ISSN 0142-6192

Hobby Electronics

October '79
45p

TANTRUM
At long last

HOBBYTUNE
HE music box

MULTI SIREN
Annoy the neighbours

FREQUENCY METER
Hertzometer

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Play the game!

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Cook your goose.

Hobby Electronics

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GMT ELECTRONICS

(A DIVISION OF GOTHIC ELECTRONIC COMPONENTS LTD)
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ALL PRICES IN PENCE EACH UNLESS OTHERWISE STATED

CAPACITORS

Electrolytic Axial Leads

−10% to +50% Tol

Order Code: Cap 015 + μF + V d.c.

μF \ V d.c.	16	25	40	63
1.0				8
1.5				8
2.2				8
3.3				8
4.7				8
6.8			8	9
10		7		9
15	7		8	10
22		7		12
33	7		8	
47		7	10	12
68	8			
100		8	12	
150	8	9		29
220	12		24	34
330			28	37
470		21	30	44
680	19	28	36	50
1000	23	28	55	
1500	32	36		
2200	39			

Tantalum Bead

·20% Tol.

Order Code: Cap PR + μF + Volts

μF \ V d.c.	3.15	6.3	10	16	25	35
.01						9
0.15						9
0.22						9
0.33						9
0.47						9
0.68						9
1						9
1.5						10
2.2				9		11
3.3				9	11	14
4.7				10	14	15
6.8		9		11	15	.6
10		10	11	14	16	20
15		11	14	15	20	
22	11	14		16		
33		15	16	20		
47		16	20			
68	16	20				
100	20					

Electrolytic Can Type

High Ripple, IEC Grade 1, Low E.S.R.
Supplied complete with Vertical Fixing Clip

Order Code: Cap HR + μF + Volts

		Ripple 1A @ 85°C	1.4A @ 50°C	
2200 μF	16V	Ripple 1A @ 85°C	1.4A @ 50°C	166
4700 μF	16V	2.6A	3.6A	184
10000 μF	16V	5.8A	8.1A	222
22000 μF	16V	9.8A	13.7A	346
2200 μF	25V	1.3A	1.8A	175
4700 μF	25V	4.6A	6.4A	201
10000 μF	25V	8.0A	11.2A	264
22000 μF	25V	12.8A	17.9A	438
1000 μF	40V	0.9A	1.2A	168
2200 μF	40V	2.4A	3.3A	188
4700 μF	40V	5.6A	7.8A	231
10000 μF	40V	9.2A	12.8A	367
1000 μF	70V	1.8A	2.5A	190
2200 μF	70V	4.0A	5.6A	235
4700 μF	70V	7.5A	10.5A	376
1000 μF	100V	4.0A	5.6A	222
2200 μF	100V	7.8A	10.9A	346

Electrolytic Radial Leads

−10% to +50% Tol.

Order Code: Cap 034 + μF + Volts

μF \ V d.c.	6.3	10	16	25	35	40	50	63
.47								6
.68								6
1.0								6
1.5								6
2.2								6
3.3								6
4.7						6		7
6.8				6			7	8
10			6			7		8
15			6	7			8	10
22		6	7			8	10	
33			7	8		10		
47		7	8		10			
68			8	10				
100		8	10					
150		10						
220	10							

Trimmers

250V D.C. Wkg. Film Dielectric, Miniature

		Order Code
1.4 – 4.1pF	19	Cap 808 A
2 – 8pF	19	Cap 808 B
2 – 20pF	21	Cap 808 C
5.5 – 59.5pF	29	Cap 808 D

500V D.C. Wkg. C004 EA Tubular Type

		Order Code
.8 – 3.8pF	46	Cap 802 3
.8 – 6.8pF	48	Cap 802 6
1 – 13pF	61	Cap 802 12
1.7 – 19.7	62	Cap 802 18

Miniature Low Value

	Order Code
Polystyrene, Axial, ±1% Tol., ≥ 63V D.C. Wkg	Cap 424
Ceramic Plate, Radial, Low K, 1.8pF–8.2pF ±.25pF Tol, 10-330pF ±2% Tol, 100V D.C. Wkg	Cap 632
Ceramic Plate, Radial, Med K, ±10% Tol, 100V D.C. Wkg	Cap 630
Ceramic Plate, Radial, High K, −20% to +80% Tol, 63V D.C. Wkg	Cap 629
	+ Value

pF	424	632	630	629	pF	424	632	630	629	nF	424	632	630	629
1					100	16	6			10	25			8
1.2					120	16	8			12	26			
1.5					150	16	8			15	26			
1.8		5			180	16	6			18	27			
2.2		5			220	16	6			22	28			8
2.7		5			270	18	8			27	38			
3.3		5			330	18	8			33	41			
3.9		5			390	18		5		39	43			
4.7		5			470	18		5						
5.6		5			560	16		5						
6.8		5			680	16		5						
8.2		5			820	16		5						
10		5			1000	16		5	5					
12		5			1200	16		5						
15		5			1500	18		6						
18		5			1800	18		6						
22		5			2200	18		6	6					
27		5			2700	18		6						
33		5			3300	18		6						
39		5			3900	18		6						
47		5			4700	23		7	6					
56		6			5600	23								
68		6			6800	23								
82		6			8200	23								

Polyester Radial Leads

	Order Code
Dipped Type, ±20% Tol, > 250V D.C. Wkg. C280/352 Style	Cap 352
Moulded Type, ±10% Tol, ≥100V D.C. Wkg. 10.2mm Pitch Centres	Cap 360
Moulded Type, ±10% Tol, ≥100V D.C. Wkg. 7.6mm Pitch Centres	Cap PHE280
	+ Value

μF	352	360	PHE280	μF	352	360	PHE280
.001		5	6	.1	6	8	9
.0015		5	6	.15	7	9	
.0022	5	6	7	.22	8	10	
.0033	5	6	7	.33	10		
.0047	5	6	7	.47	12		
.0068	5	6	7	.68	15		
.01	5	6	7	1.0	19		
.015	5	7	8	1.5	27		
.022	5	7	8	2.2	32		
.033	5	7	8				
.047	5	7	8				
.068	6	8	9				

CASES

Small Desk Console – Boss Industrial Mouldings

Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
W161, D96, H39 (57)	186	Case BIM1005 OR
W215, D130, H47 (73)	268	Case BIM1006 OR

Plastic Boxes – Boss Industrial Mouldings

Moulded Box and Close Fitting Flanged Lid
ABS Box, C/W Brass Bushes, and Lid In Orange

		Order Code
L112 W62 D31	87	Case BIM2003 OR
L150 W80 D50	115	Case BIM2005 OR
L190 W110 D60	195	Case BIM2006 OR

Instrument Case – Boss Industrial Mouldings

Covers Manufactured from 14SWG Aluminium
Chassis Manufactured from 18SWG Mild Steel
Covers Finished Orange
Chassis Finished Matt Black

		Order Code
W250 D167.5 H 68.5 (Chassis 153mm Deep)	1480	Case BIM3000 OR

Plastic Boxes with Metal Lids – Boss Industrial Mouldings

Recessed Top Box
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
L85 W56 D29	97	Case BIM4003 OR
L111 W71 D42	130	Case BIM4004 OR
L161 W96 D53	182	Case BIM4005 OR

Diecast Boxes – Boss Industrial Mouldings

Diecast Box and Flanged Lid
Aluminium Box and Lid in Natural Finish

		Order Code
L113 W63 D31	104	Case BIM5003 NA
L152 W82 D50	181	Case BIM5005 NA
L192 W113 D61	280	Case BIM5006 NA

VERO ELECTRONICS PRODUCTS

2.5" x 5" .1" pitch Veroboard	59	VERO 21069J
3.75" x 5" .1" pitch Veroboard	66	VERO 21072D
2.5" x 1" .1" pitch Veroboard (5)	70/Pack	VERO 21076C
3.75" x 5" .1" pitch Plain Board	56	VERO 21078E
5.82" x 2.9" .1" pitch V-Q DIP Board	111	VERO 21084E
Spot Face Cutter	89	VERO 21013A
Pin Insertion Tool for .040 type pin	122	VERO 21015F
DS Pins .040 (100)	38/Pack	VERO 21087G
SS Pins .040 (100)	38/Pack	VERO 21017B
6mm Board Standoff (100)	181/Pack	VERO 21321K
15mm Board Standoff (100)	215/Pack	VERO 21322G
19mm Board Standoff (100)	226/Pack	VERO 21323D
Verowire Kit (1-pen, 2-wire, 25-comb)	375/Kit	VERO 21341D
Verowire Combs (100)	407/Pack	VERO 21339F
Verowire Wire (4)	228/Pack	VERO 21340G
Flip Top Box, Small, Black	192	VERO 21317D
Flip Top Box, Large, Black	250	VERO 21319J

Small Desk Consoles – Boss Industrial Mouldings

Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey
Ventilation Slots In Base

		Order Code
W105 D143 H32 (56)	206	Case BIM6005 OR
W170 D143 H32 (56)	271	Case BIM6006 OR
W170 D214 H32 (82)	375	Case BIM6007 OR

All Metal Desk Consoles – Boss Industrial Mouldings

Slope Front Console, Recessed Top
Two Piece All Aluminium Construction
Ventilation Slots In Rear and Base
Choice of 15° or 30° Sloping Front
Off White Top Panel, Blue Base

		Order Code
W102 D140 H28 (51) 15° slope	1018	Case BIM7151A
W165 D211 H33 (76) 15° slope	1350	Case BIM7154A
W254 D287 H33 (76) 15° slope	1572	Case BIM7156A
W356 D287 H33 (76) 15° slope	1823	Case BIM7158A
W102 D140 H28 (76) 30° slope	1018	Case BIM7301A
W165 D183 H28 (102) 30° slope	1202	Case BIM7303A
W254 D259 H28 (102) 30° slope	1572	Case BIM7306A
W356 D259 H28 (102) 30° slope	1823	Case BIM7308A

Eurocard Size Desk Console – Boss Industrial Mouldings

Slope Front Console
ABS Case, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel, Finished Grey

		Order Code
W169 D127 H45 (70)	375	Case BIM8006 OR

HARDWARE

Order Code

D.I.L. Sockets

8 Pin Low Profile Socket Tin	11	DIL SKT 8
14 Pin Low Profile Socket Tin	13	DIL SKT 14
16 Pin Low Profile Socket Tin	14	DIL SKT 16
24 Pin Low Profile Socket Gold	66	DIL SKT 24
28 Pin Low Profile Socket Gold	78	DIL SKT 28
40 Pin Low Profile Socket Gold	127	DIL SKT 40

Heatsinks

Individual Type for 1 x T05 50°C/W	10	Sink 5F
Individual Type for 1 x T066 10.5°C/W	26	Sink TV2
Individual Type for 1 x T03 7.2°C/W	24	Sink TV3
Individual Type for 1 x T0126 17°C/W	23	Sink TV4
Individual Type for 1 x T0220 17°C/W	23	Sink TV5

P.C.B. Components

Dalo Pen, Blue Ink, Slow Drying	92	Pen 33PC

Fuseholders

Suit 20mm x 5mm fuses.

P.C.B. Mounting, Open Type	8	Fuse/H20B
Chassis Mounting, Open Type	17	Fuse/H20C
Panel Mounting, Screwdriver Slot	77	Fuse/H20PT
Panel Mounting, Finger Release	56	Fuse/H20P

Fuses

20mm x 5mm Glass.

Quick Blow, Range 100mA–5A	8	Fuse 20
Slow Blow, Range 250mA–5A	22	A/S Fuse 20
		+ Rating

Lampholders, Panel Mounting

Similar In Style to Fuse/H 20P
Low Voltage Type Suits LES and M/F Bulbs.

Low Voltage, Red, Amber or Green	75	Lamp LV
Internal Neon 200/240V Red or Amber	95	Lamp N
		+ Colour

Bulbs, Low Voltage, L.E.S.

6V, 0.36W; 6.5V, 1W; 14V, 0.75W	22	Bulb LES
		+ Voltage

RESISTORS

Order Code

Carbon Film, Fixed

0.25W, E24 Values 1R0-10M, 5% Tol.	1.5 ea.	90p/100 (Mult 10/Value)	£7.90/1000 (Mult 100/Value)	Res RD¼
0.5W, E12 Values 1R0-4M7, 10% Tol.	2 ea.	1.25p/100 (Mult 10/Value)	£10.10/1000 (Mult 100/Value)	Res RD½
				+ Value

Metal Film, Fixed

0.5W, E24 Values, 5R1-1M, 2% Tol.	6 ea.	3.80/100 (Mult 10/Value)	£32.40/1000 (Mult 100/Value)	Res MR30
2.5W, E12 Values 10R-27K, 5% Tol.	13 ea.	7.90/100 (Mult 10/Value)		Res PR52
				+ Value

Metal Glaze, Fixed

0.5W, E24 Values, 1M-33M, 5% Tol.	10 ea.	5.40/100 (Mult 10/Value)	Res VR37
			+ Value

Skeleton Presets, Miniature

Order Code

0.1W, E3 Values, 100R-1M, Lin. Vertical Mounting	7	Min Preset V
0.1W, E3 Values, 100R-1M, Lin. Horizontal Mounting	7	Min Preset H
		+ Value

Skeleton Presets, Standard

0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	10	Std Preset V
0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mounting	10	Std Preset H
		+ Value

Potentiometer, Rotary

0.5W, E3 Values, 1K-2M2 Lin.	34	Pot Lin
0.25W, E3 Values, 4K7-2M2 Log.	34	Pot Log
		+ Value

Monitor

LASERISED LETTERS

If you can tear your eyes away from the photograph for one minute we'll tell you all about laser printing. The machine on the right is an extremely sophisticated laser printer. Now for some pretty impressive statistics (it's all in the mind) how about 10,000 personalised letters per hour of 20,000 lines of type per minute. The big bonus in using such a technique is the ability to personalise each and every letter with the recipient's name — cheaply. This means that there's a strong possibility that those endless circulars that come through your letter-box could have your name on it.

Laserprint, the company responsible, have already tried a test sample of 10,000 letters, half of them personalised, to see whether having your name on a letter or circular makes any difference to the response and it appears that it does. So next time you get a letter from one of those mail order companies with your name on it, don't just throw it straight in the bin, look at it, it may have been printed by laser, now you can throw it in the bin.

SMOKEY BEARS GET NEW RIGS

No, they're not CBs, they're the all new Motorola VHF MX350 hand portable transceivers recently delivered to the Fife constabulary, 60 in all, to replace their ageing existing equipment. All the new units are two-channel switchable and such is their durability that during the evaluation period not one fault occured to the 12 sets used. The transceivers deliver 2.5 watts RF into the antenna, mounted on a remote mike/speaker to avoid body absorbtion of RF. The internal rechargeable batteries will last approximately 8 hours under normal conditions and can be fully recharged within 1 hour. There, we've resisted the temptation to make any jokes about CB, and any suggestions that the officer in our picture is saying "Breaker One Four," are totally intrue.

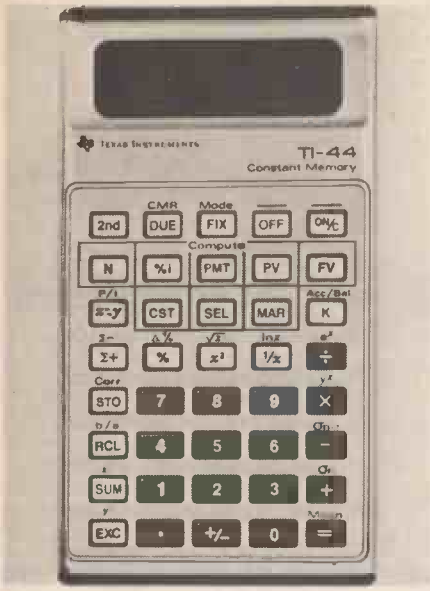
NEW PICTURE BOX

For the first time JVC have introduced a video cassette recorder with slow motion facility. The new machine rejoices under the title HR-3660. (We are starting a campaign to get manufacturers to think up more inspiring names for their products).

All the now standard features are to be found, audio dubbing, 8 day digital clock/timer and 3 hour recording capacity. The slow-motion feature has a variable speed and even a freeze capability to stop the recording on any selected frame. There is also a speed up facility (double speed) to allow the viewer to whizz through the irrelevant or boring bits, a speech compression circuit ensures that speech is still understandable even at double speed.

As an added bonus the HR-3660 has a wired in remote control unit that operates most of the recorders functions. The VHS format on this machine is fully compatible with other ½" VHS recorders and will accept an input from a variety of colour cameras. No price as yet, the launch date will be September so any enquiries can be made to; JVC (UK) Ltd, Eldonwall Trading Estate, Staples Corner, 6-8 Priestley Way, London, NW2 7AF.

News from the Electronics World



MONEY BOX

What does time-money and mortgage loan calculations? Give up? How about compound interest, annuities, investment yields schedules, accumulated interest, and principle interest splits, (whatever they may be)? If you understood all that chances are you're in the market for Texas's new financial button box. The TI-44 is the first multi-mode slimline calculator in the UK with pre-programmed financial, profit margin, and statistical functions.

The TI-44 has a constant memory feature, retaining information even when switched off. Something called APD (Automatic Power Down) turns the calculator off automatically after seven minutes of non-use, battery life should be around 1 000 hours under normal conditions.

Now its our turn for statistics, weight 85 grammes, size, 13.5 by 7.4 by 0.69 centimetres. Complete with carrying case and manual it has a suggested retail price of £36.95 (inc VAT). It should be available now from your local calculator stockist.

CLASSY CASIO

Casio must have taken our recent comments on the lack of new calculators to heart, we're almost back to our old level of five a month. Stories of new machines are coming in thick and fast. Latest arrival is the JR-110 (Casio are nearly the worst offenders when it comes to nameing their products, we'll start our campaign with them). This little box (only 24 x 13 x 5 cm) has a lot of useful features. The mini-printer is backed up by a ten digit display, a plethora of mathematical functions and all powered by four penlight batteries or optional AC adaptor.

A nice touch is the inclusion of a switch to turn off the keyboard when not in use (these puns are getting worse!). Recommended retail prices which are usually quite meaningless are; £74.95 for the JR-110 and £64.95 for the JR 101 which does not have a separate display. Casio can be found at their usual address which is: 28 Scrutton Street, London EC2A 4TY.

DIGITAL DEFENCE

Something new in car protection from across the big pond. It is blessed with the name 'Steal Stopper' and comprises a small keyboard attached to your dashboard. Upon entering the car it must be fed with a secret four digit code. Providing the correct code is entered it will enable th car's ignition. The system will also prevent the ignition from being 'Hot Wired' from inside the car; a possible 11 880 combinations will effectively remove any 'lucky guessers' from pinching your car. The system can also be disengaged by pressing a further code to enable the car to be parked in garages or attendant operated car-washed (must be American). Price over here is £29.95 from Kramer and Co., 9 October Place, Holdershill Road, London NW4 1EJ.

KIT CAT

T. K. Electronics, the people who supplied us with this month's Kit Review sample have also shown us their latest catalogue and very interesting reading it makes too. T. K. stock a good selection of most common components and a few uncommon ones too — all at reasonable prices. It is always good to see a large data content in these catalogues, these small touches make them very useful additions to your library. The last few pages of the catalogue are devoted to TK's range of kits. They seem to specialise in lighting control, from disco to domestic, we were very impressed with the Touch controlled light dimmer. For your copy write to T. K. Electronics; 106 Studley Grange Road, London, W7 2LX.

LED ASTRAY

Have you ever wondered why you've never seen blue LEDs? Now for the first time the truth can be told — they're very difficult to make. Several large companies have for some time been engaged in trying to develop blue LEDs, mostly with little success. One company however, Siemens have not given up and are rumoured to be very close to producing blue LEDs on a commercial basis. One problem has dogged the LED story from the beginning, the materials used, Expital Silicon Carbide (SIC for short) are difficult to produce in sufficient quantity in the correct size. The crystals used need to be quite large physically, around 1 square centimetre.

As with all research, 'mother is the neccesity of invention.' Perhaps if sufficient demand for blue LEDs existed it would hasten their development. We at HE ever keen to help in such matters would like to suggest that, if the Police could be persuaded to place a large enough order, possibly for indicator lamps on their walkie-talkies, their introduction to the general public could be that much sooner.

ERRATA 1

The Combination lock in the September issue (it does work, really) had a couple of errors on the wiring of SW1 and SW2. They are as follows: connection D now goes to tag 1 on SW2, connection F now goes to tag 11 on SW2, C to tag 8 on SW1 and E to tag 4 on SW2.

In the how it works, first paragraph RS now reads R3, third paragraph R7 now reads R5, fifth paragraph R10, is now R8, final paragraph, the bypass capacitors ar C3, C6 and C8 and R11 should read R9. Thanks to Mr R. Bleach for his prompt assistance and be assured that heads will roll.

ERRATA 2

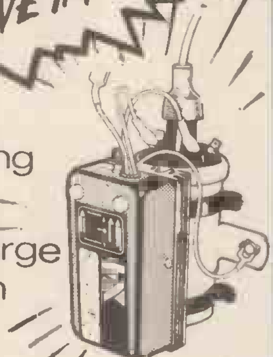
The Ultra Switch nearly escaped but not quite. One thing to look out for however was the values of C5 and C6 on the Ultra-Switch (Page 46, 47) the values shown on the parts list are correct, the decimal point slipped a little on the circuit diagram.

ERRATA 3

We just caught this one in time, on the overlay for Starburst (Sept HE page 26) one or two of the proverbial gremlins did their worst. R 14, 13 and 12 should now read R 7, 8, 9. The connections for 9 V and 0 V are back to front. Sorry again.

The latest kit innovation! from Sparkrite

Sparkrite–as featured by Shaw Taylor in 'DRIVE IN'



the quickest fitting
CLIP ON
capacitive discharge electronic ignition in KIT FORM

- **Smoother running**
- **Instant all-weather starting**
- **Continual peak performance**
- **Longer coil/battery/plug life**
- **Improved acceleration/top speeds**
- **Optimum fuel consumption**

Sparkrite X4 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 1/3 mins.
Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). The circuit incorporates a voltage regulated output for greatly improved cold starting. The circuit includes built in static timing light, systems function light, and security changeover switch. All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED

Die pressed epoxy coated case. Ready drilled, aluminium extruded base and heat sink, coil mounting clips, and accessories. Top quality 5 year guaranteed transformer and components, cables, connectors, P.C.B., nuts, bolts and silicon grease. Full instructions to assemble kit neg. or pos. earth and fully illustrated installation instructions.

NOTE – Vehicles with current impulse tachometers (Smiths code on dial RV1) will require a tachometer pulse slave unit. Price £4.25 inc. VAT. post & packing.

Electronics Design Associates, Dept. HE10
82 Bath Street, Walsall WS1 3DE. Phone: (9) 614791.

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Address ....

Phone your order with Access or Barclaycard

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X4 KIT £17.95 inc. VAT	
TACHO PULSE SLAVE UNIT £4.25 inc. VAT	

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Cheque No.

Access or Barclaycard No. ....

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LIMITED

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for Miniature Soldering Irons & Accessories

		PRICE EACH	P & P Extra EACH
S-R-B	18 watt Soldering Iron available in 12, 110 & 240 Volts, fitted with No. 20 bit	£4·43	+ 24p
SPARE BITS	No. 19 size 1.5mm or No. 20 size 3 mm or No. 21 size 4.5 mm or No. 22 size 6 mm	52p	—
	No. 78. I.C. Desoldering Bit	£1·04	+10p
	No. 1920L Long Life Bit	£1·12	10p
SAFETY STAND		£4·23	+ 70p
SOLDER	Savbit 20'	61p	+ 9p
	Savbit 10'	32p	+ 5p
	Lowmelt 10'	76p	+10p

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We also Offer & Recommend for Mail Order & Personal Callers Only

	PRICES EACH including V.A.T. and P & P
Oryx 50 Temperature Controlled Soldering Iron	£11·75
Spare tips for above	£1·39
Isotip quick charge rechargeable Soldering Iron	£24 60
Spare tips for above	£3 42
Cable 7/0.2 11 Colours 100 meter reel	£2 40
0.1 Veroboard 3¾" × 11½"	£2·00
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POLYESTER CAPACITORS: Axial lead type (Values are in µF)
400V: 0·001, 0·0015, 0·0022, 0·0033, 0·0047, 0·0068, 0·01, 0·015 9p; 0·018 10p; 0·022, 0·033, 11p; 0·047, 0·068 14p; 0·1 17p; 0·15, 0·22 24p; 0·33, 0·47 41p; 0·68 48p.
160V: 0·039, 0·15, 0·22, 11p; 0·33, 0·47 19p; 0·68, 1·0 22p; 1·5 29p; 2·2 32p; 4·7 36p.
DUBILIER: 1000V: 0·01, 0·015 20p; 0·022 22p; 0·047 26p; 0·1 38p; 0·47 53p; 1·0 175p.

POLYESTER RADIAL LEAD (Values in µF) 250V: 0·01, 0·015, 0·022, 0·027 5p; 0·033, 0·047, 0·068, 0·1 7p; 0·15 10p; 0·22, 0·33 13p; 0·47 17p; 0·68 19p; 1·0 22p; 1·5 30p; 2·2 34p.

FEED THROUGH CAPACITORS 100µF 350V 8p

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF) 500V: 10 40p; 47 68p; 250V: 100 65p; 63V: 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, 8, 10, 15, 22 8p; 47, 32, 50 12p; 63, 100 27p 50V: 50, 100, 220 25p; 470 32p; 1000 50p; 40V: 22, 33, 3p; 100 12p; 2200 68p; 3300 68p; 4700 85p; 35V: 10, 33 7p; 330, 470 32p; 1000 49p; 25V: 10, 22, 47 6p; 80, 100, 160 8p; 220, 250 13p; 470, 640 25p; 1000 27p; 1500 30p; 2200 45p; 3300 68p; 4700 85p; 16V: 10, 40, 47, 68 7p; 100, 125 8p; 220, 330 14p; 470 16p; 1000, 1500 20p; 2200 34p; 10V: 100 6p; 640 12p; 1000 14p.
TAG-END TYPE: 70V: 2000 89p; 4700 135p; 50V: 10,000 255p; 40V: 2500 65p; 3300, 4700 70p; 15,000 299p; 25V: 4700 70p 2200 48p; 325V: 200+100+50+100 190p; 32+32 175p.

TANTALUM BEAD CAPACITORS 35V: 0·1µF, 0·22, 0·33, 0·47, 0·68, 1·0, 2·2µF, 3·3, 4·7, 6·8 25V: 1·5, 10 20V: 1·5 16V: 10µF 13p each 47, 100 40p. 10V: 22µF, 33 20p 6V: 47, 68, 100, 30p 3V: 68, 100µF. 20p

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01µF 6p
0·015, 0·02, 0·04, 0·05, 0·056µF 7p
0·1µF, 0·2 9p 50V: 0·47 12p

MINIATURE TYPE TRIMMERS
2-5·6pF, 3-10pF, 10-40pF 22p
5-25pF, 5-45pF, 60pF, 88pF 30p

COMPRESSION TRIMMERS
3-40pF, 10-80pF 30p; 25-190pF 33p
100-500pF 45p; 1250pF 60p

POLYSTYRENE CAPACITORS
10pF to 1nF 8p; 1·5nF to 10nF 10p.

SILVER MICA (Values in pF) 3-3, 4-7, 6-8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 180 9p each
220, 250, 300, 330, 360, 390, 600, 820 16p each
1000, 1200, 1800, 2000 20p each

SOLDERCON PINS★
100 50p; 500 200p

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All parts now available

POTENTIOMETERS: (ROTARY)
Carbon Track. 0·25W Log & 0·5W Linear Value.
500Ω, 1K & 2K (Lin. only) Single 27p
5K-2MΩ single gang 27p
5K-2MΩ single with DP switch 65p
5K-2MΩ double gang 78p

SLIDER POTENTIOMETER
0·25W log and linear values 60mm
5KΩ-500KΩ single gang 70p
10KΩ-500KΩ dual gang 80p
Self Stick Graduated Bezels 25p

PRESET POTENTIOMETERS
Vertical & Horizontal
0·1W 50Ω—5MΩ Miniature 8p
0·25W 100Ω—3·3MΩ Horiz 10p
0·25W 200Ω—4·7MΩ Vert 10p

RESISTORS—Erie make 5% Carbon Miniature High Stability, Low noise

	RANGE	VAL	1-99	100+
¼W	2·2Ω-4·7M	E24	1·5p	1p
½W	2·2Ω-4·7M	E12	2p	1·5p
1W	2·2Ω 10M	E12	5p	4p
2% Metal Film	10Ω-1MΩ		6p	4p
1% Metal Film	51Ω-1M		10p	8p

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LW to MW Converter for Radio 4
Complete kit of parts inc. Instructions. £4·95 inc. VAT

OPTO ELECTRONICS★

LEDs plus clips	
TIL209 Red	13
TIL211 Grn	17
TIL212 Yellow	18
2" Red	15
2" Yellow Green	18
Square LED	48
ORP12	63
2N5777	45
7 Seg Displays	
LS400	255
TIL312 C An 3"	105
TIL313 C Cth 3"	105
TIL321 C An 5"	115
TIL322 C Cth 5"	115
DL704 C Cth 3"	99
DL707 C.A. ·3"	99
DL747 C.A. ·6"	180
FND357	120
MAN3640	175
LCD 3½ digit	875
TIL307	675

SWITCHES★
TOGGLE 2A 250V
SPST 28p
DPDT 38p
4 pole on/off 54p
SUB-MIN TOGGLE
SP changeover 59p
SPST on/off 54p
DPDT 6 tags 70p
DPDT c/off 79p
DPDT Biased 115p
SLIDE 250V:
1A DPDT 14p
1A DP c/off 15p
½A DPDT 13p
4 pole c/over 24p
PUSH BUTTON Spring Loaded
SPST on/off 65p
SPDT c/over 70p
DPDT 6 Tag 85p

SUPERBOARD II Microcomputer. Ready-built and tested. Only £188, ex-stock. Call in at our retail shop for demonstration.

	JACK PLUGS Screened chrome	Plastic body	SOCKETS open metal	moulded with break contacts
2·5mm	13p	10p	8p	
3·5mm	15p	10p	8p	
MONO	25p	14p	13p	20p
STEREO	32p	18p	15p	24p

	Plugs	Sockets	In Line
DIN			
2 PIN Loudspkr.	10p	6p	20p
3 4 5 Pin Audio	13p	10p	20p
CO-AXIAL plastic	10p	12p	12p
metal	18p	18p	22p
PHONO		6p single	—
assorted colours	10p	8p double	15p
Metal Screened	15p	15p 4-way	20p
BANANA 4mm	11p	12p	—
2mm	10p	10p	—
1mm	6p	6p	—
WANDER 3mm	6p	6p	

SWITCHES ★ Miniature Non-Locking
Push to Make 15p Push to Break 25p
ROCKER (white) 10A 250V
SP changeover centre off 35p
ROCKER: SPST on/off 10A 250V 23p
ROCKER: Illuminated (white)
Lights when on: 3A 240V 52p
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way 2p/2-6W, 3p/2-4W, 4p/2-3W. 41p
ROTARY: Mains 250V AC, 4 Amp 45p

DIL SOCKETS ★ (Low Profile – Texas)
8 pin 10p; 14 pin 12p; 16 pin 13p; 18 pin 16p; 20 pin 22p; 24 pin 25p; 28 pin 39p; 40 pin 50p.

