Standard socket	15p	2·5mm socket	8p
Stereo socket	18p	3·5mm socket	8p

D.I.N. PLUGS AND SOCKETS
2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable, 15p/metre.
6 way screened cable, 22p/metre.

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

LARGE (CAN) ELECTROLYTICS

1600μF	64V	74p	2500μF	64V	80p	4500μF	16V	50p
2500μF	40V	74p	2800μF	100V	£2·60	4500μF	25V	£1·68
2500μF	50V	58p	3200μF	16V	50p	5000μF	50V	£1·10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0·01μF	10p	0·047μF	13p	0·22μF	20p
0·022μF	12p	0·1μF	13p	0·47μF	22p

POLYSTYRENE CAPACITORS 160V 2½%
10pF to 1,000pF E12 Series Values, 4p each.

SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI
The GDI is the world's first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector.
Detector GDI, £2. Kit of parts for detectors including GDI and P.C. board but excluding case. Mains operated detector £5·20. 12 or 24V battery operated audible alarm £7·30. As above for PP9 battery, £6·40.

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

LARGE RANGE ITT/TEXAS IC's NOW IN STOCK

PRICES ARE CALCULATED ON TOTAL NUMBER ORDERED REGARDLESS OF MIX

	1–11 p	12–24 p	25–99 p	100+ p
7400	18	16	14	13
7401	18	16	14	13
7402	18	16	14	13
7403	18	16	14	13
7404	20	18	16	14
7405	20	18	16	14
7406	50	45	40	35
7407	56	50	44	38
7408	36	30	27	23
7409	36	30	27	33
7410	18	16	14	13
7411	23	21	20	18
7412	36	30	27	23
7413	34	28	26	22
7416	45	43	39	34
7420	18	16	14	13
7421	36	30	27	23
7426	32	29	23	20
7430	20	18	16	14
7432	40	36	32	28
7440	20	18	16	14
7441	80	75	70	65
7442	80	75	70	65
7443	125	120	115	115
7447	175	165	150	120
7448	185	175	170	165
7450	18	16	14	13
7451	18	16	14	13
7453	18	16	14	13
7454	18	16	14	13
7460	18	16	14	13
7470	30	28	25	24
7472	30	28	27	23
7473	40	38	36	30
7474	40	36	32	28
7475	55	52	50	49
7476	40	36	32	30
7480	100	95	90	85
7481	125	115	110	105
7482	100	96	90	85
7483	100	97	95	92
7484	120	115	110	105
7485	250	245	240	230
7486	45	42	37	33
7490	75	67	60	52
7491A	100	92	85	79
7492	75	70	65	60
7493	75	68	60	52
7494	95	90	85	80
7495	105	100	95	90
7496	100	95	90	85
74100	250	240	235	230
74118	100	82	73	64
74121	43	40	38	36
74141	100	95	90	85
74145	150	140	135	130
74150	330	280	250	220
74151	110	100	95	89
74153	120	110	105	95
74154	200	180	170	160
74155	150	120	100	86
74156	130	120	100	96
74180	155	136	112	105
74190	195	190	185	180
74191	195	190	185	180
74192	200	190	180	164
74193	200	180	170	150
74196	200	190	180	170
74197	200	195	180	170

LINEAR IC's

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

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 $4\frac{1}{2}$" x 2" x $\frac{11}{16}$". 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. $4\frac{1}{2}$" x 2" x $\frac{11}{16}$", 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.)

everyday electronics

PROJECTS. THEORY....

WIRE-LESS

In the good old days when radio was known as wireless, it was commonplace to hear the question posed: why do they call it "wireless" when, as everyone knows, the set simply teems inside with wires? The knowledgeable would immediately explain that "wireless" was a contraction of wireless telephony (or telegraphy), and the significant thing was the absence of any interconnecting wires between the broadcasting station and the receiving set.

Wireless nowadays has a rather ancient ring about it and is seldom used in reference to radio. Yet strangely enough, there is every good reason for taking this word out of storage, dusting it down a bit and reintroducing it into the modern world of electronics. For it aptly describes some of the techniques now used in assembly work.

Yes, indeed, a perfectly accurate description of today's most popular methods for building electronic circuits would be "wireless construction." Wire has not, of course, been banished altogether as yet and interconnecting wires do still exist, often in great profusion. But most components in modern equipment are assembled on laminate plastics boards which embody either copper strips or patterns that serve the function of circuit wiring.

These wire-less constructional methods are described in this month's special supplement, as are certain other building techniques that do depend upon the use of conventional wiring throughout. All these methods are suitable for home construction purposes, and beginners are recommended to try their hand at all in turn as the opportunity arises.

TUNE IN

Talking of radio, there can be few who have not at some time or another felt the urge to explore the short wave bands and to seek out broadcast and amateur stations operating in the four corners of the earth. This ethereal globe trotting becomes an even greater thrill when the vehicle used is a radio receiver built by one's own hands.

This need be no great or difficult task, even for the relatively inexperienced, as the constructional article in this issue will make quite clear.

ON THE SCENT

From a traditional field to one of the very latest developments in electronics. The Gas Alarm design is based upon a solid state sensor which represents an important breakthrough in technology.

Just another example of how EVERYDAY ELECTRONICS keeps the home constructor right up to date.

Fred Bennett.

Our December issue will be published on Friday, November 16

Everyday Electronics, Fleetway House, Farringdon Street, London, E.C.4. Phone: *Editorial* 01-634-4452; *Advertisements* 01-634-4202.

.EASY TO CONSTRUCT
.SIMPLY EXPLAINED

VOL. 2 NO. 11 NOVEMBER 1973

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

SPECIAL SUPPLEMENT **YOUR GUIDE TO CONSTRUCTIONAL METHODS**

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Special tool kit offer—see page 622.

EXPLORE THE AIR WAVES!

4 BAND T.R.F. RECEIVER

BY F.G.RAYER

For reception of "amateur" short wave transmissions as well as the normal medium wave

When correctly used, a t.r.f. (tuned radio frequency) receiver is highly sensitive and is capable of long-distance reception. Its great advantage lies in its relative simplicity of construction, since there are no tuned circuits which have to be aligned, as with a "superhet" receiver. All tuning takes place at the radio frequency at which reception is wanted—it is in fact this which distinguishes any t.r.f. receiver from a superhet, as the latter has oscillator and intermediate frequency circuits which must be tuned to different frequencies.

Thus in its simplest form the t.r.f. receiver needs one tuning coil only for each waveband. This circuit employs Denco miniature plug-in coils, which fit a B9A holder.

The receiver to be described is primarily intended for short wave reception, but operates well over medium waves also. Any one of four coils may be inserted, giving the wave bands shown in Table 1.

The four coils will thus give continuous coverage from 550kHz to 38MHz.

CIRCUIT

The complete circuit diagram is shown in Fig. 1, and a few notes on this will help make clear the function of the various items.

Coil L1 is one of the four tuning coils, placed in the holder mentioned. Capacitor C3 is the tuning capacitor, operated by a dual-speed ball drive, and frequencies can be marked directly on the scales. Components C2 and VR2 control regeneration in the f.e.t. detector TR1.

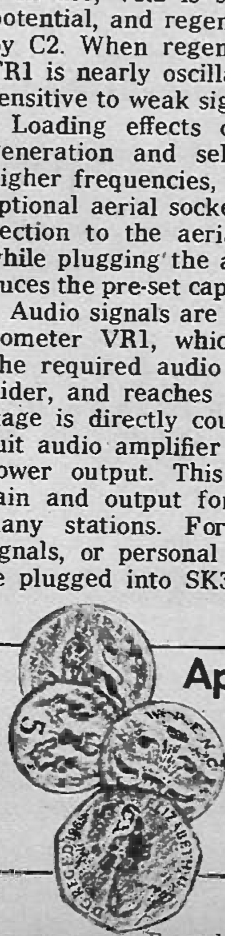
In use, VR2 is set to give a suitable drain potential, and regeneration is controlled mainly by C2. When regeneration is adjusted so that TR1 is nearly oscillating, the detector is highly sensitive to weak signals (more about this later).

Loading effects of the aerial influence regeneration and selectivity, especially on the higher frequencies, so it is worth while having optional aerial sockets—SK1 gives a direct connection to the aerial coupling winding of L1, while plugging the aerial into socket SK2 introduces the pre-set capacitor C1.

Audio signals are developed across the potentiometer VR1, which acts as volume control. The required audio level is taken off by VR1 slider, and reaches the pre-amplifier TR2. This stage is directly coupled to the integrated circuit audio amplifier which can provide 250mW power output. This arrangement has enough gain and output for loudspeaker reception of many stations. For weak short wave (s.w.) signals, or personal listening, headphones may be plugged into SK3. Resistors R7, R8 and R9

Table 1: Wavebands obtainable

Coil	Waveband	Frequency
2	Medium wave	550-1500kHz
3	Amateur and shipping	1·5–5·5kHz
4	Generally used short wave	5·0–20MHz
5	High frequency short wave	10–38MHz



Approximate cost of components including V.A.T.

£8:00 plus case

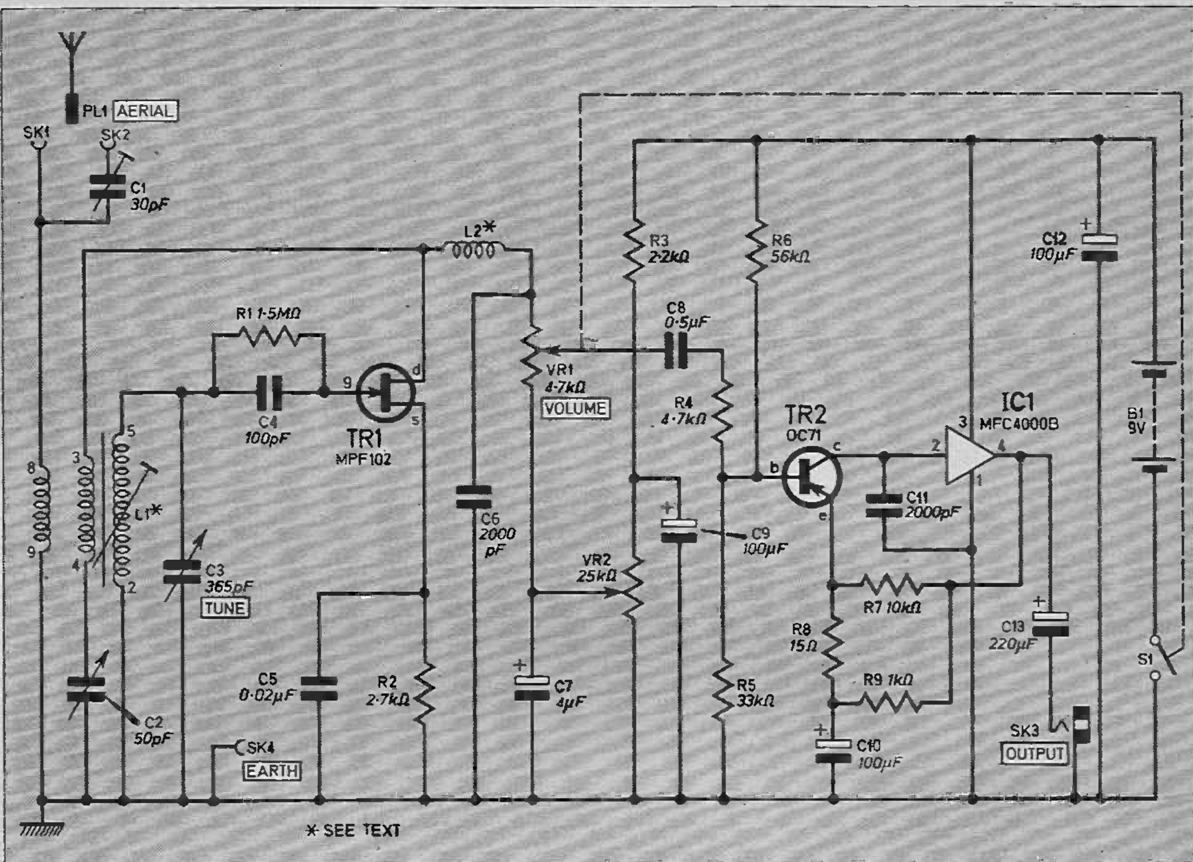


Fig. 1 Complete circuit diagram of the Four Band T.R.F. Receiver.

are feedback components which stabilise the whole audio section, including TR2.

Construction is in three main sections—the r.f. (radio frequency) circuit board containing the detector stage, the a.f. (audio frequency) board which consists of the audio amplifier, and the chassis and panel for the controls.

R. F. CIRCUIT

The board on which the r.f. section is mounted measures 75mm by 50mm, and is 0·15 inch plain matrix Veroboard. The components should be mounted exactly as in Fig. 2. First drill the holes for the 6BA bolts. Place the board in the chassis in the position shown in Fig. 4 and drill matching holes in the chassis. Fit two 12mm long bolts, with soldering tags locked on the underside of the board by means of nuts. Put an extra nut on each bolt. When the board is wired these bolts pass through the matching holes in the chassis, and further nuts on top of the chassis secure the board, and provide the electrical chassis return.

Mouth the r.f. choke (L2), R1, C4, R2, C5 and C6 as in Fig. 2. Turn the board over, and

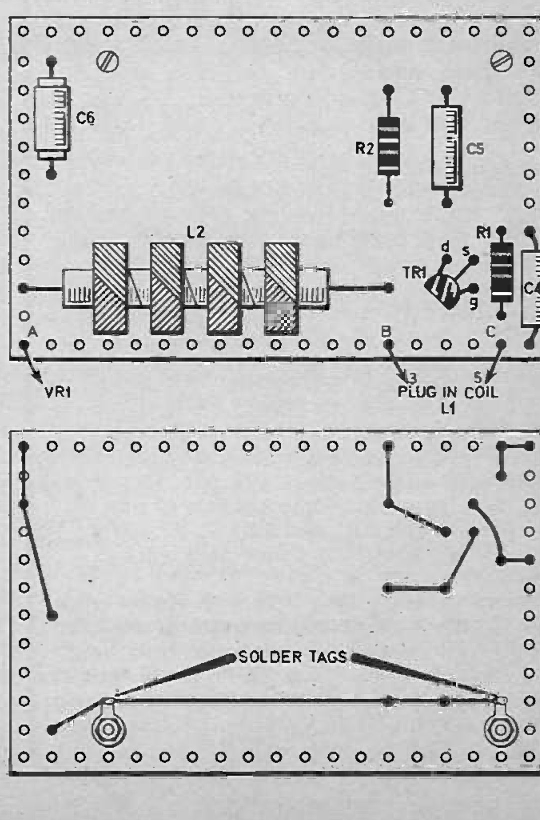


Fig. 2 (right). Layout and wiring of components mounted on the r.f. circuit board.

connect as shown for the underside wiring. A 20 s.w.g. tinned copper or similar wire is soldered between the tags for the metal chassis return points. In other places, the wire ends of the components are bent over and soldered as shown, and excess wire is then snipped off.

Later, connections will pass from the board to tags 3 and 5 of the coil holder, and to VR1 as indicated. This can be arranged by fitting three Veropins, or by leaving short projecting wires to which longer leads can be soldered.

Components....

Resistors

R1	1·5MΩ	R5	33kΩ
R2	2·7kΩ	R6	56kΩ
R3	2·2kΩ	R7	10kΩ
R4	4·7kΩ	R8	15Ω
		R9	1kΩ

All ±5% ¼W carbon

Capacitors

C1 30pF beehive trimmer
C2 50pF variable, Jackson C804
C3 365pF variable, Jackson 00, single gang
C4 100pF
C5 0·02μF
C6 2000pF
C7 4μF elect. 9V
C8 0·5μF
C9 100μF elect. 10V
C10 100μF elect. 10V
C11 2000pF
C12 100μF elect. 10V
C13 220μF elect. 10V

SEE SHOP TALK

Potentiometers

VR1 4·7kΩ log, with switch
VR2 25kΩ lin

Semiconductors

TR1 MPF 102 *n* channel f.e.t.
TR2 OC71 germanium *p.n.p.*
IC1 MFC 4000B audio amplifier

Inductors

L1 Denco "Green" miniature plug-in coils:
Range 2 550-1500kHz
Range 3 1·5-5·5MHz
Range 4 5·0-20MHz
Range 5 10-38MHz
L2 Denco RFC5 radio frequency choke

Miscellaneous

SK1, 2, 4 insulated single sockets (3 off)
PL1 plug to suit SK1 and SK2
B1 9V PP9 battery and connecting clips
SK3 Jack socket
Veroboard 78 x 51mm, 0·15 inch matrix plain type (2 off), insulated mounting tag, Jackson type 6/36 No. 4103/A drive and dial, H. L. Smith type W case (203 x 152 x 152mm) and type K chassis (178 x 146 x 146mm). Universal chassis flanged runner 76mm x 51mm, control knobs (3 off), earth tags, wire, 4BA fixings, etc.

The field effect transistor TR1 has drain, source and gate leads. If the transistor is placed as shown for the top of the board in Fig. 2, the wires can be brought out at the positions d, s and g, as marked for the underside of the board. As these wires are short, provide connections from R1, C5 and L2 for them, as in Fig. 2.

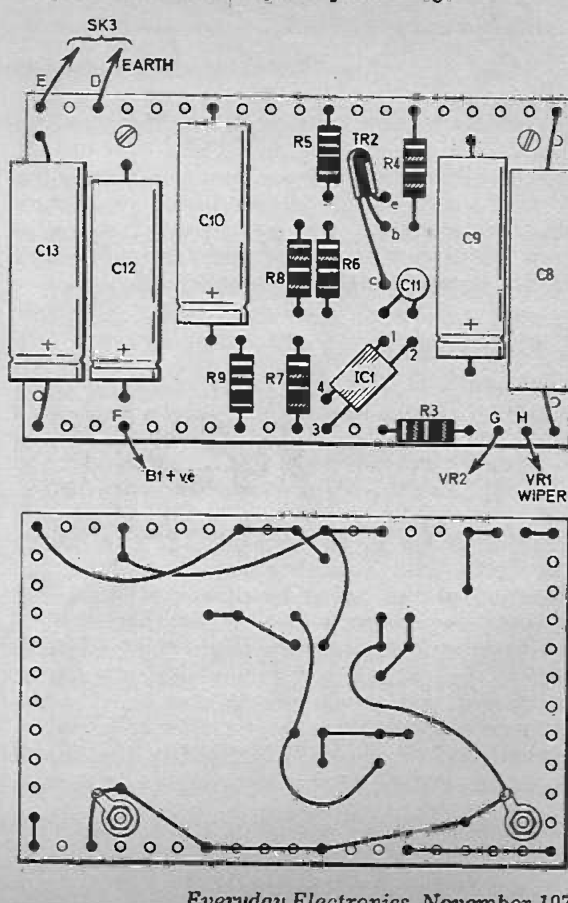
In the actual receiver, a "three lead" transistor holder was used but this was mainly so that alternative transistors could be tried easily. If a holder is fitted, connect its tags correctly, and afterwards insert the correct wires of TR1 into the sockets. If a holder is not used, solder these points directly to the leads using a heat shunt, but do not keep the iron in contact with the joint for more than a second or two, to avoid overheating.

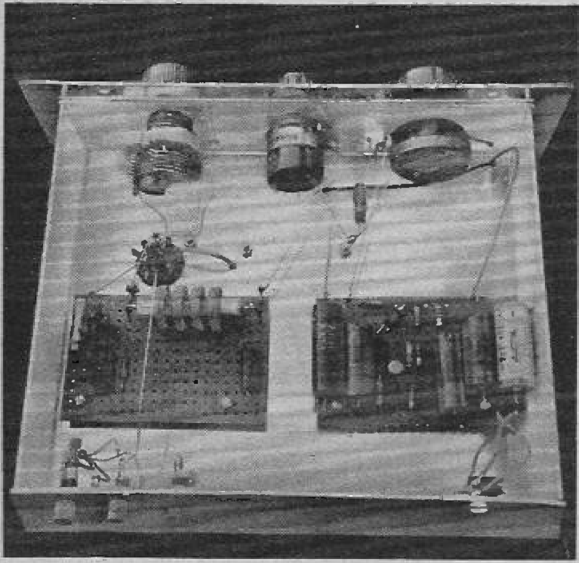
AUDIO BOARD

The board housing the "audio" components is shown in Fig. 3. Wiring of this board is along similar lines to that already described. The electrolytic capacitors C9, C10, C12 and C13 have positive and negative ends, and must be fitted in the polarity shown.