JACKSONS VARIABLE CAPACITORS
Dielectric
100/300pF 140p
500pF 165p
6 1 Ball Drive
4511/DAF 115p★
Dial Drive 4103
6 1/36 1 650p★
Drum 54mm 30p★
0-1·365pF 245p
00 2 365pF 275p
0 2 365pF with slow motion Drive 325p
00 208/176 285p
" " with slow motion drive 325p
C804-5pF 10 15
25 50 pF 175p★
100, 150pF 250p★
'L' 3 x 310pF 495p
00·3 x 25pF 430p

DENCO COILS
'DP' VALVE TYPE
Range 1 to 5 Bl., Rd., Yl. Wht. 86p
6-7 B.Y.R. 75p
1·5 Green 92p
'T' 1 to 5 Bl., Yl., Rd., Wht. 93p
B9A Valve Holder 25p
RDT2 92p
RFC 5 chokes 91p
RFC 7 (19mH) 96p
1 FT 13; 14; 15; 16; 17 86p
1 FT 18/1·6 99p
1 FT 18/465 105p
TOC 1 86p
MW5FR 82p
MW/LW 5FR 102p

VEROBOARD★	0·1	0·15 (copper clad)	0·15 (plain)
2½ × 3¾	46p	39p	24p
2½ × 5	55p	50p	31p
3¾ × 3¾	55p	50p	—
3¾ × 5	62p	67p	43p
2½ × 17	169p	135p	92p
3¾ × 17	218p	180p	120p
4¾ × 17	280p	—	183p
Pkt of 35 pins			30p
Spot face cutter			85p
Pin insertion tool			120p

DIODES

AA119	25
AA129	20
BA100	10
BY126	12
BY127	12
CRO33★	148
OA9	75
OA47	12
OA70	12
OA79	15
OA81	15
OA85	14
OA90	7
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2★	5
IN4003★	6
IN4004/5★	6
IN4006/7★	7
IN4148	4
IS44	20
3A/100V★	18
3A/400V★	20
3A/600V★	27
3A/1000V★	30
6A/600V	65

ZENERS
Range 2V7 to 39V 400mW 9p each
Range 3V3 to 33V, 1·3W 15p each

NOISE
25J 160

★BRIDGE RECTIFIERS (plastic case)

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/100V	72
4A/200V	75
4A/400V	79
4A/600V	105
4A/800V	120
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	40

SCRs★ Thyristors

0·6A/200V	30p
0·8A/100V	30p
0·8A/200A	35p
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A500V	58
8A600V	85
12A300V	59
12A500V	92
15A/700V	195p
2N444	140p
BT106	150
C106D	38
TIC44	25
TIC45	45

TRIACS★

3A100V	48
3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
12A800V	130p
16A100V	95
16A500V	150
25A800V	295
25A1000V	480p
40669	120

DIAC★
ST2 25

TTL 74★								LINEAR IC's			
		7494	78	74193	98	4056	134			MC1488★	85
7400	11	7495	65	74194	98	4059	480	702	75	MC1489★	90
7401	11	7496	57	74195	98	4060	115	709C 14 pin	35	MC1495★	350
7402	11	7497	189	74196	93	4061	1425	710★	67	MC1496	92
7403	12	74100	119	74197	80	4062	999	723★	38	MC1710	79
7404	12	74105	62	74198	150	4063	110	733★	125	MC3340P★	120
7405	18	74107	29	75150	175	4066	58	741C★ 8 pin	18	MC3360P	120
7406	28	74109	54	75491	92	4067	380	747C★	78	MC3401	52
7407	38	74110	54	75492	92	4068	22	748C★	36	MC3403★	135
7408	17	74111	68			4069BE	20	753	150	MFC6040★	97
7409	17	74112	125	CMOS★		4070	32	810	159	MK50362★	650
7410	11	74116	198	4000	13	4071	21	8038CC★	340	MK50398★	635
7411	20	74118	83	4001	13	4072	21	AY-1-0212	580	MM2102-2★	170
7412	17	74119	149	4002	15	4073	21	AY-1-1313	660	MM2112-2N★	250
7413	30	74120	115	4006	87	0475	23	AY-1-1320	315	MM5303★	635
7414	45	74121	25	4007	18	4076	85	AY-1-5050	190	MM57160★	620
7416	30	74122	46	4008	82	4077	40	AY-1-5051	145	NE555★	22
7417	30	74123	48	4009	38	4078	21	AY-1-6721/6	195	NE556DB★	60
7420	16	74125	38	4010	38	4081	20	AY-3-8500★	390	NE560★	325
7421	29	74126	57	4011	18	4082	21	AY-5-1224A★	260	NE561★	395
7422	17	74128	74	4012	18	4085	74	AY-5-1230★	450	NE562★	410
7423	27	74132	73	4013	45	4086	73	CA3011★	82	NE564★	425
7425	27	74136	65	4014	80	4089	150	CA3018★	68	NE565A★	120
7426	36	74141	56	4015	82	4093	85	CA3020	170	NE566★	160
7427	27	74142	209	4016	45	4094	190	CA3023	170	NE567★	170
7428	35	74143	314	4017	82	4095	105	CA3028A★	80	NE571★	420
7430	17	74144	314	4018	87	4096	105	CA3035	240	RAM2102-2★	170
7432	25	74145	65	4019	48	4097	372	CA3043	190	RC4136D★	120
7433	40	74147	175	4020	99	4098	110	CA3046	71	ROM2513★	650
7437	30	74148	109	4021	95	4099	145	CA3048	210	SAD1024★	1350
7438	33	74150	99	4022	85	4160	109	CA3080E★	80	SFF96364E★	1150
7440	15	74151	64	4023	22	4161	109	CA3081	190	SG3402	295
7441	74	74153	64	4024	66	4162	109	CA3805★	85	SN76003N	170
7442	68	74154	96	4025	19	4163	109	CA3089E	210	SN76013N	140
7443	115	74155	52	4026	180	4174	110	CA3090AQ	398	SN6023N	140
7444	112	74156	80	4027	45	4175	99	CA3123E	200	SN76033N	175
7445	94	74157	67	4028	81	4194	108	CA3130★	85	SN76115N	215
7446	94	74159	185	4029	99	4408	720	CA3140★	70	SN76227	115
7447	57	74160	82	4030	58	4409	720	ICL7106E★	795	SN76477★	225
7448	51	74161	92	4031	205	4410	720	ICL7107★	975	TAA621AX1	250
7450	17	74162	92	4032	100	4411	958	ICM7205★	1159	TAA960	300
7451	17	74163	92	4033	145	4412V	1380	ICM7217A★	790	TBA120S	70
7453	17	74164	105	4034	116	4415F	795	ICM7555★	89	TBA641BX11	250
7454	17	74165	105	4035	111	4415V	795	LD130★	452	TBA651	180
7460	17	74166	140	4036	325	4419	280	LM300H★	170	TBA800	90
7470	28	74167	200	4037	100	4422	545	LM301A★	30	TBA810S	95
7472	25	74170	185	4038	108	4433	995	LM308	110	TBA820	70
7473	32	74172	625	4039	320	4435	825	LM318★	195	TBA920	260
7474	25	74173	120	4040	105	4440	1275	LM324★	68	TCA270	220
7475	38	74174	87	4041	80	4450	295	LM339★	70	TDA1004★	290
7476	36	74175	87	4042	75	4451	295	LM348★	90	TDA1008★	310
7480	48	74176	75	4043	94	4490F	695	LM379★	375	TDA1022★	575
7481	86	74177	78	4044	95	4490V	525	LM380	80	TDA2020	320
7482	69	74178	153	4045	145	4501	19	LM381	145	TL061CP★	76
7483	72	74180	85	4046	128	4502	120	LM381AN	248	TL072★	125
7484	95	74181	165	4047	87	4503	69	LM382	125	TL081CP★	52
7485	75	74182	88	4048	58	4506	51	LM1458★	50	TL082CP★	96
7486	31	74184	135	4049	48	4507	55	LM3900★	60	TL083★	105
7489	140	74185	135	4050	48	4508	298	LM3909N★	70	TL084CP★	130
7490	30	74188	275	4051	72	4510	99	LM3911★	125	UAA170	198
7491	75	74190	95	4052	72	4511	150	M253AA★	795	ZN414	90
7492	38	74191	95	4053	72	4512	98	MC1304P	260	ZN424	135
7493	32	74192	98	4054	110	4520	108	MC1310	149	ZN425E★	415
				4055	123			MC1312P	195	ZN1034★	200

TRANSISTORS

AC117★	35	BC169C	12	BF181★	35	OC25★	170	TIS91	24	2N3135	33
AC125★	20	BC170	18	BF182★	35	OC26★	170	ZTX107	12	2N3250	30
AC126★	20	BC171	11	BF183★	35	OC28★	150	ZTX108	12	2N3442★	140
AC127★	20	BC172	11	BF184★	38	OC29★	160	ZTX109	14	2N3563	20
AC128★	20	BC177★	18	BF194	12	OC35★	130	ZTX300	13	2N3614★	199
AC141★	24	BC178★	16	BF195	12	OC36★	130	ZTX301	15	2N3615★	199
AC141K★	38	BC179★	18	BF196	12	OC41★	48	ZTX302	20	2N3663	26
AC142★	24	BC182	9	BF197	14	OC42★	48	ZTX303	25	2N3702	11
AC142K★	38	BC182L	11	BF198	18	OC43★	55	ZTX304	24	2N3703	11
AC176★	24	BC183	9	BF200★	30	OC44★	31	ZTX311	17	2N3704	11
AC187★	24	BC183L	11	BF224A	18	OC45★	28	ZTX314	24	2N3705	11
AC188★	24	BC184	9	BF244	30	OC46★	28	ZTX326	40	2N3706	11
ACY17★	35	BC184L	11	BF256★	60	OC70★	28	ZTX341	20	2N3707	11
ACY18★	40	BC186	21	BF257★	30	OC71★	28	ZTX500	15	2N3708	11
ACY19★	40	BC187★	28	BF258★	30	OC72★	42	ZTX501	15	2N3709	11
ACY20★	40	BC212	10	BF259★	30	OC76★	36	ZTX502	19	2N3710	18
ACY21★	35	BC212L	11	BF394	27	OC77★	76	ZTX503	15	2N3711	12
ACY22★	40	BC213	10	BF594	40	OC79★	76	ZTX504	25	2N3713★	215
ACY28★	40	BC213L	12	BF595	38	OC81★	50	ZTX531	25	2N3715★	250
ACY39★	78	BC214	10	BFR39	25	OC82★	50	ZTX550	25	2N3771★	233
ACY40★	48	BC214L	13	BFR40	28	OC83★	48	2N526★	58	2N3772★	195
ACY44	39	BC307B	20	BFR41	28	OC84★	44	2N696★	36	2N3773★	288
AD140★	70	BC308	20	BFR79	28	OC122★	75	2N697★	25	2N3819	22
AD149★	70	BC328	15	BFR80	28	OC123★	75	2N698★	44	2N3820	45
AD161★	42	BC338	12	BFR81	28	OC139★	110	2N699★	54	2N3882★	130
AD162★	42	BC441★	36	BFX29★	28	OC140★	110	2N706A★	19	2N3823★	95
AF114★	40	BC461★	36	BFX81★	45	OC141★	110	2N707★	39	2N3824★	70
AF115★	40	BC477★	25	BFX84★	26	OC170★	85	2N708★	19	2N3866★	90
AF116★	40	BC547	12	BFX85★	28	OC171★	75	2N914★	32	2N3903	20
AF117★	40	BC548	12	BFX86★	28	OC201★	75	2N916★	27	2N3904	18
AF118★	65	BC549	13	BFX87★	28	OC202★	95	2N918★	40	2N3905	18
AF121★	48	BC557	15	BFX88★	28	OC203★	85	2N920★	51	2N3906	17
AF124★	55	BC558	20	BFY18★	50	OC204★	85	2N930★	18	2N4037★	52
AF125★	35	BC559	20	BFY50★	20	TIP29	43	2N961★	61	2N4058	17
AF127★	35	BCY30★	57	BFY51★	20	TIP29A	44	2N1131★	22	2N4061	17
AF139★	35	BCY34★	75	BFY52★	20	TIP29C	60	2N1132★	22	2N4064★	120
AF178★	70	BCY39★	80	BFY71★	20	TIP30	47	2N1302★	35	2N4236★	145
AF180★	70	BCY40★	78	BRY39★	39	TIP30A	50	2N1303★	50	2N4289	20
AF186★	50	BCY43	85	BSX20★	18	TIP30B	64	2N1304★	50	2N4859	65
AF239★	42	BCY58★	90	BSY65★	30	TIP30C	65	2N1305★	28	2N5135	42
ASY26★	40	BCY59★	90	BSY95A★	18	TIP31★	50	2N1306★	35	2N5136	42
ASY27★	45	BCY70★	18	BU105	140	TIP31A★	52	2N1307★	50	2N5138	20
BC107★	9	BCY71★	20	BU205★	190	TIP31B★	58	2N1308★	46	2N5179★	60
BC107B★	10	BCY72★	20	BU208★	225	TIP31C★	66	2N1613★	23	2N5180★	80
BC108★	9	BCY78★	25	MD8001★	158	TIP32★	55	2N1671B★	215	2N5191★	70
BC108B★	10	BD115★	65	ME4102	10	TIP32A★	58	2N2160★	350	2N5305★	40
BC108C★	12	BD121★	95	ME6002	10	TIP32B★	70	2N2217★	43	2N5457	32
BC109★	9	BD123★	98	MJ400★	90	TIP32C★	75	2N2218A★	34	2N5458	32
BC109B★	12	BD124★	115	MJ491	160	TIP33★	80	2N2219A★	22	2N5459	32
BC109C★	12	BD131★	45	MJ2955★	120	TIP33A★	85	2N2220A★	25	2N5485	35
BC113	20	BD132★	45	MJE340★	54	TIP33B★	100	2N2221★	23	2N5777★	45
BC114	20	BD133★	43	MJE370★	58	TIP33C★	105	2N2222★	20	2N6027	40
BC115	20	BD135★	38	MJE371★	60	TIP34★	85	2N2303★	45	3N128★	112
BC116	20	BD136★	37	MJE520★	65	TIP34A★	85	2N2368★	21	3N140★	112
BC117	20	BD137★	38	MJE521★	74	TIP34B★	110	2N2369★	15	40311★	60
BC118	20	BD138★	50	MJE2955★	99	TIP34C★	110	2N2476★	125	40313★	125
BC119★	28	BD139★	40	MJE3055★	70	TIP35★	179	2N2483★	28	40316★	86
BC134	20	BD140★	36	MPF102	66	TIP35A★	185	2N2484★	25	40317★	52
BC135	20	BD142★	59	MPF103	36	TIP35C★	220	2N2646★	48	40324★	85
BC136	18	BD145★	198	MPF104	36	TIP36A★	220	2N2784★	55	40326★	52
BC137	20	BD222★	75	MPF105	40	TIP36C★	255	2N2894★	30	40327★	62
BC140★	38	BD659A★	65	MPF106	40	TIP41A★	63	2N2904A★	22	40348★	105
BC142★	30	BD696A★	65	MPF107	50	TIP41B★	73	2N2905A★	22	40360★	43
BC143★	30	BDY17★	195	MPSA05★	25	TIP42A★	72	2N2906★	22	40361★	45
BC147	8	BDY60★	110	MPSA06★	25	TIP42B★	82	2N2907A★	22	40407★	52
BC148	8	BDY61★	165	MPSA12	42	TIP2955★	65	2N2926G	10	40411★	295
BC149	8	BF115★	34	MPSA55	25	TIP3055★	65	2N2926R	8	40412★	65
BC153	27	BF154★	25	MPSA56	25	TIS43	34	2N2926Y	8	40467★	95
BC154	27	BF156★	29	MPSA70	34	TIS44	45	2N3011★	24	40576★	190
BC157	10	BF167	30	MPSU02★	58	TIS46	45	2N3053★	20	40594★	90
BC158	11	BF173★	25	MPSU05	50	TIS50	47	2N3054★	55	40673★	68
BC159	11	BF177★	24	MPSU06	56	TIS60	50	2N3055★	48	Matched pair	
BC160	42	BF178★	25	MPSU52★	65	TIS62	52	2N3108	32	add 20p	
BC167A	11	BF179★	30	MPSU55★	55	TIS74	47	2N3121	40	per pair	
BC168C	12	BF180★	35	MPSU56★	60	TIS90	20	2N3133	43		
				MPU131★	39						

Tantrum

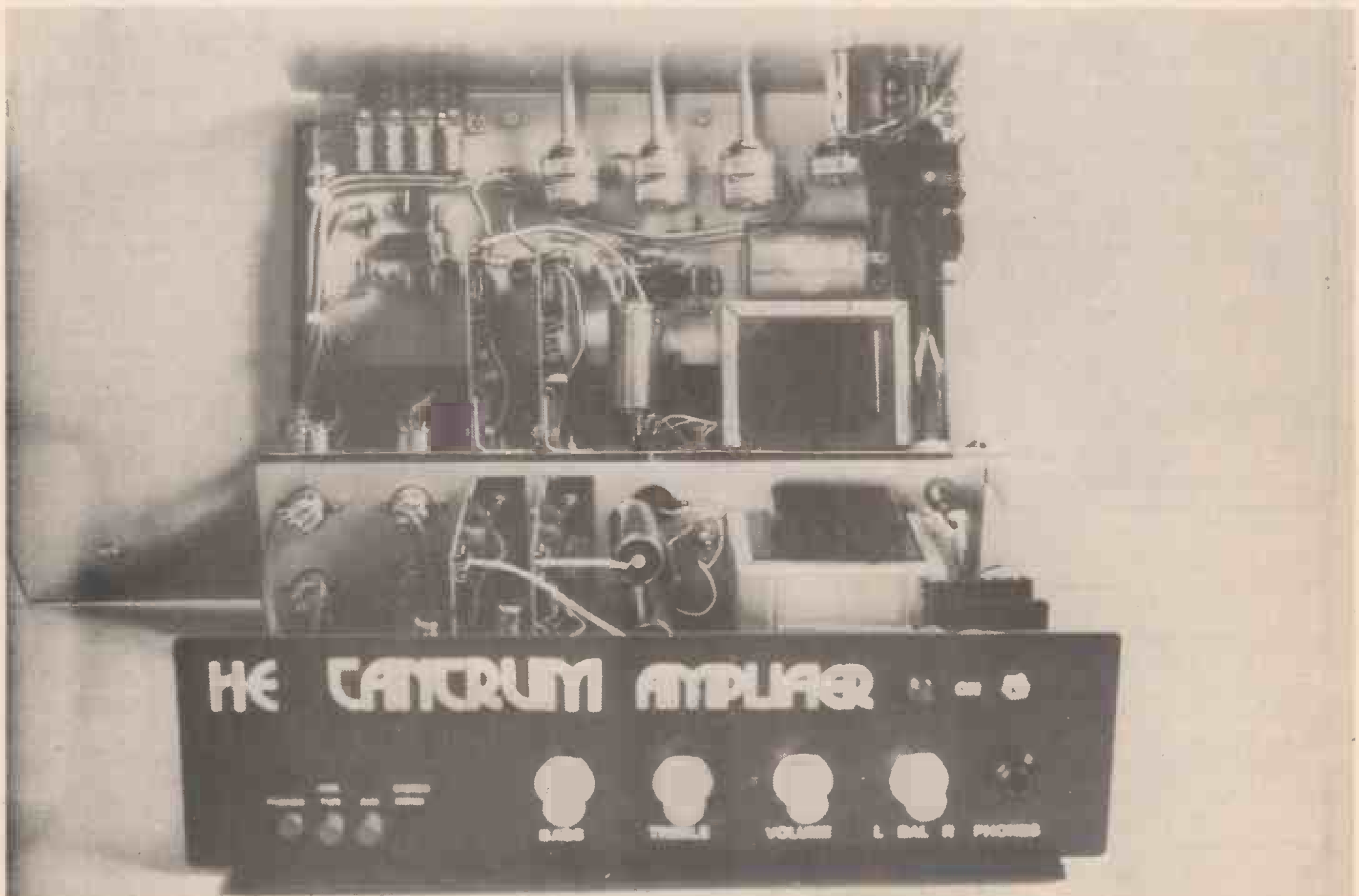
We've had a few mumbles and grumbles concerning the lack of audio projects in recent issues. Nuff said — up come the project boys with a first rate 25 watt stereo amplifier.

AMPLIFIER CONSTRUCTION Is full of such heart-breaking terms as: — mains hum, earth loops, harmonic distortion, low signal to noise ratio etc., etc. ad nauseam. Mention any of these terms to a professional (let alone an amateur) audio engineer and you will see him turn a deep yellow colour and cower into a corner whimpering to himself or take a long, long holiday. Incidentally, this is the sort of thing which happens in our projects lab 3 or 4 times a week, hence the name of this project — TANTRUM.

Amplifier design has been known to push many a good audio engineer over the top and turn to digital circuits (the easy way out). However, we at HE have faced up to the subject with a great deal of trepidation, hard work and dutch courage and finally have the solution.

The HE TANTRUM is a stereo amplifier using good design and construction techniques which upon completion will reward the builder with a 25 watt stereo amplifier with a signal/noise ratio of over 70 dB, negligible mains hum (due to the special construction techniques) and distortion of less than 0.1% (the human ear can't even pick that up).

Now, we don't often boast but though we say it ourselves, we have produced a printed circuit board layout for the pre-amplifier which is nothing short of superb. The distortion and noise figures for the pre-amp are remarkably low. On first sight the board might appear large but the quality obtainable using this layout far outweights the minor disadvantage of size. Besides, the use of on-board switches and pots presents an enormous reduction in interwiring (and therefore noise levels) to be achieved. It also eases cabinet construction problems.



Inside the HE Tantrum, the modular construction results in a very neat and practical design

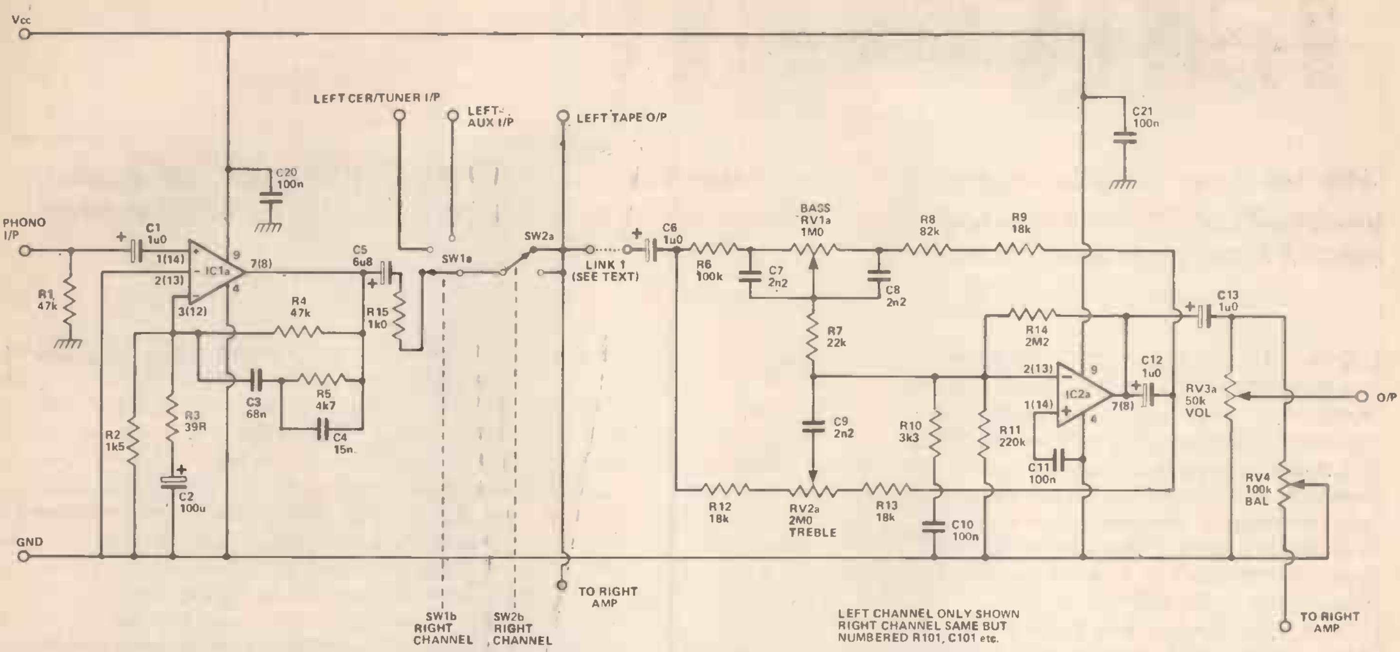


Fig. 1. Main circuit diagram for the Tantrum, only the left channel is shown

How it Works

Any audio amplifier has two basic parts to it:—the pre-amplifier and the power amplifier (three parts if the power supply is taken into account).

The pre-amplifier is a voltage amplifier dealing with low voltage inputs, for example from a magnetic phono cartridge (which produces a signal of about 5 mV). The output from the pre-amp is normally set at a few hundred millivolts, enough to drive the power amp. Tone controls and volume are normally provided in this section.

The power amp is a current and voltage amplifier, to provide the power to drive the speaker. Because the power amps in TANTRUM are modular and are bought complete and tested there is little need for circuit explanation.

The design of the pre-amp is centred around two LM 381 dual, high quality op amps. IC 1 is used as a RIAA equalisation amplifier. This is necessary when using a magnetic phono cartridge, as certain frequencies are emphasized on the recording of a record and consequently need to be de-emphasized on playback, hence the term equalise.

The second LM 380 is used for tone control, the controls being in the standard Baxendall type circuit.

The RIAA equalization is provided for in the feed-back loop of IC1, likewise the bass and treble controls are in the feedback Loop of IC2. Equalization and tone control can be obtained using passive resistors and capacitors, but significant noise is introduced, due to voltages across these components. Theoretically, an op amp produces no current flow through the components in its feedback loop. These 'active' components produce much less noise than any type of corresponding passive circuit.

We looked around and sampled power amplifiers which might fulfill 3 criteria:—

1) ease of use
2) adequate power levels
3) low noise and distortion figures

Integrated circuit amplifiers tend to have high distortion figures, while discrete components (transistors, etc.) amps can get very involved and are more often than not troublesome to build — and so, for these reasons we decided on the use of purpose built amplifier modules which are obtainable ready built to high specifications. A great many such amps were discussed and researched until a suitable one was found. The chosen one is the AL 60, available form BI-PAK (See Buy-lines).

This is a power amplifier of very respectable quality which, with only one extra capacitor and a power supply will provide up to 25 watts RMS of power. The distortion and noise figures for the modules are low and, when connected, give a very acceptable sound output.

As an added extra to TANTRUM we have included links 1 and 2 in the PCB so that a remote volume control along ultrasonic principles can be used. This is planned for a future issue of HE, until then insert links 1 and 2.

CONSTRUCTION

The pre-amplifier should be constructed first. Do this very carefully. Make sure you have the correct sized

Parts List

RESISTORS (All ¼W, 5%)	
R1, 4, 101, 104	47K
R2, 102	1K5
R3, 103	39R
R5, 105	4K7
R6, 106, 108	100K
R7, 107	22K
R8	82K
R9, 12, 13, 112, 113	18K
R10, 110	3K3
R11, 111	220K
R14, 114	2M2
R201	6K8
R301, 302	270R
POTENTIOMETERS	
RV1	1Meg Dual Lin
RV2	2Meg Dual Lin
RV3	50K Dual Log
RV4	100K Single Lin
CAPACITORS	
C1, 12, 13, 101	1u0 Tant 25 V
C6, 106, 112, 113	1u0 Elect 63 V
C2, 102	100u Tant 25 V
C3, 103	68n Polyester
C4, 104	15n Polyester
C5, 105	6u8 Tant 25 V
C7, 8, 9, 107, 108, 109	2n2 Polystyrene
C10, 11, 20, 21, 110, 111	100n Polyester
C201	4700u Elect 63 V
C202	10u Elect 40 V
C203	22u Elect 40 V
C301, 302	To suit speakers used
SEMICONDUCTORS	
IC1, 2	LM 381
BR 201	2 Amp 100 V Bridge Rectifier
Q201	BD 131
D201	33 V Zener Diode
MISCELLANEOUS	
SW1, 2	Push Button Signal Switches (DPDT) with mounting bracket
SW3	DPST Mains Toggle
Neon	
FS201	1.5A Fuse + Chassis Holder
FS202, 203	750 mA Fuse + PCB mounting holder
T201	Mains/30 V 50 VA Transformer

2 x Power Amp Modules (see Buylines)
Case to suite
Approximate cost £35.00.

Buylines

All parts for the pre-amplifier, power supply and ancilliary hardware should be readily available at any reasonable component stockist. The power amplifier modules, the AL 60's are distributed solely by Bi-Pak, The Maltings, 63A High Street, Ware, Hertfordshire, who for a limited period are offering the modules to Hobby TANTRUM constructors for the greatly reduced price of £4.85 VAT inclusive. A pleasing gesture.

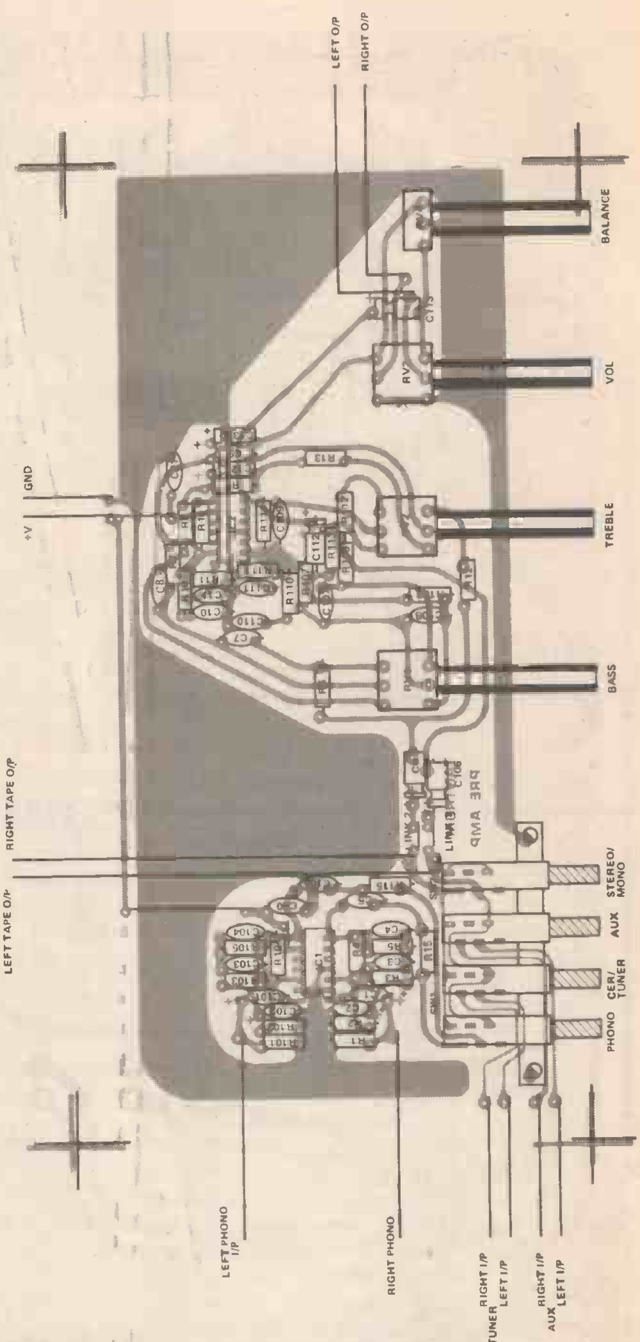
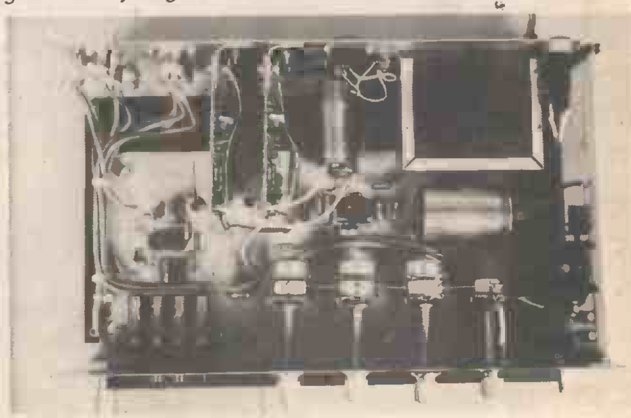


Fig. 2. Overlay diagram for Tantrums main board.