Underneath, keep all connections close against the board, and put insulated sleeving on any leads which run near or cross other leads.

Fig. 3 Audio board layout and wiring.





When fitting TR2, place emitter, base and collector leads in the positions e, b and c. The collector is marked by a spot on the case. The audio integrated circuit IC1 has two long and two short tags, and fits as in Fig. 3. These joints should be soldered without prolonged heating and preferably a heat shunt should be clipped on the leads while soldering.

Fit Veropins or projecting wires for the connections to VR1, VR2, B1 positive, and SK3, as before.

CHASSIS PREPARATION

Drill or punch holes for VR1, VR2 and C2 in the chassis, as in Fig. 4. Place the front panel and chassis together, marking through these holes so that the front panel can be drilled to match. Note that with the cabinet listed the panel must project 13mm lower than the bottom edge of the chassis. Also drill holes for the output jack (SK3), etc.

The coil holder is bolted as in Fig. 5, with its sockets located as in Fig. 4.

Capacitor C3 is mounted on a bracket, so that the ball-drive can be accommodated behind the panel. (This bracket can be cut from a 75mm×50mm flanged "universal chassis" member.) The capacitor spindle passes through a clearance hole, and the capacitor is secured with three 4BA bolts. These bolts must be short, or washers must be put under their heads, so that they do not project more than the thickness of the capacitor frame. If they are longer than this, they may short-circuit or damage the capacitor.

The panel is fixed by VR1, VR2 and C2. Capacitor C3 is then temporarily moved forwards and the drilling position for its spindle marked on the panel. Drill through from behind, then use a punch or hole-cutter to obtain a 19mm diameter hole. The slow-motion drive is fitted with the countersunk bolts provided with it. A template is also provided, and this is located on the panel, and the four corner holes for the dial are marked and drilled.

Check that the capacitor and drive line up correctly before tightening the bolts. Adjustment should not be necessary, but if it is, the holes in the capacitor mounting bracket can be enlarged or elongated with a small file, to permit horizontal and vertical adjustment of the capacitor, to match the drive.

The drive automatically provides two ratios. Some users may prefer the higher ratio to operate continuously. If so, place the control knob spindle in a vice, and cut off the small projecting stop which will be seen.

BOARD MOUNTING

If leads are kept near the boards, there should be no chance of shorts to the metal chassis, as the boards stand a little clear of this. If such shorts appear possible, due to large joints, the mounting bolts can be made longer, to give more clearance, or pieces of card can be cut to fit between the boards and chassis.

One top nut of the r.f. board also secures an insulated tag, Fig. 5. The centre pin of C1 is soldered to this, and insulated wires pass down to sockets SK1 and SK2. Socket SK4 (earth) is connected to the metal chassis, but C1 must of course be completely insulated from the metal.

OTHER WIRING

Complete the wiring as in Fig. 4. Leads from the r.f. board go to tags 3 and 5 of the coil holder, tags 2 and 9 are earthed to the chassis, tag 4 goes to the fixed plates of C2, and tag 8 to SK1. An insulated lead from tag 5 passes through the chassis to C3, Fig. 5.

Earth C7 negative at a bolt as shown in Fig. 4. Connect VR1 and VR2 as shown. Run a thin black flexile lead from S1 through the chassis, and solder on a negative battery clip. A red lead runs from B1 positive on the a.f. board, to a positive clip.

If the output jack is insulated, it does not matter which tags are used for the two leads. But if it provides a metal contact between chassis and plug sleeve, this lead must be that running to the earth line on the circuit board, Fig. 3, or the output will be shorted.

CABINET

The metal case measures 203×152×152mm (8×6×6 inches) and for easy coil changing it is necessary to arrange for an opening top. This can be done by marking a section 152×102mm in the case top, which is then cut out. A saw can be started by drilling a row of small holes (not larger than 2mm) close togther. A file is used to smooth the cut edges afterwards.

4 BAND T.R.F. RECEIVER

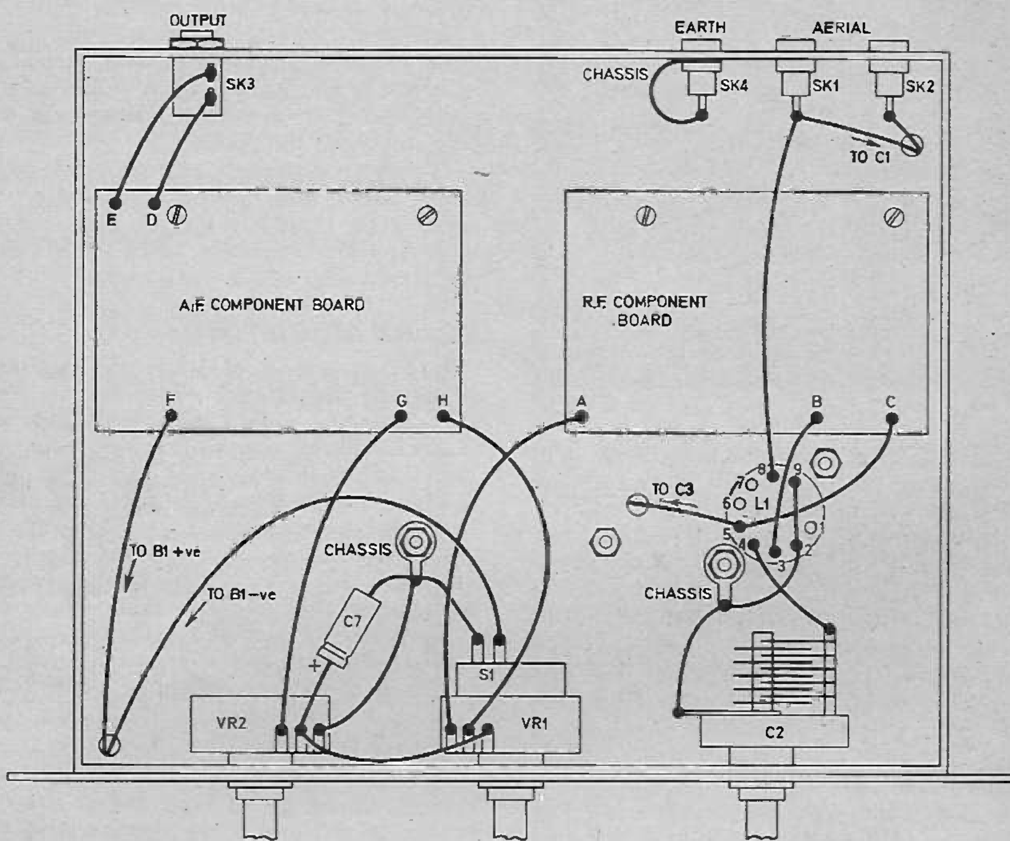


Fig. 4. Layout and wiring of parts mounted on the underside of the chassis.

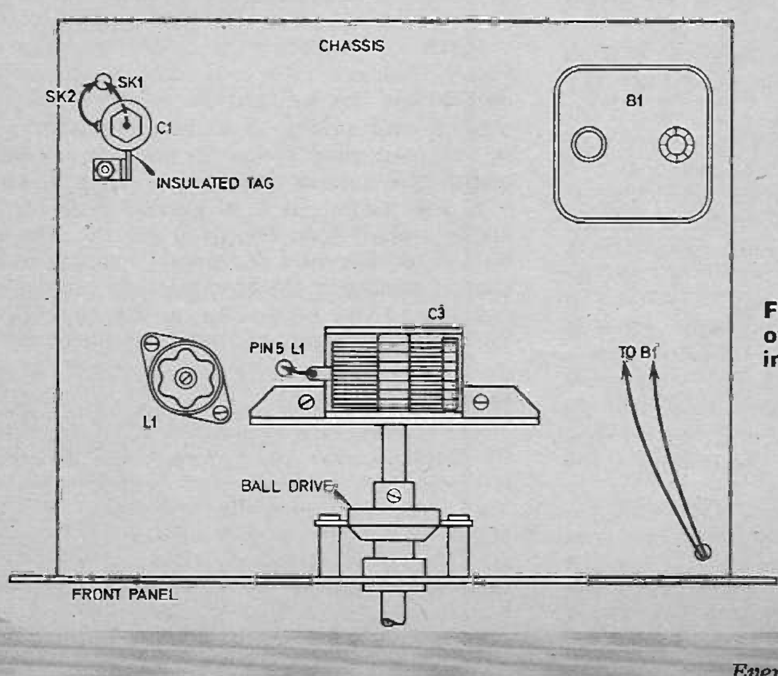


Fig. 5. Showing the positioning of the components and mounting for C3 on top of the chassis.

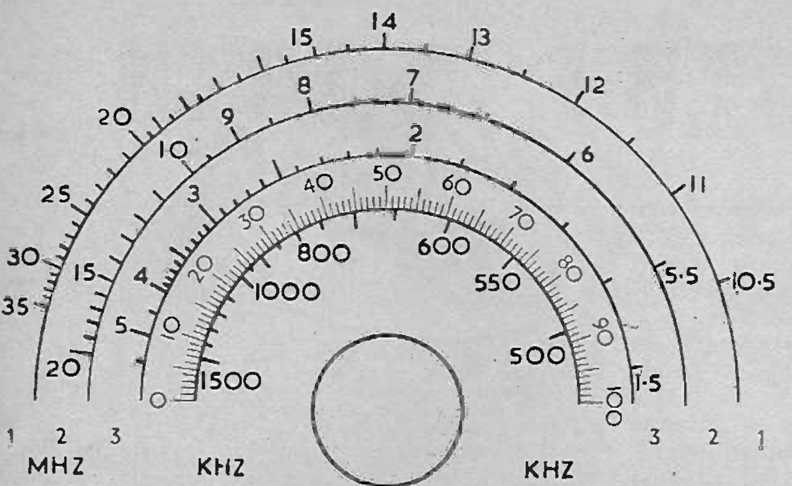


Fig. 6 Markings for the various ranges on the tuning dial this is shown full size and may be transferred directly to the scale.

The cut-out piece is hinged by a 152mm cabinet hinge at the back, or by cutting 152mm from a long plastic or metal hinge of this type available at carpentry equipment shops. A strip of aluminium about 180mm long and 25mm wide is bolted inside the top, at the front, for the lid to rest on when shut. A small terminal head was fitted to the lid here to enable it to be raised.

An alternative, with the case listed, is to drill out the six aluminium rivets which hold the top. This part can then be hinged on two 6BA bolts, passed through the rivet holes each side near the back. Another possibility would be to cut about 150×100mm from the cabinet back, so that the coils can be inserted from here.

A 25mm diameter hole was punched opposite the output jack. Two similar holes were punched near the earth and aerial socket position, and the metal between them cut away, so that aerial and earth plugs can be inserted.

A PP9 9 volt battery stands on the chassis to the right of C3.

LOUDSPEAKER/PHONES

A 16 ohm speaker is most suitable, but a 25 ohm unit can be employed with almost similar results. For best volume, a 90mm (3½ inch) or larger diameter speaker is recommended. It should be fitted in a cabinet or attached to a baffle.

When using headphones, maximum output is not required, and it is in order to have a headset of over 16 ohms impedance. Phones of 50 ohms or 100 ohms will work well, and phones of up to 500 ohms are satisfactory, though with these, and higher impedances up to 2,000 ohms, there is naturally a loss of volume.

TUNING DIAL

The drive has a scale marked 0-100, and three blank scales. These can be marked for ranges 1, 2 and 3, as shown. If range 4 (medium waves) is also wanted, this is best marked on the inside of the 0-100 scale (Fig. 6).

Place the cursor line at 100 with C3 fully closed, and lock it here. The actual band coverage obtained with any coil depends on the position of the coil core. If agreement with the scales shown is to be obtained, it is necessary to adjust each core at some known frequency, preferably fairly near the low frequency end of the band.

As examples, adjust range 3 core for reception of a broadcast near 1·5MHz (1500kHz) while the cursor is set for this reading, and Range 2 core for reception of 7MHz amateurs while the cursor is at 7·0 to 7·1MHz.

The scales are given for guidance, and there is no need that these exact ranges are obtained. No loss of efficiency arises from having the cores in different positions, and stations can be logged against the 0-100 scale, if required. Subsequently, each core is locked with a 6BA nut, to maintain readings.

AERIAL AND EARTH

Many signals can be expected even with a short indoor aerial, but an outdoor aerial will give better volume and longer range. Even with a highly expensive commercial receiver, long distance short wave reception requires the use of a good aerial, and a short wave listener will give some attention to this item.

Some 8 to 18 metres or so of wire, supported by insulators, and as high and clear of walls and earthed objects as possible, can be expected to give good results. For particular purposes, such as long distance reception of weak 1·8MHz amateurs, a greater length would be put up, if circumstances allowed.

Again, many signals can be received at adequate speaker volume with no earth. But an earth connection, to a metal spike or other earthed object, can give a considerable increase in signal strength, and this may be very noticeable with frequencies from about 1·5 to 4MHz.

USING THE RECEIVER

For maximum sensitivity and selectivity (the ability to receive very weak signals, and choose one transmission from others on nearby frequencies) regeneration **must** be correctly adjusted. Results then compare with those obtained with a superhet.

With VR1 set at about half way (or as volume requires) close C2 slightly and slowly rotate VR2 until whistles are heard when tuning through signals, C2 should then be backed off very slightly so that oscillation **almost** rises.

To receive the usual a.m. broadcasts on medium or short waves, TR1 is kept just below the oscillation point, in this way. For the reception of c.w. morse, it is necessary to advance regeneration a little, so that an audible heterodyne note is produced, the pitch being adjusted by tuning.

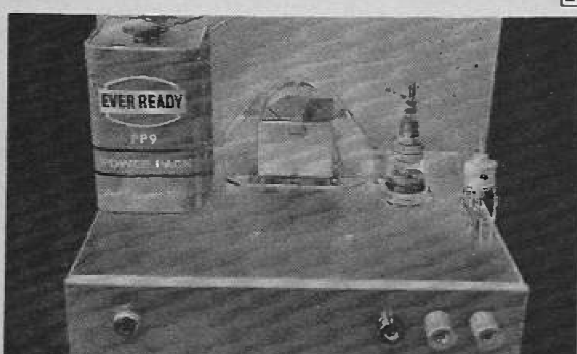
The circuit will also receive single sideband, suppressed carrier (s.s.b.) signals, as largely used by amateurs. To do this, it is necessary to advance regeneration until oscillation provides the local carrier (removed at transmission) and to carefully adjust tuning until the speech is resolved. As strong c.w. or s.s.b. will tend to block the receiver, it may be necessary to transfer the aerial to SK2, or to open C1 if SK2 is in use, to weaken signals.

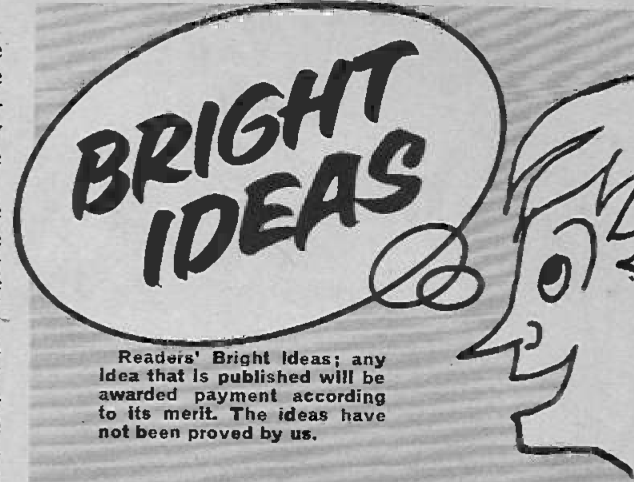
If VR2 is in the wrong position, the control of regeneration by C2 will be erratic and abrupt, and a smooth build-up of sensitivity will be impossible. So experiment with the setting of VR2, if necessary.

Abrupt loss of regeneration on some frequencies may be caused by resonant or loading effects from the aerial, and are avoided by plugging into SK2. Generally, SK1 is suitable for a short aerial, and SK2 for a long aerial.

Regeneration depends somewhat on the positions of the coil cores, as will be found if these are moved away from normal settings.

From these details it should not be expected that using the receiver will be exceptionally tricky. However, the results which are obtained with any t.r.f. circuit depend so greatly on regeneration that it must be understood that the adjustment of C2 and VR2 is very important. ▣





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

I would like to submit, for possible publication in your Bright Ideas column a cheap way of mounting l.d.r.s, such as the ORP12, when used remote from a unit. First, obtain a DIN in-line plug (or socket) and remove the metal plug section. Leads are then soldered to the l.d.r. which is pushed into the DIN plastic case until it is flush with the outside of the case. To avoid a possible short circuit within the case it is a good idea to cover the bare connections with suitable sleeving.

J. R. Seymour,
London.

I have found a good method of fitting small to medium size speakers on projects without glueing, so that they may be removed later if necessary. Blu-Tack, a putty-like adhesive sold in small slabs by Bostik is used. A small piece is worked into a thin "cord" by rolling and stretching, this is lightly placed around the edge (not on the cone) of the speaker, on the front where the glue would normally go. The speaker is placed on the desired spot and pressed down hard around the edges. This method provides quite a firm fix, especially if the speaker is fitted to Perspex or a smooth surface.

Blu-Tack can also be used to fix Veroboard into cases, provided the surface it is fixed onto is plastic, as metal is likely to short-circuit the connections underneath the board. This is easier than using screws as no fixing holes are drilled in the board.

M. Batter,
Shoreham-by-Sea.

If, like mine, other readers' hands shake when trying to paint straight, clean printed circuit outlines with enamel and a moulting brush or even the special, expensive pens, they might like to try covering the p.c. board, after polishing, with white p.v.c. tape, ensuring no trapped air, and transferring the pattern to tape through carbon paper as usual.

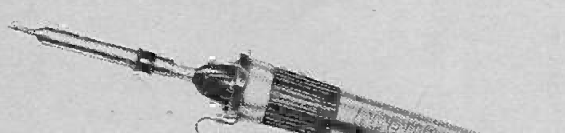
Then, with a sharp pointed craft knife, cut around the outline using a straight edge if needed. With point of knife, remove the tape from copper areas to be dissolved and agitate the board in ferric chloride. Rinse and peel off the remaining tape. The white adhesive tape takes and displays the transferred outline more clearly than copper and excludes the etchant perfectly. Also, there is no waiting for paint to dry or risk of blots, smudges, missed areas, loose bristles, etc.

M. E. Mullis,
Dunmow.

SOLDERING COMPETITION...

RESULTS

The first prize—a complete Viscount Audio System from RTVC.



Runner-Up prizes from Antex and Adcola

In our June issue, we offered a whole host of prizes for a competition based on soldering; readers were invited to place eight factors into the order of importance they contributed to the perfect soldered joint. Having considered all the entries, the judges decided that the best received were a small number which gave the following order: 1st-A; 2nd-C; 3rd-E; 4th-J; 5th-K; 6th-L; 7th-D; 8th-B.

In accordance with the rules, these tying competitors took part in a postal eliminating contest, from which **Mr. David Riley** of Orpington, Kent emerged as the first prize-winner. His award is that super **Viscount Audio System,** donated by Radio and TV components (Acton) Ltd.

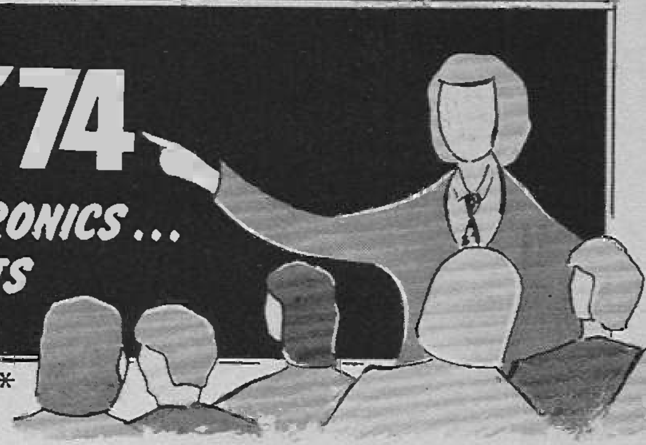
These are the names of the 100 runners-up, who have won items of soldering equipment donated by Adcola Products Ltd, Antex (Electronics) Ltd and Multicore Solders Ltd.