The two power amplifier modules (upper) can be seen mounted onto the rear of the case

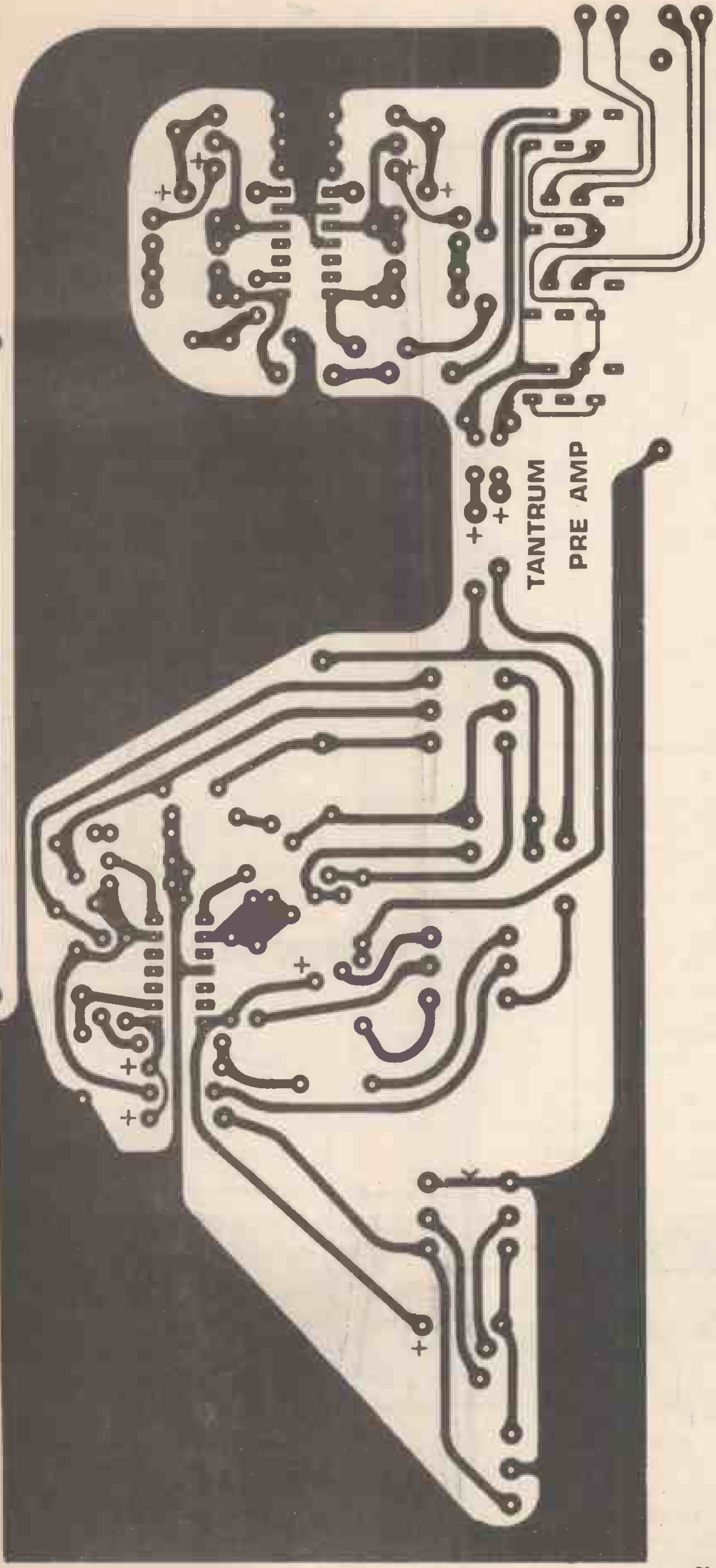


Fig. 3. PCB foil pattern for the main board.

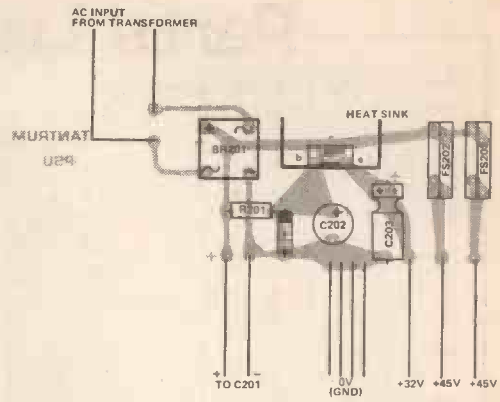


Fig. 4. Overlay diagram for Tantrums PSU.

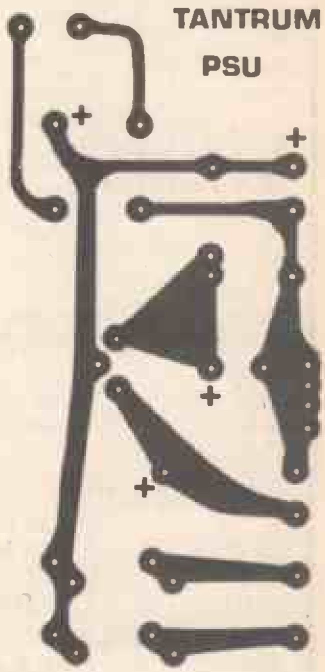
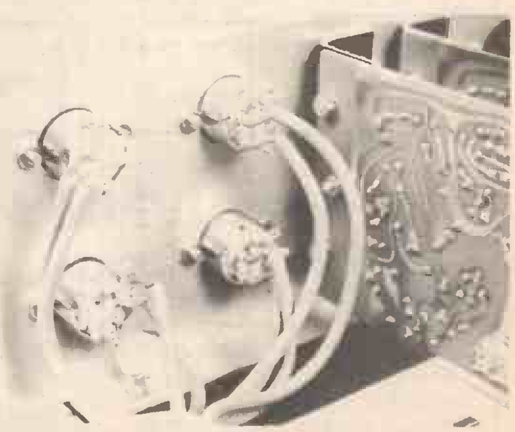


Fig. 5. PCB foil pattern for the PSU module.



Close-up of the connections to the input sockets, note the use of screened lead

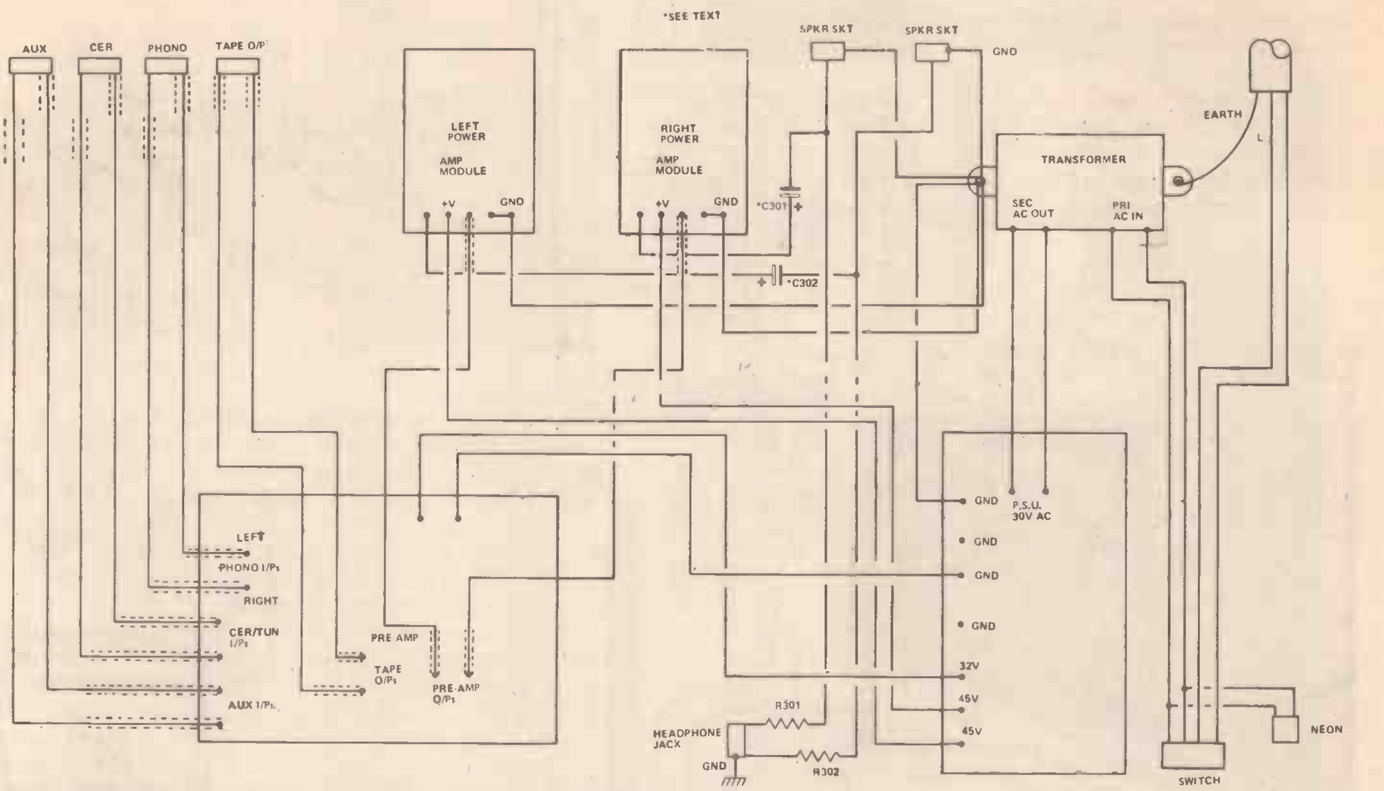


Fig. 6. Interwiring diagram for the pre-amp, PSU and power amplifier modules

FS2 and FS3, clipped into PCB fasteners which make a nice neat job, are necessary to protect the amplifiers in the case of overload.

C201 is mounted separate to the power supply board and hard-wired into circuit. This is best left until final assembly.

push button switches for SW1 and SW2 as sizes vary slightly from manufacturer to manufacturer. The on-board pots can be of the PCB type, or you can simply drill larger than average holes (1.5mm) and insert ordinary potentiometers (as we did with our prototype). To do this the tags have to be bent carefully through 90 degrees and then shaped using pliers to fit through the PCB holes. This is a smiple job and provides a suitable alternative to obtaining the more expensive, difficult to obtain PCB pots. The bodies of the pots should be all connected to earth via a length of single strand wire to provide screening.

Construct the power supply next — being careful that the bridge rectifier and the transistor are inserted correctly. Note the polarity of the zener diode. The heatsink should be attached to the transistor with a nut and bolt, smearing the connecting surfaces with heat-sink compound (this helps to dissipate heat) before

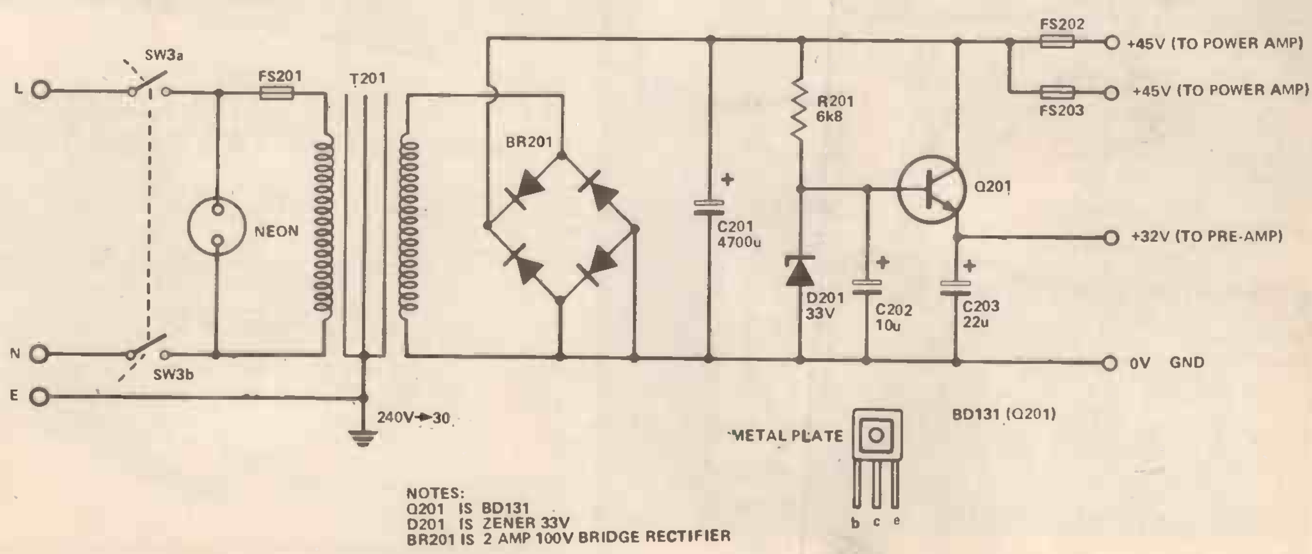


Fig. 7. Circuit diagram for the PSU for Tantrum.

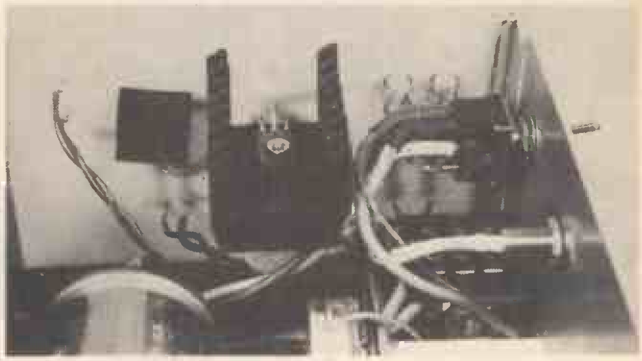
fastening together. Make sure the metal heatsink is not touching anything else metallic as a short circuit could result.

Note in the interwiring diagram the use of a single point earth for the power amplifiers, taken to a convenient point on the chassis (we used a transformer mounting bolt) close to the power amps. The earth return from the speakers also goes to this point. This single point earth system is used in audio equipment to minimise the effects of the high currents flowing through the leads, on the pre-amplifier.

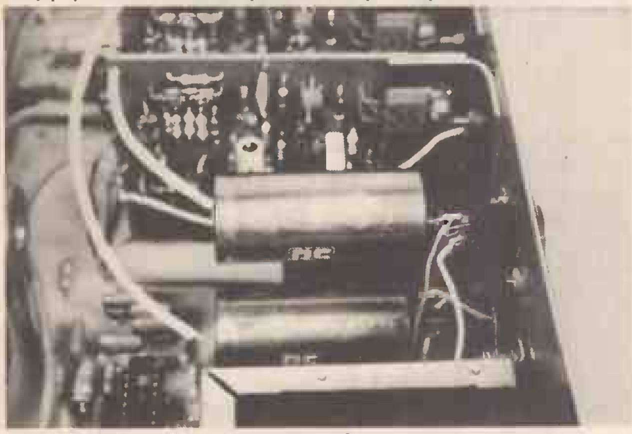
Follow the inter-wiring diagram when connecting the modules. Use if possible a length of ribbon cable, colour coding each strand. This can only be used for power supply connections, power amp outputs and the leads from the speaker DIN socket to the headphone jack. Any low level signal leads ie pre-amp I/P and O/P leads need to be screened low loss cable.

Finally, R301 and 302 are hard-wired in series with the left and right headphone outputs (taken from the speaker DIN sockets). These cut the power down to a reasonable level for headphones.

Full connecting instructions are supplied with the Bi-Pak modules. A capacitor has to be connected between power amp O/P and speaker DIN socket. The value of this capacitor depends upon the impedence of the speakers to be used although incorrect values will only affect the bass response of the amplifier. According to Bi-Pak information the values of C301 and C302 are 1000 uF when using 3-4 ohm speakers, 470 uF for 8 ohm speakers and 220 uF for 16 ohm.



Close-up of the PSU module, note the heat-sink on the regulator



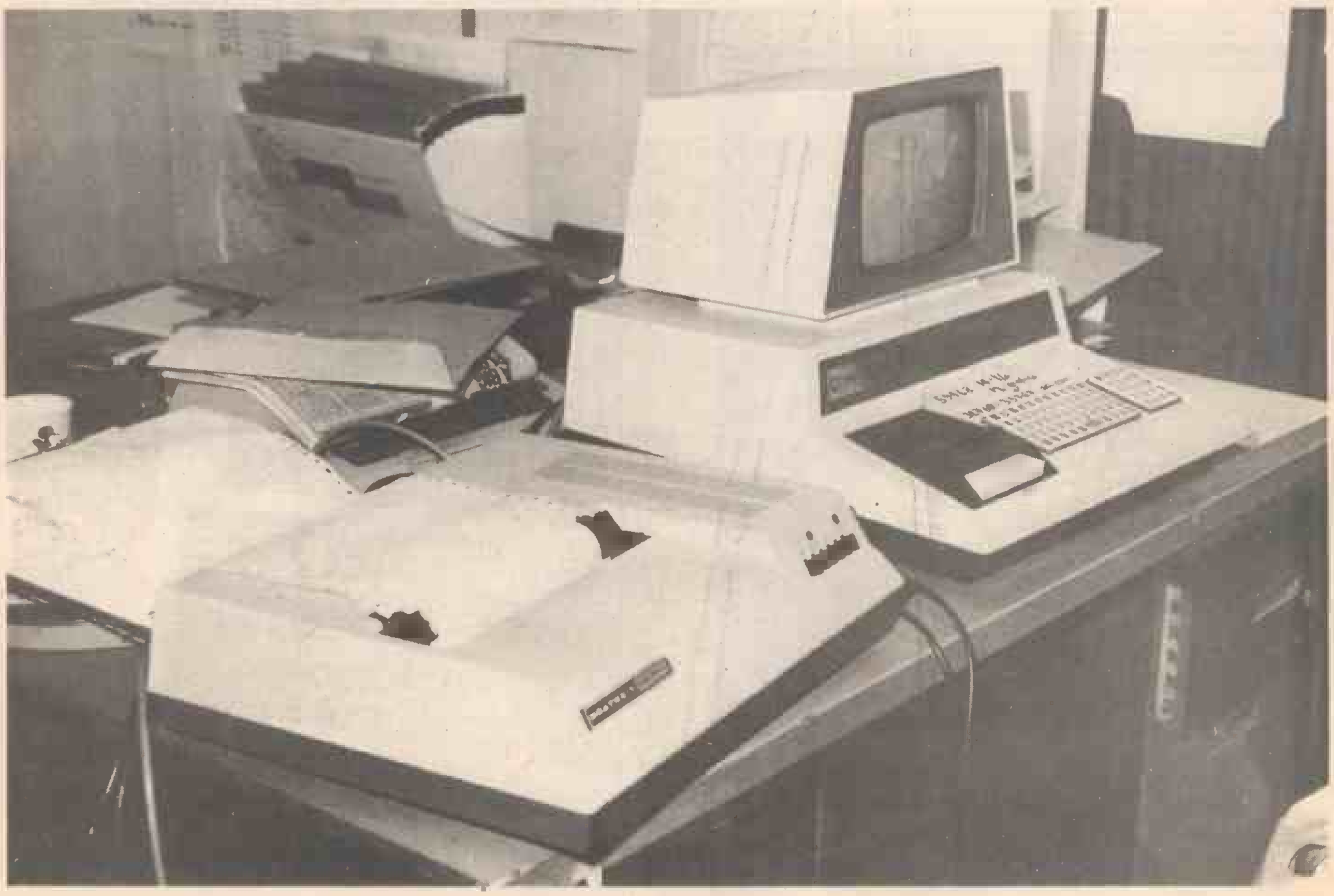
Close up of the power amp mounting.

Home Computing

The advent of the microprocessor has brought computer technology into the home, yet the subject remains shrouded in mystery. Peter Howells attempts to explain some of the basics.

HAVING TAKEN LEAVE OF MY SENSES for long enough to agree to write this article, and having subsequently found that there was no way out, I tried to ask myself the question, 'What makes a Home Computer different to any other computer?' The only answer that appeared was 'Nothing.' A Home Computer, it seemed to me, only became such because lots of people have them at home. Is this a fair picture? The answer, based on a wide experience of The Way Things Are in the World, is immediately obvious, and no. Most 'Home Computers' are bought and used by schools, colleges and businesses.

The term 'Home Computer' is a misnomer, the only real justification for it being that the machines are now small enough, light enough, sturdy enough and cheap enough for people to own and use them at home. Anyhow, having got your computer home, the next question to come up is what does one do with it? The



A complete, if rather tatty, computer system based on the Commodore PET. The PET consists of MPU, memory (with BASIC interpreter in ROM), keyboard, cassette drive and VDU. Also in the picture is a printer so that a permanent record may be kept of output. A setup like this can handle most requirements.

answer is 'Anything you want.' Computers can, and have been, put to many varied uses. There is no reason why yours should not also do these things. All that needs to be done is for the necessary hardware to be hooked on and the right program loaded. And here comes the crunch; hardware tends to get expensive and programs tend to get complicated. Hardware is the mechanical end of the computing business; it refers to all the physical bits and pieces without which the computer becomes deaf, dumb and blind; keyboards, printers, TV displays, disc and cassette drives and all that. The programs, also known as 'software', are the sets of instructions which guide the computer as to how to use the hardware; when to 'listen' to the cassette, what to do about what it 'hears', and what to 'say' about what has been heard and done, say on a printer.

Neither of these aspects of computing can function without the other, and both become very closely interrelated. Both are, however, very different beasts and should, initially, be looked at separately.

HARDWARE

The heart of the small computer is the microprocessor unit (MPU). This can perform basic mathematical and logical functions on data. The data appears in the form of electrical signals representing strings of binary digits (Bits). The bits are usually arranged in sets of eight, known as a byte. The MPU must also have some form of input in order to select which of its repertoire of functions to perform on the data. This, too, is of the form of electrical signals representing bits. The mathematical

A drive for floppy discs. The magnetic disc has the advantage over tape of being much faster in use and has a much larger capacity. The unit above can take up to two discs — a most useful feature as data could be input from one, processed, and the output recorded on the other.

functions, performed in binary arithmetic, are very basic: add and subtract. Multiplication and division are

This counter is instrumental in the decision making ability of the computer. Having ascertained that a certain state of affairs exists, it may become necessary for a different course of action to be followed. The counter thus becomes reset, according to the instructions, to point to a set of instructions that deal with the situation. This is the 'jump if' type of instruction, and is what allows the computer to become rather more than a pocket calculator.

If I leave the impression that each function is pretty straightforward I am wrong. The steps within even a binary addition, to say nothing of subtraction, are numerous and convoluted: fetch the first datum, save it, fetch the second datum, add them (there are eight bits here), indicate a carry or overflow, save the answer, etc.

All the data and instructions that the MPU has access to must come from somewhere, and this is where memory comes into the picture. Memory can be, and usually is, pictured as rows of pigeon holes. Each one has a unique label, or address. The counter referred to usually done the hard way — repeated addition and subtraction. The logical functions are those of Boolean algebra: AND, OR, NOT etc. I don't intend to go into the intricacies of binary arithmetic or Boolean algebra as literature on the subjects is plentiful, but suffice it to say that the mathematical functions make possible the calculator aspect of a computer, and the logical ones give it the decision making capability. In addition to mathematics and logic, the MPU must be able to obtain the data and the instructions from the correct place and in the correct order, and there are a number of 'get' and 'put' functions to this effect. To get instructions in the correct order there will be a counter to record where in the memory (more on this later) the next instruction is.

earlier points to these addresses. 'Inside' each pigeon hole are to be found, in sets of eight, the electric signals that form either an instruction or a datum, and these can be extracted or replaced by the MPU. At least, sometimes they can.

Memory comes in two types: random access memory (RAM) and read only memory (ROM). RAM can be read, erased or replaced by the MPU. It is used for holding transitory data — totals that are changing, intermediate results of calculations or the program that is currently being run and which will be replaced by something different. ROM is used for storing fixed and unchanging data — this is usually a program, or sets of programs for performing standard jobs (such as calculating sines and cosines etc); the plug-in cartridges for many of the video games available usually consist of a ROM with the program for the game held on it. ROM has the advantage that the data held by it remains intact when the power goes off — the computer can come to life at the flick of a switch (not so long ago starting up a computer was a long job; having turned on the power the memory had to be loaded by hand, using sets of switches to set the state of each bit, with a short program which could then be run to load more memory with more complex programs; a process known as 'bootstrapping' as it was similar to the concept of pulling oneself up by one's bootstraps.) It is also worth mentioning EROMs, PROMs and their offspring EPROMs. The 'E' stands for erasable, and the 'P' for programable. A PROM can have data written to it and then have it frozen in place, usually by a high voltage charge. An EROM can have the data it contains erased, usually by exposure to ultra-violet light. It is not difficult to guess what you can do with an EPROM. All this means is that it is a lot easier to create a ROM without having it custom built.

Having looked at memory in general it is also worth looking at a couple of types of specific memory which figure prominently in today's small computer. One is the memory mapped VDU (Visual Display Unit) area. Here some specific hardware is used to directly translate an area of memory into a picture on a TV screen. To give an example, the PET has a section of memory, with addresses 32768 to 33767, the binary contents of which are translated into a display of 40 characters per line and 25 lines on its built-in VDU. Each byte can specify any one of 256 characters on the screen, and the section of memory consists of 1000 characters. Thus to cause any specific display to appear one is required to insert the relevant data into the memory locations corresponding to the required positions on the screen. The other is the I/O RAM type of device of which there are too many to mention. What happens here is that, in effect, a section of memory is shared by the MPU and a peripheral device such as a printer. The printer will take any data appearing at the specific address as something to be output, in this case printed as a character on paper.

Two types of communication with the outside world by the MPU have now been mentioned — through a VDU and through a printer. Both, you may have noticed, are in the same, single, direction — from the MPU to you (or whoever else may be on the receiving end). This is called Output. There are numerous other forms of output, although the most common are the direct-to-human types of printer or VDU. In theory, at least there is no reason why the output should not take any form desired. In practice only the more useful forms are employed.

Useful output is output that can be read or understood by people and/or things. It can, for instance, be a control signal to a machine or data on a punched or

Again from commodore is this printer. Printed copy does not, unlike a VDU, fade when the power is turned off, but as it needs mechanical devices to produce it, takes a lot longer to produce.

Some machines of the larger and more expensive variety. Bottom left are some disc drives which take disc packs, rather than single floppy discs, and have a staggering speed and capacity.

magnetic tape which would then be used as input to another program.

Input is the other major requirement for an operating computer system. The programs that are run and the data that is operated on have to get into memory somehow. This is most commonly done via a keyboard initially, but where large and complex amounts of data are to be transferred a more convenient medium, such as a magnetic tape or disk is used.

SOFTWARE

Having glanced briefly at the hardware requirements of a computer it becomes worth looking at what keeps it working: the sets of instructions to the MPU which are called a program. When you turn on the computer and plug in the printer not a lot will happen until the MPU starts following some instructions. In a small computer there will practically always be a monitor program available in ROM, which will start to run when the power comes on. The monitor, at its most basic, will allow the user to examine and alter locations in the RAM, and thus enter a program, and then to cause the MPU to jump from the sequece of instructions of the monitor to the user's own program. At this level input would probably be via a small keypad and output to a calculator display. A more complex monitor program would accept input from a typewriter keyboard and a cassette, and output to a memory mapped VDU.

Hexadecimal (Hex for short) is a term often heard in connection with monitor programs. It is a counting system: standard decimal arithmetic is based on a count of ten, binary on two, and hex is based on sixteen. It becomes a convenient shorthand method of representing binary — it is a lot easier to understand 6 (in decimal) as 6 (in hex) than as 110 (in binary) or 11 (decimal) as A (hex) and 1011 (binary). In hex the figures 0 to 9 represent the equivalent decimal values, and the letters A to F to represent the values ten to fifteen (when you get to sixteen you carry). When working in hex you are working in the binary code to which the MPU will respond, but made that little bit more readable.

Another program that is commonly available in ROM, but which sometimes must be loaded into RAM, by the monitor, from tape or disk, is called a BASIC interpreter. When this program is run the system will look for input data from the user. The data is entered through the keyboard and consists of instructions to the computer, but written in a way that is very much like the English language. Having typed in the program in BASIC and instructed the interpreter to get to work, it will examine each line of the program and convert this into the equivalent binary code, put it into RAM, and then execute it. It is not the program that was typed in that runs, but the interpreter as guided by the program. As it is the interpreter program that is running it is possible to have it produce messages on the spot, so a misspelt instruction is spotted immediately. To the user it appears that the program in BASIC runs directly on the computer which, in turn, comes out with helpful (sometimes) remarks.

All this takes time, particularly as sections of a program which are repeated are interpreted each time they are used and with a complex program the time taken becomes very noticeable. It is far more efficient to run a program in machine code straight from RAM. While hex is alot easier to handle than binary code, a string of hex digits is still a bit much to try to read and understand. It makes a lot of sense to use words or abbreviations to represent the instructions, and then have a computer program translate this into binary code. Such a program is called an assembler, and takes as the program written in words as input and produces the binary coded version as output. This can then be stored, and loaded into RAM by the monitor so that it can be run, at any time.

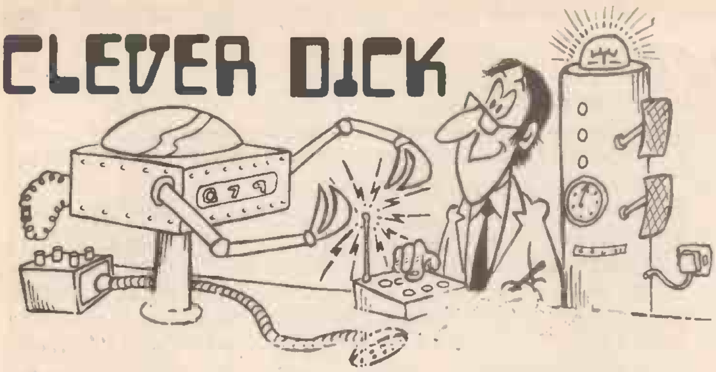
You can make life still easier for the computer user. There are programs called compilers which take a program written in a code which, like BASIC, is very much akin to English (FORTRAN, COBOL and ALGOL are but a few of many examples). As with an assembler the program code is translated into binary code which can be stored and used at any time.

And there is more to come. Research into speech recognition is very advanced, and the days of Hal, the computer in the film 2001, are approaching on schedule.

But all this doesn't tell you what to do with your computer. For myself, I'm happy to write and play games programs. The Klingons will never take me alive.

A combined VDU output and keyboard input of the type that has become very popular.

CLEVER DICK



Quite a varied postbag this month. We have had one or two letters on the article Display Techniques, concerning some of the companies mentioned. Batteries, too, seem to trouble some of our readers, find out why.

NO MESSING ABOUT this month, we've got a lot to get through. Our first enquiry comes from the Department of Physics, Pinderfields General Hospital in Wakefield. John Mason the area physicist asks:

Dear Dick,

In the article on Display Techniques (June HE) you mentioned a firm called Iltron as manufacturing a large range of fluorescent displays.

We are developing terminals for bedside use in a neurosurgical ward and are trying to incorporate a large bar-graph display, possibly including some alphanumeric information. I would be grateful if you could let me have the address of Itron and if possible any information you may have on LCD matrix displays.

Yours,
John Mason
Wakefield, West Yorks

No sooner said than done John. Itron are a Japanese company and their products are distributed by: ITT Meridian Ltd, West Road, Harlow, Essex CM20 2BT. We've been in touch with Tim Orr (the author) and he recommends a company called Hamlin for the LCD displays, they live at: Park Road, Diss, Norfolk. Hope we've been of some help.

Now for a regular request, PCBs, a lot of people seem to be afraid of making their own PCBs, not so Mr Buchan.

Dear Dick,

I am a regular reader of HE as an amateur. I have recently started a job as a mechanical draughtsman and PCB layout engineer, the latter being a new subject to me. Could you please advise me of a source of information which will help me to produce printed circuit layouts and circuit diagrams, using ICs if possible.

L. G. Buchan
Suffolk

Some people try to make out that PCB design is an art, this is just not so. It would be impossible to outline all the ins and outs in such a small space so we would recommend you try looking in our special 'Into Electronics Plus' there is a large feature on PCB manufacture and we can assure you its really very easy. We might be doing a feature in the near future covering PCB design so keep your eyes peeled for that one.

We thought we had heard the last of the White Noise Generator but this was not to be (a good project just won't lie down). Mr J. Hendry writes to us with a somewhat strange request.

Dear Dick,

I am building the White Noise unit (Hope you remember to get the PCB the right way round — Dick) as featured in the May edition of HE and would like to know whether connecting the unit to the power amplifier of my stereo record player would damage my stereo in any way. I have already built the graphic equalizer for my record player and it would be a simple case of unplugging the equalizer and plugging in the noise unit. Advice please.

J. Hendry
Montrose, Angus

It would seem from reading Hi-Fi magazines (yes we do read other people's stuff) that most manufacturers spend a large amount of time in trying to eliminate noise from their system but doubtless you have your reasons. Of course you can connect the White Noise Generator up to your stereo, you may find you will need some attenuation, try connecting a 10k pot across the output and taking the output from the wiper. Good luck (Hmmm, strange people).

Our final question comes from Richard Carsons (another clever Dick?), he has a problem with power supplies:

Dear C.D.