100 Runner-Up Prize Winners
Everyday Electronics Soldering Competition

L. Addison, London N.22; Peter Alexander, Swansea; A. C. Archard, Chippenham; R. Arendse, Harrow; M. J. Avery, Horsforth; Paul Beeson, Radlett; J. W. Berry, Bury St. Edmunds; M. J. Berry, Newmarket; T. Blackwell, Kenilworth; Richard Bowen, Shipley; R. C. Brackin, West Wickham; P. L. Bryan, Coventry; C. H. Burford, Eastbourne; John Carrington, Kirkby; C. M. Christison, Whauphill; Martin Cook, Dorchester; Martin Cooper, Teesside, Dave Copestake, Walsall; Gordon Coppock, Cranleigh; G. Crook, Bristol; W. J. Cuthbert, Hastings; R. B. Dale, Thirsk; R. S. Dewar, Keighley; Paul Dootson, Bolton; M. Dorsett, Bangor; Jeffrey Dunstone, Weston-Super-Mare; J. S. Ewins, London W.3; T. J. Felmingham, Wantage; R. Fletcher, London N.3; D. S. Franklin, High Wycombe; B. Fraser, Barrow-in-Furness; A. W. French, Brigg; W. R. Fulton, Middlesbrough; Jim Fulton, Dromore; K. Garten, London N.21; M. Georgiou, London N.22; M. Greest, Thornton Heath; David Hamilton, Slough; F. Higginson, Belfast; W. Hitchon, Blackpool; Anthony Hodkin, Sheffield; D. G. Hughes, Clayton-le-Moors; A. Humpston, Derby; Kevin King, Tadcaster; Peter Lamswood, Luton; G. Luckhurst, Erith; G. N. McCorkell, Londonderry; Gordon McKay, Eccles; William McLachlan, Greenock Kevin Maddy, Halifax; I. Marsh, Maidstone; K. Martin, Luton; L. B. Mayger, Maidstone; H. Miles, Houghton-le-Spring; E. Milton, Aberdeenshire; W. Moran, Londonderry; L. R. Parker, Upton-by-Chester; C. Payne, Peterborough; N. H. Peebles, Haydock; Vercel Pinnock, Huddersfield; K. G. Prince, Bolton; Kevin Richards, Rainham; D. H. Robinson, Fiskerton; William Roots, Gillingham; B. P. Rumble, Bristol; Andrew Sasse, Leigh; C. Self, North Walsham; David Silvester, Dartford; Derek Smart, Motherwell; E. Smith, Poole; John Smith, Sheffield, P. A. Stonebanks, Newcastle upon Tyne; J. R. Stone, Buxton; A. Strickland, Ruislip; J. Sundberg, London E.6; P. R. Taylor, Benfleet; Kevin Terry, Scarborough; Ian Thomas, Theydon Bois; P. Thompson, Haywards Heath; D. A. Thornley, Dukinfield; Philip Thursfield, Newport; Ian Tindale, St. Albans; R. P. Tingle, Kettering; M. Turner, Lakenheath; John Tyler, Malvern; A. Vivian, Bournemouth; C. Wade, Leeds; G. Walker, Glasgow; K. Walker, Runcorn; Glyn Wall, Lydney; Geoffrey E. Walsh, Reading; Robert Wardle, Coalville; Cliff Watson, London S.W.1; Keith White, Birmingham; Ian Wilkie, Edinburgh; D. Wilkinson, Redditch; Jonathan Williams, Ruislip; N. E. Williams, Llandudno Junction C. Willis, Benfleet; R. Brendon-Wynne, Birmingham.

TEACH-IN '74

FOR BEGINNERS IN ELECTRONICS . . . THEORY AND EXPERIMENTS



TUTOR: PHIL ALLCOCK*

LESSON 2 Current Flow, Resistance and the Diode

LAST month, in the first lesson of this series, some basic ideas about current flow and series circuits were covered. Current is known to be simply a movement of electrons and each electron conveys a fixed amount of charge wherever it goes. This charge "on the move" is a very important concept which we shall refer to later on in the series but at this point it is necessary to mention a slight anomaly relating to current.

CONVENTIONAL CURRENT

Early scientists assumed that electrical current flow was from the positive (+) terminal of the battery, through the circuit components and then back to the negative (−) terminal of the same battery. This concept remains with us today. It is used in the majority of modern textbooks relating to the theory of circuits and has come to be known as **conventional current**.

The actual physical process is however a movement of electrons through the circuit in the opposite direction to the conventional current flow as shown in Fig. 2.1. The fact that the wrong direction was assumed by these early scientists need not cause any trouble. The electronic charge is negative and the movement of this charge, in one direction, is equivalent to the movement of a similar amount of positive charge in the opposite direction.

Hence our so called conventional current is simply a representation of the circuit behaviour using positive charge, and since like charges repel, this positive charge tends to move away from the positive battery terminal and proceed towards the negative terminal just like the assumed conventional current flow. When it is necessary to distinguish between conventional and electron flow the text will be specific, otherwise conventional flow should be assumed.

VOLTAGE DIFFERENCE

It is usually convenient to refer to the voltage difference between two points in a circuit, as this can be readily measured, rather than refer to the absolute voltage at a particular point. Such voltage differences can be positive, negative or zero and their measurement is similar to that normally used for specifying the heights of particular points on the surface of the earth. Sea level is usually taken as the arbitrary reference and is given a height of zero. Consequently the mountain in Figure 2.2 has a height of +3,000 feet whereas the sea bed has a height of −1,000 feet. The negative sign simply means that the sea bed is below the reference point.

Using the same ideas, in Fig. 2.1 the voltage of any point can be measured with respect to

Fig. 2.1. Conventional current and electron flow.

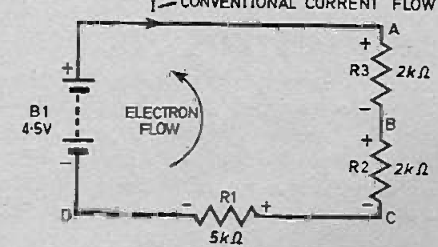
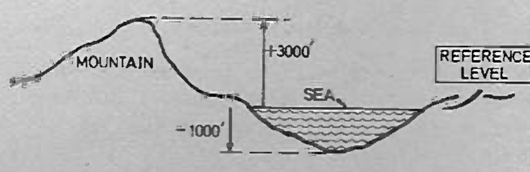


Fig. 2.2. Height with respect to the sea level reference.



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any other chosen reference point. If we choose point D as the reference and measure the voltage at points A, B and C the results will all be positive values.

REFERENCE

It is sometimes necessary to indicate the reference point in symbolic form and this can be done by writing, say, V_{AD} which means the voltage at point A with respect to D. Similarly V_{BC} is the voltage of point B with respect to C. The use of subscripts is very common in electronics, particularly when dealing with the voltages and currents in semiconducting devices such as transistors. Recalling what has been said above the reader should note that $V_{AB} = -V_{BA}$ and $V_{AC} = V_{AB} + V_{BC}$, etc. An example using Fig. 2.1 should make this all quite clear.

The total series resistance is $R_T = 2k\Omega + 2k\Omega + 5k\Omega = 9k\Omega$.

Hence the current $I = \dfrac{4 \cdot 5}{9 \cdot 0} = 0 \cdot 5$ mA. $\left(\dfrac{\text{volts}}{\text{kilohms}} = \text{milliamps} \right)$

Thus $V_{AB} = 2 \times 0 \cdot 5 = 1$ volt (volts = kilohms × milliamps)

$V_{BC} = 2 \times 0 \cdot 5 = 1$ volt
$V_{CD} = 5 \times 0 \cdot 5 = 2 \cdot 5$ volts
$V_{DB} = -(7 \times 0 \cdot 5) = -3 \cdot 5$ volts
and $V_{AB} + V_{BC} + V_{CD} = V_{AD} =$ battery voltage $= 4 \cdot 5$V.

Notice that for resistors, the terminal at which a positive value of conventional current enters always has a positive voltage with respect to the other terminal, whereas for the battery the reverse is true. In the case of the battery conventional current leaves the battery at the positive terminal and returns via the negative terminal.

PARALLEL RESISTORS

Sometimes it is necessary to use resistors in parallel as shown in Fig. 2.3. The parallel connection differs from the series arrangement in that each component may now carry a different current. Since the current flowing into point A, must at all times be equal to the current flowing away, we can write $I_{total} = I_1 + I_2$.

Since the voltage across each resistor is the same, namely $V_{AB} = 9$ volts, the total current is given by

$$I_{total} = \frac{9}{6 \cdot 0} + \frac{9}{3 \cdot 0} \text{mA} = (1 \cdot 5 + 3 \cdot 0) \text{ mA} = 4 \cdot 5\text{mA}.$$

As far as the battery is concerned the parallel combination of these two resistors behaves as though it was a single resistor of effective value given by

$$R_{effective} = \frac{9 \cdot 0 \text{ (V)}}{I_{total}} = \frac{9 \cdot 0 \text{ (V)}}{4 \cdot 5 \text{ (mA)}} = 2k\Omega.$$

In general the effective value of two parallel resistors R1, R2 is given by

$$R_{effective} = \frac{R1 \times R2}{R1 + R2}$$

If more than two resistors are connected in parallel the effective value can be calculated from the formula

$$R_{effective} = \cfrac{1}{\cfrac{1}{R1} + \cfrac{1}{R2} + \cfrac{1}{R3} \cdots}$$

MIXED SERIES/PARALLEL

To cover all possibilities it is necessary to study the circuit shown in Fig. 2.4 in which three resistors are arranged in a mixed series-parallel arrangement. Resistors R2 and R3 are in parallel with each other whilst the combination is in series with R1 and the battery. If we replace R2 and R3 by their effective parallel resistance value the circuit becomes a simple "two-resistor" series circuit as indicated in Fig. 2.4. If the currents in the three original resistors are called I_1, I_2 and I_3 it is possible to write the following equations using the ideas already covered:—

$I_{total} = I_1 = I_2 + I_3$
$V_{AB} = I_1 \, R1$
$V_{BC} = I_2 \, R2 = I_3 \, R3 = I_1 \, R_{effective}$
$V_{AB} + V_{BC} = 4 \cdot 5$ volts.

It is not necessary to learn these particular equations by heart. What is important however is to follow the basic principles used in their derivation so that each circuit encountered can be studied and calculations made where this is necessary.

Series or parallel arrangements of resistors can be used to give a particular resistance value that is not otherwise to hand, or to give a higher effective power rating. This is covered later.

Fig. 2.3. Resistors wired in parallel.

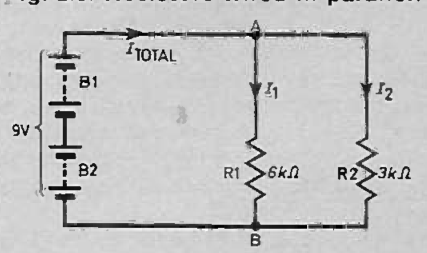
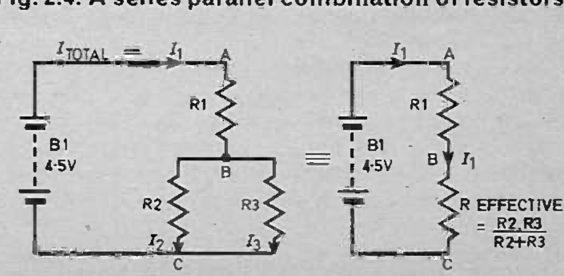


Fig. 2.4. A series parallel combination of resistors.



VARIABLE RESISTORS AND POTENTIOMETERS

Use has already been made of the 100 ohm and 5 kilohm potentiometers on the Tutor Board and most readers will have realised, from last month's experiments, that such a component is simply a resistance element with a moveable tapping point. The resistance between the outer tags is that of the whole element whilst the resistance between the sliding contact and either end varies with the slider position.

In the Tutor Board system the potentiometers are operated by rotating a spindle which moves the sliding contact over approximately ¾ of a complete turn. When connected so that only the slider and one end are in use the device is simply a variable resistor, covering the resistance range from zero to a maximum equal to the potentiometer value, say 5 kilohms.

In later experiments these components will be used as potentiometers for deriving a (variable) fraction of a given voltage applied across the whole resistance element. This is illustrated in Fig. 2.5 where the control varies the output voltage difference from zero to 4·5V if negligible current is taken from the output terminals.

POWER, ENERGY AND HEAT

When current flows in a resistor energy is dissipated. A similar situation occurs when someone pushes a load up an incline. The source of the electrical energy is the battery and the energy lost is expended as heat, produced in the resistor. The situation is most easily explained by referring to Fig. 2.6.

The flow of current I in resistor R1 involves the expenditure of energy at a rate of $V_1 \times I$ joules per second. A rate of one joule per second is known as a power of one watt. Thus power, which is a measure of the rate of doing work or the rate of using up energy is given by

power in $R1 = V_1 I$ watts

but $V_1 = I\,R1$ by applying Ohm's law.

Hence, power in $R1 = I\,R1 \times I = I^2\,R1$.

An alternative expression can be obtained by substituting $V_1/R1$ for I,

i.e., Power in $R1 = V_1^2/R1$.

The power dissipated in R2 is obtained in a similar way by replacing R1 by R2 in the above equations.

Every resistor can dissipate a certain amount of power without suffering damage or excessive rise in temperature. If the power dissipation rating of a component is insufficient one can put resistors in series or parallel, as mentioned earlier to get a higher total dissipation. For example, two one watt-rating, 1 kilohm resistors give the equivalent of a two watt 2 kilohm resistor, when in series, or a 500 ohm two watt resistor, when in parallel.

In the Tutor Board experiments it is unlikely that any heat dissipation problems will arise due to the relatively low voltages in use. It is however necessary to be aware of the possibility of overheating in such circuits as power supplies, power amplifiers and similar equipment.

The resistance element of an electric fire is specially made to withstand high power dissipation even when the wire is glowing red. In general high dissipation resistors are large and sometimes have a vitreous coating to protect the wire.

Fig. 2.5. A potentiometer used for deriving a fraction of a given voltage.

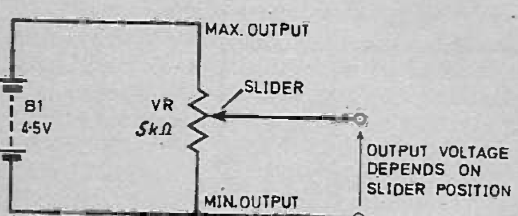
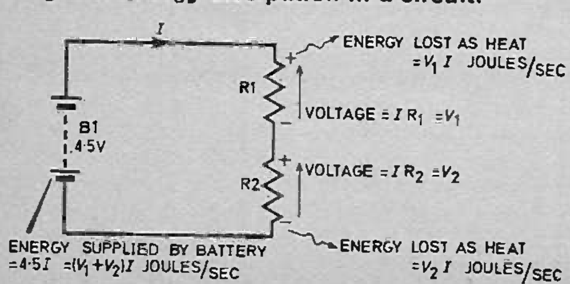


Fig. 2.6. Energy dissipation in a circuit.



SEMICONDUCTOR DIODES

The components used so far will all allow current to flow in either direction. Reversing the connections of say resistor R1 in Fig. 2.4 does not affect the current in any way. Similarly if we change over the battery connections the currents flow in the opposite direction to before but the magnitude of these currents is unchanged.

The voltage differences are also the same magnitude as before, although opposite in polarity due to the reversed currents. The battery polarity is the important factor in determining the current direction and when it is delivering energy to the circuit the current always flows out of the positive terminal.

Unlike the resistor, the semiconductor diode will only pass current in one direction. For this so-called **forward bias** direction the diode offers very little resistance to current flow whereas for the opposite direction, known as **reverse bias**, the resistance is very high and the current flow is virtually cut off. The action is that of a one-way valve, just like the valves in our own blood circulation system, Fig. 2.7.

The easy direction or "forward bias" flow of conventional current is from anode to cathode and since the cathode is usually marked with a band this is the lead from which current leaves the diode. If the diode is connected in a circuit so that current tries to flow into the cathode lead the diode turns off and the current is virtually zero.

The diode differs from the simple resistor in other ways. With a resistor the voltage difference is proportional to the current flow. As the current increases so does the voltage. However the current-voltage variation for the diode does not follow Ohm's law and the characteristic of a typical diode is shown in Fig. 2.8.

For appreciable forward current the voltage across a silicon diode must be about 0·6V. At this voltage the diode readily conducts and the current flow is then mainly determined by the conditions in the rest of the circuit. The voltage V_{AC} across the diode rises only slightly even though the current may increase from say 1mA to 100mA. A similar change of current in a resistor would involve a hundred-fold increase in the voltage.

If the diode or battery connections are changed over, current virtually ceases and the diode remains non conducting until the breakdown voltage is reached at point *X*. For the silicon 1N4001 diode this breakdown voltage is at least 50 volts. The maximum forward current must be restricted to 1 ampere due to power dissipation requirements.

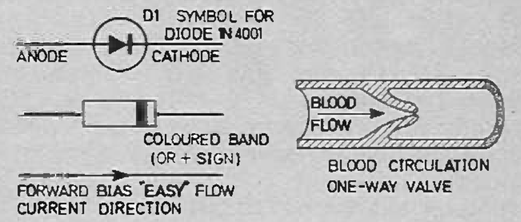


Fig. 2.7. The Diode and representation of its action.

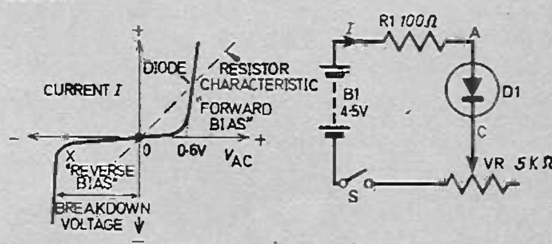


Fig. 2.8. Diode characteristics and test circuit.

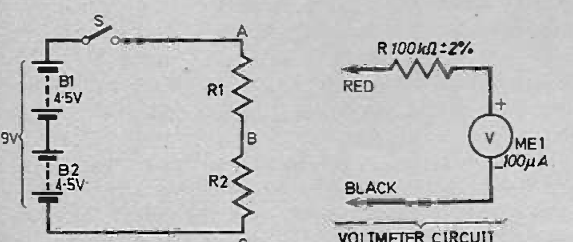
Next month: another new component known as a capacitor is introduced and its behaviour is examined in theory and practice.

TUTOR BOARD EXPERIMENTS

Test No. 4

Build the series circuit shown in Fig. 2.9 together with the 0-10V voltmeter circuit. Remember to remove the shorting lead. Initially make R1 = R2 = 1 kilohm and with the switch set to on, measure the voltages between points *A* and *B*, *B* and *C*, and *A* and *C*. Allowing for experimental error check these readings which should satisfy the relationship $V_{AC} = V_{AB} + V_{BC}$.

Fig. 2.9. Circuit and voltmeter circuit for use with test 4.



The red voltmeter lead should always be connected to the point at which current enters the component, otherwise the meter pointer will try to turn backwards. Repeat the test with R1 = R2 = 10 kilohms and then with R1 = R2 = 100 kilohms. In this last case the readings for V_{AB} and V_{BC} will both be lower than before at about 3·0 volts, whereas V_{AC} will still be approximately 9·0 volts. By reviewing Fig. 2.4 try to explain these results which are due to the loading of the circuit by the resistance of the voltmeter. Dismantle the circuit, except for the voltmeter, and record your observations for future reference.

Test No. 6

In this test the circuit of Fig. 2.8 is used to measure the forward characteristic of the 1N4001 diode. The 5 kilohm potentiometer is used as a variable resistor to alter the circuit current over a range of about 4 to 40mA. The current, *I*, can be estimated by using the voltmeter to measure the voltage difference across the fixed 100 ohm resistor. By Ohm's law this voltage will be:—

$$V_R \text{ across } 100\Omega = \frac{I(\text{mA}) \times 100\,(\Omega)}{1000} \text{ volts}$$

Hence $I = (10\ V_R)$ mA where V_R is the voltmeter reading in volts.

The diode voltage V_{AC} for any level of current

Table 2.1; Diode Characteristics

V_R (Volts)	0	1·0	2·0	3·0	4·0
$I = 10V_R$ (mA)	0	10	20	30	40
V_{AC} (Volts)	0				

V_R READINGS CAN BE SET BY 5kΩ POTENTIOMETER

DIODE VOLTAGE DIFFERENCE FOR EACH LEVEL OF CURRENT can also be recorded by using the voltmeter across points *A* and *C*. The corresponding results should be recorded in a table as shown (Table 2.1).

Notice that when the voltmeter is connected across the 100 ohm resistor the combination behaves in the same way as a 0-100mA milliammeter. Draw a schematic for this part of the circuit and try to explain how this behaviour arises.

Dismantle the test circuit and replace the shorting lead across the meter terminals for protection.

LAST MONTH'S TESTS

Last month the first two tests introduced a simple series circuit and the idea of a voltmeter. The series arrangement, Test No. 1, illustrates the existence of current flow when the switch is closed by virtue of the light output from the 6 volt bulb. Altering the total circuit resistance by means of the 100 ohm variable potentiometer changes the current flow and the light output varies.

The resistance of the lamp is not constant and actually rises as the element heats up. The bulb rating refers to operation at 6 volts and the nominal current of 60mA implies a resistance of 100 ohms at this voltage. When the element is cold the resistance will be less than 100 ohms.

The second test introduces the concept of a voltmeter. An ideal voltmeter would not require any current to operate it but this cannot be achieved with the simple arrangement used. Since the meter requires current to make the pointer move, this current must be taken from the circuit being measured and will disturb the circuit conditions. This is often called "circuit loading". The extent of this loading effect depends on the circuit under consideration and the resistance of the voltmeter circuit.

The Tutor Board system uses a 100 μA meter and this represents the maximum current necessary to give a full scale deflection. The loading effect can be considered by thinking of the voltmeter as a 100 kilohm resistor and comparing this with the effective resistance at the measuring point in the circuit. As a general guide the best results are obtained when the effective circuit resistance is much less than the voltmeter resistance.

The third test illustrates some of the ways in which voltage measurements can be taken. With the potentiometer set at maximum resistance, 5 kilohms, the circuit current is 1·5mA, assuming the batteries each provide 4·5 volts. Consequently the voltage across the 1 kilohm resistor must be 1·5 volts and that across the 5 kilohm potentiometer $(9-1{\cdot}5)=7{\cdot}5$ volts. These values correspond to a difference of 3·0 volts between the points originally specified.

The potentiometer must be set to introduce a voltage difference of 4·5 volts, for the zero reading condition, and this corresponds to a value of 1 kilohm and a circuit current of 4·5mA. The resistance values are sufficiently low in this test that voltmeter loading errors are negligible.

What do you know?

CURRENT

1 Say which way conventional current flows and state the difference between this and electron flow.

2 An alternating current is applied to a circuit via a single diode, show the waveform of the voltage across the circuit.

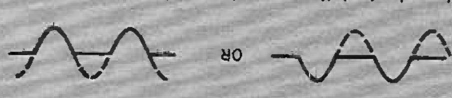
3 The waveform above is applied to a large value electrolytic capacitor, show what effect this has on the waveform and say why this is advantageous in audio circuits.

4 What refinement can be made to the circuit of (3) to improve it further for supplying audio equipment, and what is the advantage.

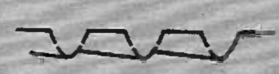
ANSWERS

1 Conventional current flows from positive to negative, electrons flow in the opposite direction.

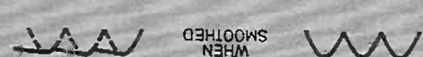
2 The waveform will be a sine wave cut in half, it could be either positive or negative going, depending on the connection of the diode e.g.



3 The electrolytic capacitor will tend to smooth the waveform. This is advantageous particularly in audio circuits because it helps to reduce the hum created by the pulsating supply; on load the waveform should appear thus:



4 A full wave or bridge rectifier could be used. This would invert the "lost" half cycles of the original circuit and provide a much smoother waveform, thus reducing hum further e.g.



SEMICONDUCTORS

SIX — TRANSISTOR TESTING

J.B. DANCE M.Sc.

In this, the final part of the Semiconductors series, we deal with simple testing of *npn* and *pnp* transistors.

TESTING TRANSISTORS

Most of the simple transistor testers measure the leakage current and the common emitter current gain.

The circuits of Figs. 6.1 and 6.2 (for *npn* and *pnp* transistors respectively) are the simplest form of circuit for measuring the leakage current and checking that the transistor has a reasonably high current gain. These circuits can be assembled in a few moments by the amateur experimenter and crocodile clips may be used for connecting the leads to the emitter and collector of the transistor.

The circuits are intended mainly for the testing of small signal transistors; modifications to the resistor values and meter range may be desirable when testing power transistors.

However, the fact that the testing is carried out at small values of collector current prevents any possibility of the transistor being damaged. The 820 ohm series resistor limits the current which can flow to about 7·3mA when a 6V battery is employed.

TESTING PROCEDURE

Leakage current

In order to check that the transistor does not pass excessive leakage current, it should be connected in the circuit as shown, but no connection should be made to the base.

If the transistor is a silicon one, no detectable meter deflection should be observed. Small germanium transistors will pass a leakage current which is normally less than 0·2mA.

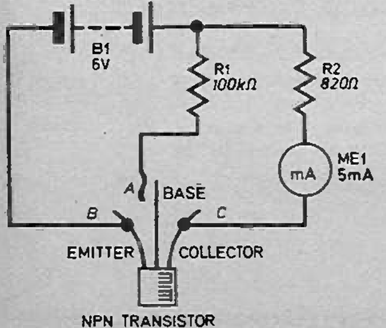
If the meter reads above 1mA when a small signal transistor is being tested, the leakage is excessive and the transistor is defective. Germanium power transistors may pass a higher current, but this leakage should not noramlly exceed about 3mA.

Current Gain

To test the current gain the lead marked *A* in Figs. 6.1 and 6.2 should be touched onto the base of the transistor. If the component is functioning satisfactorily, the collector current will rise and, in the case of a high gain transistor, the meter will show a full scale deflection.

If no appreciable deflection occurs when the lead *A* is connected to the base lead of the transistor, the device is almost certainly defective.

It should be mentioned, however, that there are a few types of switching transistor (such as the 2N711) which have a very low current gain at low collector currents. If such types are being tested, it is worth while checking that no appreciable collector current increase occurs when the 100 kilohm resistor is replaced by a 22 kilohm resistor before the transistor is discarded. However, it has been found that, even in the case of the 2N711, virtually all of the specimens tested gave a satisfactory reading even when the 100 kilohm resistor was used in the base circuit.



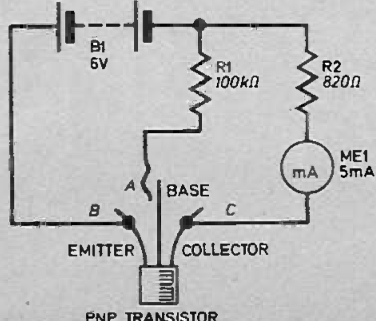


Fig. 6.1 (left). Circuit for the basic tests on an *npn* transistor.

Fig. 6.2. Circuit for the basic tests on a *pnp* transistor.

The current which flows in the base circuit when the lead *A* touches the base lead is given by Ohm's law, $I=V/R$ and is approximately 6/100,000 amps = 60μA.

If the common emitter current gain (h_{fe}) of the transistor is 10, then 600μA will therefore flow in the collector circuit.

If the transistor gain is 500, one might expect that a collector current of (60 x 500) μA = 30mA would flow. In this case, however, the collector current flowing through the 820 ohm series resistor limits this current to about 7mA. With a very high gain transistor, one may obtain a deflection which is a little over full scale.

Although it is possible to use this simple type of circuit to estimate the current gain of a transistor, the circuit is really intended to show only whether the transistor is functioning satisfactorily.

TESTING UNKNOWN TYPES

The circuits of Figs. 6.1 and 6.2 can be used for the testing of unknown transistors and for identifying the electrodes if the connections to the transistor are unknown.

A pair of the unknown transistor leads are connected between *B* and *C* of either circuit, first in one direction and then in the other. This is repeated with other pairs of the transistor leads (if necessary) until a pair is found which pass little current in either direction.

These two leads are the emitter and collector, since if the base were taken with either the emitter or collector, the base/emitter junction or the base/collector junction would conduct in one direction.

If no two leads can be found which show a high resistance in *both* directions, the device is almost certainly useless.

Before the device is discarded, it may be worth while checking that no two leads can be found which pass little current in either direction when the battery voltage is reduced to 1·5 volts.

The reason for using this lower voltage is that some transistors (especially modern silicon planar types) have an emitter/base breakdown voltage which is smaller than 6V.

We now know which electrode is the base, but we have not yet distinguished between the collector and emitter. If the base and either of the other electrodes is connected between *B* and *C* of either of the test circuits, an appreciable current will flow if the base is *positive* in an *npn* transistor or *negative* in a *pnp* type. Thus this test shows whether the device is *npn* or *pnp*.

Finally, the transistor is connected in the Fig. 6·1 circuit if it is an *npn* type or in the Fig. 6·2 circuit if it is *pnp*.

The deflection of the meter is noted when *A* touches the base lead, first with the other two transistor leads connected in one way to *B* and *C* and then with these two connections reversed. The orientation which gives the greatest meter deflection is the one in which the collector is connected to the meter.

Although one can obtain a current gain in some transistors when the emitter and collector leads are interchanged, one normally obtains a much higher current gain when the connections are made in the correct way. This applies more to modern silicon transistors than to the older germanium types.

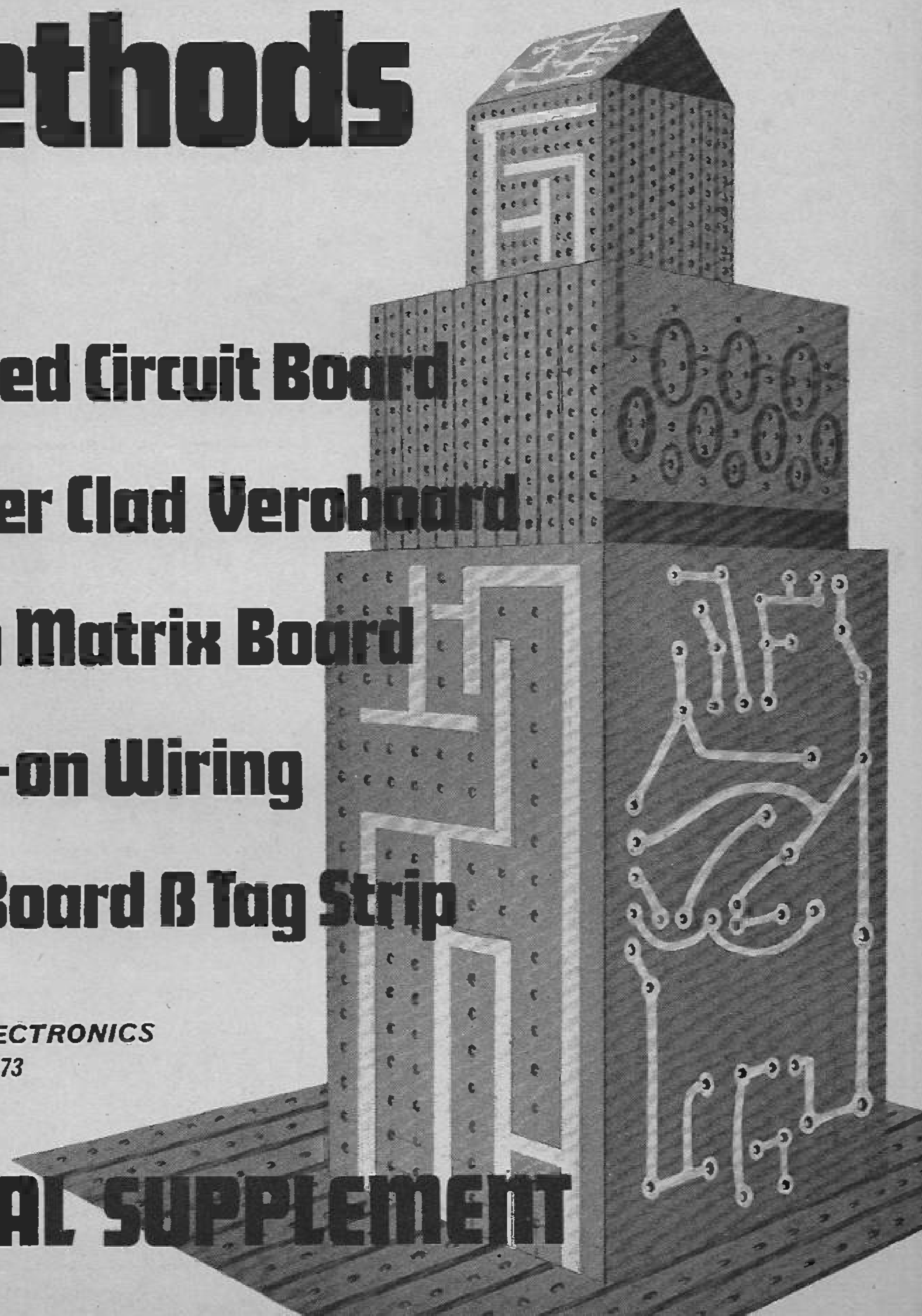
Indeed, a few germanium types have been made in the past which are known as "symmetrical transistors" because the emitter and collector are completely interchangeable and a similar gain is obtained with both connections.

FOUR LEADS

Devices which have four leads may cause problems when the device type is unknown and one wishes to test it. It may be that the device is not a simple transistor at all, but it is worth while ascertaining whether one of the leads is connected to the metal case. If so, one carries out the above tests using the other three leads. ▣

YOUR GUIDE TO –

Constructional Methods



- Printed Circuit Board
- Copper Clad Veroboard
- Plain Matrix Board
- Stick-on Wiring
- Tag Board & Tag Strip

EVERYDAY ELECTRONICS
NOVEMBER 1973

SPECIAL SUPPLEMENT

NOT going back too far into the history of electrical and electronic circuits, the latter were built up in quite a different fashion from that employed today; the system used was called point-to-point wiring or the wired circuit, and this was the major (if not the only) method open to the amateur constructor at the time.

DAYS GONE BY

In these days gone by, the larger components (valves, large capacitors etc) were mechanically secured in position on the chassis or component board and were linked together and to the other components using the latter and many lengths of wire; it was quite common to find several components and wires all joined at a common point. Solder tags and tag strips were used extensively.

The general appearance of the finished product was, if special care was not taken, a mass of wire and a maze of components, not the ideal situation for the beginner or the constructor of limited experience. Also, this method was especially susceptible to omitted wire links and fault finding was tedious and difficult to carry out.

For today's amateur constructor of electronic projects there are several forms of construction open, namely (a) printed circuit board (b) Veroboard, copper clad and unclad (c) stick-on wiring, Q-strip (d) tag board and tag strip.

Each have their own advantages (and disadvantages) for a particular project but some methods will be found more suited to the project than others.

CONSIDERATIONS

Some factors to take into consideration when selecting a particular form of construction are: (1) maximum current flow in the circuit, especially in the cases of (a) (b) and (c) above; (2) the required completed size and geometry of the board; (3) high frequency signals where the inductance of a copper strip becomes evident as does the capacitance between neighbouring copper strips; (4) mounting the finished form to case or other components; (5) the component layout should be kept as simple as possible so that the circuit can be easily traced in the event of a failure.

PRINTED CIRCUIT BOARD

The printed circuit board, as its name implies, has the circuit of the project printed on the board. This is in the form of a copper laminate bonded, in general, to one side of an s.r.b.p. (synthetic resin bonded paper) or fibreglass board; the "pattern" of copper is designed to link all the components, as required by the circuit diagram, see Fig. 1.

Components are connected to the copper circuit by drilling holes in the board and copper and inserting the appropriate component leads into these holes and soldering to the copper. Care must be taken not to leave the soldering iron on the joint too long because the copper may be lifted from the board.

Thus the printed copper takes the place of the linking wires mentioned earlier and gives a much neater and compact finished product.

The printed circuit is very versatile and is perhaps the neatest and most reliable of all electronic constructional methods.

Although it is easy to construct a printed circuit board, it takes time and patience, and is probably more suitable for large quantity production than for the amateur constructor requiring "one-off" quantities. It is found to be slightly more expensive than other methods but points in its favour lay in the fact that the finished product has a professional appearance and fault tracing is relatively simple.

The raw board comes in the form of a thin sheet of copper bonded to one side of an s.r.b.p. or fibreglass board; the copper pattern is made by dissolving, with a suitable solution, certain areas of the copper; this is known as etching. A common etchant is a solution of ferric chloride ($FeCl_2$).

In EVERYDAY ELECTRONICS and other journals, projects to be built on p.c. board show what is known as the "master-drawing", showing the copper pattern (full size) required to be formed on the board. The deep-black areas are the required areas of copper (referred to as "lands") to remain after etching, see Figs. 2 and 3.

Component layout diagrams in EVERYDAY ELECTRONICS show the components mounted in position on the top (plain) side of the board over a tinted area; this area is the copper pattern that would be seen when the board is held up to a strong light—plain side towards you—or what you would see if constructing with the aid of the *P.C. Viewer* (E. E. July 1973).

This tinted overlay helps to ensure that the component locating holes are found with minimum trouble and error, see Fig. 4.

When mounting components, the component leads should be bent neatly so that they are parallel and exactly span the holes allocated to them refer to Fig. 5.

The protruding leads should be cut so that only about 1 or 2 mm extends below the copper and then the lead is soldered to the copper. If desired a semi-mechanical joint can be made by bending the component leads parallel to the board prior to cutting and soldering. This way several components can be fixed in position and

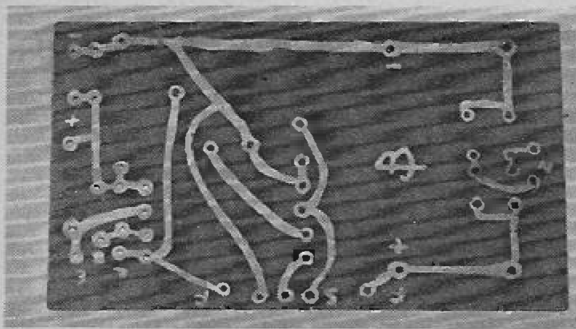


Fig. 1. The copper laminate pattern that replaces discrete wiring between components.

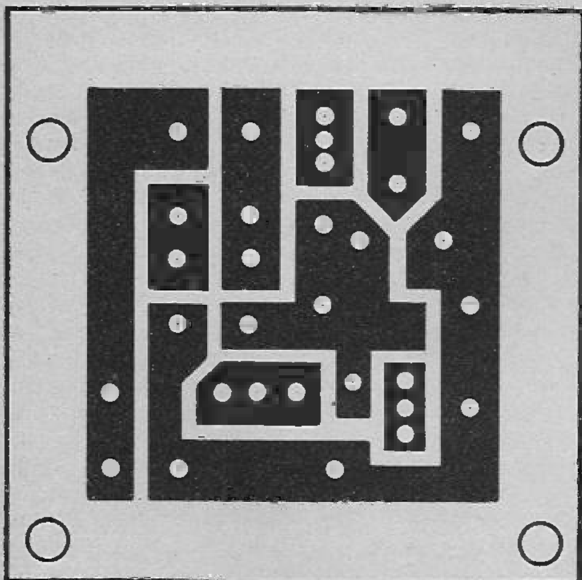


Fig. 2. The master drawing of the printed circuit.