Why is it so many circuits require odd-voltage supplies? Cases cost more the larger they are, so with microelectronics why do we have to pay a small fortune for a case that is larger than we really need, just so there is room to take all the batteries? TTL devices, for example, often require a specific supply of 5-5½ V, but batteries come in 1½ (or multiples of) or 9 V, such as the trusty PP3. Mains supplies are not convenient if something is to be really portable.

A PP3 is a small handy battery, so is there any way that it can be used and the voltage reduced (potential divider etc. How useful are the 'hearing aid' type cells, are these 1½ V? If so, 6 of these in a clip would make a very small 9 V supply but would they have enough capacity to drive anything?

Richard Carsons
Surrey

Quite an interesting problem Richard, much of the TTL family of ICs have already been replaced with the more versatile CMOS type of IC so that particular problem should disappear before too long. In the meantime if you cannot use CMOS a small IC voltage regulator is probably the best way to derive 5 V from a 9 V battery, potential dividers tend to be less efficient. Try the 7805 or equivalent. As for hearing aid batteries they are usually only 1.1 or 1.2 V mercury or alkaline cells but can supply considerable current for long periods, trouble is they are rather expensive, you would be better off using re-chargeable Ni-Cads. We have a feature on power supplies and batteries coming up soon, you may find that helpful. See you next month.

HE Back Numbers

Shown here are all the past issues with their major features and projects. All are available (at the moment) for just 60 pence each, including post and packing. Send your order to:

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Shown next to each issue is the relevent code letter to use when ordering Hobbyprints. (See Hobbyprints ad. elsewhere in this issue.)

NOVEMBER 78 (Hobbyprint A)
Projects: Stereo Amplifier, Digital Clock, Wah-Wah Pedal, Bedside Radio.
Features: The Edison Effect, Robots, Hi-Fi Specs, Kit Review, Transducers, Metal Locators etc.

DECEMBER 78 (Hobbyprint B)
Projects: Metronome, Photon Phone, Audio Mixer, Electronic Dice.
Features: Deep Space Communications, Understanding Bias, Lasers, Photocells, Calculators, The Tesla Controversy etc.

JANUARY 79 (Hobbyprint C)
Projects: Graphic Equaliser, Touch Switch, Vari-Wiper, Flash Trigger.
Features: BASIC programming, Viewdata, Starship Daedalus, Pinball Machines, etc.

FEBRUARY 79 (Hobbyprint D)
Projects: Short Wave Radio, Sine/Square Generator, Scratch/Rumble Filter, Car Alarm Project.
Features: Video Tape Recorders, Radioactivity, CA 3130 Circuits, Computer Glossary etc.

MARCH 79 (Hobbyprint E)
Projects: Light Chaser, Tone Controller, Photographic Timer, Cassanova's Candle.
Features: TV Signals, Test Gear, SW Aerials, Interfering Waves, Communications Satellites, etc.

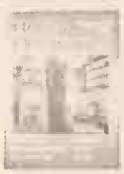
APRIL 79 (Hobbyprint F)
Projects: Model Train Controller, Cistern Alarm, Transistor Tester.
Features: The Telephone System, TV Aerials, Electronics in Warfare, Catalogue Survey etc.

MAY 79 (Hobbyprint G)
Projects: Power Supply; Parking Meter Timer, Digibell, White Noise Effects.
Features: Feedback, Electronic Music, AB Circuits, 555 Circuits, Aerial Tuners, Varicap Diodes etc.

JUNE 79 (Hobbyprint H)
Projects: GSR Monitor, Envelope Generator, Drill Speed Controller.
Features: Citizen Banned, Display Techniques, Moving Coil Meter, Electronics in Music Pt 2, etc.

JULY 79 (Hobbyprint I)
Projects: Shark, Baby Alarm, Point Controller, Linear Scale Ohmeter.
Features: Cassette Decks and Tapes, Binary Numbers, Fixed Resistors, Short Circuits Special, etc.

AUGUST 79 (Hobbyprint J)
Projects: Home Security System, LED Tachometer, Injector/Tracer, Constant Volume Amplifier.
Features: Security Installation, Variable Resistors, Tools, Satellite Power etc.



SEPTEMBER 79 (Hobbyprint K)
Projects: Combination lock, Light dimmer, Starburst, Ultrasonic Switch.
Features: Electronic Timekeeping, Thyristors, Radio Control, FET Special.

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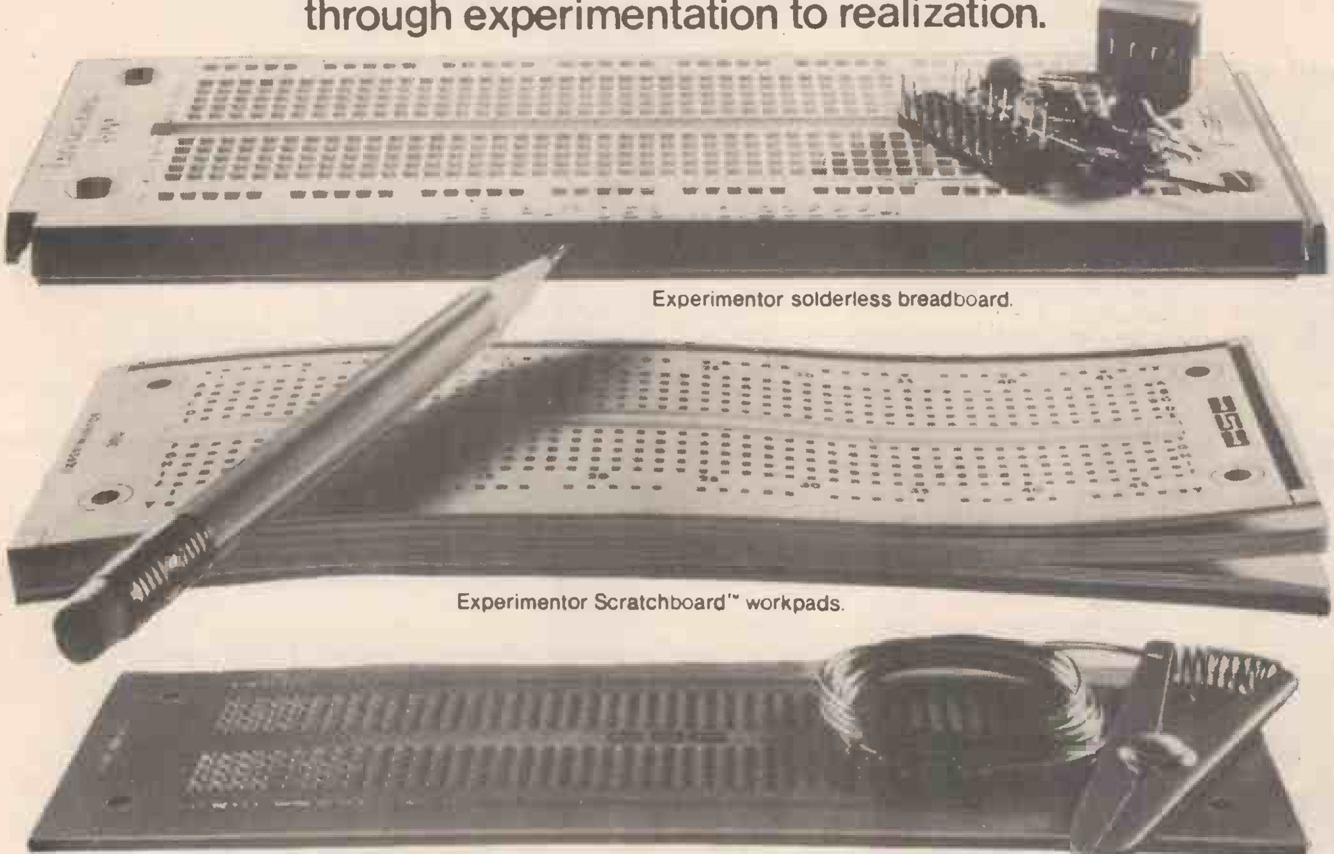

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Hobbytune

Build a full feature monophonic organ for less than ten pounds

HOBBYTUNE IS A SELF-CONTAINED, battery-powered stylus organ with a number of novel features. You can select between four independent voices, use them all at once or in combinations for a full chorus sound. Vibrato is available and the depth of modulation is fully adjustable enabling effects from a gentle 'harmonica' beat to a modern synthesizer sound to be produced.

A twenty note keyboard was chosen as the best compromise between economy and performance. This gives a scale in the key of 'C' ranging between 'G' and 'D' including sharps and flats; the 'black' notes. Though only an octave with a fourth below and a tone above, the range of the instrument can be extended by judicious use of the stops as square and triangle outputs are available both at the fundamental pitch and an octave below.

The vibrato frequency is fixed, though it is very easy to change if required by selection of three capacitors. Though designed for use with its built-in amplifier and loudspeaker, Hobbytune can be easily modified to plug into your home stereo amp by taking an output from the slider of the volume control. Also the keyboard can be extended to any desired size by addition of further tuning resistor networks. As each note can be individually adjusted the instrument can be tuned very accurately avoiding the generation of unwanted 'blue' notes. The unmodified instrument, built as described here proved to be very popular in the office and the tone was very pleasant with more than adequate volume.

The Hobbytune awaiting a guiding hand, note the use of an old jack-plug for the stylus

Fig. 1. Circuit diagram for the HE Hobbytune

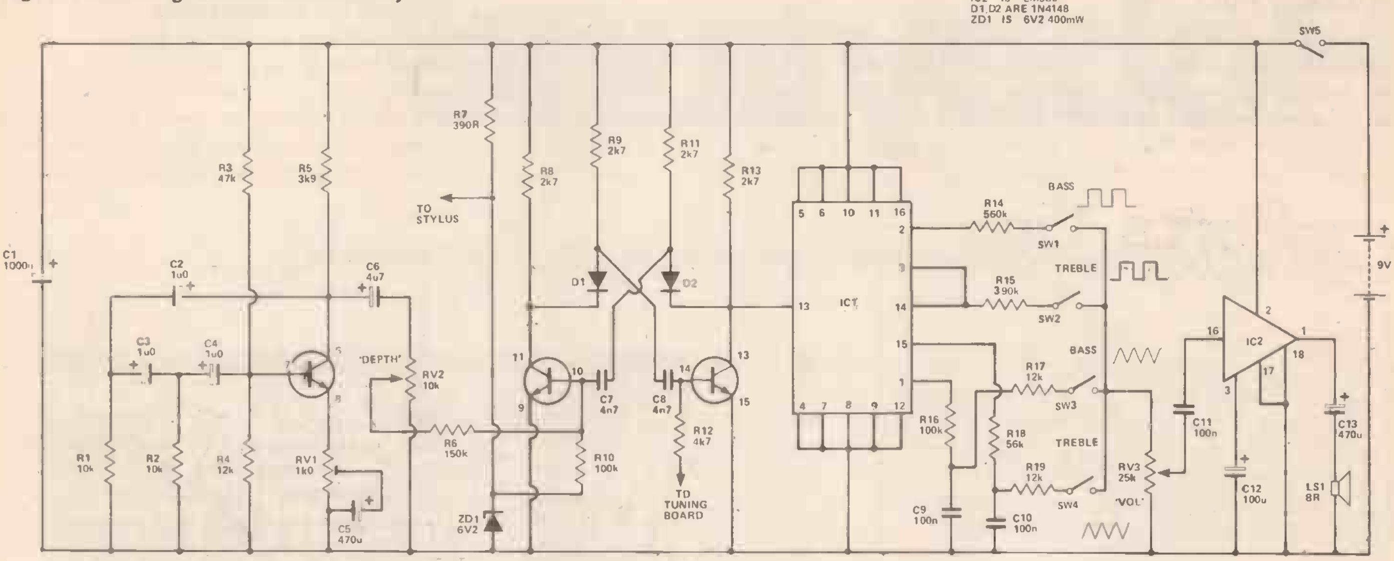
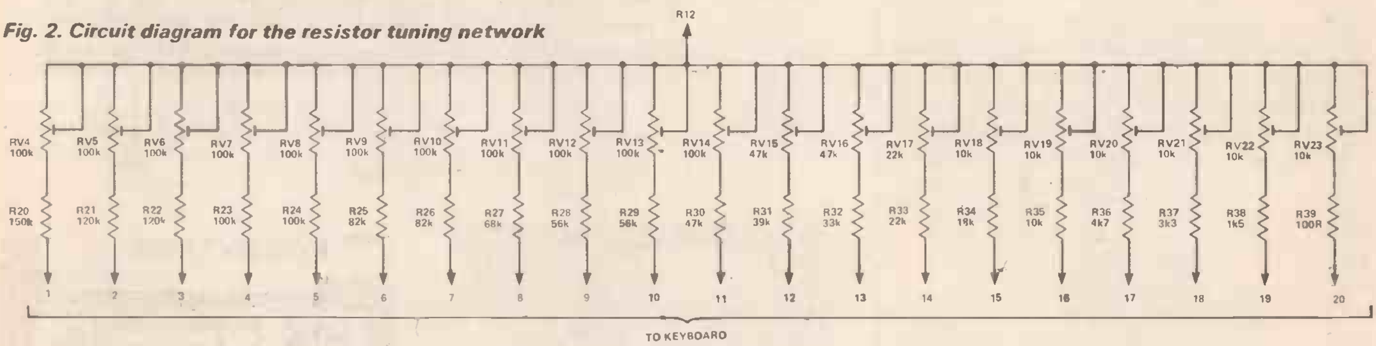


Fig. 2. Circuit diagram for the resistor tuning network



How it Works

Circuit operation may be most easily understood by considering it as four separate sections. The master tone generator, vibrato oscillator, divider and waveshaping circuits and the audio amplifier. We will look at these in more detail.

The master tone generator is formed by two transistors (pins 9, 10, 11 and 13, 14, 15) connected as an astable multivibrator. The only unusual feature of this circuit is the inclusion of diodes D1, 2 and resistors R9, 11. These components steer current into the timing capacitors C7, 8 on the positive going edges of the waveform and enable clean fast squarewaves to be obtained at the transistor collectors. This ensures reliable triggering of the CMOS divider IC1. Frequency is altered by adjustment of resistance between R12 and the junction of R7 and ZD1. The zener diode is included to provide a measure of protection against falling battery voltage. The frequency may be altered by injecting a current into the base of either transistor. In this circuit, the modulation voltage is applied to R6. Modulation depth is controlled by adjustment of RV2.

The modulation signal, an approximation to a sinewave at between 5 to 10 hertz, is obtained from the phase-shift oscillator built around one transistor (pins 6, 7, 8) which runs continuously. C2, 3, 4 set the frequency of oscillation and should be adjusted equally if a change is required. RV1 sets the gain and should be adjusted so that the stage just oscillates. The easiest way to do this is with the master tone generator working and the modulation depth control set at maximum. Simply play a note by touching the stylus to the keyboard, adjust RV1 and listen to the result. The best sinewave and most attractive effect is obtained when the circuit is just oscillating.

There is little to say about IC1. It simply divides the master tone generator output by two and divides its own output by two again producing two squarewave signals of equal duty cycle an octave apart. As signals are available from both the Q and $\bar{Q}$ outputs, one of these is simply attenuated by a resistive divider (R14, RV3) whilst the other is shaped by a lowpass RC filter formed by R16, C9. Values of the waveshaping and attenuating components are not critical though those shown gave good results in the prototype.

IC2 contains an audio amplifier with a voltage gain fixed at about 20 and-bias set internally. C12 is a decoupling component while C11 and C13 couple the signal input and output respectively. C1 is the overall supply decoupling capacitor.

TAKE TWO

Only two integrated circuits are used in the unit. Do not be misled by the circuit diagram, the three transistors and the audio amp are all contained in a single package, the LM389 from National Semiconductor. The other device is an ordinary CMOS dual JK flip-flop configured as two divide by two counters. This ensures symmetrical waveforms are available for waveshaping. Very simple RC filters are used to perform waveshaping and square and triangle waveforms are available. These approximate to string and woodwind sounds. More complex tone formation would have been prohibitively expensive and is really unnecessary as the tones produced by the simple techniques used sound very good.

Parts List

RESISTORS (All ¼W 5%)

R1, 2, 35	10k
R3, 30	47k
R4, 17, 19	12k
R5	3k9
R6, 20	150k
R7	390R
R8, 9, 11, 13	2k7
R10, 16, 23, 24	100k
R12, 36	4k7
R14	560k
R15	390k
R18, 28, 29	56k
R21, 22	120k
R25, 26	82k
R27	68k
R31	39k
R32	33k
R33	22k
R34	18k
R37	3k3
R38	1k5
R39	100R

POTENTIOMETERS

RV1	1k preset
RV2	10k lin
RV3	25k lin
RV4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	100k preset
RV 15, 16	47k preset
RV17	22k preset
RV 18, 19, 20, 21, 22, 23	10k preset

CAPACITORS

C1	1,000µ electrolytic
C2, 3, 4	1µ tantalum
C5, 13	470µ electrolytic
C6	4µ7 tantalum
C7, 8	4n7 polyester
C9, 10, 11	100n polyester
C12	100µ electrolytic

SEMICONDUCTORS

IC1	4027B
IC2	LM389
D1, 2	1N4148
ZD1	6 V2 400 mW

MISCELLANEOUS

SW1, 2, 3, 4, 5	SPST
LS1	8 ohm 2¼"
Stylus (see text)	case to suit
	Approx. cost £8

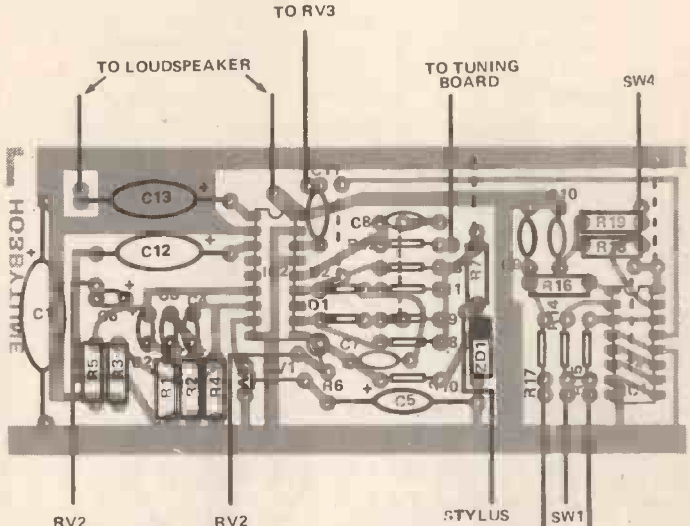
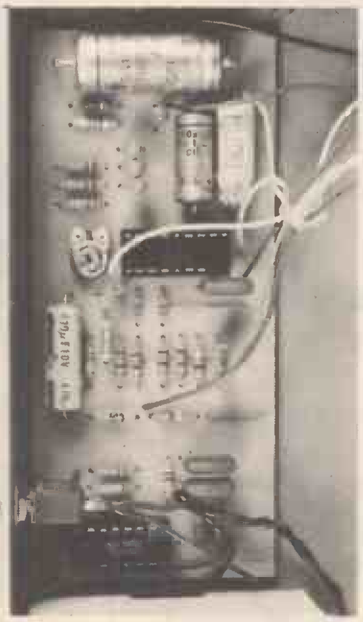


Fig. 3. Overlay diagram for the main PCB



Close-up of the main electronics

Buylines

The only component likely to cause any problems here is the LM389 which is available from Marshall's, as is a suitable 18 pin Dil socket.

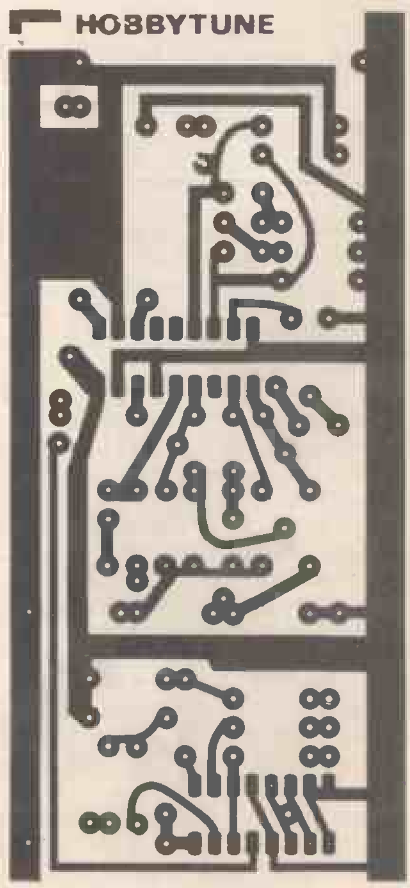


Fig. 4. PCB foil pattern for the Hobbytune main board

CONSTRUCTION

The organ is assembled on three PCBs. Other methods may be used but use of our PCBs will greatly reduce the chance of errors creeping in and simplify construction. To enable flexibility of layout and design, the main circuitry is contained on one board while another carries the tuning resistors. The third board is used as the keyboard. Keyboard and tuning board may be mounted together, simplifying the interwiring and producing an efficient use of space as shown in our photos.

Construction should proceed in the usual order. Insert and solder the links first followed by the IC holders, resistors, capacitors and diodes. Make the connections between the case mounted components and complete the interwiring between boards. A connector may be used for the stylus if required or a wire may be brought out directly from the board.

If all looks well, connect a battery (we used six HP7s giving nine volts) and switch on. By selecting a voice and touching the stylus to the keyboard, a tone should be produced. You can now tune the instrument by adjustment of the trimmer resistors.

Anything from a disused test probe to a ball point pen may be used as a stylus. We used part of an old quarter-inch jack plug with good results.

Once the instrument is in tune, you can begin playing in earnest. Some sample tunes are included here . . . and you know what practice makes.

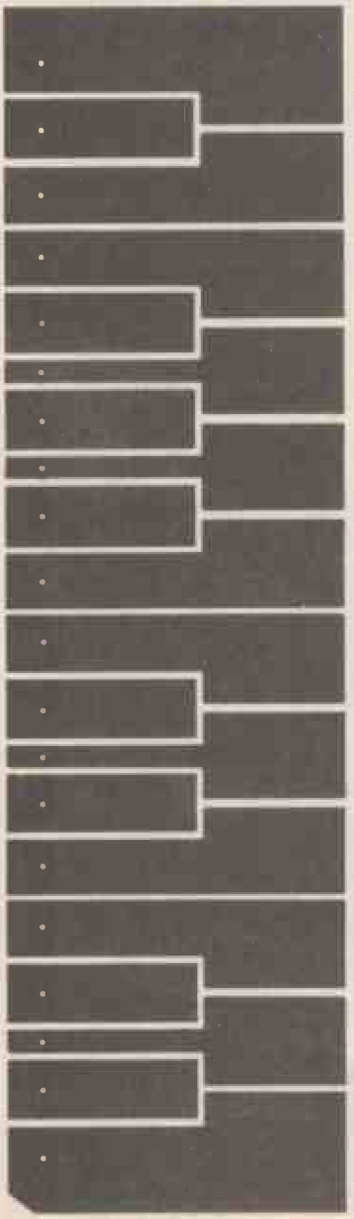


Fig. 6. PCB pattern for the keyboard

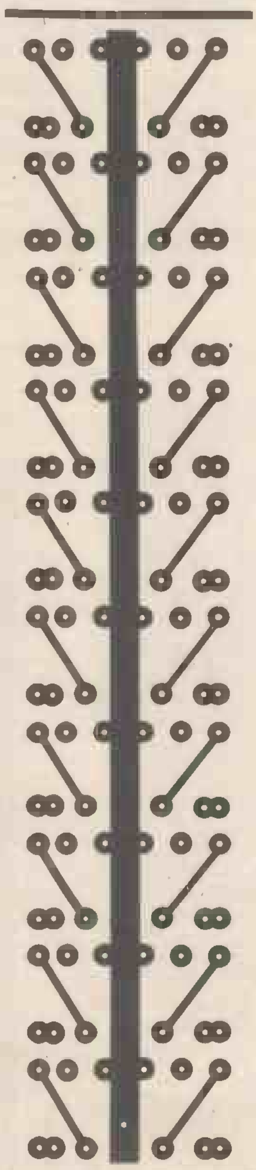


Fig. 7. PCB foil pattern for the resistor tuning board

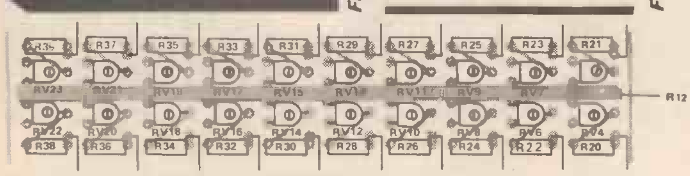


Fig. 5. Overlay diagram for the tuning board

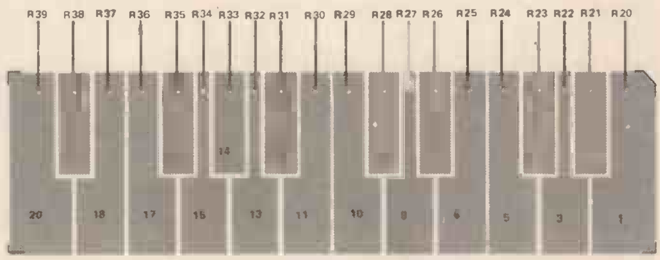
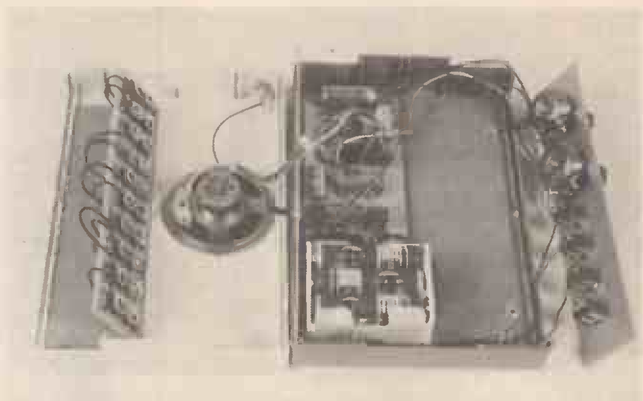


Fig. 8. Connections for the Hobbytune keyboard



Hobbytune — naked to the world, we strongly advise any budding musicians to use our PCB design to ensure an easy and trouble-free project

HOBBYTUNES

AMAZING GRACE

6, 8, 11, 15, 13, 11, 15, 15, 13, 11, 8, 6, 6, 8, 11, 15, 13, 11, 15, 18, 18.

TELSTAR

6, 1, 3, 6, 11, 10, 8, 6, 8, 1, 11, 10, 8, 6, 8, 1, 13, 15, 13, 6, 13, 11, 10, 3, 10, 8, 10, 10, 11, 10, 8, 6, 8, 8, 10.

LAND OF HOPE AND GLORY

6, 6, 5, 6, 8, 3, 1, 11, 11, 10, 11, 13, 8, 10, 10, 12, 13, 15, 20, 13, 18, 18, 17, 15, 13.

Kit Review

DIGITAL PANEL METER

It's time to remove that tube of mercury and replace it with a digital thermometer using a liquid crystal display.

WHAT IS THE TEMPERATURE TODAY? Your starter for 10 — a popular question. But can you answer without squinting, putting your specs on, even taking wild guesses, in the end giving an uncertain answer. If you happen to fit into any of these categories then it's about time that you had an electronic thermometer.

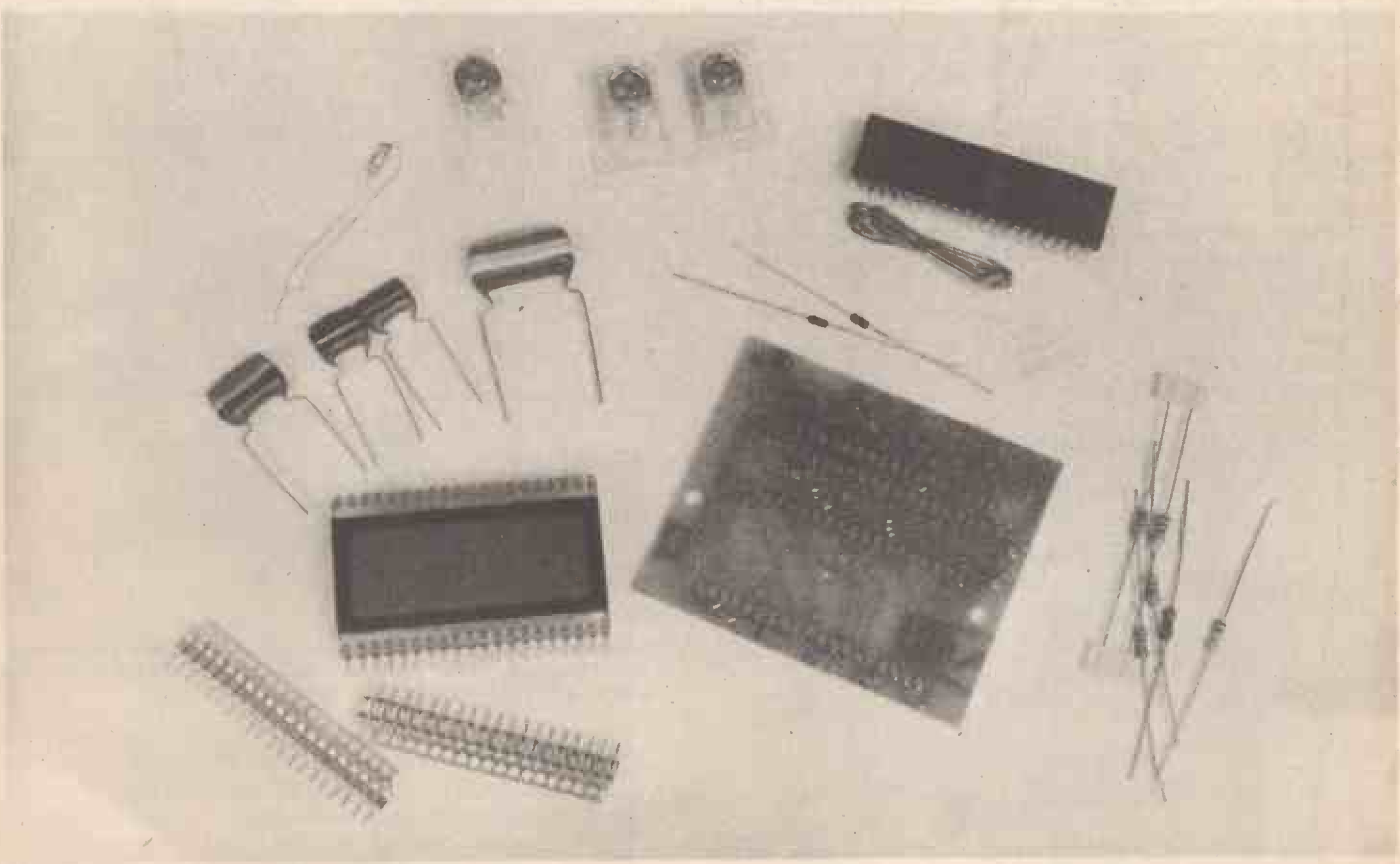
Our kit this month is based around a digital panel meter IC. This 40 legged giant can be used either as a digital voltmeter (DVM) or a thermometer. (The DVM can be set for a 200 mV or 2 V full scale reading). From this basic circuit the thermometer can be built with the addition of just a few components (to be exact two resistors, one preset and a diode). The diode is used as the temperature sensor which is connected via a screened lead. Calibrating the thermometer is very simple. By placing the sensing diode into ice and then into boiling water, two presets are adjusted to give a 000.0 and a 100.0 display respectively.

Being homoiothermic creatures (constant body temperature to you and me) at heart we decided to build the thermometer,voltmeters tend to be a bit boring anyway. Having made our choice we were ready to reveal the hidden contents.

OPEN SESAME . . . . .

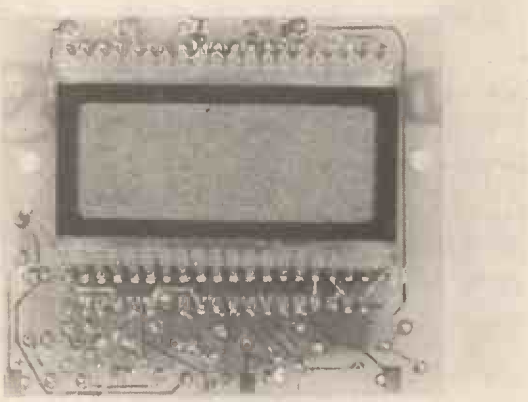
The most fragile component we encountered was the liquid crystal display, this was carefully packed between two polystyrene containers, minimising any damage through transit. The CMOS IC was housed in the usual anti-static holder. The rest of the components were all neatly packed into a plastic bag with the component count being fairly low, it made checking the contents against the parts list relatively easy, we found no ommissions here, everything was included, even a length of solder.