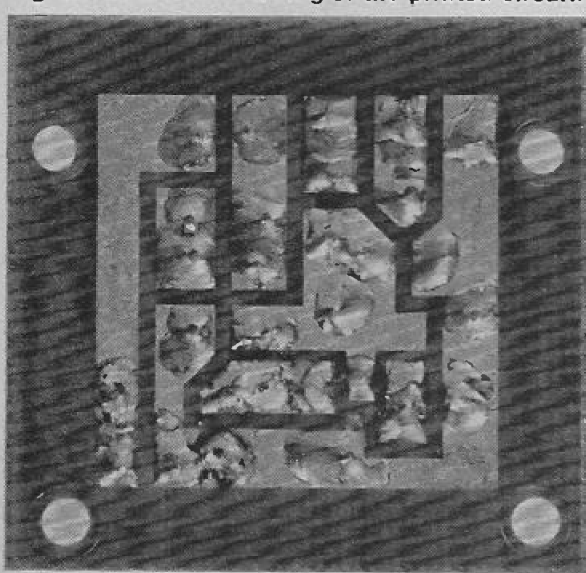


Fig. 3. The completed printed circuit board of Fig. 2 with components soldered.

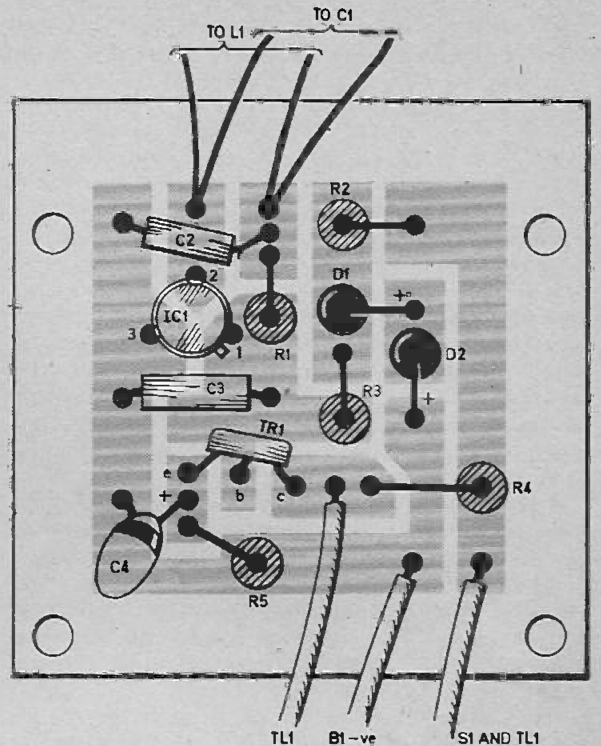
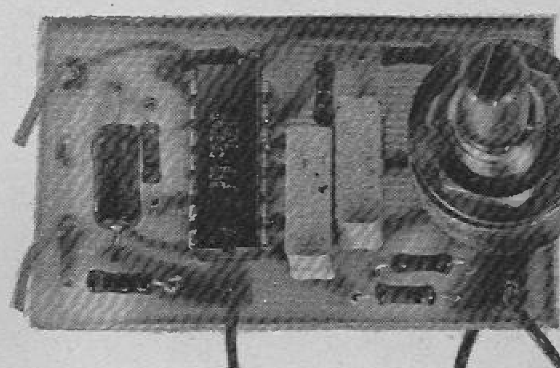


Fig. 4. Topside of printed circuit board showing component positions relative to copper pattern on underside (shown tinted).



Photograph of a completed component board using the p.c. board method, illuminated from the rear.

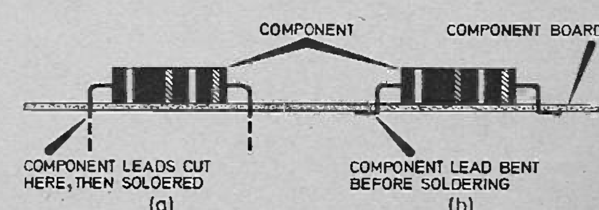


Fig. 5. Method of securing components to the component board.

then all is turned over. It is inadvisable to cut the component leads after soldering has been carried out since this can result in damage to the soldered joints.

In places where the copper is narrow, especially, do not apply the soldering iron for too long, otherwise the printed circuit will come away from the board and possibly be severed.

Connection of other components not mounted on the component board calls for the use of flying leads. These can be directly soldered into appropriate holes on the p.c. board—from the plain side through the board to the copper—and then soldered, or Veropins can be inserted and soldered in the holes and the wires connected to these. This method of using Veropins enables more than one flying lead connection to a single point if desired or required.

Flying leads from the board to remote components can be eliminated if desired, by the use of an edge connector. When using the latter, the printed circuit is designed so that all the required external connection points are brought out to one edge of the board, and the board is then plugged into the appropriately wired connector.

Mounting of the board in its case is accomplished by drilling suitable sized holes in a region on the board devoid of copper and then using a 4 or 6 BA nut, bolt and spacer.

Sometimes, when the p.c. board is small and light and when, say, a printed circuit type potentiometer has been used, the board need not be mounted in the above way, since the potentiometer when bolted in position, on say, the front panel of a case, eliminates the need for other fixings.

Full details of making printed circuit boards —from personal designs or those given in journals can be found in the June 1973 issue of EVERYDAY ELECTRONICS.

VEROBOARD

This is probably the most used type of general purpose construction board and is featured regularly in EVERYDAY ELECTRONICS constructional projects. The copper clad variety, as will be seen, is a special type of p.c. board.

Veroboard is available in two main sizes referred to as 0·15in. and 0·1in. types. This coding refers to the matrix of drilled holes i.e. the perpendicular distance between neighbouring rows and columns of holes.

The board is generally made of Paxolin (a brown plastic type insulator) but can be obtained in fibreglass. The two matrix sizes mentioned above are available in three versions: (a) with parallel strips of copper bonded to one side of the board along the rows of holes (b) with both sides clad in the above fashion (c) unclad board, referred to normally as plain perforated or matrix board. Type (b) is hardly ever used in the amateur field and so will not be discussed further.

COPPER CLAD

The copper strips on the Veroboard are utilised as circuit interconnections, and the strips are linked or cut as required to produce the "physical" of the theoretical circuit diagram.

Usually in constructional projects, two views of the board are shown, one from the unclad side of the board, on which side the components are mounted—and the underside showing the copper strips with breaks and join along them where necessary, see Fig. 6. The holes in which component leads and flying leads emerge to be soldered to the strips, are shown as black dots, see Fig. 6.

For easy reference, all the holes on the board are labelled by use of co-ordinates from the topside; the rows are labelled *A, B, C, D, E* . . . etc and the columns, 1, 2, 3, 4 . . . e.g. location *D*6 is the intersection of row *D* with column 6, Fig. 7.

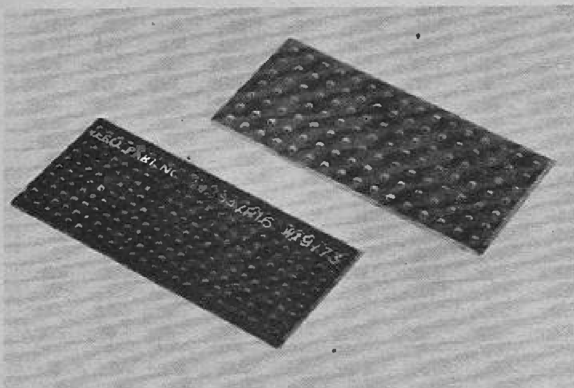
Components can be mounted in two ways, these being either with the component body parallel to the board or perpendicular to it, the latter method usually being employed when the completed size of the component board is to be kept minimal, see Fig. 8.

When mounting components (with the exception of transistors) the leads should be bent as indicated in Fig. 5 so that they exactly span the holes allocated to them. This can be done with either a pair of tapered nose pliers or the bending tool featured in *Bright Ideas* March 1973.

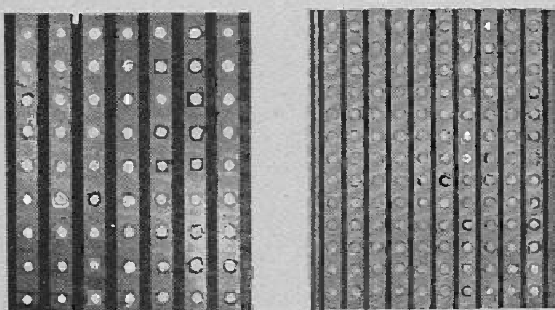
Once the leads have been bent, they should be inserted in place on the board and the leads cut so that only about 1 to 2mm projects below the board. The components can then be soldered directly by applying heat and solder to the component lead and copper around it, Fig. 5a; another method often employed is to bend the leads as shown in Fig. 5b to form a semi-mechanical joint before soldering. It should be pointed out that if this method is used component removal at a later stage, if necessary, can be a little difficult.

The main advantage of copper clad Veroboard is that the "wiring" is permanently bonded to the board (the copper strips) and this affords a rigid anchor point for the component when soldered.

A useful accessory (more used with the unclad board though) is the Veropin. This is a tinned brass pin manufactured so that it can be pushed into the holes of the matrix where desired, and holds firm. The pin should then be soldered to the copper strip at the point of entry.



Photograph, above and below, of the two most commonly used types of Veroboard referred to in the text.



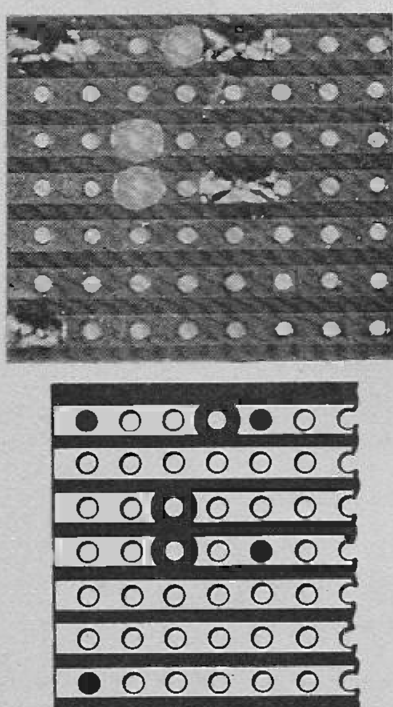


Fig. 6. Photograph and drawing of the underside of the same component board showing breaks and soldered connections.

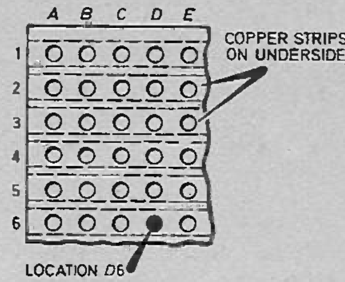


Fig. 7. Hole location using system of co-ordinates.

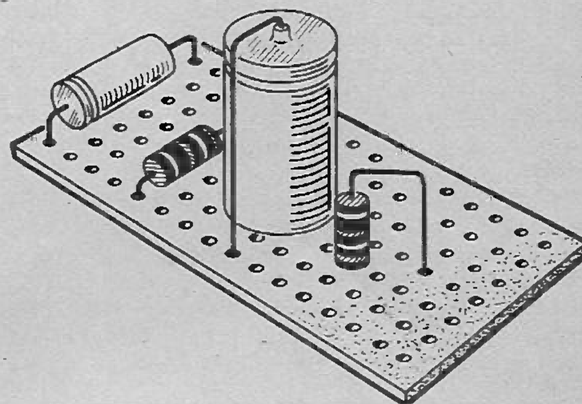
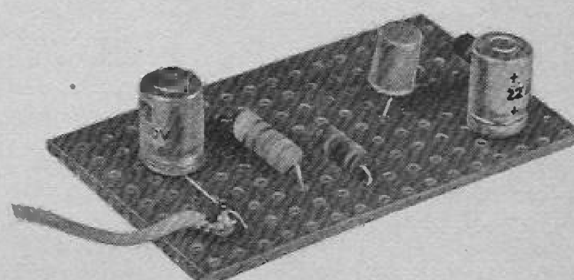
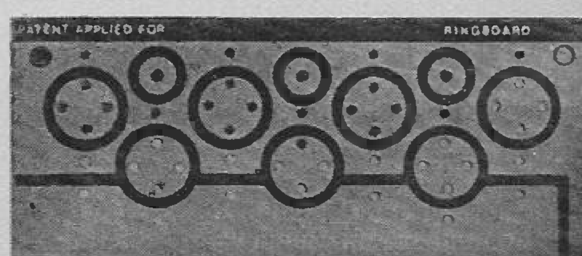


Fig. 8. Details of the two methods, horizontal and vertical, of mounting components on the component board.



Photograph of a simple project built on copper clad Veroboard.



Photograph of another general purpose wiring board (Ringboard).

UNCLAD VEROBOARD

Unclad Veroboard is also known as plain perforated board or matrix board.

Components are mounted in a similar fashion to that on the copper clad version i.e. component leads pushed through holes in the board, but here the components have to be linked using the component lead out wires and/or stout tinned copper wire, say 18 to 22 s.w.g. Single stranded p.v.c. covered connecting wire is also used.

A very useful accessory for plain matrix board is the Veropin discussed earlier. These afford rigid anchorage points for large components and flying leads to other components such as switches, potentiometers, lamps etc; they are also extremely useful when it is necessary to make multiple connections at a single point.

Both sides of the board are used and constructional projects in EVERYDAY ELECTRONICS show both sides of the board. On one side, called the topside, the component positions (layout) are shown; the reverse side shows all the interconnections required to link the board components as per circuit diagram, see Fig. 9.

When one wire (or more) is soldered to another on the underside, this is signified in the conventional way by a solder blob at the point of connection; emerging component leads are shown as black dots.

Flying leads to other circuit components usually are double labelled—at the end of the flying lead e.g. to VR1, and at its origination from the board by letters *A, B, C, D*, etc. The advantage of the latter labelling is evident when referring to the complete wiring diagram.

Mounting of the board is carried out in a similar manner to the clad Veroboard using 6BA or 4BA nuts, bolts, and spacers.

When mounting perpendicular to a chassis or front panel, right angled brackets can be used.

This form of construction has proved very popular with the amateur and has been successfully proven over and over again. However, its main drawback is that for complicated circuits, the number of linking wires on the underside tends to look "messy" and fault finding and circuit tracing can then be difficult.

STICK-ON WIRING

Stick-on wiring, available under the brand name of Q-strip, is another useful means of circuit construction and will be seen to be yet another form of printed circuit.

Basically, Q-strip consists of a narrow length of high-purity copper with a self-adhesive on one side. The self-adhesive carries a paper backing to protect its adhesive properties; Q-strip is available in widths of ⅛in. and $\frac{1}{16}$in. and is sold in reels.

The use of stick-on wiring enables the "physical" circuit layout to be made as per the theoretical circuit diagram. This is a very useful property for the beginner because he is readily able to see the component interconnections and compare them with the circuit diagram.

The idea behind Q-strip is that it is stuck down on to the component board and used as the connecting links between the components in just the same way as the strips on copper clad Veroboard or printed circuit board form connections between the components.

Q-strip can be stuck on almost any type of insulating board, the most favoured ones being Paxolin board, plain matrix Veroboard and Perspex.

First of all the layout is designed (if not given) on say a piece of graph paper—this is very useful for designing all types of layout. If using Paxolin or Perspex, it will then be necessary to drill all the component locating holes with reference to the graph paper layout. If using matrix board this is obviously not necessary.

The strip is applied to the board in much the same way as Sellotape is used; the strip is cut to the required length and offered up to check; the paper backing is then removed and the strip is carefully placed in the correct position and pressed down firmly. Run a finger or side of a pencil along the strip to remove any kinks that there may be. It is essential that the adhesive backing is not touched during this process, as this will impair its effectiveness. If the strip is found to be incorrectly positioned it can be carefully removed and replaced.

There are two modes of laying the stick-on wiring with reference to the component holes. One way is to cut the required length and stick the wiring to the board so that it *covers* all the component holes it is to link. Then using a pointed tool such as a sharp nail or scriber, the copper strip is pierced at the hole positions. Component leads can then be pushed through these holes from the unclad side and soldered in a similar way to when using Veroboard, Fig. 10a.

The second way is to stick the copper strip *alongside* the holes that are to take the components, and then when the component leads are pushed through, to bend the latter over so that they are in contact with the strip and then soldered in position, Fig.10b.

When two pieces of Q-strip are to be joined this can be done quite easily by merely butting the two strips and then applying a blob of solder at the butt.

It will sometimes be found necessary to have one strip crossing another, but with no electrical contact. This is done by sticking a small piece of insulating tape over the lower strip and then passing the other strip over the top.

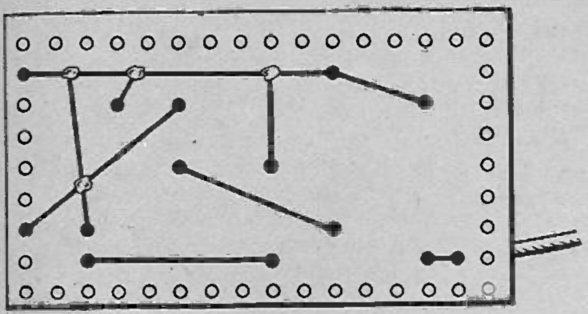
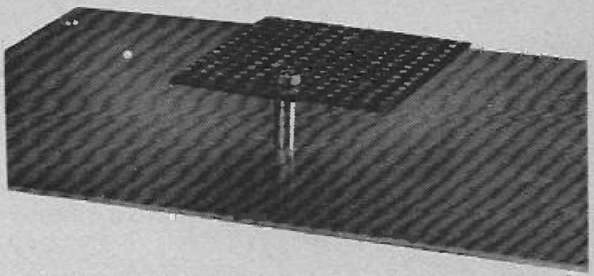
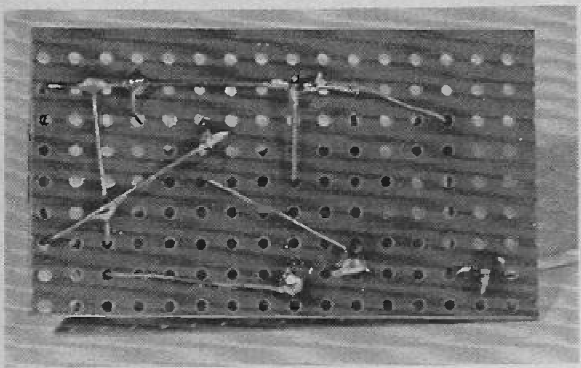


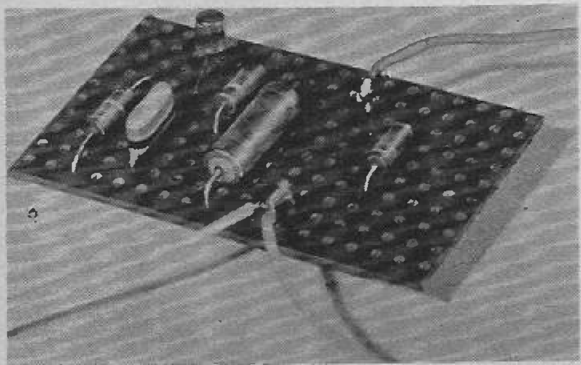
Fig. 9. Schematic of underside of component board using unclad Veroboard.



Method of mounting component board; applicable to all types of construction discussed here.

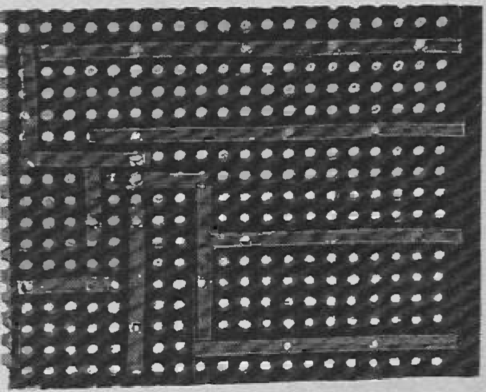


Photograph of Fig. 9.



Photograph of simple project built on unclad Veroboard.

(a)



(b)

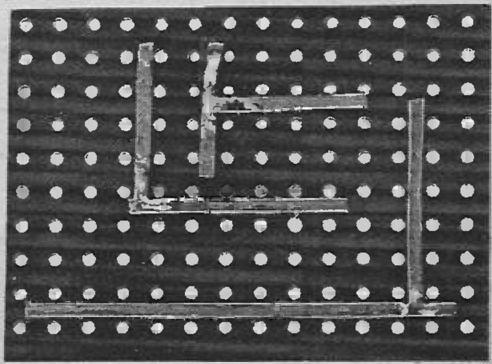


Fig. 10. Methods of placing stick-on wiring with reference to component holes.

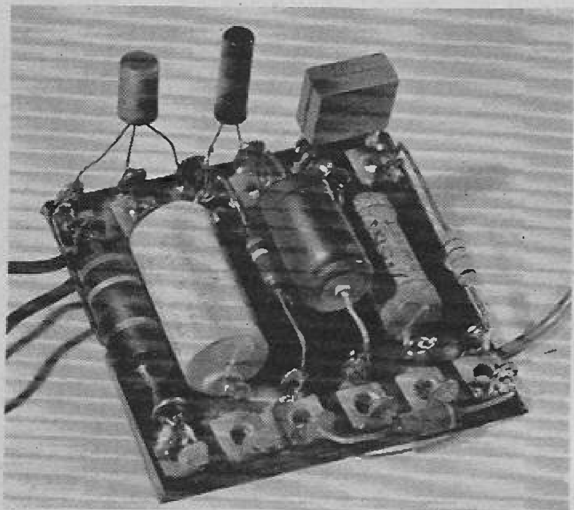
Difficulty will arise if the Q-strip is bent to form a curve of small radius since kinking will occur and the strip will not be adequately secured to the board. This should be avoided wherever possible and short-lengthed butting employed as mentioned above.

When Q-strip is being soldered the adhesive backing tends to melt, especially if the soldering iron is held on the strip for too long a period, and the strip is inclined to shift particularly in the case of short lengths. No permanent damage is incurred due to adhesive melt, since its property is restored on cooling off. After soldering it is advisable to press the strip firmly home again (and re-position if called for); long soldering periods should, of course, in any form of construction, be avoided.

Appearance-wise, the finished Q-strip board is like the printed circuit board; the difference is that no chemicals have been used by the constructor to produce it.

If required a double sided board can be made using this method.

Veropins will be found very useful with this method of construction for flying leads, large components, multiple connections at one point etc. and should be used as described in the previous methods.



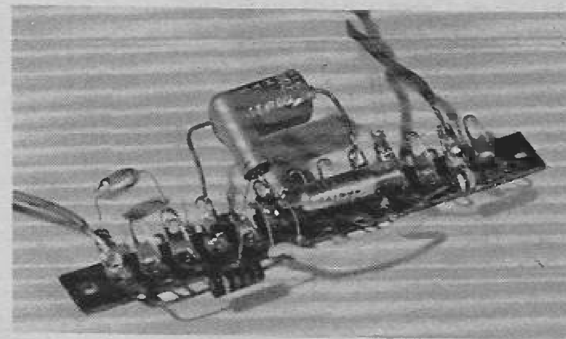


Fig. 12. Method of wiring up components on a piece of tag strip.

Fig. 11. A simple project wired up on a piece of standard tag board.

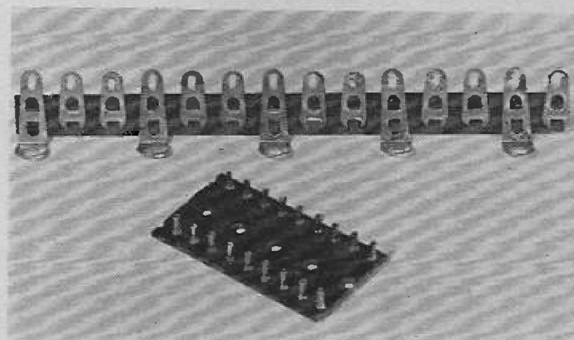


Fig. 13 (right). Photograph of alternative type tag strip and miniature tag board.

TAG BOARD

Tag board, also known as group board, is available in two sizes, standard and miniature, these sizes referring to size of the tags.

It consists of a Paxolin base panel with two rows of double tags directly opposite each other along the sides of the panel. The tags are held in position by means of small rivets or bent clips, these can be seen on the underside and are a possible means of connection.

The standard board is available in 8- and 16-way versions and the miniature in 10- and 20-way. This refers to the number of tags along each side, but these boards can be cut to suit individual requirements.

This means of construction is generally only suitable for projects containing only a small component count.

Components can be mounted and soldered across opposite tags or across tags on the same side, Fig. 11; wiring linkages between the various components can be carried out by using the tag fixings on the underside of the panel.

There is a series of holes along the centre of the tag boards and these afford a means of mounting the completed board; 6BA or 4BA nuts, bolts and spacers should be used.

TAG STRIP

There are some several forms of tag strip available in various lengths and tag size. The two most commonly encountered types are shown in Figs. 12 and 13.

One version consists of a thin strip of Paxolin with double sided tags riveted perpendicular to the length. Fixing holes for mounting are provided at both ends.

The second version is basically the same except that the tags are only single sided and every fourth tag affords a means of mounting to a base board or chassis.

Component mounting is carried out by soldering the component leads to the tags and then linking up the component with p.v.c. covered wire.

For the tag board and the double sided tag strip, tag push-on connectors are available for connecting, via a flying lead, to components remote from the board/strip. These push-on connectors are advantageous when the tag board/strip needs to be removed—desoldering is not then necessary.

Tag strip is secured to a base board or chassis by using 6 BA or 4 BA nuts, bolts and stand-off spacers through its fixing holes. ●

Feedback

You often say that there is negative feedback from the emitter of a transistor and yet, more often than not, there is no obvious wired conection from the emitter back to the input; how, then, can any feedback occur?

This is a very common problem for beginners because it is difficult to see how you can get feedback without wiring. The answer lies in the action of the transistor. When we say there is feedback from the emitter you will always find a resistor going between emitter and ground—there might be a capacitor associated with it. You must understand that to make a transistor conduct we must pass base current and this in turn is controlled by the potential difference between the base circuit and the emitter potential of the transistor.

The driving potentials in the base circuit are usually set relative to ground and in the absence of any resistor in the emitter circuit of the transistor you could say that base current is directly proportional to the voltages in the base circuit. However as soon as you introduce even a small value resistor in the emitter circuit base current will cause current to flow between collector and emitter of the transistor. This causes a potential difference between the ends of the emitter resistor and you can say that the emitter potential starts to rise—relative to ground.

This rise in the emitter's potential reduces the potential difference between the base circuit and the emitter and hence effectively reduces the amount of base current that can flow. It counteracts the input signal and hence is a form of negative feedback.

Bridge

What is the advantage of a bridge rectifier over a single diode in a power supply?

A single diode removes one half of the 50Hz a.c. current so you end up with a waveform that looks like half a sine wave (say just the positive going parts). This represents a voltage that rises and falls back to zero sinusoidally but then stays at zero for the period of the negative going half of the cycle. The power is rectified because all the voltages produced are either at zero or are all on the same side of zero; however you have a very intermittent signal. This has to be smoothed with capacitors to give an even d.c. level.

A bridge rectifier not only allows through the positive going parts of the cycle but also turns the negative going halves upside down and fills in gaps between the separated positive going "humps" you would have had with a single diode. The signal is still of an intermittent d.c. but is much easier to smooth because you do not have the gaps you had before.

In many simple power supply situations you could substitute a single diode for a bridge but you would have to increase the value of the smoothing capacitor to get rid of residual hum—particularly when high currents are being drawn (see *What Do You Know*).

Pots

Would it be possible, in experimental circuits, to use cheap skeleton potentiometers instead of the expensive types with shafts and knobs whenever the latter are specified?

This is certainly possible but you should remember that preset potentiometers are usually linear law—although for experimental work this does not matter very much. More important is that you should check the power dissipation of the circuit in which you intend to use the substitute devices. The larger shaft type pots usually have a rating of around 500mW while many of the sub miniature presets are less than 100mW.

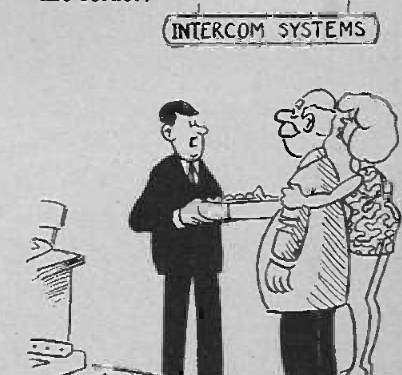
As a general guide you can do the substitution where small signals (e.g. audio signals) are concerned in applications like volume controls and tone controls, but you should be wary when dealing with power stages —e.g. the control potentiometers of a variable power supply.

Soldering

Having just started in electronics I am not very good at soldering but I have followed your various instructions to the letter. However when I use Veroboard I can never get the solder to wet the copper strip and flow on to it nicely—I always end up with a blob on the end of the lead. Is there any special trick?

The first thing to ensure is that the Veroboard is clean. Often—if it has been in store for a long time—the copper strips can tarnish slightly and this might not be very obvious to the naked eye. We suggest you try lightly polishing the copper side of the board before you start construction—use a household scouring powder and water but remember to wash off all the particles of the powder and dry the board properly before you begin.

When doing the soldering remember that you must make the iron touch the copper strip at the same time as it is touching the component lead and allow 2 or 3 seconds for it to take up the heat of the iron before you apply the solder.



"This one has a warning system—a red light flashes whenever your wife enters the office building."

GAS ALARM

By M.H. KEENE

Detects the presence of smoke and combustible gases and vapours

THIS article describes an alarm suitable for the detection of combustible gases, vapours and smoke which is ideal for domestic use. The main sensing element is a variable conductivity device whose resistance changes quite markedly in the presence of a combustible gas.

The device is suitable for n-butane, propane, ethane, methane, town gas, hydrogen, carbon monoxide and smoke, and will detect these gases in concentrations of 0·2 per cent which is well below the explosive limit of these gases, see Table 1. The device is also useful as a smoke or fire alarm as combustible gases are present as a result of fire. The level at which the alarm actuates may be varied using the described circuitry.

Table 1: Explosive limits

Gas	Lower Explosive Limit*
Butane	1·8
Propane	2·12
Ethane	3·0
Methane	5·0
Hydrogen	4·0
Carbon monoxide	12·55

*Expressed as percentage by volume in air at room temperature.

SENSOR

The sensing element is an *n*-type semiconductor. The doping is such that when the sensor material is heated in air it reacts with oxygen causing a decrease in conductivity. This can be seen when the sensor is first turned on, as it will conduct quite heavily and then slowly, the resistance will increase in time in the warming up period as there are less free electrons available. This condition then changes when a de-oxidising i.e. combustible gas or vapour, is present when there are free electrons available thus increasing the sensor's conductivity.

CIRCUIT

The complete circuit of the Gas Alarm is shown in Fig. 1 and can be seen to consist of four distinct sections: the power supply, level switch, output amplifier and audible alarm.

Now the sensor heater can run off a.c or d.c. It has been decided to use an a.c. supply, the voltage and current required being 1 volt at 500mA.

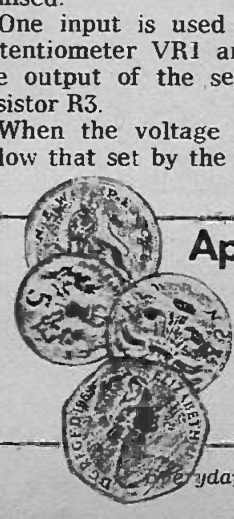
The mains transformer used in the prototype is a readily available one with two 6V secondary windings. One is used for the heater of the sensor in series with R1, a voltage dropper resistor, while the voltage from the other winding is half-wave rectified by D1 and then smoothed by capacitor C1. This gives about 8V d.c. to supply the rest of the circuitry.

Resistor R2 is included to limit the current flow through the detection part of the sensor.

The level switch part of the circuit uses an integrated circuit IC1, known as an operational amplifier, and this enables an alarm level to be set, below which, there will be no signal to the load circuit. Unlike in normal use, no feedback resistor is used and full open loop gain is utilised.

One input is used as a reference set by a potentiometer VR1 and the other is fed from the output of the sensor via current limiting resistor R3.

When the voltage level of the output falls below that set by the potentiometer, the output



Approximate cost of components including V.A.T.

£6·30 plus case

of IC1 will switch from the zero volts to that of the full positive supply. The reverse will occur when the output rises above that set by the potentiometer

The capacitor C2 on the inverting input of IC1 provides additional smoothing to the signal which prevents chattering of the output at the switching point.

The output circuit can be of many types depending on which form of alarm indication is required. In its simplest form the output of IC1 can switch on a low power bulb or l.e.d. If using an l.e.d. a current limiting resistor must be placed in series with l.e.d. When *only* this type of alarm is required TR1, RLA and the audible alarm are omitted.

For those output circuits which require more current than the output of IC1 can supply, some current amplification is required. This can easily be achieved by a single transistor, TR1.

The load for TR1 may be bulb, or a relay coil as in the prototype. Resistor R4 is used to limit the base current of TR1. Reversed biased diode D2 across the coil protects the transistor from any back e.m.f. spikes caused when the relay is released. The contacts of the relay specified may be used to switch up to mains voltages.

One pair of contacts are used on the prototype to switch on the power to the audible alarm, a simple astable multivibrator, which gives a continuous tone at the alarm condition, through loudspeaker LS1. Other alarms, in-built or remote from the unit can be obtained by using any additional relay contacts, the power of the alarm depending on contact rating.

Components....

Resistors

R1 12Ω 5W
R2 2·2kΩ
R3 1kΩ
R4 1kΩ
R5 1kΩ
R6 10kΩ
R7 10kΩ
R8 1kΩ
(R2–R8) ½ watt carbon ±10%

Potentiometer

VR1 10kΩ carbon linear

SEE SHOP TALK

Capacitors

C1 1000μF 9V elect.
C2 100μF 9V elect.
C3, C4, C5 0·1μF

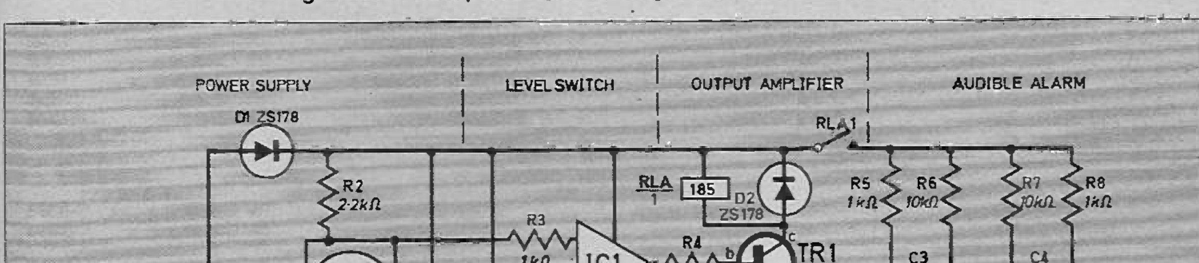
Semiconductors

TR1 ZT80 or 2N3704 silicon *npn*
TR2 ZTX300 silicon *npn*
TR3 ZTX300 silicon *npn*
D1 ZS178 or IN4001
D2 ZS178 or IN4001
IC1 741 operational amplifier and holder
SGS1 Semiconductor gas sensor

Miscellaneous

S1 Mains on/off switch
T1 Mains transformer, secondary 6V-6V 500mA
RLA Type PC2, 185Ω or similar with at least one set of normally open contacts
LS1 Miniature loudspeaker 35Ω impedance; base holder type B7G; metal case; Veroboard 0·1in. matrix 24 x 22 holes; nuts and bolts, 4BA and 6BA; length of three core mains lead.

Fig. 1. The complete circuit diagram of the Gas Alarm.

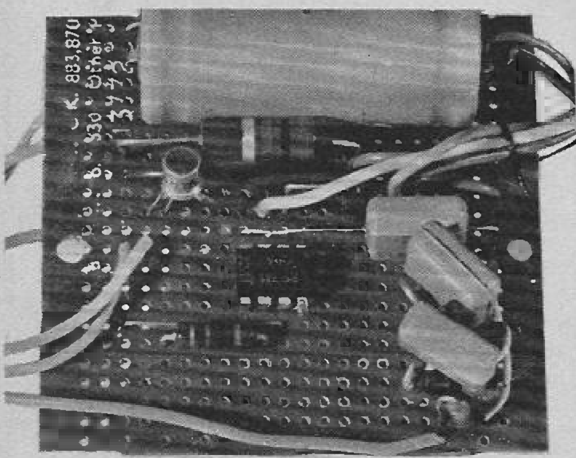


CONSTRUCTION

The components are mounted on a piece of 0·1in matrix Veroboard size 24 x 22 holes. The layout of these components is shown in Fig. 2.

Begin construction by drilling the two mounting holes and making the cut-outs along the copper strips as detailed in Fig. 2. Next mount and solder the resistors, capacitors, i.c. holder, link wires and flying leads as shown.

When this has been done, the transistors should be soldered in position, remembering to use a heatshunt when doing so. Failure to do this may result in permanent damage to the transistors.



Photograph of the completed component board of prototype.

The prototype Gas Alarm was housed in a metal instrument box, approximate dimensions 170 x 120 x 50mm, with cut-outs as indicated in Fig. 3. A metal box is recommended since dropper resistor R1 dissipates some heat. The metal box must be earthed as a matter of safe practice.

Arrange the components, transformer, mains switch, loudspeaker, circuit board and relay in the box as shown in Fig. 3 so that none are physically too close to each other, especially the mains transformer. Remember also to check the position so that there is no physical interference when the lid is on.

When this has been achieved make the cut-out in lid and then mount the transformer, sensor base holder, loudspeaker and switch in their respective positions. Wiring up the components should now be carried out as shown in Fig. 3.

The sensor can be mounted on the outside of the instrument box via the B7G holder as in the prototype or if a hand held probe is required for gas leak detection in confined areas, the B7G base can be mounted on a piece of wood with a handle. A wander lead will then connect this to the instrument box.

The voltage dropping resistor R1 is mounted on a piece of Veroboard on stand-off legs and then spaced from the instrument case. It is advisable to keep this well away from the rest of the electronics to minimise any thermal effects.

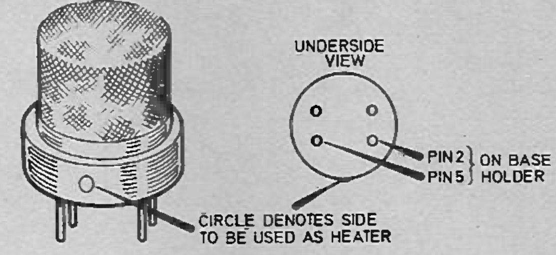


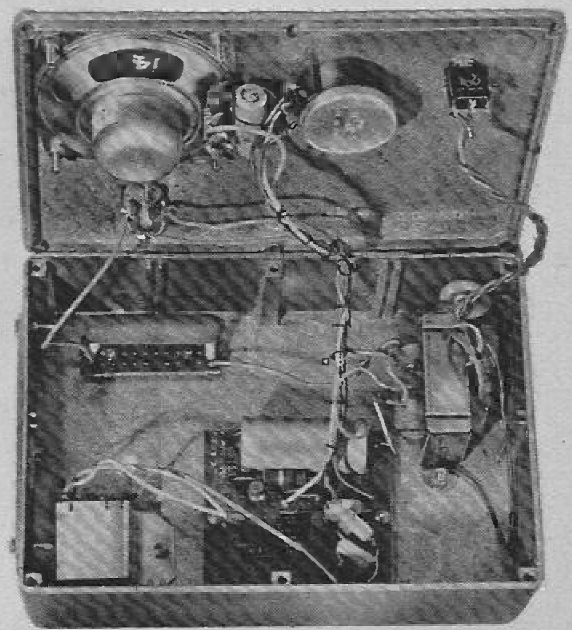
Fig. 4. Details of the sensor.

TESTING AND OPERATION

Before plugging into the mains for testing, check that the wiring is correct. If satisfied insert the sensor in the B7G valve base remembering that the heater side of the sensor is marked with a circle on the outside metal edge, see Fig. 4. Switch on the mains and check the voltage across the sensor heater and d.c. rail is correct, 1V and 8V respectively.