The instruction leaflet starts off by giving hints on



The assortment of parts laid bare for inspection.

soldering and assembling of PCB's, always good to see, this is followed by a brief description of the available functions on both options. To aid recognition, the capacitor colour code was given for the individual capacitors used, though for some reason there was no mention of the resistor code. However, this should not present a great problem to a studious Hobby reader as an early back issue would rescue you.



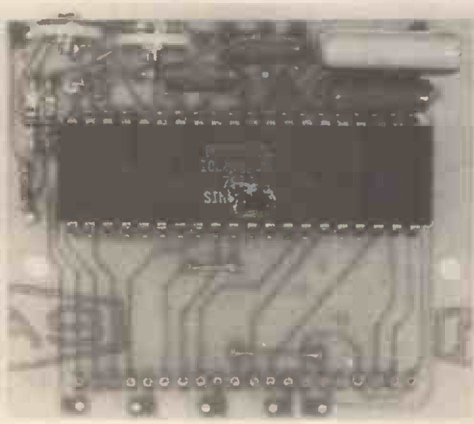
The liquid crystal display mounted on the copper side of the PCB.

PUTTING IT TOGETHER

The instructions show two component overlays, we recommend that they both be structured closely before construction commences. After identifying all the components and inserting them in their respe tive place and applying the trusty soldering iron, the next stage was to make up a DP (decimal point) driver circuit. There are three suggested circuits, two give a fixed DP the other a floating point. The thermometer uses a fixed decimal point.

As there was no provision made on the PCB for the components, all connections required were brought to the edge of the board. The circuit can then be hand-wired on the edge of the PCB. (It is worth noting that these components are not included in the kit as requirements will vary). To complete the construction you'll need to find a length of screened cable and attach the sensor diode to one end, observing the polarity. Total construction time was approximately 20 minutes.

Upon checking things over we noticed that C5 had suffered a crack on one side. This was due to the pitch



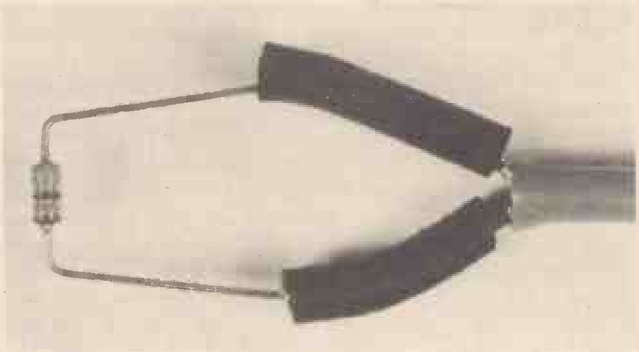
The completed PCB, note the use of Soldercon pins for mounting the IC, so take care when inserting the device.

spacing being fractionally out. The wretched component was pulled out 'gracefully' and replaced this time standing it further above the PC board. Doing this will reduce the tension placed on the component.

MOMENT OF TRUTH

Reaching for a PP3 power was applied to all parts, to our dismay were were confronted with a blank display — back to the drawing board. With the aid of the component overlay and much head scratching the mistake was found, a missing link (in more ways than one!) was the problem. Trying once more, we inserted the link — and it worked!

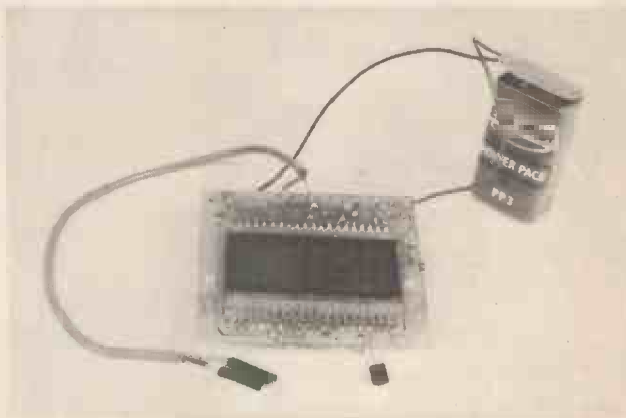
In use the thermometer proved sensitive enough to the surrounding atmosphere, even by blowing onto the sensor diode gave a significant change in temperature.



The diode sensor shown wired onto the screened lead.

CONCLUSION

Overall a neatly packaged and well presented kit, giving clear simple instructions, it was pleasant to find that there were no major problems. Therefore, if you are new to the game and need some experience in building then this is the kit for you! It has two added compensations, it will ensure that your temperature as well as heart-beat will remain constant — because it works!



The thermometer in its full glory with the decimal point driver on the edge of the PCB. The display is showing a genuine atmospheric temperature reading.

The DVM/thermometer kit is available from TK Electronics 106 Studley Grange Road, London, W7 2LX. Price £20.75 plus VAT. However if you are prepared to wait a few months for "the special Autumn offer" commencing in Oct/Nov then the kit will be offered at the price of £17.50 plus VAT.

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All prices include VAT @ 15% — just add 30p post

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Packs of 100 sq ins of good size pieces about 4x3" in the following types:
K541 0.1" copper clad **£1.50**
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Large range of Standard Veroboard and boxes/cases in stock. Details in Catalogue, **45p.**

SCOOP!!! Verobox type 2522, unused but has 3 ½" holes in one end and 1 ⅜" hole in the other, so instead of **£3.96**, we are selling these at **£1.85**

SWITCHES

Push-button banks — 20 types listed on Bargain List No 8, free with cat **(45p)** or send SAE. Samples:
W473 3 interlocking 4PCO+2 independent, **70p**
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W106 DPCO slide switch 23x15x7mm **10/£1.20; 100/£9**
W107 SPCO min slide switch with 2 wires attached. **10/80p 100/£6**
W508 SPCO 5A microswitch with 29mm lever 20x12x6mm **38p 10/£3.00**
W302 Rocker switch on/off 10A white. **22p 10/£1.80**
W305 Rocker SPCO, centre off, 10A rating, white. **30p 10/£2.30 100/£19**

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Z401 Powerful 6V DC, all metal construction. 50mm dia x 20mm **70p**
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PA 100V line speaker type. Pri tapped 0.625W-10W in 5 steps. Sec 4 or 8 ohm **£1.75 10/£15 100/£110**
Mains pri, 3 sec windings, 8, 25 and 40V, each at 100mA. A selection of voltages from 8 to 73V is therefore obtainable. 57x48x36mm with flying leads. **£1.50**
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X901 Telescopic 8 section 970mm long extended, 175mm collapsed. Swivel joint. 2BA fixing hole in base. **75p**
X904 Ferrite rod 140mm x 9mm LW/MW/coupling coils, each independently moveable **64p**
X905 As above, but LW/coupling coil together on moveable former. **55p**

CLOCK CASE BARGAIN

Z472 Oval format, overall size 130x68x87mm deep, with built in stand. Rear panel drilled to accept 4 switches+alarm. **60p**

THE AMAZING *GREENWELD* CATALOGUE

FEATURES INCLUDE:

- 50p Discount Vouchers
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3W Amp Module

Ready built and tested, this handy amplifier will prove very useful around the workshop. Just requires 17V ac source (and 8R spkr) as bridge rect and smoothing cap are mounted on the PCB. The 4 transistor circuit provides enough sensitivity for most applications. Supplied complete with circuit diagram and wiring details. Only **£1.75**. Suitable transformer **£2.20.**

LINEAR IC BARGAIN

We have just received a large consignment of popular linear ICs that have failed the manufacturer's stringent tests. However, on checking through a few hundred we have found that quite a large proportion tested in a simple oscillator circuit are functional, so are offering them in packs as follows:

Type	Package	% good	qty	price
702	14DIL	65%	25	£1.20
709	8DIL	75%	20	£1.20
709	14DIL	50%	30	£1.20
710	T099	30%	40	£1.20
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720	14DIL	80%	20	£1.20
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Connexion data is supplied. One of each pack, **£8.50**

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Amazing variety of values and voltages from a few pF to 2.2uF! 3V to 3kV! 200 **£1** 500 **£2.25** 1000 **£4.00**

DIODE SCOOP!!!

We have been fortunate to obtain a large quantity of untested, mostly unmarked glass silicon diodes. Testing a sample batch revealed about 70% useable devices — signal diodes, high voltage rects and zeners may all be included. These are being offered at the incredibly low price of **£1.25/1000** — or a bag of 2500 for **£2.25**. Bag of 10,000 **£8.** Box of 25,000 **£17.50.** Box of 100,000 **£60**

VU METERS

V002 Twin type, 2 meters 40x40mm and driver board, supplied with circuit and connexion data. **£3.50**
V003 New type, just in. Twin type moulded in one piece, 80x40mm (no driver board but suitable circuit supplied) **£2.50**

NOW THIS IS SOMETHING NEW! and so simple to construct

CONTROL UNIT CONSTRUCTION KIT for DISCO LIGHTS, GROUPS, HOME DISPLAYS etc.

KIT £15.95 inc.VAT

A new world in lighting effects is opened to the amateur interested in miniature electronics evolved for the space and computer programmes. This comes to you NOW, in kit form, an easy to construct 4-Channel 'Chaser' Unit, which when connected to a light display of your own design, will supply an on/off sequence giving the effect of chasing or moving lights. It has a speed control and has the ability to automatically make the lights appear to move forwards, backwards or alternate between the two. The unit is designed to fit into your equipment or into a box of its own. Size of completed unit 180x95x30mm. Price £15.95 including VAT. P & P 30p extra. The 4-Channel 'Chaser' Unit can also be purchased assembled, tested and guaranteed by qualified staff. Special price £21.95 including VAT. P & P 30p extra.

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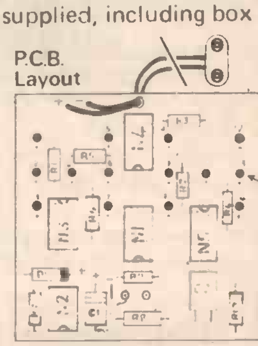
P.C.B. Layout



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HE MA

CLOCK RADIO

You probably won't believe us as we're selling the goods but we're going to tell you anyway! We have *rejected* eight clock radios for Marketplace, they were all cheap enough but the quality was so poor that we couldn't have lent our name to them. However, we are now able to offer a portable LCD Clock Radio to you which meets our standards.

The clock is a 12-hour one with AM/PM indicated and a back light. The radio is Medium Wave with very nice quality for a small speaker. The alarm can be either a beep-beep type or the radio, there's also a snooze facility.

The cylindrical construction is in keeping with the very modern styling. The tuning dial is actually incorporated into one of the end caps!

We won't even mention the RRP — but just check on comparable prices — you'll find ours a bargain.

An example of this Clock Radio can be seen and examined at our Charing Cross Road offices.

£17.95

(Inclusive of 15% VAT and Postage).

To:
CLOCK RADIO Offer,
HE Magazine,
145 Charing Cross Road,
London WC2H 0EE.

Please find enclosed my cheque/PO for £17.95 (payable to HE Magazine) for my Clock Radio.

Name . . . .

Address . . . .

. . . .

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Please allow 28 days for delivery.

DIGITAL ALARM

THIS IS THE THIRD digital alarm clock that we are offering (we regret the earlier versions are no longer available). We have sold thousands and thousands of these and our buying power enables us to offer a first rate branded product at a really excellent price.

The Hanimex HC-1100 is designed for mains operation only (240V/50Hz) with a 12 hour display, AM/PM and Alarm Set indicators incorporated in the large display. A switch on the top controls a Dim/Bright display function.

Setting up both the time and alarm is simplicity itself as buttons are provided for both fast and slow setting and there's no problem about knocking these accidentally as a 'locking' switch is provided under the clock. A 9-minute 'snooze' switch is located at the top.

A example of this clock can be seen and examined at our Charing Cross Road offices.

£10.60

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RKETPLACE

LCD CHRONO

We feel we've got to tell you carefully about this offer which we're intreducing for the first time. Why? Because our price is so enormously lower than anywhere else you may suspect the quality.

The display is LCD and shows the seconds as well as the hours — and minutes — press a button and you'll get the date and the day of the week.

Press another button for a coujple of seconds and you have a highly accurate stopwatch with hundredths of a second displayed and giving the time up to an hour. There is a lap time facility as well — and of course a back light.

Our Chrono comes complete with a high grade adjustable metal strap and is fully guaranteed.

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This new addition to our unbeatable selection of bargains is no ordinary LCD watch. It's a slim, multi-function, dual time chronograph alarm watch, no less.

This model will show hours, minutes, seconds, date, day of the week, stop watch, split time, alarm and alternate dual time zone — not all at once, of course. There is also a night light.

Hours, minutes, seconds and day of the week are displayed continuously, while the date will appear at the touch of a button. The day of the week is indicated by a flag. When used as a stopwatch, the maximum count is 0.1secs. short of thirteen hours.

£19.95

(Inclusive of 15% VAT and Postage).

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ALARM/CHRONO LCD WATCH Offer,
HE Magazine,
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Please allow up to 28 days for delivery.

Hobby Chit~Chat

LET THERE BE LIGHT

This month our chief designer Ray Marston looks towards those dark evenings and suggests some ways they may be illuminated, electronically of course.

NOW THAT THE SUMMER is drawing to a close many HE readers will no doubt be thinking of tackling major DIY jobs around the house. If complete or partial rewiring of the home lighting circuits figures in your 'jobs-to-be-done' list, you should find this month's 'Chit-Chat' article of interest. The feature is devoted entirely to household lighting circuits.

I completely rewired my own house a couple of years ago, and had to cut some fifty feet of channeling, through brick and plaster, to accommodate new lighting cable runs. Half of that channeling was used to provide two-way switching for the landing light and three-way switching for the hall light. That experience made me realize how awkward conventional single- and multi-way light switching is to install. Since then, I've designed a few electronic circuits that can be used to replace conventional switches and greatly simplify the rewiring problem. Some of these multi-input switching circuits are shown in Figures 1 to 5.

In use, these circuits are intended to be mounted in the ceiling space and wired to the ceiling rose of the lamp in question. The ON/OFF switches can be modern keyboard push-button types, fixed to a flat blanking plate that can be screwed to a wall without any need for recessing. The wiring between the ON/OFF switches and the electronic unit can be lightweight twin-flex, which can be buried in a channel of groove measuring little more than ⅛in wide and deep. The circuits can accept any number of input switches, so multi-input switching ceases to be a problem.

If you're thinking of building any of these circuits, remember that they carry mains voltage, so proceed with caution, otherwise death may seriously damage your health.

CIRCUITS WITH INDIVIDUAL ON AND OFF BUTTONS

Figures 1 and 2 show multi-input electronic switches that employ individual ON and OFF buttons. The Fig 1 circuit uses relay contacts to switch power to the lamp. The Fig 2 circuit switches the lamp directly via a Triac or 'solid-state relay'.

The operation of the Fig 1 circuit is very simple. IC1 is a quad 2-input CMOS NOR gate, and two of it's gates are cross-coupled to form a basic bistable circuit. When one of the ON switches is momentarily operated the CMOS circuit locks into a state in which its output (pin 4) is high, thus driving relay RLA on via Q1 and activating the lamp via relay contacts RLA/1. The

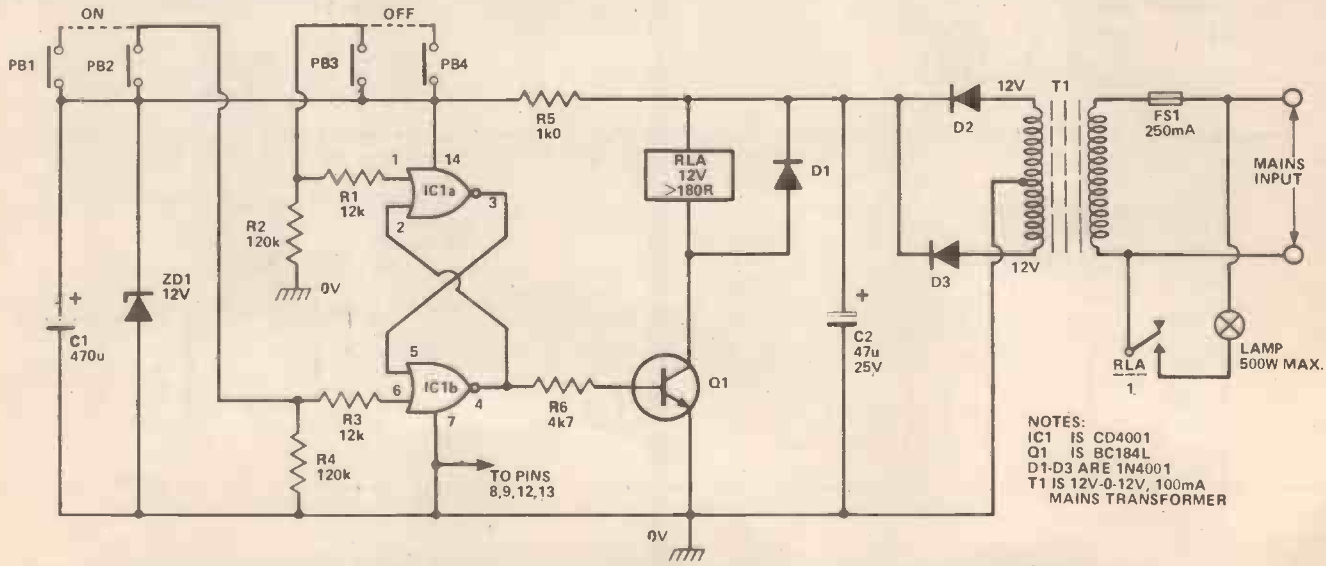
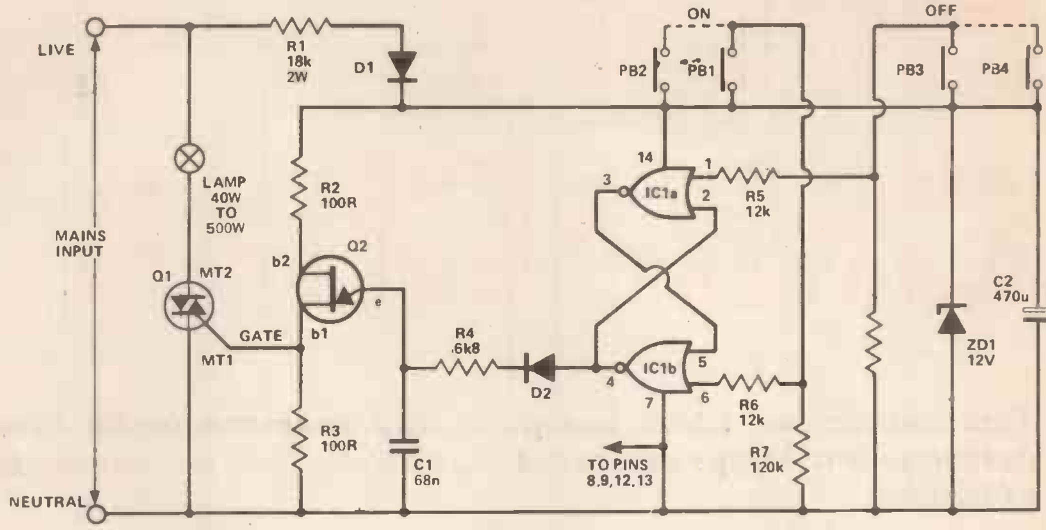


Fig. 1. A relay-output, multi-input electronic light switch using individual ON and OFF push-button switches.

Fig. 2. A Triac-output, multi-input electronic light switch using individual ON and OFF push-button switches.



NOTES:
Q1 IS 400V, 8A TRIAC
Q2 IS TIS43 UNIJUNCTION
IC1 IS CD4001B
D1 IS 1N4004
D2 IS 1N4148

bistable remains in the ON state until one of the OFF switches is momentarily operated, at which point the output of the bistable locks into the low state, and Q1 and the relay and lamp turn off. The power supply for the circuit is derived from the mains via step-down transformer T1 and the associated rectifier/smoothing network.

The operation of the Fig 2 circuit is only slightly more complicated. Here, when an ON switch is operated the output of the CMOS bistable switches high and enables unijunction oscillator Q2, which feeds a chain of trigger pulses to Triac Q1 which turns on and activates the lamp. When an OFF switch is operated the output of the bistable switches low and disables the unijunction oscillator, so the Triac and lamp turn off. The power supply to the CMOS and unijunction circuit is derived from the mains via R1-D1 and ZD1-C2.

CIRCUITS WITH SINGLE ON/OFF BUTTONS

Figures 3 to 5 show multi-input electronic switches that employ single ON/OFF buttons or touch pads, so that the lamp changes state (from ON to OFF, or vice versa) each time that a button or pad is operated. The Fig 3 circuit uses relay contacts to switch power to the lamp. The Fig 4 circuit also has a relay output, but is activated via touch pads rather than switches. The Fig 5 circuit switches the lamp directly via a triac.

All of these circuits are designed around a CD4013 dual D-type flip-flop, and use only one half of the IC, configured as a divide-by-two circuit. The clock input pulses to this circuit must have rise times less than 15 uS. In the Fig 3 circuit the clock pulses are obtained by operating one or other of the push buttons. Each time a button is closed, C2 charges rapidly via C1 and the button switch, and provides the required fast-rise-time clock pulse: C2 discharges slowly via R2 when the button is opened, thus elininating false-triggering via switch-bounce effects, etc. Q1 and the relay and lamp change state each time a push-button switch is operated.

Figure 4 shows how the above circuit can be modified for operation via so-called 'touch pads'. Normally, the input of IC1a is held high via R1. Whenever a finger is pressed against a touch pad, the skin resistance pulls the input of IC1a low by potential-divider action and causes IC1a output to switch high and rapidly charge C2 via D1. The transition in the C2 voltage is amplified (and effectively speeded up) via IC1b and IC1c, thus providing the required clock pulse to IC2.

If you decide to build or experiment with the Fig 4

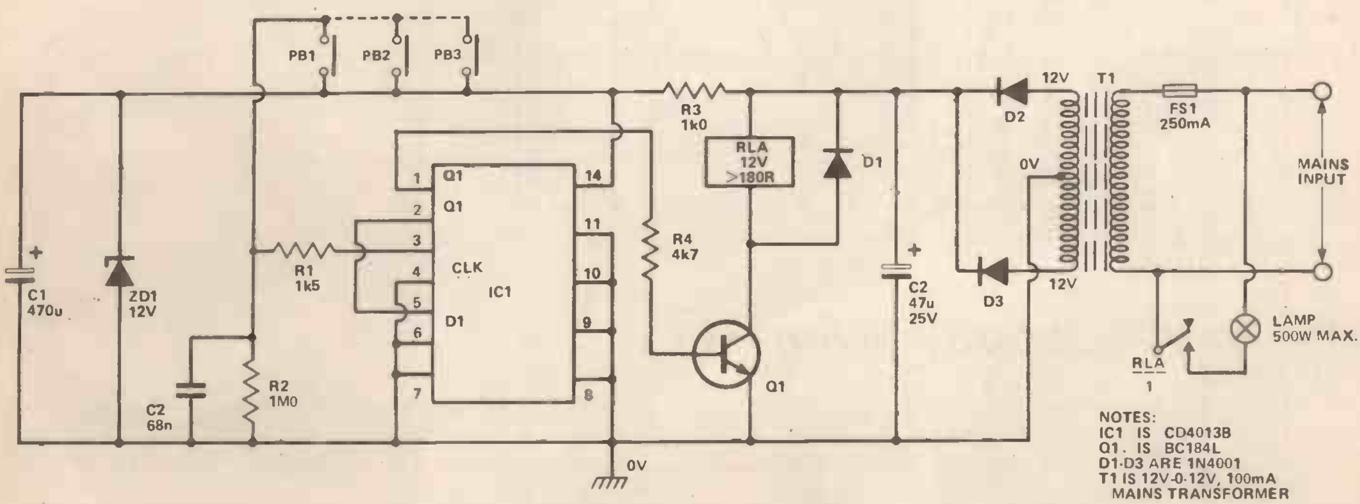


Fig. 3. A relay output, multi-point electronic light switch using single ON/OFF push-button switches.

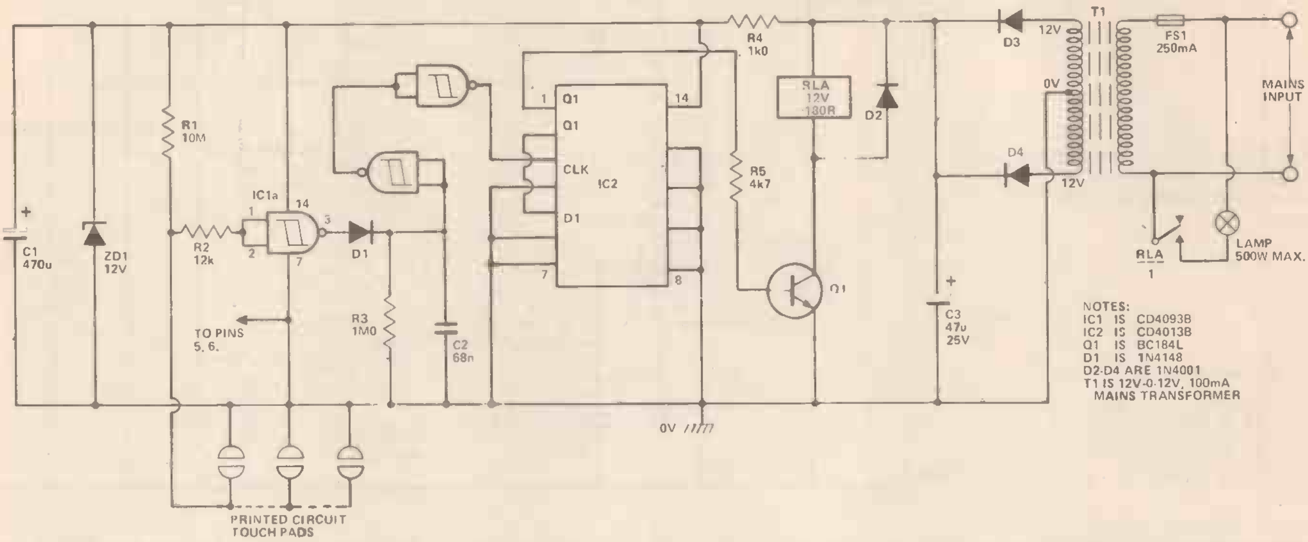


Fig. 4. A relay output, multi-input electronic light switch using single ON/OFF 'Touch pad' switches.

circuit, note that the IC1 circuitry is rather susceptible to hum pick-up, so the connections to the touch pads should be made via screened or twisted flex. Also, the touch pads can be disabled by moisture or dampness. The touch pads can, however, be formed in a variety of decorative patterns, and the circuit can make an excellent conversation piece.

Finally, Fig 5 shows a Triac-output version of the multi-input push-button operated circuit. Here, the output (pin 1) of IC1 changes state each time a push button is operated. When the output is high, unijunction oscillator Q1 is enabled via D2, and feeds trigger pulses to the gate of Triac Q1, which turns on and activates the lamp. When the output of IC1 is low Q2, Q1, and the lamp are off.

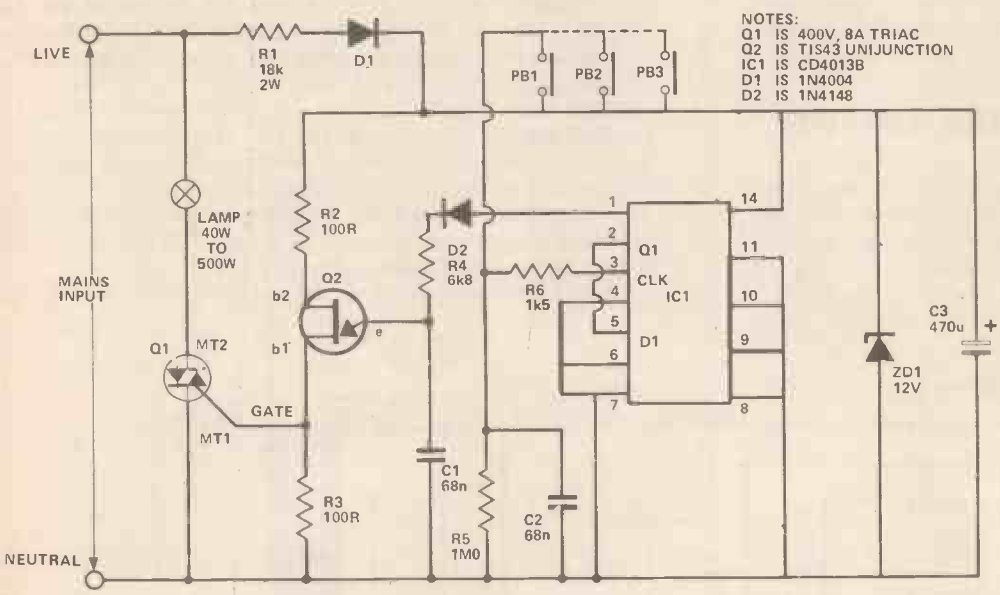
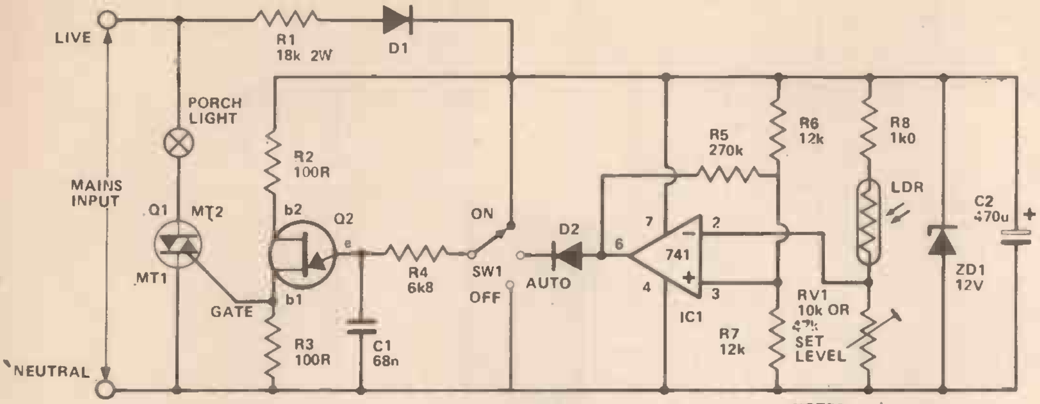


Fig. 5. A Triac output, multi-input electronic light switch using single ON/OFF push button switches.

ELECTRONIC PORCH LIGHT SWITCHES

While we're on the subject of rewiring, how about adding a touch of class to your home by fitting a sophisticated porch-light switching system? Possibly the Fig 6 circuit, which turns the light on automatically when darkness falls. Or the Fig 7 circuit, which turns the light on for a fixed period (about ten minutes) whenever the START button (a 2-pole door bell switch?) is operated. Or perhaps the 'intelligent' circuit of Fig 8, which does the same job as the Fig 7 circuit, but operates under dark conditions only.

The Fig 6 circuit can be set for manual or automatic operation via SW1. Assume that SW1 is in the AUTO



NOTES:
Q1 IS 400V, 1A TRIAC
Q2 IS TIS43 UNIJUNCTION
IC1 IS 741 OP-AMP
D1 IS 1N4004
D2 IS 1N4148
LDR IS ORP12 OR SIMILAR

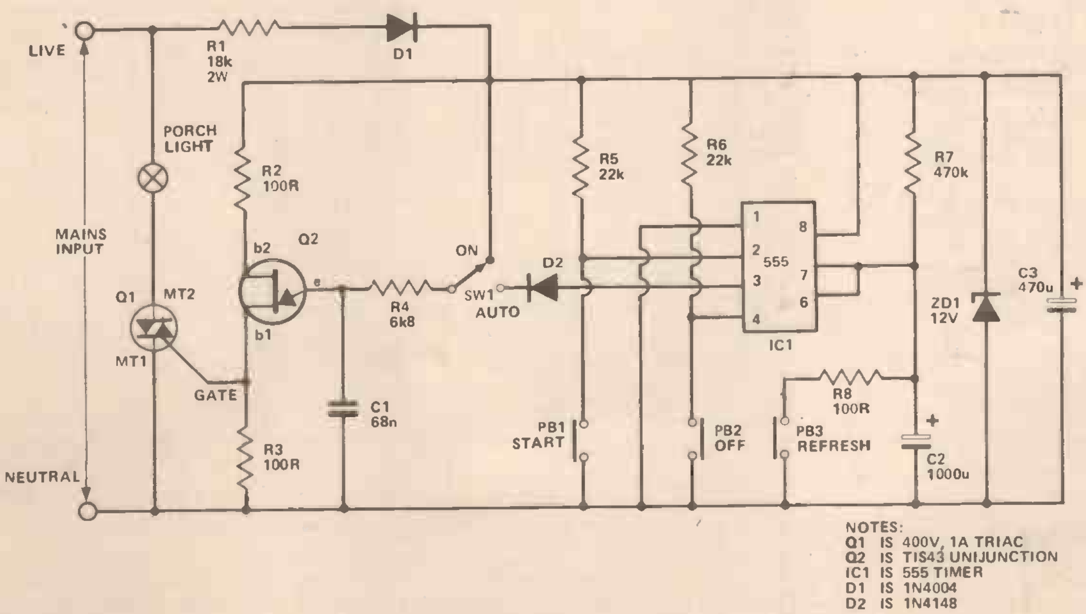
Fig. 6. An automatic (dark activated) porch light.

position. Operational amplifier IC1 is wired as a light-sensitive switch, with its trigger level adjustable via RV1. The output of the op-amp is high under dark conditions, thus enabling unijunction oscillator Q2 and turning Triac Q1 and the lamp on. Under bright conditions the op-amp output is low, so Q1-Q2 and the lamp are off.

If you build this circuit, place the LDR in a position where it won't be influenced by the shadows of people or animals standing in the porch, or by the light of the porch lamp. RV1 should initially have a value of 10k, but can be increased to 47k if you can't get enough adjustment to give triggering at your required 'darkness' level.

The Fig 7 circuit can also be set for manual or automatic operation via SW1. Assume that SW1 is set to the AUTO position. IC1 is a 555 timer. Its output (pin 3) is normally low, but goes high for a period determined by the R7-C2 values when a negative-going START command is fed to pin 2. At the end of the period the output automatically switches low again. The period can be terminated part way through the cycle by briefly operating OFF switch PB2, or can be extended by operating REFRESH switch PB3. Q1-Q2 and the lamp are on when the output of the IC1 is high, and are off when it is low.

Finally, Fig 8 shows how the above circuit can be modified so that it only operates under dark conditions. Here, the LDR and RV1 act as a potential divider whenever PB1 is closed, and ensure that a suitable trigger pulse (below ⅓rd of the supply voltage) is fed to IC1 only when PB1 is closed under dark conditions. The LDR must be placed in a position where it won't be influenced by the shadows of people or animals standing in the porch.



NOTES:
Q1 IS 400V, 1A TRIAC
Q2 IS TIS43 UNIJUNCTION
IC1 IS 555 TIMER
D1 IS 1N4004
D2 IS 1N4148

Fig. 7. An auto turn-off porch light. The light turns on when the 'start' button is operated and turns off automatically after about ten minutes. The period can be extended by operating the 'refresh' button part way through the cycle, or the period can be terminated by pressing the OFF button.

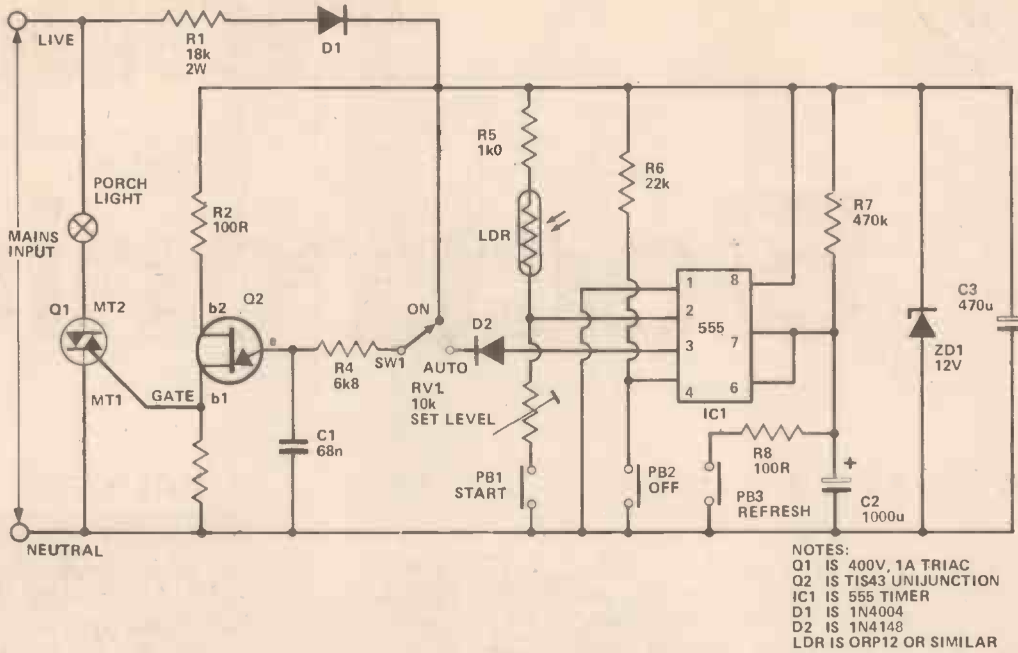


Fig. 8. An 'intelligent' auto turn-off porch light. The light only operates under 'dark' conditions.

Note in the Fig 2, 4, 5, 6, 7 and 8 circuits that we've shown the LIVE side of the mains going to the lamp and the NEUTRAL side going (effectively) to the switches. This conflicts with normal practice. You can reverse the input connections if you prefer.

Aggin we must emphasise that mains electricity is fatal stuff to play around with. We strongly advise against anyone not completely familiar with mains electricity not to build these circuits unless they have expert assistance. We would hate to lose any of our readers. **HE**

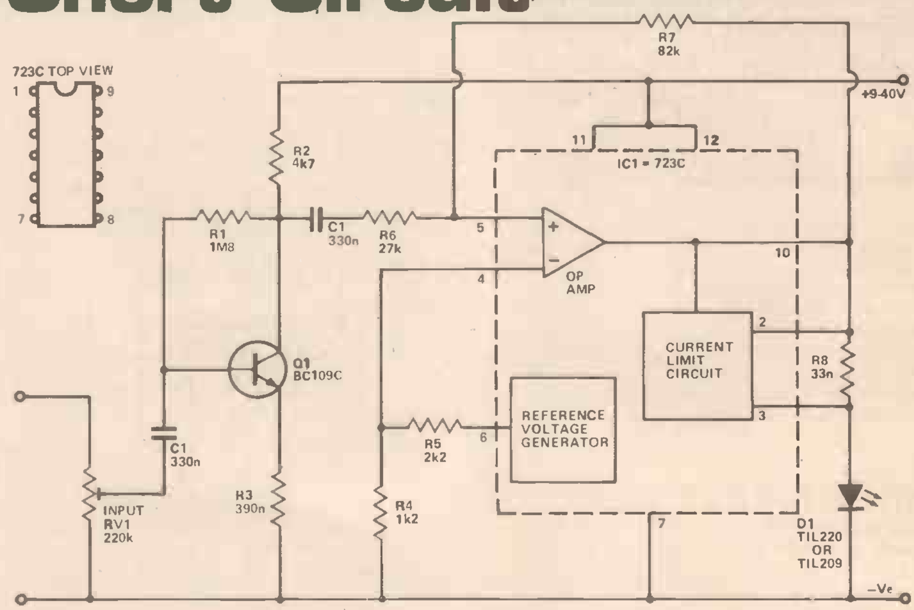
Short Circuit

LOW BATTERY VOLTAGE INDICATOR

This circuit can be used to monitor a supply voltage of between about 5 and 25 volts (30 V absolute maximum) and will switch on a warning light if the supply falls below some predetermined threshold level.

Although only five components are used, the circuit is actually quite sophisticated, giving good reliability and precision. This is due to the use of an 8112 voltage detector IC. A comparator forms the heart of the device, and a highly stable internally generated reference voltage is fed to the inverting (—) input of the comparator. Its non-inverting (+) input is available at pin 3, and in this circuit it is fed from the supply lines via the potential divider circuit which consists of R1 and RV1. The output of the comparator is available at pin 4, but is obtained by way of a constant current generator which limits the output current to a nominal figure of 7 mA.

If the voltage at the non-inverting input exceeds the reference voltage, the output assumes the high state and LED indicator D1 is not switched on. If the non-inverting input voltage falls below the reference level, the output then goes low and power is applied to D1. The constant current source limits the LED current to a suitable level. In practice RV1 is adjusted so that with the supply voltage at its minimum acceptable level the non-inverting input is at a potential just marginally higher than the reference voltage. In other words it is adjusted for the lowest voltage that does not cause D1 to be switched on. A fall in supply voltage below the threshold level then takes the non-inverting input below the reference voltage and switches on the warning light. C1 decouples any stray pick-up which could otherwise cause spurious triggering of the circuit. The quiescent current consumption is typically only about 50 uA.



Next Month

Hobby Electronics

HAPPY BIRTHDAY TO US . . . .

Yes, it's HEs first birthday next month, as a special treat to all our readers we will be featuring an eight page pull-out section containing masses of useful data. How to de-code those colour coded components, how to connect up all those little legs on ICs and transistors, everything in fact (well, nearly everything) you'll ever need to know.

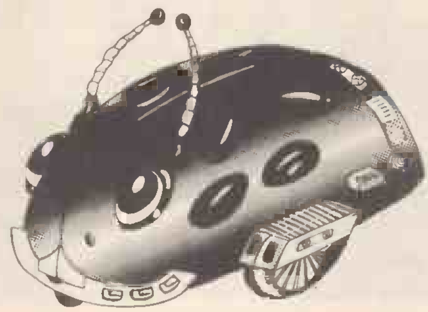
TV BROADCASTING

Even if you can only get two channels (industrial action notwithstanding) you can still find out all about how those exciting episodes of Crossroads and the Magic Roundabout (no they're not using the same actors) reach the flickering picture box in the corner of your living room. What dramas never reach the watchful eye of the camera, how high is Nicholas Parsons in real life, these are some of the questions that probably won't be answered next month.

WRIGHT FIRST TIME

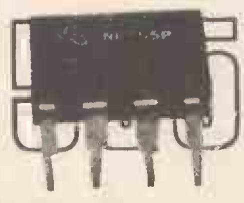
Congratulations to Mr D. J. Wright of Bodmin, Cornwall, and Mr P. R. Cheeseman of Birstall, Leicester, for winning the first and second prizes in our August Scope competition — more details next month. In the meantime we'll be contacting all the winners and runners-up by post.

HEBOT



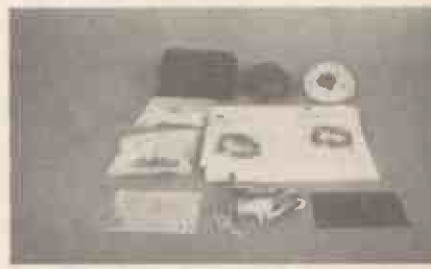
From the darkest corners of the HE workshop comes a new terror to strike fear into the hearts of brave men (and women, if they dare). HEBOT is here, from an original design by the Gonoids of Andromeda it will over the next few months develop into a creature to rid you of the mother-in-law for ever. The first part next month will describe how to assemble the locomotive and propulsory support mechanism (Chassis and drive gear to mere earthlings) and basic sensory perceptors. The basic module will perform evasive manoeuvres and month by month we will attempt to increase its 'intelligence' until it is able to exist on its own. If our plans are fulfilled they will wipe out the human race HEBOTs will control the universe . . . Exterminate, we will exterminate . . .

INTO LINEAR ICs



This month just over half-way through the series, Ian Sinclair takes leave of the 741 to start anew with the famous 555 timer, as usual all of the circuits are practical, tried and tested. For those of you following the series with the Eurobreadboards we will include all of the codings for the board.

KIT REVIEW



Something out of the usual in the way of kits next month, we shall be looking at a rather novel car burglar alarm. This new kit should be of interest to anyone wanting to protect their vehicle, without having to take out a second mortgage to buy the kit.

BREAKER ONE FOUR

Following our disclosure this month you can be sure that next month's Breaker One Four will have some more very interesting revelations. Remember Breaker One-Four is Britain's first and best, regular Citizens Band feature.

MINI-MODULES

We've been promising some Vero-Board based projects. Well, here they are, ten of them, all using a commercially sized piece of strip board. All of the Modules can be used either as building blocks for larger, more ambitious projects or used on their own as projects in their own right.

The November issue will be on sale October 12th

The items mentioned here are those planned but circumstances may affect the actual contents

It's playtime kiddies. The juvenile staff of HE aided and abetted by the playful, Rick Maybury have put the latest crop of electronic games through their paces.

OTHER ELECTRONIC MAGAZINES PLEASE NOTE, do not under any circumstances attempt to do an electronics games survey, you just won't be able to get any work done. It's not the constant distraction of bleeps, squarks and other outlandish noises, not even the perpetual outbursts of cheering and booing from other members of the office staff, it's the near impossible task of tearing yourself away from the games long enough to put pen to paper.

Having tied our hands behind our backs to prevent any spurious attacks of button pushing and typing with our noses we'll attempt to elaborate on some of the latest machines that have put this months HE in serious jeopardy. If this issue has more than its usual quota of spelling mistakes, you'll know why.

A GAME IN THE HAND . . . . . .

Basically all the electronic games we've managed to prise away from the various companies (take them back, please or there won't be another issue of HE) fall into one of three categories. The first (and probably oldest) are the video games, they're the ones you plug into the back of your telly. The second group are the most recent arrivals to the electronic games field, the hand-held games. Usually not much larger than a medium sized pocket-calculator and with one or two exceptions, they play only one game. The final and definitely the most demanding are the specialist and novelty, microprocessor games, such as the many versions of chess, backgammon, and now completely new games like Simon.

Inside the Master Blaster, the green LED display (right) can be seen with the three rows of flying saucers and the score.

HISTORICAL NOTE

Without doubt, electronic games are a product of the seventies. (Although versions of electronic dice etc have been the mainstay of several notable electronic magazines for many years).

Undoubtedly the daddy of them all was the famous AY 38500 games IC from General Instruments. It was the first truely domestic version of the now legendary pub game of 'tennis'. It offered four basic 'ball and paddle' games of tennis, squash, solo and football, as well as a rather dubious shooting game that rarely had a range of more than a few feet. All the games had sound effects, and were revolutionary in that all the video processing, sync, sound, and video information were generated on one 28 pin chip. To get the games going required only a simple oscillator, paddle controls, modulator and a power supply.

The eventual demise of the AY 38500 was brought about by the development of the so-called programmable game. Instead of producing large quantities of 'dedicated' games, ie putting all the video generating circuits on one chip, the games manufacturers kept all the standard circuitry in a basic control box, along with a set of controls etc and loaded the various game information into the everpresent microprocessor via a IC memory or PROM. (Programmable Read Only Memory) These proms are usually standard 'off the shelf items', the game information is permanantly 'burned' onto the IC by fusing microscopic links within the IC.

Perhaps it's a little unfair to say the dedicated game is dead, one company, Teleplay, have suceeded in making a sort of programmable TV game with the dedicated chips although we fear that sooner or later the supply of new games using this format will dry up. However its worth bearing in mind that these machines are very much cheaper than the present generation programmable games.

All the current crop of TV games are in full colour (of course) and the sound is modulated onto the TV speaker.

Examples of the old AY 38500 ICs are still to be seen on sale for as little as 50p in some cases, so it will not be disappearing just yet. Indeed black and white versions can still be bought in Woolies and Dixons for under a tenner.

It's interesting to note that the company that developed the idea of using TV sets for such purposes still hold the patents and presumably are still raking in the royalties, perhaps we should patent some of our projects, you never know . . . . . .

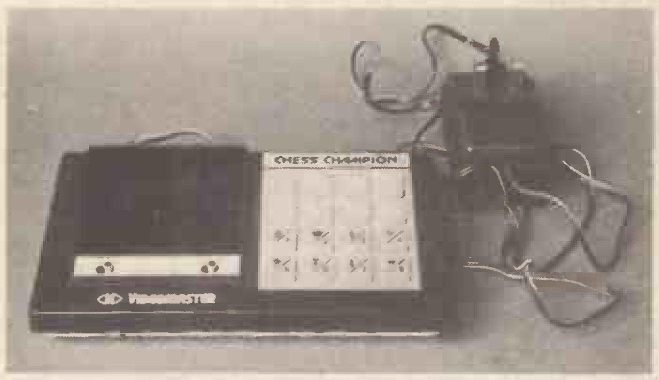
POWER TO YOUR POCKETS

Now you can rule the universe from the comfort of your own jacket pocket. Its always been a little impractical to carry a TV set around with you (unless you've got a Sinclair Microvision and very good eyesight) so it was a logical step for the games manufacturers (with spare capacity after flooding the calculator market perhaps) to turn their attention to the portable market. All of the games are pretty much the same requiring a degree of manual dexterity (with a couple of exceptions, like Mastermind) to destroy malevolent UFOs, drive race cars or play soccer. Nevertheless the accompanying sound effects coupled with an almost paranoid horror of being beaten by a machine ensures that they will not be put down till they have either been beaten or thrown in disgust at the nearest brick wall. One or two or our samples came perilously close to ending their days in a less than solid-stale.

It took us a long time to think up a convincing escuse to print this picture, we finally decided the HE just visible in the centre was justification enough.

BRAIN GAMES

Our last group are what might be called the 'thinking mans' electronic games, they include the almost unbeatable chess, backgammon and now bridge, playing microprocessors, they've all had the treatment. The other new games (as opposed to chess, being hundreds of years old) include Simon, somewhat overrated, and Zodiac, a fortune telling micro. Lastly we have Owl, from the look of the box we would deduce its intended for the 5-10 years age range but without exception every member of the HE staff has secretly played with it!



The Videomaster Chess Champion with its external AC adapter. Unlike the Challengers you require a separate board and pieces.

TURN THE TABLE

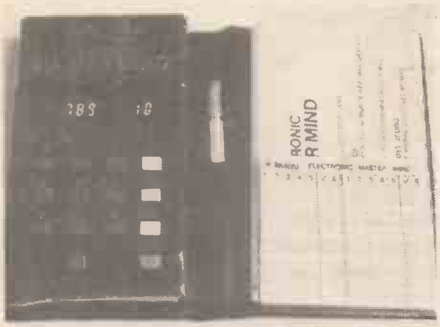
So now read on. On the following pages we've included as many details as possible but as always 'one mans meat . . . . . .' All we can say is, go along to your local stockist and play with a few, then after two days if he still hasn't managed to get you out of the shop buy one.

LIST OF SUPPLIERS

1. Spectrum Marketing
   12 The Shrubberies
   George Lane
   South Woodford
   London, E18
2. NIC Models
   27 Sidney Road, London N22 4LT
3. Videotime Products
   56 Queens Road, Basingstoke
   Hampshire
4. Comp Computer Components
   14 Station Road, New Barnet
   Herts.
5. Milton Bradley Ltd
   Century House
   61-63 Uxbridge Road, Ealing
   London W5 5SA

HAND HELD GAMES

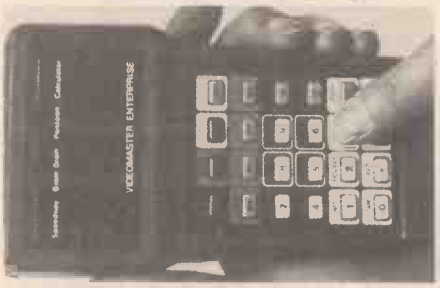
Hand-held games are being hailed as the latest 'craze' in the 'States. Well, crazes come and go (whatever happened to Skateboards?) but this time we believe these games will really catch on. Most of the games are fairly limited in that they only play one or two



MASTERMIND

An electronic version of the very popular board game, the machine sets up a 3 to 5 digit code that the player must guess (or work out if you're very clever) by entering numbers on a keyboard. The game comes in a very attractive wallet with score cards and a pen. The game allows up to two players, where the opponent can manually set a code. Battery operated, no sound effects, price £15.85, supplier (2).

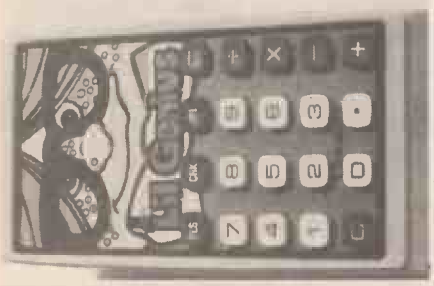
A real thinking man's game, the wallet and pen made it even more attractive especially for long train journeys. It may look a little pricey but we considered that it would have lasting appeal and was not a game that could ultimately be beaten as it would constantly generate new and random codes.



ENTERPRISE

At the time of going to press we had not actually received a sample of Enterprise so we can only go by the publicity handout. It has 3 games as well as being full four function calculator, the games are Speedway, Pontoon and Brain Drain. Battery operated, no sound effects, price £24.95, supplier (2).

We can't really comment on this one, but from our picture of it it looks very interesting indeed. We liked the idea of it having a calculator, something other manufacturers might consider.



LIL GENIUS

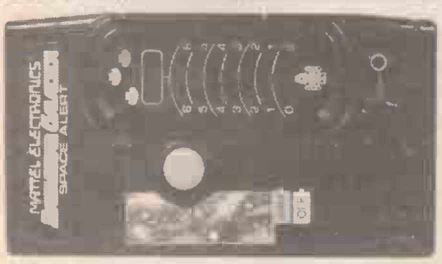
This is definitely one for the kids, it is a mathematical game, you simply enter in your sum and by pressing a series of buttons the bespectacled youth will flash either his green eye if you are right or his red eye and sound a buzzer if you are incorrect. Battery operated, sound effects, price £6.45, supplier (1).

This was one of the least pretentious games, unashamedly for the 5 year olds, well worth thinking about if you have a budding mathematician in the family and your maths are none too hot.

UFO MASTER BLASTER

This game has one of the more dramatic displays, the object of the game is to launch your missiles before the approaching flying saucers reach your position at the bottom of the small screen. Your missiles are controlled by a 3 position switch and launched by pressing the red fire button. Battery operated, sound effects, price £21.95. Supplier (1).

The sound effects on this game are superb, a really exciting, though somewhat pricey game. We particularly like the futuristic looking case which ensured it was never left alone for long.

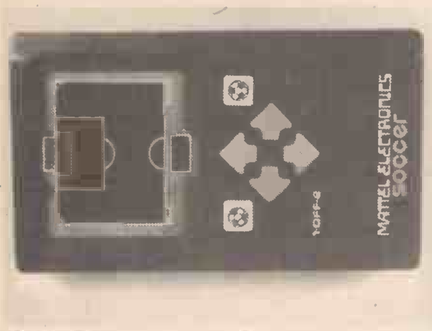


BATTLESTAR GALACTICA

Another variation on the Master Blaster type game, though this time without the superb graphics of that game. The object of the game is to destroy with the aid of steerable missiles oncoming UFOs. Battery operated, sound effects, price £15.90 supplier (2).

For anyone with limited funds and a yen for the space war type game this would be ideal. This is again a reaction game, the object is to destroy as many UFOs as possible in a given time, but ultimately beatable with perseverence.

games (with exceptions) but they are like like good books, difficult to put down. We won't recommend any specific games, after all "one man's meat . . .", what we will say is, look out for the games that are not easily beaten and won't be put to one side after a couple of hours play.



SOCCER

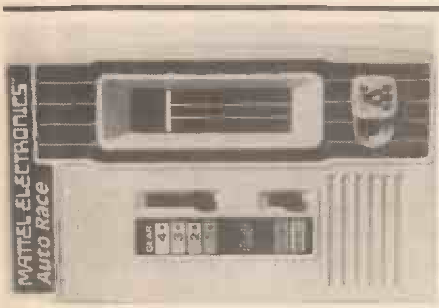
A one or two player game, the 'pitch' (or half of it at least) is represented by little LED men dashing about trying to prevent your man from scoring a goal. Your man is moved about by a series of four positional controls and a 'shoot' button kicks the ball from his position. There are two game speeds and each shot can be deflected by opposing players, who really do whizz about on the fast speed. Battery operated, sound effects, price £21.50 supplier (2).

A very interesting game, especially for football fans, the sound effects, goal scoring tune and half time whistle are most impressive. We found that the fast speed was almost impossible to play except by luck. Definitely one for the football buffs.

DIGITS

An electronic variation on the mastermind theme, the machine sets up a hidden code which the player then must guess in as few attempts as possible, it was unfortunate that this game was so similar to the genuine Mastermind game from Invicta, interesting nevertheless. Battery operated, no sound effects, price £13.95, supplier (1).

A good game for enthusiastic code-breakers, as we have said the genuine Mastermind is somewhat similar if not better. Worth thinking about if cash is tight, otherwise the proper Mastermind for a few pounds more is a better deal.



ROAD RACE

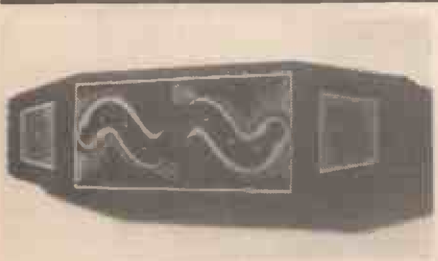
The object of this game is to steer a race car indicated by a bright LED up a race track full of slower cars. The car will progress up the track until it either reaches the end or is hit by a slower car whereupon it will be knocked back down the track. The track has to be covered four times before the game is over. Battery operated, sound effects, price £15.90 supplier (2).

Quite a novel game, although we suspect that the displays used in Road Race and Battlestar are the same. Again once the game had been beaten it rather lost its appeal. Good table top game to leave lying around when the neighbours call.

AMAZE-A-TRON

This is basically a maze game not relying on any kind of manual dexterity. In all there are 8 variations and the player must find his or her way from the starting point to the finishing point using coloured pegs on a keyboard. This game is unusual in that it has a two player game. There are apparently over one million variations so it should retain interest for some time. Battery operated, sound effects, price £17.95, supplier (1).

Quite an interesting game, we particularly like the little tunes and sound effects it made during the game, again this game produces a certain amount of frustration, especially to the impatient. Worth considering.



ZAP

A two player game, each player has to punch a large button which reverses a snake-like line of LEDs, the speed of the LEDs increases until the line of light eventually 'breaks through' and hits the home base. A score is indicated after each round by a number of LEDs at each end. Battery operated, sound effects, price £10.95, supplier (1).

Not one of our favourite games, we found that it was, to a certain extent easy to beat, good fun nevertheless. This game would probably suit a lower age range as adults tended to get rather brutal with it.

VIDEO GAMES **There are numerous variations on the AY38500 type games and as most people have either got one or have played one we won't be reviewing a particular model. One dedicated game, Starchess, we have included because we felt that it was just about the best single game machine we have ever seen.**

ATARI VIDEO COMPUTER

The Atari was the first of the so-called 'cartridge programmables'. The current range comprises some 30 cartridges offering up to 50 games and variations. Four different types of controllers (two sets come with the basic unit). We found that for most of the games the basic paddle and joystick controllers are quite adequate. The new Chess cartridge is claimed to be one of the strongest chess programmes yet, unfortunately our sample was an American standard NTSC cartridge so we were unable to fully assess it on our telly. Powered by external AC adaptor sound effects on TV speaker, basic price £159.95 additional cartridges £14.95 supplier (3).

This game and its range of cartridges brought the office to a complete standstill for over a week until someone had the bright idea of taking it home. (Bring it back please). The graphics are superb in colour and although the novelty games like Outlaw, Basketball and Combat are good fun we found the simpler games of skill and reaction like Breakout (just like the pub game but with many interesting variations) and Surround had a longer lasting appeal. A really great game if you're prepared to spend a few bob. Highly recommended.

STARCHESS

Based very loosley on the ancient game of Chess this game does not actually play, rather it displays. All the pieces except the pawns (and King) make the same moves as in ordinary chess but have the added capability of being able to 'fire' missiles at your opponent from a limited missile store and 'warp' from the board (and return after a random time onto a random square). Powered by an AC adaptor, sound effects on internal speaker, price £63.93 supplier (2).

Well, what can we say, this is our kind of game, requiring a great deal of thought and skill (like a conventional game of chess). We thought it a pity that you couldn't play ordinary chess, but the superb sound effects and clever graphics more than made up for that. We particularly liked the way the pieces resembled space vehicles and the very good hand controllers. Recommended for bored chess enthusiasts.

This game is unusual, in that it is programmable but uses 'dedicated' chips. Compared with the Atari it has less to offer in the way of variety but considering the price difference it is well worth thinking about. The game is available in either ready built or kit form, additional controllers coming with each game as required. Powered by AC mains adaptor, sound on TV speaker, price £35.00 supplier (4).

There can be no doubt that apart from Starchess the only TV games worth buying are the programmables. Single game units tend to become obsolete very quickly indeed. The Teleplay comes somewhere between the two provided the manufacturers can keep a supply of new games coming it will give the larger more sophisticated games like the Atari a hard time. We liked it a lot and would recommend it to anyone. Even as a kit it is well worth buying because it will keep you interested that little bit longer.

GRANDSTAND

This programmable video game represents a good balance between the Atari and Teleplay, it is a good deal cheaper than the Atari, as shown by the quality of graphics. This is not however a reflection of the games themselves, they are all very challenging. Powered by external mains adaptor, sound effects, price £79.95 additional cartridges £12.95, supplier (3).

We were slightly disappointed by the hand controls, they lacked the precision control of the Atari, we felt they had tried to incorporate too many actions onto too small a unit, they would have been much better offering maybe two different types of control box. The games were all very good (Breakout could have been even better with different controls) the maze game we especially liked. Worth considering if your funds lie somewhere between the Atari and Teleplay.

SPECIALIST GAMES **We decided to call these 'specialist' games simply because they couldn't be put into any other category. From the most up-to-date speaking Chess Challengers to the Marksman game (a secret favourite) they cover so many different fields it would be impossible to call them anything else.**

CHESS CHALLENGERS

At the moment there are three Chess Challengers in the series. The latest arrival being the Voice Chess Challenger that actually speaks its moves. It has 9 levels of play from beginner to expert and an 'infinite' mode that will continue to compute a move until told to do otherwise. All of the Challengers have many, many important features, far too numerous to list here. We strongly recommend that you go along to your local stockist and look very carefully at what is on offer. Also worth bearing in mind are the excellent Boris Chess computer and the Video-Master Chess machine. All the Challengers operate from an external AC adaptor, prices, Voice Challenger — £249.95, Challenger 10 (10 levels) £169.95 and Challenger 7 (7 levels) £99.95 Supplier (1).

It's difficult to give an appraisal of any of these machines, we're all lousy chess players, our advice is to go along to your local stockist and give them a quick game. Convenience of use is pretty much a matter of choice, we prefer the ones that include a board and a set of pieces.

BRIDGE, BACKGAMMON AND CHECKER CHALLENGERS

Three relatively new games, the Bridge machine in particular is very advanced. The Checker Challenger (Draughts) is great fun but just a little pricey. The backgammon game again has many important features but we felt in all cases that the price of these games put them firmly into the 'enthusiasts only' bracket. All are powered by AC adaptors, prices; Bridge Challenger £299.95, Checker Challenger £54.95 and Backgammon Challenger £94.95. Supplier (1).

Without going too deeply into these very sophisticated machines we would think that they have only a limited appeal, especially at those prices but are well worth considering if you are really keen on one particular game. All of the machines seen play their respective games extremely well and a good to above average player would be hard put to consistently beat any of them.

SIMON

Outwardly this looks like a rather simple sort of game, Simon generates a random sequence of flashing lights that the player (or players) has to duplicate by pressing the appropriate button. The sequence gets longer and longer until a mistake is made whereupon it blows the loser a raspberry. Battery powered, sound effects, price — around £29, supplier (5).

A great game for parties though not much fun on your own. Worth considering if you do a lot of entertaining, it will quickly cure any dull moments.

ZODIAC

This is claimed to be the first Astrology computer, when supplied with information such as date of birth etc, it will make certain 'do or don't' predictions, complete horoscopes and what your stars fortell on a past, present or future basis. Battery powered, price £25.95, supplier (1).

We wouldn't recommend anyone to take this too seriously but as a source of amusement it may be well worth looking at. Just the thing for clairvoyant aunts perhaps?

MARKSMAN

This game was one of our favourites, an Owl shaped target (poor Owl) has to be 'shot' with a beam of light from a replica .38 revolver. When the target is hit the Owls eyes light up and it emits a rather pitiful squarking noise from its nether regions, great stuff. Battery operated, sound effects, price £5.90, supplier (2).