The circuit will go into the alarm condition for some several minutes as the sensor warms up. After a time, the alarm will come off, and the sensor will reach equilibrium.

Rotate the set level potentiometer VR1 until the alarm just comes off. This point is the position of maximum sensitivity and will easily de-



Photograph of the completed prototype with lid removed.

GAS ALARM

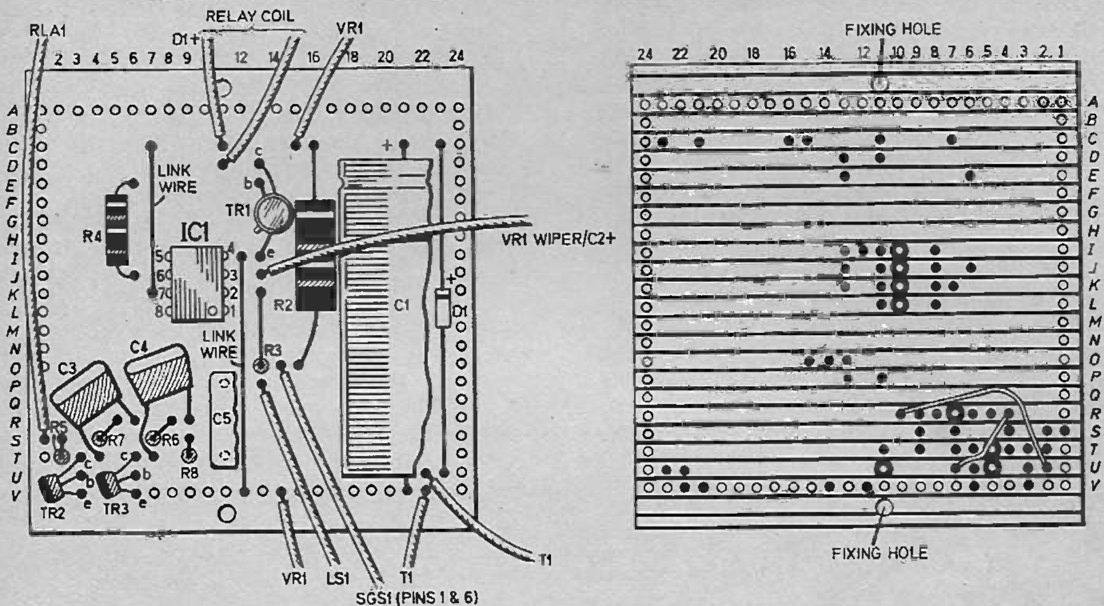


Fig. 2 (above) The layout of the components on the Veroboard.

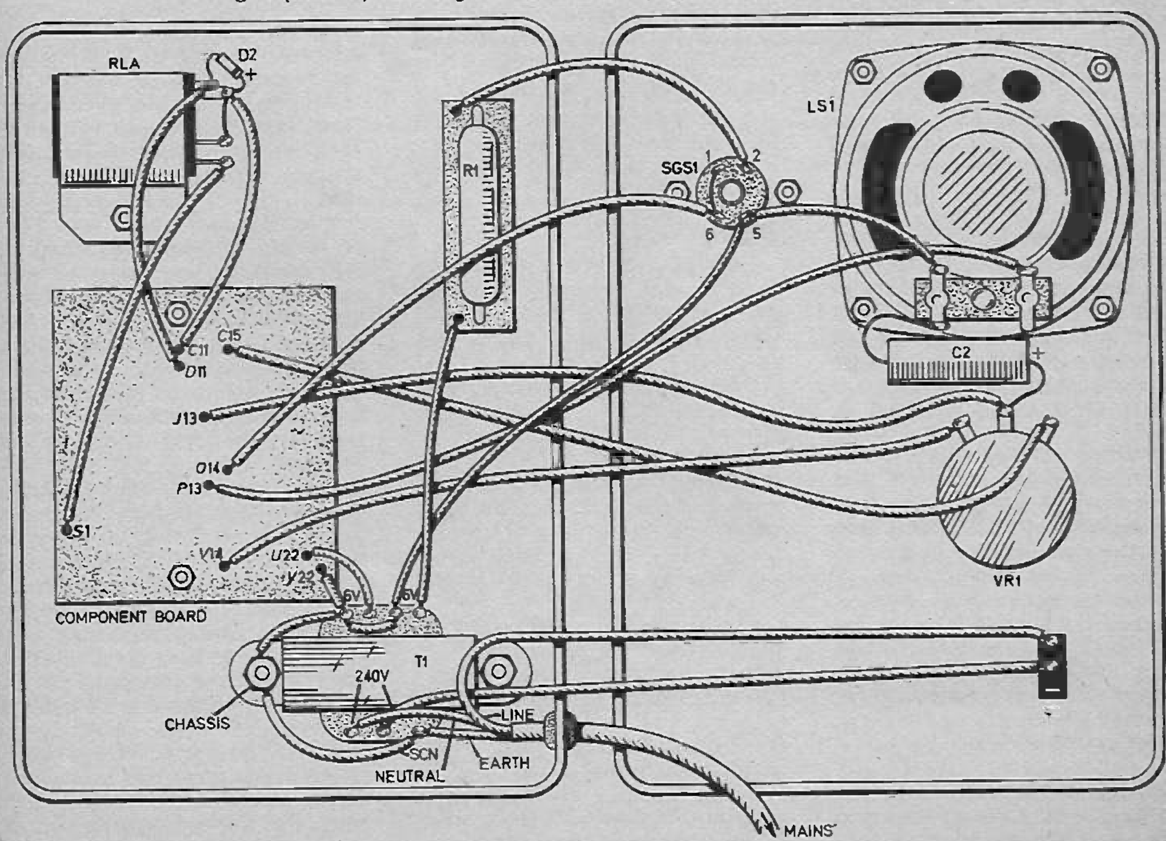


Fig. 3. Complete wiring up details.

tect most combustible gases at a concentration of 0·2 per cent in air at this point.

One of the benefits of half-wave rectification for the illustrated circuit is that the voltage supply is load dependent to a small extent. This means that at the switching point of IC1, the 8 volt d.c rail voltage drops due to the increased current through the relay. This occurs when the gas concentration is sufficient to produce a voltage from the sensor which just drops below that set by potentiometer VR1, thus actuating IC1. The increase in load current causes a decrease in rail voltage which will give a voltage from the sensor above the voltage set by VR1, thus switching IC1 output to the earth rail. This is because of the unequal resistor ratios to earth at the inputs inside IC1 and the charging rate of C2.

The result is that a gas concentration which causes IC1 just to switch, will give a pulsed tone alarm on the loudspeaker. At concentrations above this the output will be a continuous tone.

The pulsed output occurs when the set level voltage on VR1 is up to one volt above the sensor output voltage and the output from the sensor changes to just below this. This means in practice, that two alarm conditions occur:

(1) Pulsed tone when the gas concentration is approximately equal to that set by the potentiometer VR1.
(2) Continuous tone when the gas concentration is well passed this point.

The uses of the Gas Alarm are only limited by imagination or the requirements of the user, but applications such as gas pilot light failure alarm, carbon monoxide levels in garages, leak testing on domestic, camping and boating equipment, fire alarms and smoke detectors spring to mind. Some care should be taken on the installation of the alarm to give the maximum benefit. If denser gases than air are being monitored, the sensor should be placed below the possible leak source, for less dense gases, it should be placed above. ▣

...Counter Intelligence

BY PAUL YOUNG

A retailer discusses component supply matters.

LAST month I had few words to say regarding ordering components by mail. It may be useful for newcomers to recap as follows:

(1) Put on your order only the items your dealer lists.
(2) If your dealer is out of stock of an item he lists, ask him for his forecast of delivery (and please bear in mind he can only pass on the information given to him, which is often inaccurate) and don't re-order until you have made sure (by phone or letter) that the item is now in stock.
(3) Remember, with the best will in the world it may take 10-14 days to get your parcel. A letter *can* take four days, a parcel (2nd class) five days. So if you allow your dealer a two day turn round (quite fast) there will be at least one intervening weekend, and there are 13 days gone!

I would certainly advise you to plan your wants ahead. Difficult I know, but if you start ordering the parts for your next project while you are still working on your current one, with any luck you will have everything to hand for your next piece of construction, by the time the present one is finished!

Stock

Naturally, if you are starting from scratch, you will have no stock of anything, but you will undoubtedly build it up as you go along.

One item that you will cetainly be using all the time, is the ordinary $\frac{1}{4}$ watt ± 5 per cent or ± 10 per cent resistor. Every constructional article usually lists several of them. Some firms offer handy packs, giving a useful range with 5 or 10 of each value, and showing a substantial saving in price.

I think the same idea could be adopted for capacitors, of all types: ceramic, silver mica, paper, polyester and electrolytics, especially as so many projects are transistorised, and this usually means that a capacitor of 35 volts working is more than adequate. However, I don't wish to mislead you, because except for bargain parcels (where you take pot luck on the contents) I don't think anything like this at present is available.

Bargain Packs

By the way, don't think I am knocking bargain packs. They are often excellent value, and even if there are only two or three capacitors you require you will more than re-coup your outlay. I will tell you an amusing instance of this.

A small shop had a mixed lot of widely asorted capacitors, so they made them up in plastic bags and offered them at 25p a bag. The sales were steady but not exciting. Then one day customers flocked in from far and wide, some even buying 12 bags at a time until the stock was all sold.

I heard the explanation from an "amateur" friend of mine. It appears a "Ham" went into the shop one day, and bought a pack. Among the contents he found a small ceramic capacitor, several kilovolts working which normally would have cost him £3! In the mysterious way these chaps work, he managed to pass the glad news (over the air I presume) to all and sundry, without breaking the Law.

Reverting to my original topic of stock you can hold, this about covers it. Except for the usual hardware ((nuts and bolts) most other requirements are so individual that they must be bought with a project in mind.

DOWN TO EARTH

By GEORGE HYLTON

"What is the significance of 'ohms per volt' as applied to voltmeters?"

One of the aims of this column is to keep out the demon mathematics, as far as possible. If I have to let him in, it's usually towards the end of an article, and in as painless a form as possible. But in the present case, simple mathematics (Ohm's law style) plus a little low cunning cracks the problem wide open. So let's take the bull by the horns and get it over with.

DIVISION

"Ohms per volt." What does the "per" mean? When I was at school, the more long-suffering of my maths teachers used to explain that words can sometimes be translated into instructions. Thus "of" can mean "multiply", "and" can mean "add", and "per" can mean "divide by". So "ohms per volt" might mean "ohms divided by volts".

In the case of a voltmeter, "ohms" refers to the resistance of the meter, on a particular range, and "volts" to the full-scale voltage on that range.

Do I hear cries of objection? You can't divide ohms by volts, because they are two different things. ("Divide a loaf by a knife!" said the White Queen.) Rubbish! We think nothing of dividing *volts* by *ohms*, to get current ($I=V/R$), so why not ohms by volts? In engineering, you can divide anything by anything, if it suits your purpose. The only snag, in the present case, is that the result doesn't seem to mean anything.

We all know that when you divide volts by ohms the answer comes out in amps. But ohms by volts. . . .? There ain't no such animal. At this point, while we're thinking it over, we'll do our bit of mathematics. It's straightforward. Take our mysterious quantity R/V and substitute for R its Ohm's law equivalent, V/I. You then find that "ohms per volt", or R/V, is the same as $1/I$. Worse and worse, you say, R/V was bad enough, but what on earth is this strange, nameless quantity, $1/I$?

THE SMITH

Let's *give* it a name, then we'll feel better. Let $1/I$ be measured and counted in named units from this time forward. Any name will do, but since electrical units are named after famous physicists and suchlike people we'll call this one the smith. (With a small 's', of course, because this is what you do to the people when you turn them into units. Since they are invariably dead long before it happens they can't offer any objections to this indignity.)

Why "smith"? Well, there must have been some electrical pioneer called Smith at some time or other.

So, $S=1/I$. Much tidier. But what, after all this, does the smith actually measure? A fair question. Whatever it is, you can see, by putting in some real values of I, that as the full-scale current of the voltmeter increases the number of S's decreases. If meter A is 1 milliamp full-scale and meter B 10 milliamp, then meter A has 10 times the S value of B.

I suspect that for some readers the penny will now have dropped, so I'll put the rest out of their misery by suggesting that the smaller the current drawn by a meter from the circuit under test, for equal deflections of the pointer, of course, the greater the *sensitivity* of the meter; S is the unit of sensitivity. (By a fortunate coincidence, as you'll have noticed, "smith" and "sensitivity" begin with the same letter!)

WHY?

Why use this curious "ohms per volt" quantity instead of simply quoting the current required to deflect the pointer to full scale? You may well ask. Just tradition, perhaps. There is one possible reason, though. "Ohms per volt" tells you fairly directly what the resistance of a voltmeter is on any particular range, and this is often what you need to know when making measurements with it.

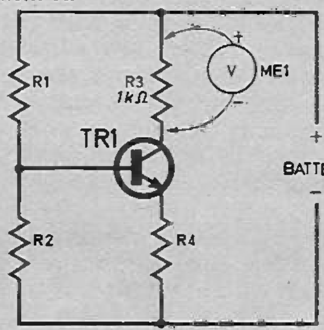


Fig. 1. Connecting ME1 as shown diverts current through R3.

Suppose you need to measure the drop across the 1 kilohm resistance in the circuit of Fig. 1. The voltmeter diverts some of the current which would normally flow through the resistor and so gives a false reading. How false? Well, obviously, the more current diverted by the meter the less accurate the readings.

To divert only a little current, the meter should have a resistance much greater than the resistance across which it's connected. Let's put some numbers in. Suppose the voltage in question is expected to be 1V. If the meter has a sensitivity of 1 kilohm per volt then in this case half the current is diverted through the meter and it reads 50 per cent low.

If you are stuck with 1kΩ/V, the best thing to do is to switch to the 10V range. The pointer won't be deflected very far (only one-tenth scale) but the meter cannot now divert more than 10 per cent of the current (actually not more than 9 per cent, if you work it out carefully) so the voltage indication is much more accurate, though harder to read because of the smaller deflection.

Armed with the "ohms per volt" figure for your meter, a quick bit of mental arithmetic tells you whether you are likely to be able to get a meaningful indication of voltage in a particular circuit.

THREE BY THREE GAME

BY GEORGE FRANCIS

A simple game for two players or a special "dice" for other games

THIS is a battery operated board game for two players, which can be used as a dice with other games or for several different games of skill. As well as trying to control the game for his own immediate and obvious advantage, the player needs to try to anticipate his opponent's probable play, as in certain Chinese games.

CIRCUIT

The complete circuit is shown in Fig. 1. The game board itself has nine small lamps, LP1 to LP9. One player has the three control push switches S1, S2 and S3, while the other player operates the push switches S4, S5 and S6. Each control switch assembly is attached to a flexible multi-way cord, and is held on the knees or under the table so that the opponent cannot see which push switch is operated.

CIRCUIT OPERATION

If player X pressed switch S1, he selects the row of lamps LP1, LP2 and LP3. Should he press switch S2, the selection is for lamps LP4, LP5 and LP6, while S3 similarly selects LP7, LP8 and LP9.

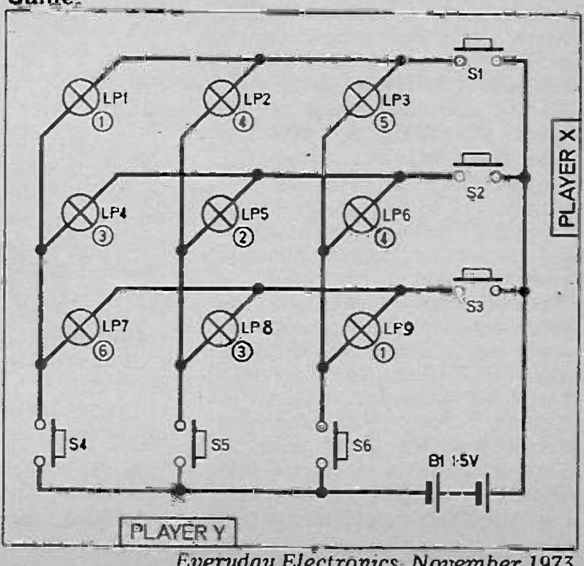
Approximate cost of components including V.A.T.

£2·10 plus case

Player Y can choose the row of lamps LP1, LP4 and LP7 by pressing S4, or the row LP2, LP5 and LP8 by S5, or the lamps LP3, LP6 and LP9 by pressing switch S6.

Though each player has to make his selection, no lamps light until *both* players have pressed one switch, and it is then too late to change or retract this "move." While deciding on each move, each player thus has to decide on the probability of securing an advantage from his own selection, however it may be modified by the selection of the other player, who will in the same way be trying to secure his own advantage.

Fig. 1. Circuit diagram of the Three By Three Game.



Components.... SEE SHOP TALK

Lamps
LP1-9 2·5V 0·3A m.e.s. (9 off)

Switches
S1-6 s.p.s.t. push to make, release to break small push buttons (6 off)

Miscellaneous
B1 1·5V HP2 or similar battery, metal clip and angle bracket for battery fixing, batten mounting lamp holders for LP1-9 (9 off), screws for fixing holders, connecting wire, materials for game board and two switch mounting boxes (see text).

The same board can be used for several games, and suggested rules for these are given later.

From Fig. 1 it will be seen that the full battery voltage is applied to only one lamp, according to the selection made. As an example, if S1 and S5 are closed, LP2 lights, while should S3 and S4 be closed, LP7 lights. At the same time, it is possible to trace out other circuit paths when player X and player Y have each closed a switch. However, these other paths through the lamps result in various series and parallel combinations, so that no lamp except the one actually chosen lights properly.

Provided all the bulbs are of the same type—2·5V 0·3A torch bulbs are suitable—only one lamp will light correctly, while others are so dim that there is never any doubt as to the indication which is to be followed.

GAME BOARD

The board was made approximately 280mm square to leave plenty of room for games. Batten mounting lamp holders are used for the lamps, these are mounted on the bottom panel which is about 45mm below the top. Nine 12mm diameter holes are made in the top panel to enable the bulbs to be seen. This allows each bulb to be fitted as in Fig. 2.

The base board is wired up as shown in Fig. 2. A hole is drilled at the centre of two adjacent sides, for the flexible leads to the switches.

SWITCH ASSEMBLIES

The switches are of an inexpensive type which make contact only when held down. Each board is about 90×45×13mm thick, and is recessed 75×25×8mm to take the switches, Fig. 2.

Each lead is made from four lengths of thin flex, about one metre long. Connect the wires as in Fig. 2. It is helpful to use a different colour to identify the common battery lead to all three switches. The other leads could be of different colours, but it easy to identify these by temporarily connecting a bulb and battery. Take the leads to the board, and connect them correctly, so that the relative positions of switches and the circuits they complete are the same as in Fig. 1.

A 1·5 volt battery was found most suitable with 2·5V bulbs, and as current is only drawn for short periods a reasonably large cell will last a long time.

The top of the board is divided into nine squares, either by drawing lines, or by drawing on a sheet of reasonably thin paper and placing this on the board. Perspex or other transparent material can be put on top, for protection.

Alternative means of construction would give the same results. This includes mounting the switches in shallow metal or plastic boxes or cases.

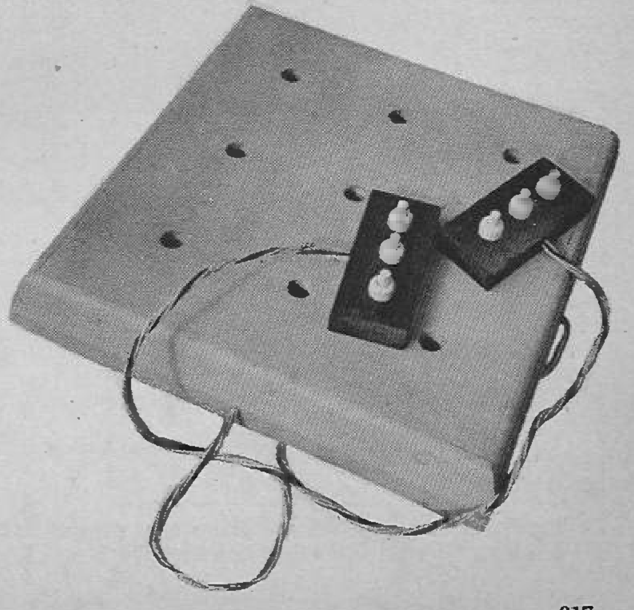
GAMES

For each "move" of any game, both players must press one button. Moves or scores are taken alternately. Each player tries to make his own turns convey the best advantage to himself, but tries to make his opponent's turns unsuccessful, or to provide the least favourable probabilities.