There's no doubt about it, this game was great fun. The gun sights were a little inaccurate but that was easily compensated for. We found the range to be in excess of 20 feet with fresh batteries. Avoid the temptation to blow on the gun barrel as this steams up the lens. Great for Christmas.

Analogue Audio Frequency Meter

Get in tune with the modern age . . . economical testgear — made to measure

THIS LINEAR SCALE AFM will enable you to resolve frequencies from 10Hz to 100kHz in four decade ranges. It is low in cost yet high in performance. Accuracy is unaffected by the waveshape of the input signal and the unit is sensitive to input levels down to about 200 mV. The input circuit features a protection diode network and the maximum safe input voltage is effectively limited by the rating of the coupling capacitor C1. The unit operates from a single 9 volt battery and current drain is low giving a useful life from a PP3 or equivalent source.

CHEAP CHIPS

Only two relatively cheap chips are used; a 3140 bi-MOS op-amp which performs signal pre-amplification and conditioning, driving an ordinary 555 timer configured in the monostable mode. Timing components are selected by a five position range control which also

Calibrating the HE Audio Analogue Frequency Meter against the workshop signal generator. For those without any test equipment an alternative method is outlined in the text functions as the power switch. Only a handful of other components are required and accuracy, after calibration, is determined by four fixed resistors.

CONSTRUCTION.

Construction may take many forms. However, use of a PCB aids assembly and reduces any chance of error. Our design is highly recommended. In any event, all leads should be kept as short as possible to avoid stray coupling; keeping signal input leads away from the 555 for example.

Construction should proceed in the usual order. Insert the IC holders first, followed by the passive components; resistors and capacitors, paying close attention to the orientation of the polarised components. Finally insert the diodes and plug the IC's into their sockets. Pin one is indicated by an indent at the top of the package or a dot by the pin itself. Note that the signal 'low' input is separate from the 0V line.

CALIBRATION AND USE

Calibration of the instrument is very straightforward owing to the high input impedence. With the unit switched to the 100Hz range, touch the input with your finger. There will generally be enough stray mains field to provide an adequate signal. This should cause a deflection on the meter and RV1 can be adjusted until a reading of 50 Hz is obtained.

How it Works

The input signal is applied to C1. R1, D1 and 2 provide protection against high input levels. IC1 is a high input impedance op-amp configured as a Schmitt trigger with R5, 6 setting the hysterisis. C2, R2, 3 provide a mid-voltage bias source.

The output of IC1 consists of a train of square waves at the same frequency as the input signal. This triggers the 555 timer which produces a monostable pulse of period determined by selection of range resistor, R9 through R12 at the output pin 3 from each negative excursion. The trigger pulse must be shorter than the output pulse and differentiating network C3, R7, 8 is used to accomplish this.

To avoid inaccuracies owing to falling battery voltage, the output of 1C2 is clamped at 5 V6 by ZD1 and the meter is driven via current limiting network RV1, R14. A 5 V6 zener is chosen as it has a low temperature coefficient. This means that its voltage exhibits little change per degree change in temperature. The reason for this is that the negative and positive temperature coefficients of the zener and avalanche effects almost cancel out in 'zener'diodes of this voltage.

The only possible source of trouble worth mention may be failure of the 555 to trigger at all. This could be caused by the value of C3 being too small. Trouble from this source is unlikely. However, C3 should be as small in value as possible consistent with reliable triggering.

Current pulses from 1C2 are averaged in the meter whose deflection indicates the input frequency. To allow for variations in component tolerances, full scale deflection corresponds to about a 75% duty cycle. C5 is a supply decoupling component.

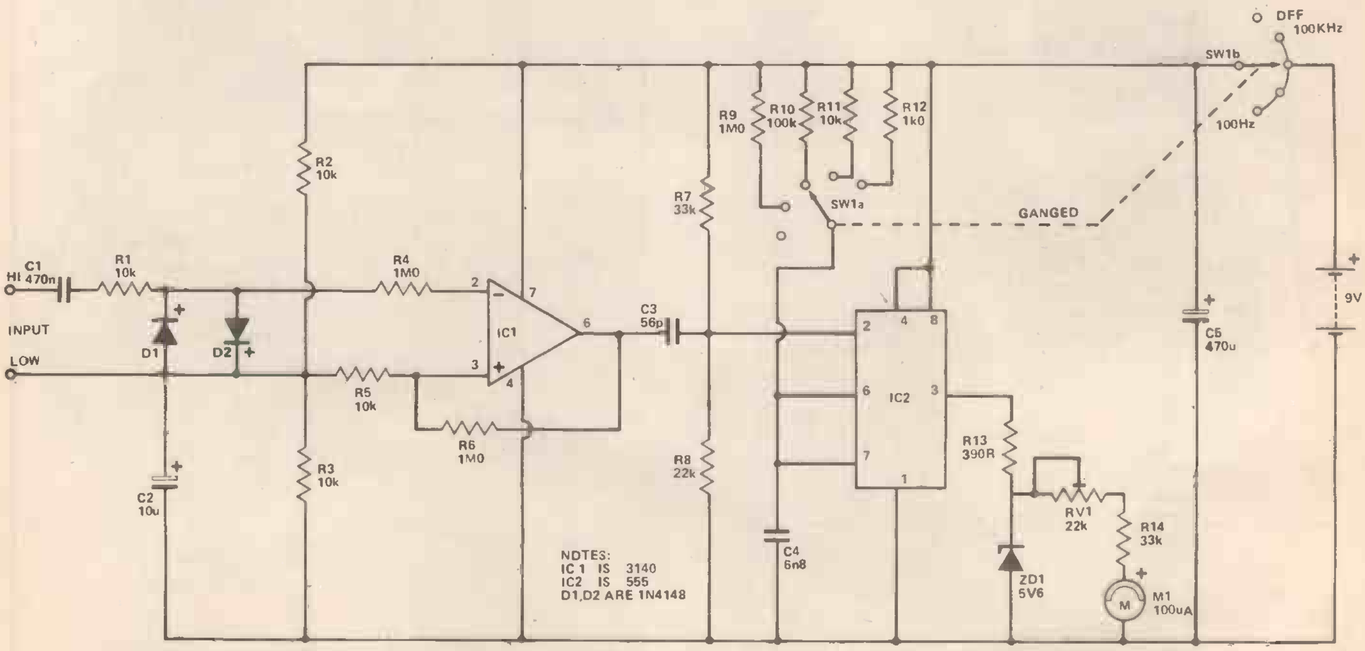


Fig. 1. Circuit diagram of the HE Analogue Frequency Meter

Of course if a signal generator of known accuracy is available, you can set up the unit on any desired range. However, the technique described above will enable useful results to be obtained. A feature of the instrument is that only one range need be calibrated; the others falling into line automatically.

In use, select the highest range (100 kHz), this automatically applies power to the unit, then connect the unknown input signal. The reading can be noted and a lower range selected if required. This is to avoid spurious readings which can be obtained on the lower ranges owing to retriggering of the 555 by high frequency input signals. There are no other adjustments to make so all you need now is something whose frequency you can measure (how about the HE siren in this issue?) **HE**

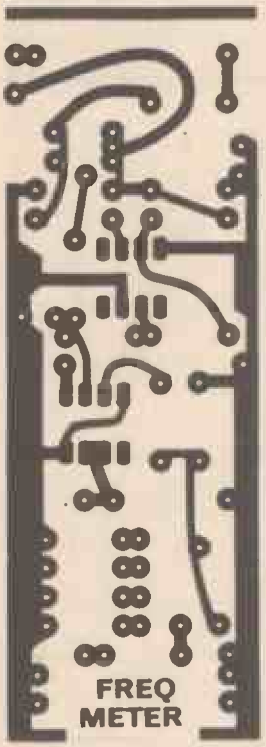
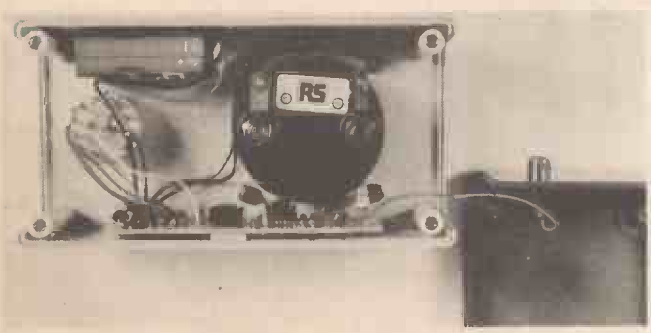


Fig. 2. PCB foil pattern for the AFM



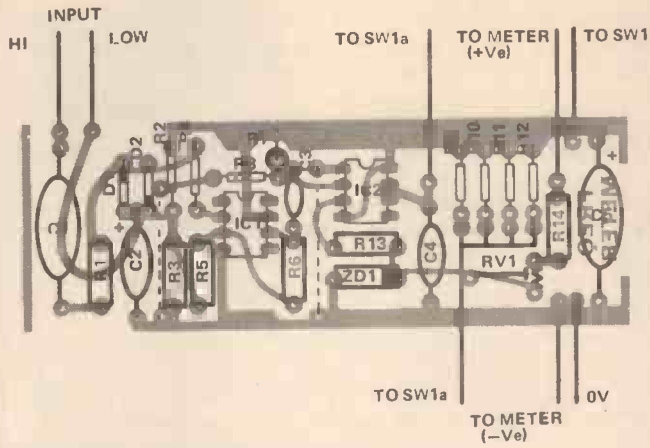
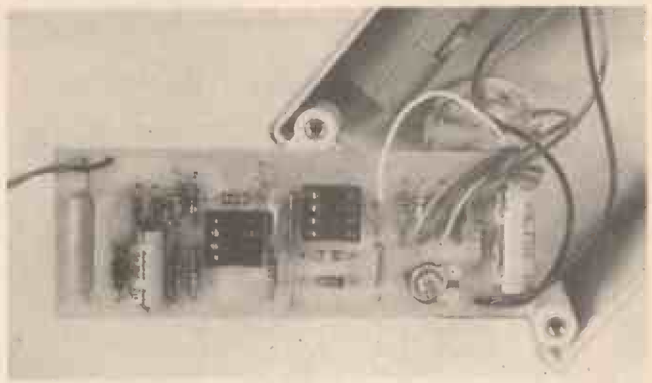


Fig. 3. PCB overlay for the AFM



Parts List

RESISTORS (all ¼W, 5%)

R1, 2, 3, 5, 11	10k
R4, 6, 9	1M
R7, 14	33k
R8	22k
R10	100k
R12	1k
R13	390R

POTENTIOMETER

RV1	22k preset

CAPACITORS

C1	470n polyester
C2	10µ tantalum
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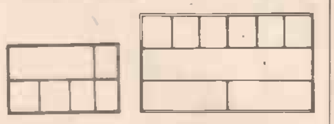

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Tech Tips has always been one of the most popular features of ETI. We're certainly not short of contributions. We thought it was about time we gave Tech Tips the deluxe treatment it deserves. Next month we have an 8-page Tech Tips Special — 8 pages of your ingenious suggestions for circuit designs.

TV GAMES UNIT

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You can play pin-ball, break-out and solo target basketball. The target basketball game is particularly difficult as you not only have to stop the ball falling off the bottom of the screen, but also press a button to shoot it up towards the target at the same instant as it hits your bat.

Break-out proved to be the star of the system. You gradually knock bricks out of the wall until your ball breaks through and hits the rear wall. It bounces back at break-neck speed and — shock, horror — your bat has shrunk to half size. If you manage to clear the screen, another wall springs up.

The sneaky part is that when you reset the unit, the last score is also displayed on the screen along with your current score. So, of course you have to beat your last score — even if you have to play all night. It's addictive.

GOT A LEAKY MICROWAVE OVEN?

You don't know, do you. If you use a microwave oven a lot, you'll naturally want to know how much radiation is leaking out to your kitchen. If you glow in the dark, you've got a good idea already.

To put your mind at rest, build our microwave oven leak detector. It couldn't be simpler.

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If you prefer to put your feet up while bringing the 8.10 to a graceful halt, there's even a two-wire hand controller that lets you control four complete systems (tracks) and shows you which set of points is selected for switching.

Full details of this major model railway project will be in the November issue of ETI.

Microwave Cooking

Much has been said lately on the subject of Microwave Cooking, is it safe, are they cheaper and quicker than ordinary methods of cooking? Find out for yourself. Dr. B. Minakovic of the University of Oxford, one of the countries leading experts takes the lid off the world of Microwaves.

INVENTED SOME TWENTY YEARS AGO, domestic microwave ovens are still somewhat rare in this country, although common in the U.S. and Japan. Industrial applications of microwave heating, on the other hand, are quite widespread and range from tyre processing to biscuit-making and the drying of peas.

The main advantage of cooking by microwaves is speed — anything from two to four times faster than by conventional means. This does not mean that one can improve very much on an electric kettle to boil water, but certainly it will cook a chicken faster than a gas or an electric cooker, despite its lower power rating.

Cooking by microwaves requires some change in cooking habits. For instance, there is no need to warm up a microwave oven before food is put into it, as it is often done with an ordinary oven. Also, there are no more temperature settings to worry about because all cooking is controlled by time.

In contrast to radiant heat, microwaves penetrate almost instantaneously into food and produce heat by agitating the atoms and molecules. The result is fairly uniform heating through the food, but without a crust or surface browning. This may be a desirable feature in some cases, for instance, when warming up or preparing pre-cooked food. When, however some crust or surface browning is necessary the cooking has to be finished off in an ordinary oven.

BROWNED OFF

To obviate the necessity of transferring the food from one oven to another some ovens are fitted with radiant electric elements. In others one can now use a so-called "browning-dish" which is designed to absorb microwaves and hence produce sufficient radiant heat to

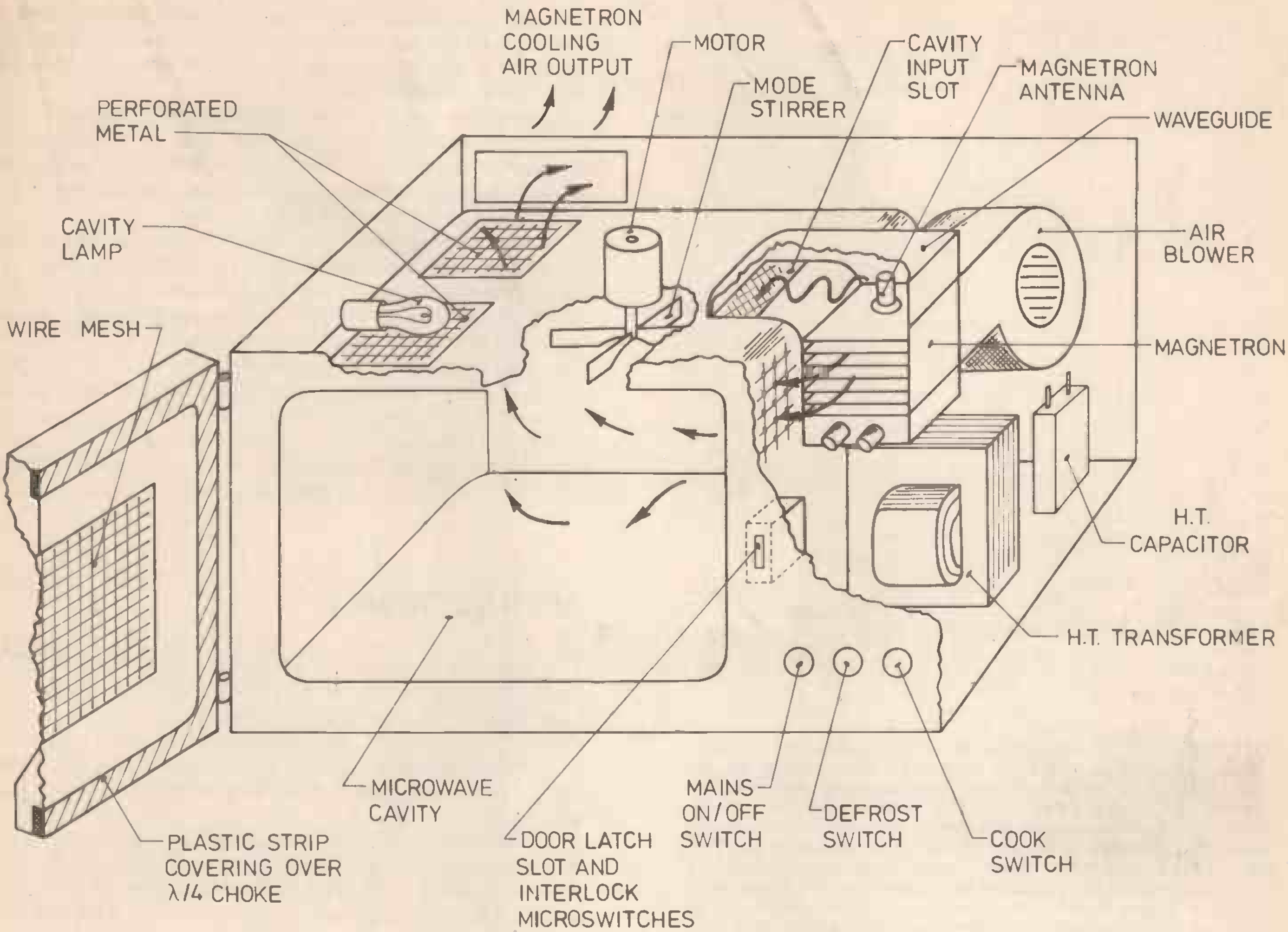


Fig. 1: Basic features of a microwave oven.

cause some browning. It should be noted that ordinary glass and pyrex dishes are not heated, being poor absorbers of microwaves. The oven, usually made of stainless steel, is also not heated because metal walls are good reflectors of microwaves. Metal utensils or dishes behave similarly and must not be used in a microwave oven. Apart from screening food from microwaves, they could produce spurious reflections which could adversely affect operation of the microwave source (magnetron) and even damage it.

Condensation on the cold oven walls is prevented by ducting into the oven the hot air from the magnetron cooling circuit, so the vapours are blown out as quickly as they are formed. As a result an oven never gets really dirty and occasional wiping with a soapy cloth is all that is usually necessary to keep it clean.

Defrosting of frozen food is possible, too. This process, however, must not be regarded just as warming up. Ice, unlike water is a poor absorber of microwaves so will take somewhat longer to heat up. If heating is too rapid, water pockets which are formed will enhance local heating, causing hot spots or even burning. This can be prevented by switching the microwave power off and on, so that the heat has time to diffuse from hot spots into the frozen region and there produce more thawing. Typical times are 7-15 sec for "off" and 5-10 sec for "on," the exact timing being determined by the power rating of the oven. The switching sequence is controlled electronically and all that a user has to do is to set the timer according to the quantity of food and depress the defrost button.

BACTERIA

The practice of defrosting food by letting it stand overnight at room temperature is rather dangerous, because, once a certain temperature is reached bacteria will start to multiply and food poisoning is possible. This cannot happen with microwave defrosting simply because the time is too short. In any case, there is some evidence that in fact microwaves tend to kill bacteria as most of them are good microwave absorbers. It is important to remember that any kind of food processing involves a certain degree of risk from bacteriological infection, so all food should only be handled in scrupulously clean conditions.

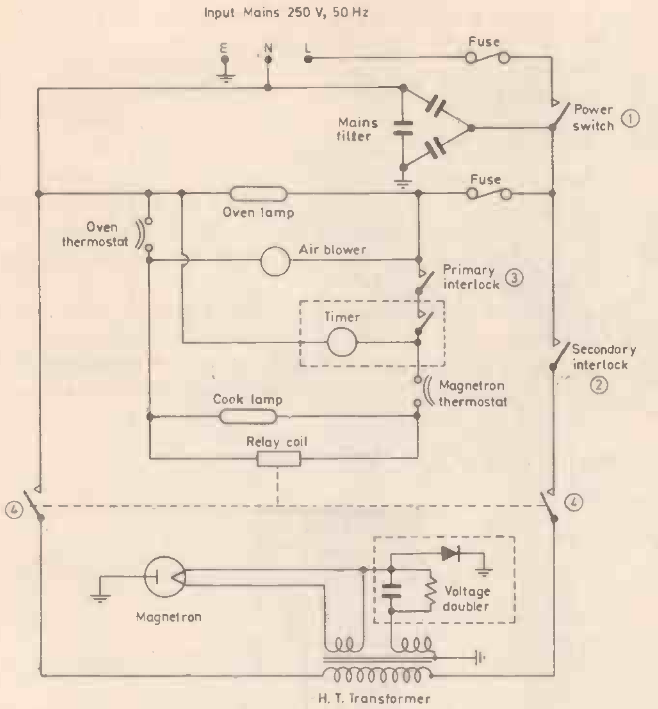


Fig. 2: Simplified circuit diagram of a microwave oven.

Magnetron HT of 4.5 kV is produced by stepping up the mains input to 2.3 kV and the half-wave doubling. The doubling circuit, consisting of a capacitor and a rectifier diode, generates a square-wave at the mains frequency. The polarity is negative so that the anode (magnetron body) can be earthed. The effect of mains fluctuations is reduced by operating the HT transformer core near magnetic saturation. The interlock switches 2 and 3 are operated by the door latches and therefore the magnetron is energised only whilst the door latches are engaged, i.e. the door is closed.

For clarity, the defrosting circuit has been omitted from the diagram.

HOW DOES IT WORK?

Radio waves, microwaves, heat, light and X-rays are examples of electromagnetic waves. Although identical by their nature, they exhibit many different properties simply because of their vastly different wavelengths (frequencies). Microwaves, developed during World War II were named so because in comparison with ordinary radio waves, their wavelengths are very small, 100mm or less.

When food or some non-metallic material is placed in a microwave field, the electric field penetrates into it and forces electrons, protons and ions into oscillations along the direction of the field and at the same frequency. Internal friction then produces heating. The rate of heat generation depends on the field strength, its frequency and a parameter tan δ which characterises the "lossiness" of a material. Materials with low tan δ like quartz and PTFE cannot be heated by microwaves. An electric field propagating through a lossy material decays in amplitude at a rate inversely proportional to the square root of frequency.

A microwave field can penetrate several centimetres into the food before it becomes very weak. This distance is known as the depth of penetration. Infra-red radiation (heat), on the other hand, penetrates less than a millimetre and thus heats the surface only and from there the heat spreads inwardly mainly by conduction, a relatively slow process. So, the essential difference between microwave and ordinary heating is that microwaves penetrate deeply into food whereas the ordinary heat radiation is absorbed at the surface.

The internationally allocated frequency band for microwave cooking is centred at 2450 MHz corresponding to a wavelength (λ) of 12.24cm (use $f\lambda = c$, c is the speed of light, 3×10^{10}cm/sec). There is no special reasons why it should be exactly 2450 MHz. A few hundreds of MHz up or down would hardly matter as far as the cooking or the depth of penetration is concerned, and equally the rate of heat generation would be hardly affected. The main reason for this allocation is that this band is not much good for anything else and it does give a reasonable depth of penetration.

MAGNETRON

The essential features of a typical modern microwave oven are show in Fig. 1. The microwave cavity, as the oven itself is usually called, is a rectangular metal box, large enough to accommodate an oversized chicken. Microwave power is fed in at the top through a large slot via a short waveguide with a magnetron antenna at the other end.

On entering the cavity microwaves spread out in all directions and undergo a series of reflections from wall to wall, passing through the food on each transit. The situation is analogous to a beam of light in a closed box with mirror walls.

Furthermore, as in the case of light, destructive or constructive interference will take place between the overlapping waves and providing the cavity dimensions are the multiples of the cavity half-wavelengths, there will be set up a three-dimensional standing wave pattern. In technical terms, the cavity is said to be resonant. Fig. 3 shows such a standing wave pattern of the electric lines of force.

Food or any other object in the cavity will distort the standing wave pattern, but nevertheless the cavity may remain resonant simply because the Q factor will be reduced too, and so the resonant range will be widened.

The heating pattern of a cavity corresponds to the electric field pattern: strong heating in the regions with strong electric field and no heating at all where the electric field falls to zero. Clearly, an oven producing an array of cold and hot spots whould not be very satisfactory for cooking. Fortunately, the heating pattern can be smoothed out by perturbing the electric field with a small metal propeller or "the mode stirrer" as it is usually called. As the name suggests, the mode stirrer moves the electric field standing wave pattern to and fro, so the cold spots at one instant become hot at the next and so on. Of course, in addition to this heat will also spread out by the ordinary conduction process. The mode stirrer is always mounted on the ceiling of the cavity and protected from accidental damage by a plastic sheet of low tan δ. Some manufacturers prefer a turn-table for the food to a mode stirrer, the others fit both.

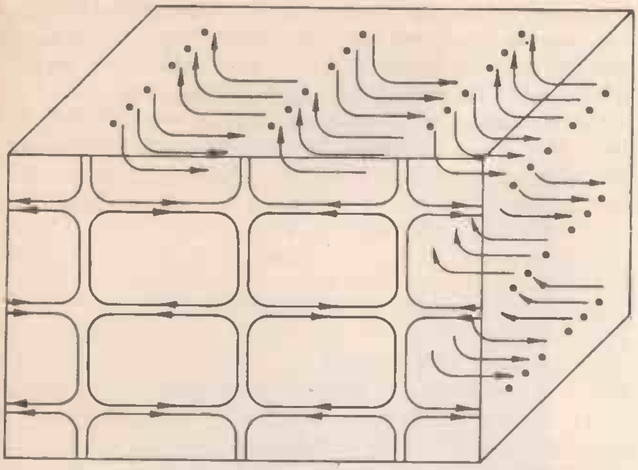


Fig. 3: The electric field standing wave patterns in a microwave oven.
The arrows indicate the direction of the electric field at an instant of time — they are reversed once every cycle, 2450 million times per second!

Power for a microwave oven comes from a magnetron. Typical microwave power rating is 500 W for a small domestic oven, increasing to around 2000 W for a catering model. The nominal guaranteed life of a small megnetron is 1000 hours, but experience shows that with careful use, this can be doubled or even trebled. In any case, bearing in mind that a microwave oven runs only for relatively short periods, 1000 hours can be equivalent to about 3 years of normal use.

EFFICIENCY

The efficiency of cooking magnetrons ranges from 50% for small units to about 75% for bigger ones. Although cooking magnetrons are designed to tolerate large load variations, an oven must not be run empty because microwaves would be reflected back into the magnetron and cause damage by overheating the cathode or the ceramic seals. Some microwave ovens are fitted with a manual power control for reducing the power output when the loading is very light — otherwise the loading should be artificially increased by putting into the oven a small cup of water.

Microwave leakage from an oven occurs mainly through the door seals and the window wire mesh. There may be also some leakage through the poor joints in the box due to poor shielding of the magnetron HT terminals.

The leakage between the door and the cavity flange is prevented by incorporating into the door frame $\lambda/4$ chokes, see figure 4.

When a wave leaking through the small gap between the door and the cavity flange reaches the slot B it is almost completely reflected back because of the discontinuity. By the time it reaches again the input plane A the wave will have travelled a total distance $\lambda/2$ and therefore it will be in the antiphase with just incoming wave and hence cancel it. In terms of impedance, the input plane A behaves as a short circuit. A small fraction of the wave that leaks past the discontinuity at B continues to the short circuit C where is reflected back to B. Any leakage from B to the outside is suppressed by the lossy rubber strip, mounted along the edge of the metal box. The $\lambda/4$ choke slot is normally covered with a plastic insert to prevent accumulation of dirt.

The door window is not absolutely necessary but it does help one to follow the progress of cooking in the lit-up oven. A wire mesh is used to prevent radiation through the window. The mesh is protected from accidental damage and from dirt by plastic sheets on both sides of the window.

The interlocks operated by the door latches are another very important safety feature. They ensure that the microwave power cannot be switched on whilst the door is open even if the cooking switch is depressed.

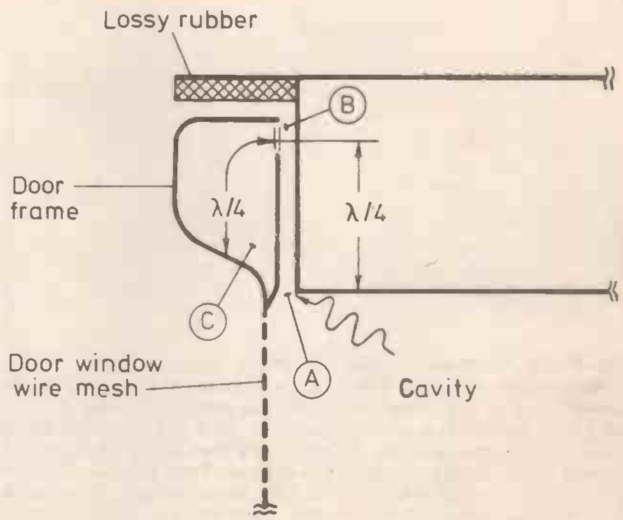


Fig. 4: Cross-section of the door frame showing $\lambda/4$ choke which reduces microwave leakage.

DANGER FROM MICROWAVES?

Microwave hazards arise mainly from internal heating and should not be confused with radio-activity which is far more dangerous. Eyes and genital organs are very sensitive to microwaves and can be damaged by fairly small doses. Prolonged exposure to microwaves can result in eye cataract, a condition in which the lens of the eye becomes clouded.

There is considerable disagreement as to what is the safe power density. The generally accepted figure is about 10mW/cm², although some sources claim that this is still too high. Microwave ovens are normally designed for 1mW/cm² or less and if necessary this could be even further reduced by another factor of 10 — at a marginal increase in the price.

Of course, a damaged door flange can increase the leakage above the permitted level and there is no way of detecting it without a leakage meter. A good practice is never to put one's face into the door window and to operate the oven from an arm's-length distance. Then, even if something does go wrong one will be fairly safe.

Claims that small leakage from a microwave oven can cause cancer are an absolute rubbish. In fact microwaves of slightly longer wavelength are used daily in hospitals, in diathermy, with beneficial results.

TESTING A MICROWAVE OVEN

Power test — Pour exactly 1 litre of water into a plastic beaker and having measured the water temperature, heat it in the oven for exactly 4 minutes. On removal, stir the water lightly with the thermometer and again measure its temperature. Calculate the temperature rise from the two readings (in °C) and multiply it by 17.5 to obtain the microwave power in watts.

If the measured temperature rise is too large for the thermometer available, use two litres of water or half the heating time — in either case use 35 as the conversion factor.

Heating pattern in a microwave oven (recorded in a horizontal plane 4in. above the cavity bottom). Dark areas indicate strong heating, light areas weak or no heating. (Courtesy Western Dynamics Ltd.)

CHECKING UNIFORMITY OF THE ELECTRIC FIELD

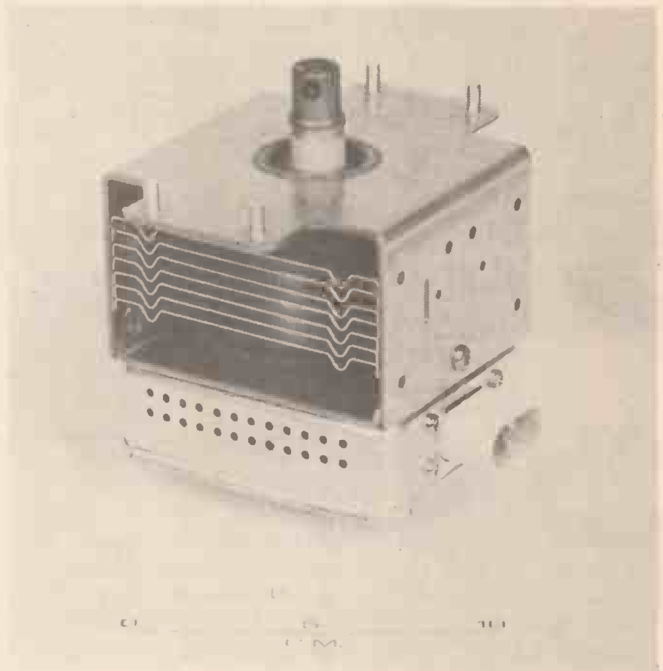
When a small neon lamp is put into a microwave field it glows bright red if the field is strong enough to ionize the gas in it. This fact is used here to sample the electric field in a microwave oven.

Bed the neon lightly into a lump of plasticine, its leads pointing upwards to act as an antenna. Normally the leads are too long and should be reduced to about 2cm or less, so that the lamp is not overheated.