The board can be added to some existing games, or can be used in conjunction with the counters or pieces of other games. With existing games, the rules can be taken from them. The following will help indicate typical methods of play.

DICE

If the board is used to replace a dice, introducing an extra element of skill. Mark the board as shown or put numbered counters in the positions as indicated by the numbers in circles in Figs. 1 and 2. Players read a number alter-



THREE BY THREE GAME

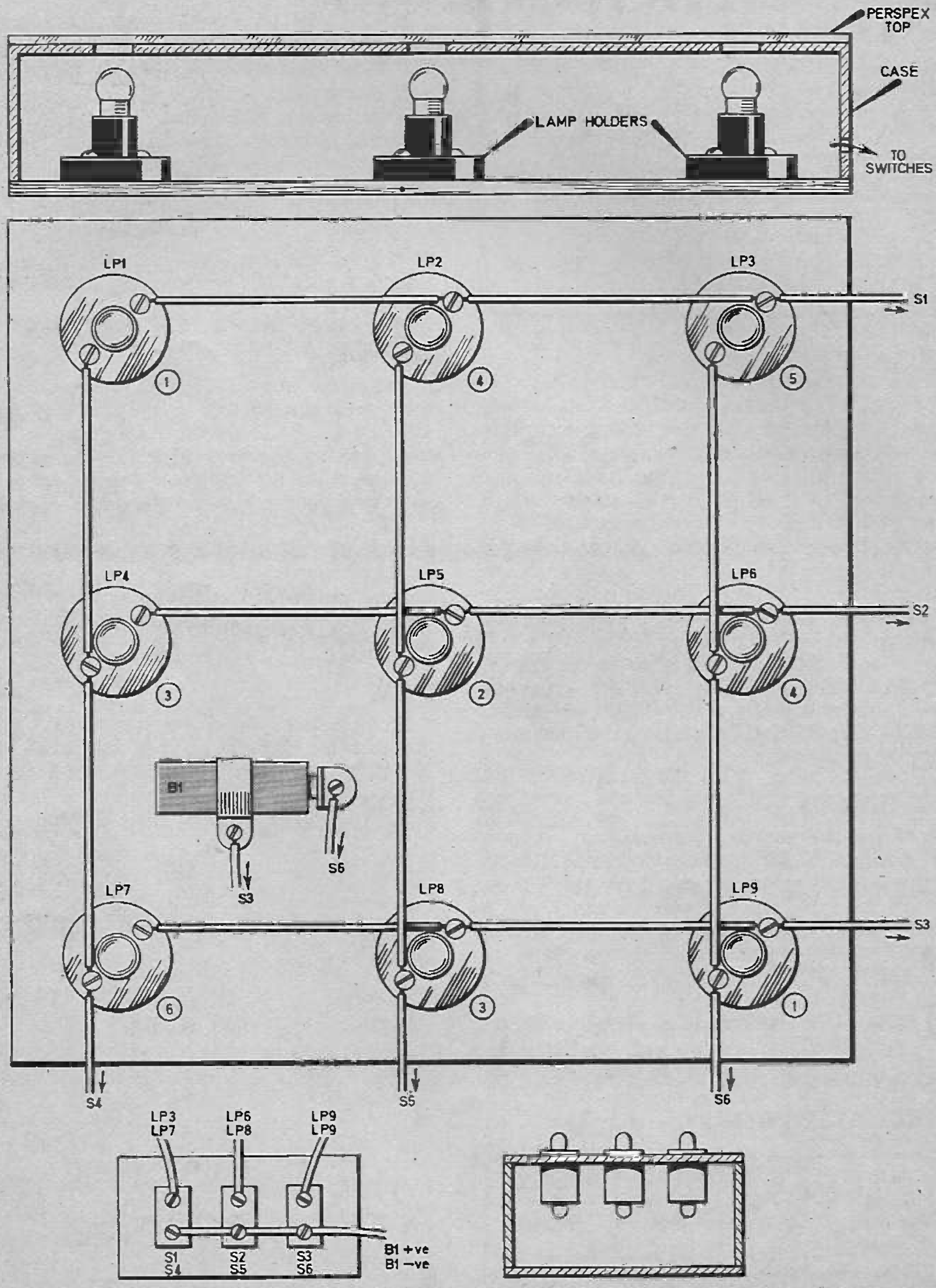


Fig. 2. Wiring of the base board and switch boxes. Two switch boxes are required, one housing S1, 2 and 3 with the other housing S4, 5 and 6.

nately, and for themselves select a row giving most favourable chance, while an opponent tries to make the indication least favourable. This can introduce the need for forethought, even with simple games such as snakes and ladders.

OTHER GAMES

It will be found that other games can be devised without too much difficulty. When doing so, check that one player cannot halt further play by always choosing a particular row. In some games this can be arranged by having a penalty for choosing such a row.

The following are among those which can be tried:

(1) **Required**: Two sets of counters or flags numbered 1-20.

Each player places any 9 counters, one on a square, where he wishes. Each takes opponents alternately. A counter is put on to replace each taken. When none are in hand, the higher score taken wins.

(2) **Required**: Two sets of small scale soldiers of different colour, or cowboys and indians, 15 for each player.

All the "men" placed on the board. Each player takes an outnumbered opponent on a lit square, and can move one piece to an adjacent square between operation of switches. Not more than four "men" may occupy any one square.

(3) **Required**: As for (2) but of varying potential: e.g. foot soldiers; machine gunners, small scale vehicles, etc.

Play as before but more powerful piece takes opponent's smaller piece. ▣

PLEASE TAKE NOTE

In Table I of the *Tutor Board* article, page 533 the wire lengths should be in cm *not* mm.

It should be noted that not all switches have the same operating position as that described in *Teach-In '74* page 538 last month. Some types, particularly miniature ones operate in the reverse direction.

Under the heading *What Do You Know?*, the formula for calculating the total resistance of resistors in parallel should have been

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots + \ldots$$

we apologise for this fundamental error.

NEXT MONTH

BABY SNATCH ALARM

Unfortunately, the instances of babies being taken from prams or push chairs left outside shops are all too common these days. Next month we publish a circuit and constructional information for an alarm to prevent this unhappy occurrence.

The alarm is basically simple, easy to use, quite cheap to build and can be quickly fitted to almost any pram or push chair without any contact to the baby.

AUTO-WATER FOR PLANTS

Make sure your plants do not die of thirst when left unattended.

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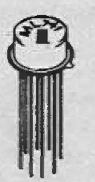
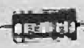


THE FERRANTI RADIO IC

Electrolytic Capacitors



4 VOLT
47µF 6½p
100µF 6½p
220µF 6½p
330µF 6½p
1000µF 18p
4700µF 29p

6·3 VOLT
33µF 6½p
68µF 6½p
150µF 6½p
470µF 11p
680µF 13p
1500µF 18p
2200µF 18p
3300µF 26p

10 VOLT
22µF 6½p
47µF 6½p
100µF 6½p
220µF 8p
330µF 10p
470µF 10p
1000µF 11p
1500µF 20p
2200µF 24p

16 VOLT
15µF 6½p
33µF 6½p
150µF 6½p
150µF 8p
220µF 9p
680µF 17p
1000µF 17p
1500µF 25p
2000µF 43p

25 VOLT
10µF 6½p
22µF 6½p
47µF 6½p
100µF 8p
150µF 8p
220µF 10p
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680µF 20p
1000µF 22p
2200µF 39p
5000µF 68p

40 VOLT
6·8µF 6½p
15µF 6½p
33µF 6½p

40 VOLT
47µF 6½p
100µF 9p
68µF 10p
220µF 11p
470µF 19p
690µF 25p
1000µF 25p
2200µF 44p

63 VOLT
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2·2µF 6½p
4·7µF 6½p
6·8µF 6½p
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AMTRON KITS

We have been appointed stockists of Amtron high quality Construction Kits. (20p P.P. on all kits).

Other Kits include:
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UK310 Radio control Receiver.... £3·28
UK325 'GCX2' channel splitting unit 1000 and 2000 Hz .... £7·86
UK330 'GCX2' channel splitting unit 1500 and 2500 Hz .... £7·86
UK345 Superheterdyne radio control receiver .... £7·55
UK515 mW Radio Receiver ...... £7·86
UK525 VHF Tuner 120 to 160 mHz £12·44
UK705 Windscreen Wiper timer .. £7·48
UK715 Photoelectric cell switch .. £8·49
UK760 Acoustic switch .... £11·85
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Specifications
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Harmonics: up to approx. 30 MHz
Output voltage: 1 V peak-to-peak
Maximum voltage applicable to the probe: 500 V DC
Power supply: 1·4 V DC
Transistors: (2) BC208B

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¼ watt 5% carbon 1p
½ watt 5% carbon 1p
1 watt 10% carbon 2½p
range 10 ohms to 4·7 megohms.
½ watt m/o 2% 3½p
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ACY21 23p
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BC135 16p
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BAX13 14p
BAX16 14p
BAY18 19p
BAY31 9p
BY100 19p
BY126 16p
BY127 19p
BYX10 24p
OA5 19p
OA10 24p
OA47 9p
OA70 8p
OA73 11p
OA79 8
OA81 9p
OA85 11p
OA90 8p
OA91 8p
OA95 8p
OA200 11p

Ruminations

By Sensor

Picking Over

A reader in Norfolk wrote in to *E.E.* with a query about possible radiation hazards from imploded cathode ray tubes. As far as I know there are no such dangers since radiation cannot be stored by the tube materials and no radiation-emitting substances are used in the construction. When tubes are working at high voltages X rays can be produced but these only present a danger when the tube is actually operating; even then, the shielding provided by the manufacturer of the television set is adequate to protect the viewer.

I know of a number of people who have picked up quite useful television and radio sets from the local rubbish tip but before you all rush off to the dump a few words of warning. Probably the best times for hunting are Saturday evenings and Sunday afternoons when the local populace are home from work and are busy clearing out their rubbish. You will have to be prepared to dig amongst the grass cuttings, hedge trimmings, builders rubble and old mattresses.

The equipment that you may find might be quite useless depending upon how long it has been lying there as well as its condition when it was dumped. Avid collectors seem to acquire a nose for the art and talk like anglers of the one that got away, i.e. of the beautiful walnut console with doors that was taken by the council man in charge of the tip.

On official tips some councils do not permit items to be removed and it is worth finding out if this is the case in your area as this can save a good deal of embarassment. One should of course be very careful to wash thoroughly after delving in to the tip because poisonous substances are often disposed of in this way. So good hunting!

One Man's Meat

In one large engineering factory, I knew an old fitter who gave a lot of help to laboratory staff by building up prototypes and models for development projects. In his greasy cap and bib and brace overalls he regularly visited the factory scrap bins and carefully collected together any material that might be useful. His bench, being also his material store, occupied the working space of eight men and with his free access to all parts of the factory he was able to obtain almost anything without a stores requisition form.

From the vaguest of instructions he would manufacture quite complex pieces of equipment in a very short time. He was not a tidy worker but he had proved his worth many times over and was therefore permitted to have a quiet corner where he could get on with the job in his own individual fashion.

SHOP TALK

By Mike Kenward

It was very interesting to look through last month's adverts and see the various prices asked for the Tutor Board kit. We did not quote the firms an approximate cost—they simply advertised their own price. Luckily the prices quoted bore out our approximate cost in all but one case; the difference between the highest and lowest prices reinforces what we have always said about shopping around for components before buying.

The prices quoted are of course for **all the electronic parts for the first six months.** There are a couple of components which are proving troublesome to supply—the MR45P meter and the precision wirewound pots, so if you receive substitutes for these don't be surprised.

Those of you who are now building or have built the Tutor Board should make sure all the components left over are carefully stored so that when they are required in the *Teach-In '74* series they are to hand and in good condition.

These components will also provide a useful stock when *Teach-In '74* comes to an end—in about 12 months. No soldering is used in the series and hence all the components will still be useful for other projects.

T.R.F. Receiver

There are one or two rather special components required for the *T.R.F. Receiver;* basically these components are all available from the larger stores but things like the Denco coils may be difficult to find in some areas.

The coils used in the receiver are available from some component shops or direct from Denco. They cost 48p each and 6p should be sent with each order to cover post and packing. Make sure you state clearly which coils are required when ordering. Incidentally, if demand is heavy there may be some delay in the supply of coils due to the shortage of polystyrene used for the formers. Write to Denco (Clacton) Ltd., 355/7/9 Old Road, Clacton on Sea, Essex CO15.

Make sure you get the plug-in types that can fit the B9A holder (this is a valve holder—valves are those glass things that light up in the backs of televisions!)

The MFC 4000B amplifier is available for 67p including VAT from Arrow Electronics Ltd., 7 Coptfold Road, Brentwood, Essex, postage is free.

The case used to house the prototype is available from H. L. Smith & Co. Ltd., 287-289 Edgware Road, London, W.2. **(Note this is not G. W. Smiths).** The Universal Chassis part, used to mount the dial, comes from Home Radio.

Gas Alarm

Yet another valve (see above) holder is used in the *Gas Alarm* this time a B7G type—it just goes to show that there was something good about valves! The gas sensor although quite a new device is now available from at least one advertiser in the issue.

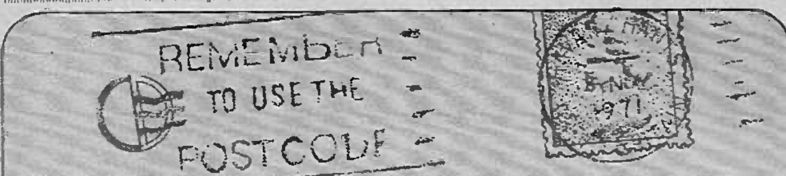
The 741 IC is generally available in two types of case—the construction is designed around the 8 pin, dual in line type and construction will therefore be easier to follow if this type is purchased. The case for the prototype was a die cast box, when painted these boxes make very tough, long lasting cases that are not unattractive.

Three By Three Game

An unusual, simple but quite interesting item, the *Three By Three Game* uses relatively few types of component, almost all of them being available from a local hardware store. The push buttons can be any cheap type and most shops keep some for less than 15p. Construction of the case is not critical and plastic boxes could easily be used.

Cases

We are often asked where small plastic cases can be purchased and we have recently noticed that Home Radio can supply a range (5 sizes) which are very strong, "showerproof" and quite cheap—starting at 24p for size 82mm x 82mm x 35mm and rising to £1·03 for size 219mm x 168mm x 79mm.



Readers Letters

Storage

On the cover and on page 234 of your May 1973 issue, you show a photograph of a set of interlocking plastic drawers, with transparent trays.

Please would you tell me by whom these are manufactured, and their address; as I wish to purchase some, but cannot, as no shops around here seem to sell them.

Mr. J. C. Ohlsen,
Glenfield, Leicester.

The storage drawers you require are available from Ivoryet Ltd, Dept EE, 124 Cricklewood Broadway, London N.W.2. They are also available from R. S. Components and can be obtained from them, via your local radio and TV shop.

Crystal Set

The article in the July issue of EVERYDAY ELECTRONICS on a *Replica Crystal Set* brought back nostalgic memories of my first efforts of building such a set as a schoolboy. Money was of prime importance and with the exception of the headphones virtually everything else in the set was made using odds and ends from the garage.

With a little ingenuity the set you describe could be made in the same way except for the tuning coil, since the sliding contact mechanism could prove difficult to improvise. I used two "spider web" coils mounted one above the other about ½ inch apart. Tuning was achieved by moving one coil across the top of the other. To the best of my recollection this device, which was quite common in the early days of radio was called a variometer.

Manufacture is easy. Cardboard discs with slots cut out can be used as the former and about 50 turns per coil of 28 s.w.g. wire should enable the medium wave to be covered, although a little experimentation with both the number of turns per coil and the gap between them may be required for best results in individual cases.

F. C. Boucher,
Chelmsford, Essex.

Thermostat Monitor

In the September issue of EVERYDAY ELECTRONICS, appeared an article entitled *Aquarium Thermostat*.

On the mains side of the circuit on page 475, the diagram shows a neon indicator in parallel with the heater. This method only indicates when the supply is on, when relay contacts RLA1 are closed. The heater could become open circuit, so that the temperature dropped considerably before the owner realised what was happening.

I know cost is the prime importance, but why not wire in series with the heater a milliamp meter —suitably shunted to read heater current.

Mr. L. H. Cox,
Pevensey, Sussex.

As you say the cost of such a meter is quite high compared with the cost of the unit, and you would have to look at the monitor to know that the heater had failed, a thermometer in the tank would serve the same purpose.

Etching

Many thanks for a very interesting magazine.

I wish to construct the *Mini Organ* in the June 1973 issue. I have read the article on *Making P. C. Boards*, and found it very helpful, but have two questions I would like answered. Firstly, the quantity of ferric chloride solution quoted is for a board 3 inches x 2½ inches, as the copper clad board of the *Mini Organ* is considerably larger, is it correct to assume I increase the quantity of ferric chloride in direct proportion to the increase in size?

Secondly, after etching has been completed does the solution have to be thrown away or can it be used again?

Mr. A. Ellis,
Brighton, Sussex.

The amount of solution required is only a rough estimate—it would be correct to increase the amount in proportion to the size of board. The solution may be used more than once but as it becomes saturated with copper the etching will take longer.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BC159	13p
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BC148/158	23p
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2N696	15p
2N697	17p
2N698	30p
2N706	10p
2N706A	12p
2N708	18p
2N911	50p
2N914	20p
2N918	42p
2N929	25p
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2N1131	24p
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7420	20p
7425	30p
7430	20p
7440	24p
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7443	£1·45
7444	£1·45
7445	£2·06
7446	£1·45
7447	£1·25
7450	20p
7451	20p
7453	20p
7454	20p
7460	20p
7470	45p
7472	32p
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7483	£1·32
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7492	85p
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74155	£1·55
74156	£1·55
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1·0	100v	8p	100	25v	9p
2·2	25v	10p	100	40v	10p
2·2	63v	8p	100	63v	13p
4·7	40v	8p	220	25v	11p
10	25v	8p	220	40v	12p
10	63v	9p	470	25v	14p
22	25v	9p	1000	25v	21p
22	40v	9p	2200	25v	39p
47	25v	9p	4700	16v	46p
47	40v	9p			

CAPACITORS—METALLISED POLYESTER

Stock values: MFD	Price each
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0·047, 0·068, 0·10	5p
0·150, 0·220	6p
0·33	8p
0·47	9p
0·68	12p
1·0	15p
1·5	22p
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100	0·28	0·37	0·52	0·52	0·55	0·64	0·70	1·54
200	0·39	0·41	0·54	0·54	0·63	0·67	0·83	1·76
400	0·48	0·52	0·62	0·62	0·74	0·83	1·03	1·93
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200	0·06	0·10	0·07	0·16	0·22	0·27	1·10
400	0·07	0·15	0·08	0·22	0·30	0·41	1·38
600	0·08	0·18	0·11	0·26	0·38	0·50	2·06
800	0·11	0·19	0·12	0·28	0·41	0·61	2·20
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UIC05	12 × 7405	0·55	UIC54	12 × 7454	0·55	UIC95	5 × 7495	0·55
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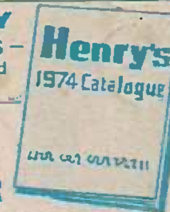

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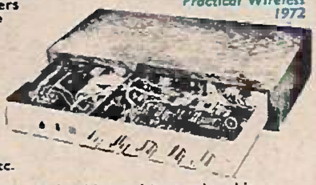

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