If necessary, sensitivity can be improved by bending the leads apart, to form a Vee. This type of an antenna is directional, so try various orientations and positions.

If several neons are available stick them on a strip of perspex, about 2cm apart. An oven must never be run empty so do this test with a cup of water in it.

The leakage field outside an oven is far too weak to ionize the gas in a neon lamp and no glow will be observed.



Microwave oven magnetron.
(Courtesy Toshiba Ltd.)
Out put power 840 W
Peak operating voltage 4.5 kV
Average anode current 350 mA
Cooling by blowing air through fins
Focussing by ferrite magnets

WARNING

In operating a microwave oven always follow the maker's instructions. Do not remove the covers because this will not only expose high voltage terminals but also increase the microwave leakage.

Also do not poke wires or sharp objects into the door seals or cavity perforations for this can significantly increase the microwave leakage.

HE

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Department of Engineering Science,
University of Oxford,
Parks Road,
Oxford,
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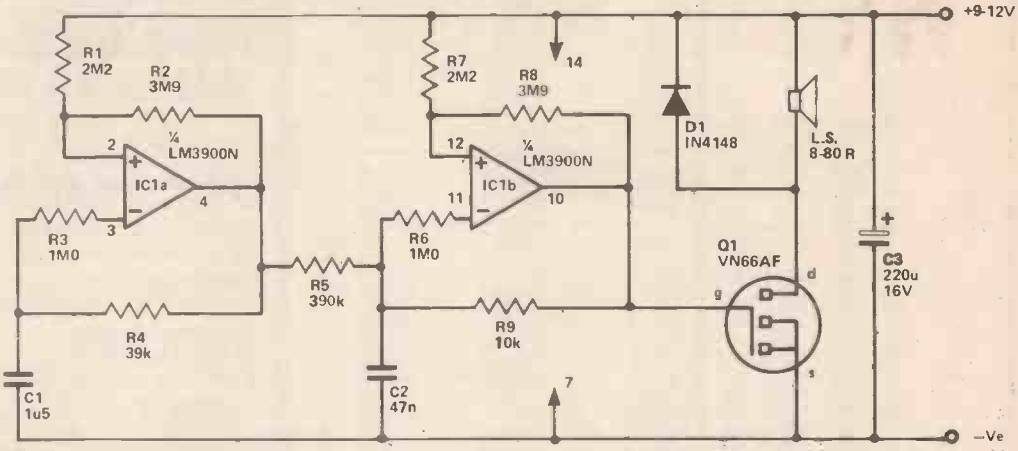
TWO TONE ALARM



Audio alarm generators are needed in a number of applications, such as fire and burglar alarm systems. This circuit generates a penetrating two tone alarm signal having an output power of between about 250 mW and 4 W RMS depending on the speaker impedance and supply voltage used. For low power applications a 9 volt supply and a speaker impedance of about 64 to 80 ohms will give a nominal output power of 250 to 300 mW for a current consumption of around 55 to 70 mA. Where high volume is needed, a 12 volt supply and 8 ohm speaker will give an output power of about 4 W RMS at a mean current consumption of about 700 mA.

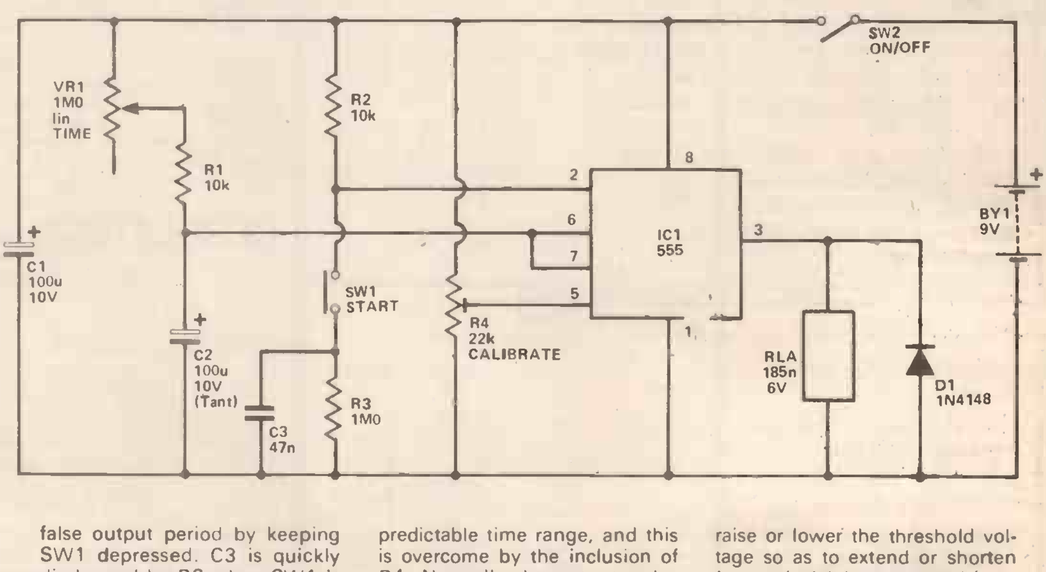
The circuit is based on two of the four Norton amplifiers contained in the LM3900N IC. A Norton amplifier is in many ways similar to an ordinary operational amplifier, but it is the comparative input currents rather than the input voltages that determine the output voltage. IC1b is used in a type of relaxation oscillator which generates the audio tone. Initially the bias current flowing into the non-inverting input takes the output high, and C2 begins to charge via R9. This causes the current flowing into the inverting input through R6 to gradually increase as the voltage on C2 builds up, until it exceeds the non-inverting input bias current. The output of IC1b then goes low, causing C2 to discharge through R9 until the inverting input current becomes less than that flowing into the non-inverting input. IC1b output then goes high, and the procedures starts again from the beginning, giving continuous oscillation. Note that when IC1b output went from the high to the low state, this resulted in R8 draining off some of the non-inverting input bias current where it had previously added to it. This makes it necessary for C2 to considerably discharge before the current into the inverting input drops below that applied to the non-inverting input. This effect is a form of "hysteresis", and is essential to the operation of the circuit. R8 also provides positive feedback which ensures that one IC1b output starts to change polarity it rapidly and reliably switches from one state to the other.

The squarewave output of IC1b is at quite a high impedance, and so the loudspeaker is driven by way of a common source amplifier using VMOS transistor Q1. IC1a is used in a second oscillator circuit, but this has component values which give oscillation at a frequency of only a few Hertz. Its output is loosely coupled to C2 by R5, and it frequency modulates the tone generator to produce a sort of warbling effect. This gives a much more noticeable and less easily masked signal than a straight forward audio tone.

Short Circuits

555 I.C. MONOSTABLE CIRCUITS

(1-Timer)



In the monostable multivibrator mode the 555 IC requires a trigger pulse which takes the trigger input below 1/3 of the supply voltage. The normally low output then goes high for a period determined by a C-R network, the pulse length being approximately 1.1 CR seconds. The device is a retriggerable type, and the output therefore stays high until the trigger pulse ceases, if the latter is longer than the pulse given by the C-R timing circuit.

The first circuit is for a timer having a 1 to 100 second range, and suitable for use as an enlarger timer, for example. It is triggered by depressing SW1 so as to generate a brief negative pulse as C3 charges via R2. This makes it impossible to prolong the output pulse and produce a false output period by keeping SW1 depressed. C3 is quickly discharged by R3 when SW1 is released, rendering the trigger circuit ready for the next operation.

The tolerance of timing components RV1, R1, and C2 make it impossible to obtain a highly predictable time range, and this is overcome by the inclusion of R4. Normally the output pulse ends when the charge on the timing capacitor reaches 2/3 V+ (it is held uncharged until the circuit is triggered, and is discharged when the ⅔ charge level is reached). R4 can be used to raise or lower the threshold voltage so as to extend or shorten (respectively) the output pulse, as necessary to obtain the appropriate timing range. The output pulse at pin 3 is used to operate the controlled equipment by way of a relay, and D1 is simply a protective diode.

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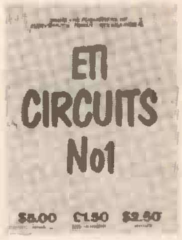

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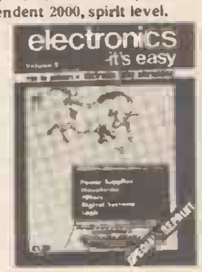

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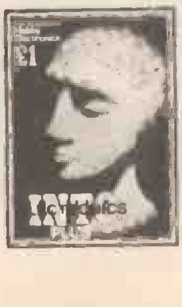

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Multi Option Siren

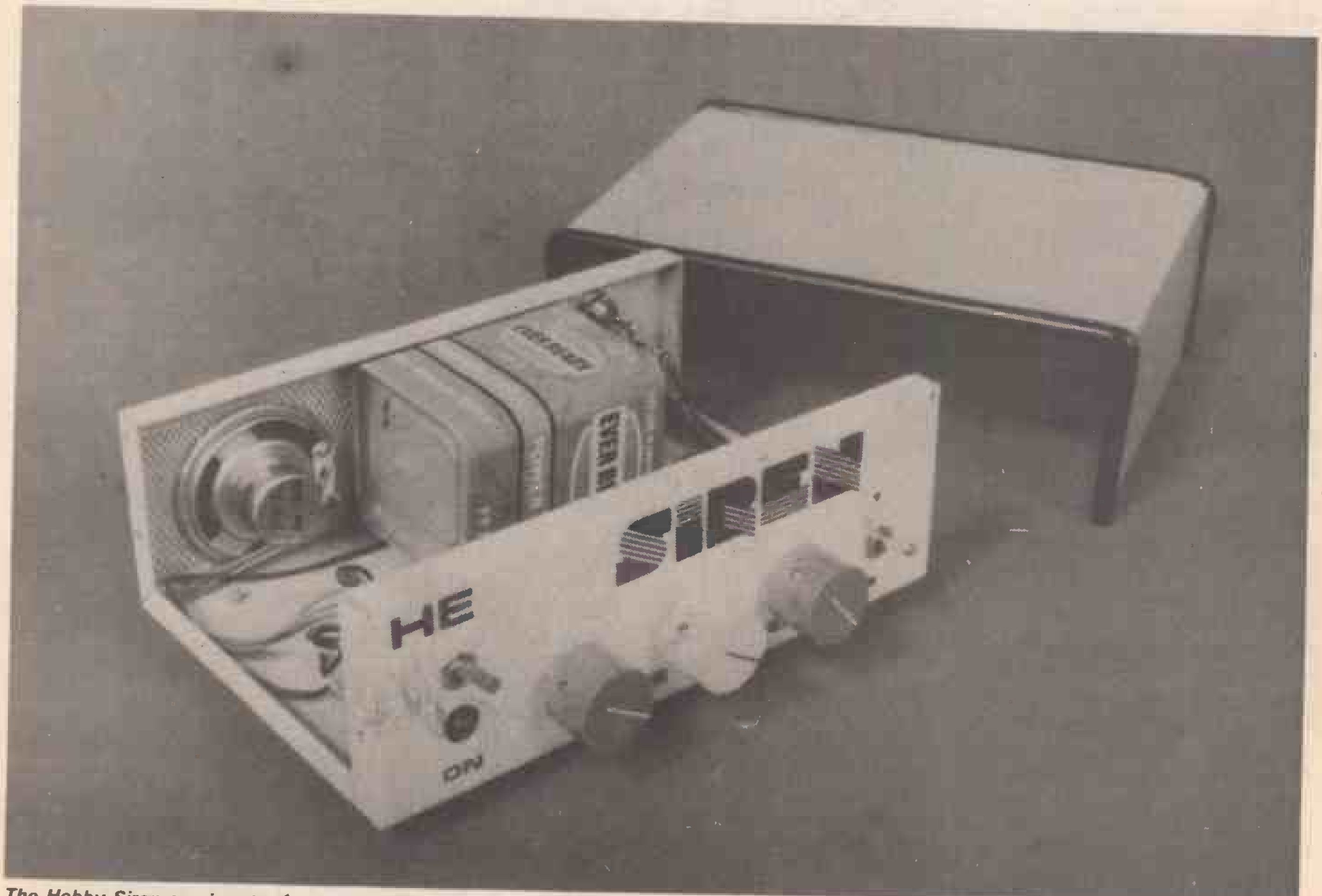
Subtle Susurrations from a Sensational Sonic Siren

ECONOMY AND VERSATILITY are the key features of this unit. We are not saying you can produce any siren sound, but there is enough variety available to keep anyone happy for hours if not days. Build two and saturate your senses in stereo. You can reproduce a great American police siren and a World War two air raid alert and a whole universe of effects as well.

Possible applications include burglar alarms, sound effects units, a 'button-box' to amuse the kids or just put it through your stereo and annoy the neighbours.

COMPLETE CONTROL

Four independently adjustable parameters give you fingertip control over the rise and fall times of the control voltage, the sensitivity of the voltage controlled oscillator and the basic centre frequency of the unit. You can switch between a square wave or triangle waveshape from the control oscillator and the control oscillator period may be varied between several seconds and several hertz.



The Hobby Siren on view to the world. Note the miniature speaker which produces suprisingly loud volume and the use of a large battery for extra long life.

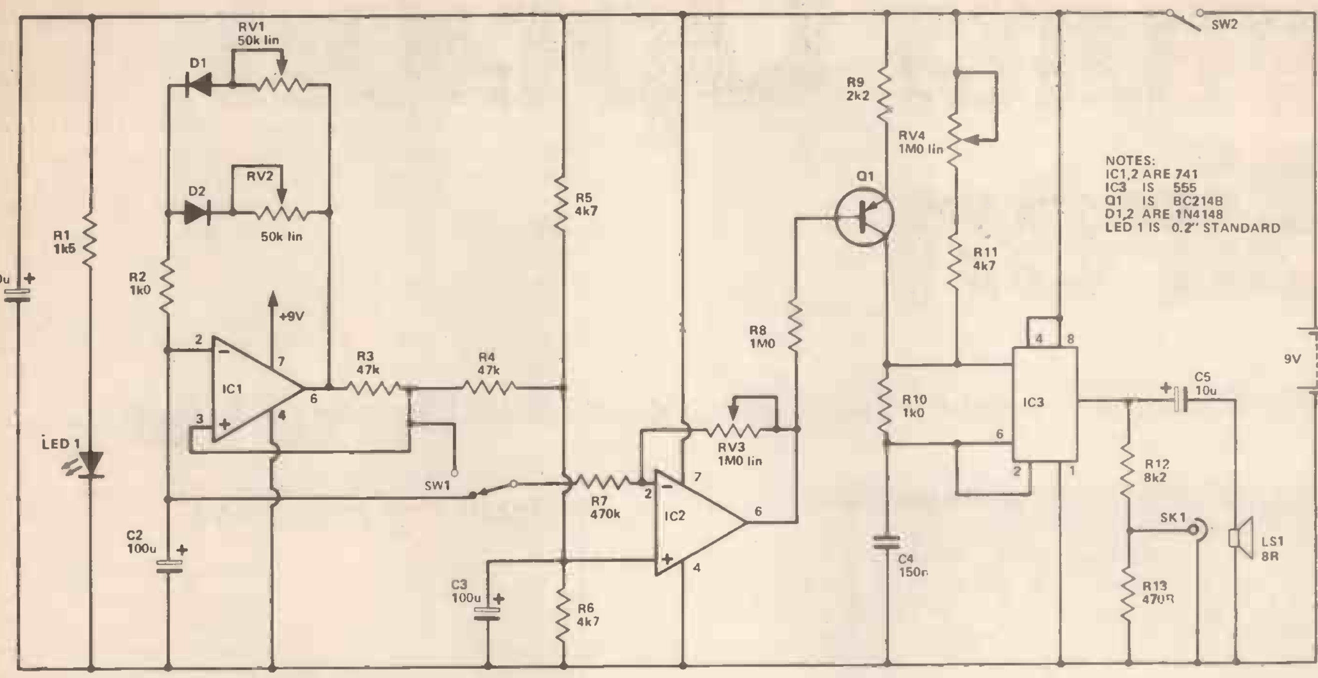


Fig. 1. Circuit diagram of the HE Multi Siren

How It Works

Circuit operation is quite straightforward. IC3 is configured as a voltage controlled oscillator and produces the audio frequency tone. RV4 provides direct control over the frequency while Q1 provides an electronic control. Frequency is altered by changing the voltage applied to R8 and thus the current into Q1. C4 is the timing capacitor.

The control voltage is derived from the slow oscillator built around IC1. IC2 is used to amplify this signal and controls the depth of modulation applied to the VCO by adjustment of feedback resistor RV3. IC1 is connected as a conventional op-amp astable multivibrator with the exception of diodes D1, 2 which are used to steer current through RV1 and RV2 on alternate half cycles. R2 limits the maximum current flow.

Power 'on' is indicated by LED 1 and current is limited to about 5 milliamps by R1. A mid-voltage point is provided by R5, 6 decoupled by C3 and overall supply decoupling is provided by C1.

TO WORK, TO WORK

The unit may find uses at home or in the family wheel-mobile. Although characterised for use at 9 volts, satisfactory operation will be obtained from a car battery (up to 14 volts) provided capacitors of suitable voltage rating are employed.

A miniature one and a half inch monitor loudspeaker was incorporated in the prototype and the sound output was surprisingly loud (we could hear it all over the office much to everyone's great delight?). If you want real pulversising power, a low level output is provided for an interface to your sound system. The output level is suitable for an amplifier line input; about 500 mV peak to peak, but can be easily changed by selection of two resistors.

The electronic 'works' of this sonic sensation are built around three readily available and inexpensive chips, two 741 op-amps and the ubiquitous 555 timer. The 555 is employed in a novel configuration as a voltage controlled oscillator with one of the timing resistors replaced by a transistor current source. Only a few other inexpensive components are required.

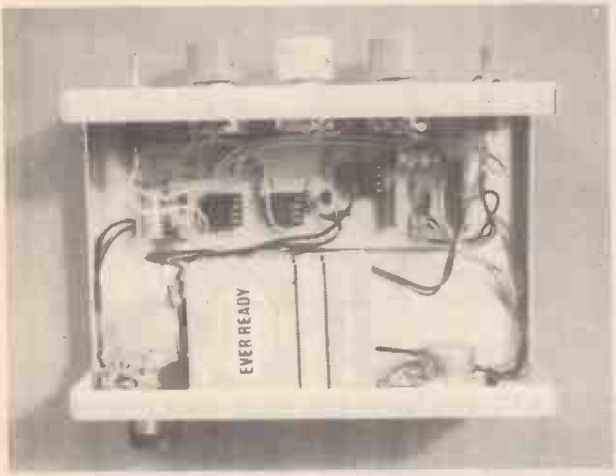
A few simple to operate controls enable the production of an amazing variety of effects.

CONSTRUCTION

Construction is uncritical and should be simplicity itself. Layout is unimportant and any scraps of veroboard, blob board, breadboard or cheeseboard (copper-clad only) may be pressed into service. Though if you are too haphazard you may have problems troubleshooting the monster you've created. For a trouble-free, no hassles, right first time project use of a PCB is recommended. Our design is best (or so we keep telling ourselves).

None of the component values are critical and you can change almost anything to achieve that elusive sound you seek. However, polarity of diodes and capacitors is important and these should be checked first if you experience any problems. Also pay close attention to the pin out of Q1. A BC214B is recommended. The 'L' suffix version follows TO92A form and requires some brutal twisting of the tranny's little legs to get it right. Once your project is built and working you won't want to switch off until you have explored the infinite variety of effects available. For this reason a PP7 is the suggested power source. A PP3 would have a very short life!

The Hobby siren was designed and built in two days. It was easy, it was cheap. Go and do it! **HE**



A bird's eye view of the Siren showing the component layout. Note the phono output socket on the rear panel.

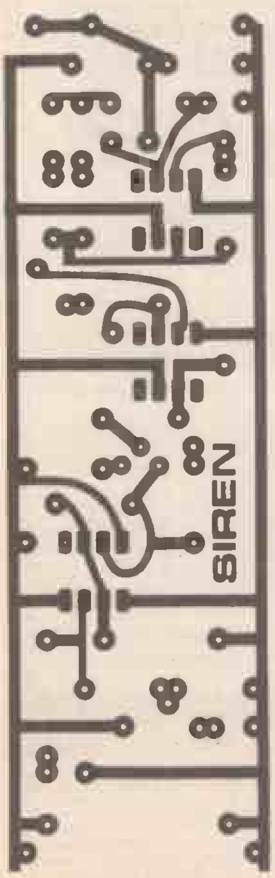


Fig. 2. PCB Foil pattern for the Siren

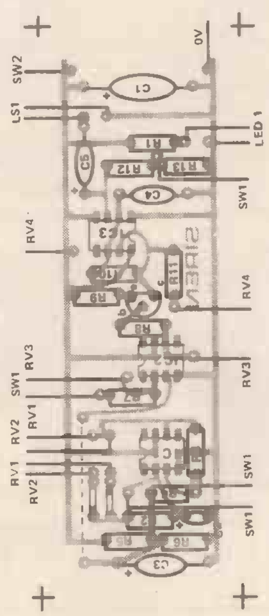


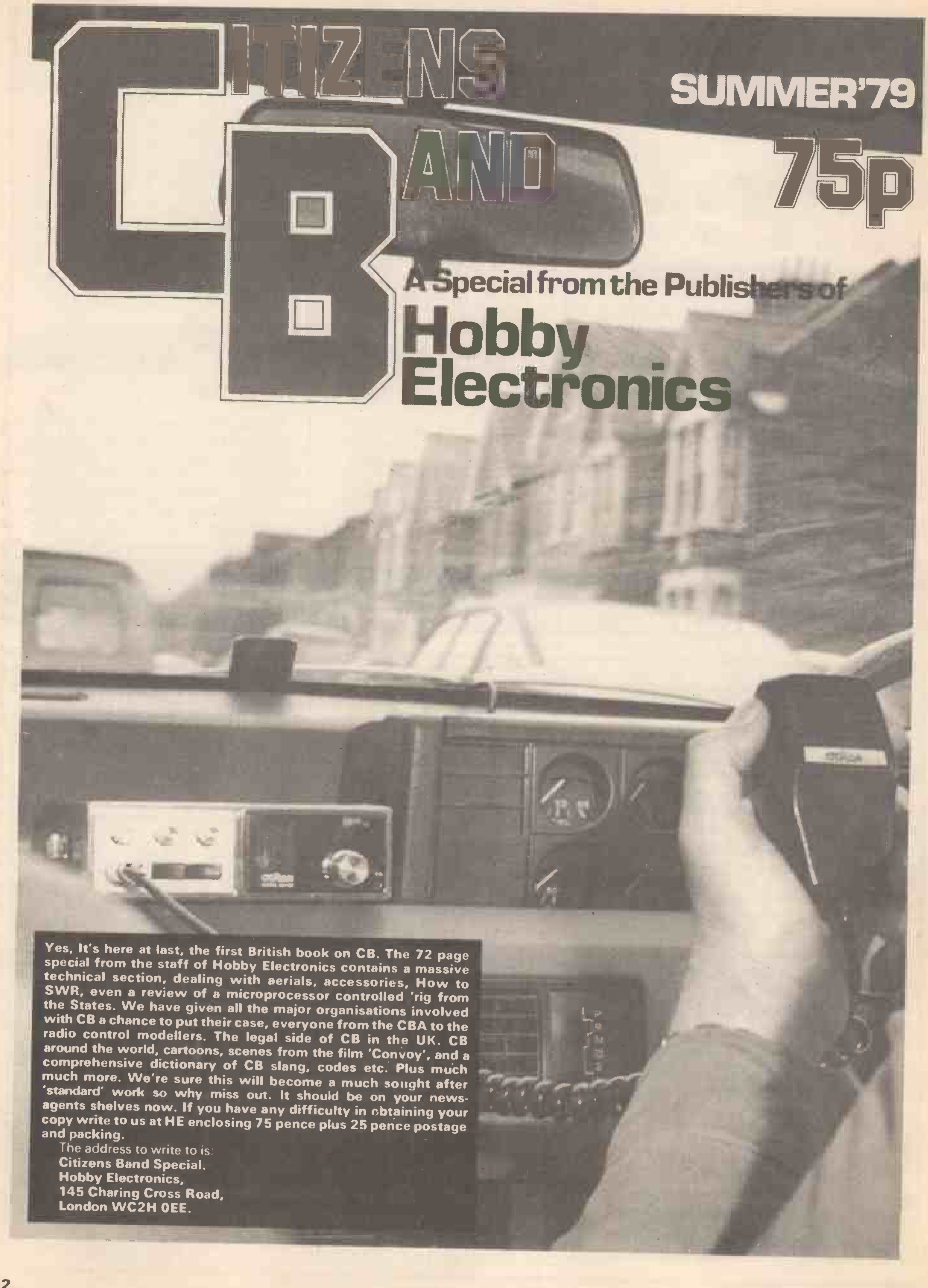
Fig. 3. PCB Overlay for the Multi Siren

Parts List

RESISTORS (All ¼W 5%)	
R1	1k5
R2, 10	1k
R3, 4	47k
R5, 6, 11	4k7
R7	470k
R8	1M
R9	2k2
R12	8k2
R13	470R
POTENTIOMETERS	
RV 1, 2	50k lin
RV 3, 4	1M lin
CAPACITORS	
C1	470µ electrolytic
C2	100µ tantalum
C3	100µ electrolytic
C4	150n polyester
C5	10µ electrolytic
SEMICONDUCTORS	
IC1, 2	741
IC3	555
Q1	BC214B
D1, 2	1N4148
LED 1	standard 0.2"
MISCELLANEOUS	
SW1	SPDT
SW2	SPST
SK1	phono socket
LS1	8 ohm loudspeaker
PCB	
case to suit	
	Approx. cost £4

Buylines

The components for this circuit should be readily available. Note that Q1 is a BC214B. A BC214L will work in the circuit as will almost any PNP silicon transistor, however, the transistor pin-out is different. Any size of loudspeaker may be used and values other than 8 ohm will give useable results.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This month at the risk of getting egg on our faces we'll make a prediction, and just in case we're wrong all the latest news from the current (illegal) CB scene including a full roundup of all the clubs that have contacted us so far.

CB TO BE LEGALISED IN NOVEMBER! We thought long and hard about printing this.

We have very good reason to believe that there's a better than 50-50 chance that CB will be legalised in November and almost certainly within the next six months.

Now to justify this rather dramatic statement. During the course of a month we receive many, many letters and phone calls on CB, quite a fair proportion contain predictions of one kind or another. Most, if not all are fairly groundless, this month, however, from quite independent sources, almost at opposite ends of the country and almost simultaneously came a common story, CB in November.

By nature we are very sceptical, especially after what we said last month about rumours, so in the normal course of events we would dismiss all of this as just sheer coincidence. The clincher came a couple of weeks ago in the shape of a letter sent into us from Keith Townsend. This letter, which we have every reason to believe to be genuine, comes from an MP, more than that we cannot disclose, suffice it to say, we're convinced.

It's been a month of coincidences, we received a copy of the proposals drafted by the SMAE (Society of Model and Aeronautical Engineers), the governing body of the R/C modellers, sent to HMG. They propose that the frequencies for radio control be moved to somewhere more suitable, possibly the almost international 35 MHz spot. What makes this even more significant is the fact that we have just heard from a very reliable source that these proposals might be implemented — in November. Now isn't that interesting?

To further encourage these events we've handed over our petition, sorry it was a bit sudden but we felt that things were beginning to happen very quickly indeed so we needed to make our presence felt as soon as possible (in fact around 15 000 times), so we're confident that some considerable weight has been added to the proceedings. Thank you to everybody who took the trouble to lend their monniker to our little campaign, you may just have helped change the law!

That really is all we can say at the moment, before anyone gets too carried away let us just say it is only a very strong possibility, not definite and it is still illegal to use CB in this country at the moment. So don't just sit back, now is the time to send that letter to your MP, keep pestering the phone-in radio programmes, strike while the iron is hot (no, not that kind of strike) and keep your fingers crossed, more details next month.

IN THE MEANTIME . . . .

Now back to business, we received through the post (quite anonymously) a notice which we have been led to believe is now being issued to all police stations. Basically it is a guide to police officers on how to identify CB rigs and users, the notice is accompanied by a selection of rather dated photographs of rigs and aerials along with a list of names of popular rigs (also dated as one or two of the manufacturers went out of business several years ago).

At the end of the notice is given a couple of phone numbers for police officers to call if (and are holding under the Customs and Exise act) they have detained an operator using CB equipment. The point of all this is to remind you that 27 Megs equipment is illegal and as such you risk up to a £400 fine and/or imprisonment. Smokey bear does know about CB, you have been warned.

400 CHANNELS!

We have some news from across the water of moves to increase the number of CB channels to an almost incredible 400, they propose to use a frequency of 900 megs which would give an effective range of about 50 kilometres. Now what you may ask would anyone need 450 channels for? Believe it or not it's to be used for home computers to allow them to talk to one another. What a good idea, how about letting us humans communicate Home Office?

One of our correspondents has just returned from a visit to the States, he tells us that the American CB market has been completely swamped, so much so in fact he was actually offered brand new 40 channel rigs at around three dollars each (that's about £1.50), the chap had apparently got a warehouse full of them, about 3 million to be precise. Eat your hearts out.

CB PERSONALITY

We wondered how long it would be before CB produced a personality, not long judging by how prolific one breaker, 'Mack The Hack', has become. After his first letter in the July HE he received a good deal of letters, we felt he had something original to say so we asked (via our contacts) him to write something for our 'special'. Now we see he has appeared in Bandstand with another article. How about a manager Mack?

PAGERS AND PACE MAKERS

After we asked last month about the problem of interference of CB and paging systems we got quite a bit of response. It's obvious when you think about it, both questions answer themselves. If 27 MHz does interfere with pacemakers, the hospitals that carry out the operations had better not use pagers on 27 MHz. In fact we did find out that the very first pacemakers of about 20 years ago did suffer from instability in the presence of strong (and we mean strong) RF fields; this was soon put right and no one today need worry about such interference, except that is if they make a habit of climbing TV transmitting towers.

Getting back to pagers it would seem most commercial systems are to be found at around 31 MHz, there are still, however, many older (and a few new systems) still on 27 MHz. Most operate at around 10 watts RF with an effective range of only 4 or 5 miles. The system uses coded bursts of tone to page an individual receiver. We're assured by a gentleman who has been involved in the design of many systems that unless you could whistle some pretty fancy tunes you'd be hard put to upset them.

CB STICKERS

As you may have guessed, our free car-stickers have been somewhat popular. If you haven't received yours yet please bear with us. If you still haven't sent in for yours yet, it's a four inch diameter cling-film type window sticker and it's costing us a small fortune so please enclose an appropriately sized SAE, we would hate to have to squeeze them in a small envelope.

If you live in London you may have seen the welcome publicity given to our campaign by our friends at the Evening News, thanks to all concerned.

TEE-SHIRTS

Our friends at the 10.4 Club tell us they've produced a club Tee-Shirt, the logo used was submitted by members of the club as part of a competition. If you should wish to adorn your torso with an example of their work write to the club at the address in the club section.

ANTENNA CATALOGUE

For anyone interested in CB/11 metre antennas a company called Telecommunications Accessories Ltd are marketing an extensive range of mobile and base station aerials. They have a very interesting catalogue (free on request) just crammed full of goodies. A very good looking "disguised" car aerial (CB/11 metre) may be of interest to our security conscious 'Ham' friends, it retails at around £20.00.

For further information and a catalogue, why not drop Telecommunications Accessories a line at, Thame Industrial Estate, Bandet Way, Thame Oxon OX9 3SS.

CB SLANG

Thanks again to everyone who took the trouble to write in, we are still waiting for some "clean" entries to the Slang competition, one entry from a young lady called Starduster was just a little too long to publish, how about something a little shorter next time?

BAND TOGETHER

IF YOU can remember back to our first Breaker One-Four we asked for details of any CB clubs that may be lurking out there in breaker land. So for the first time we present a list of all the clubs that have been in touch with us (so far) and their addresses.

The Citizens' Band Association (CBA)
President: James Bryant
16 Church Road, St Marks Road, Cheltenham, Glos. GL51

The United Kingdom Citizens' Band Campaign (UKCBC)
Chairman: Bernie Murray
32 Downbank Avenue, Barnehurst, Kent DA7 6RP

The 10.4 Club
Chairman: Ray Threadwell
83 Essex Close, Walthamstow, London, E17

The Midland Citizens' Band Radio Club (MCBRC)
Chairman: K. Townsend
Unit 19, York Terrace, Birmingham B18 5AF

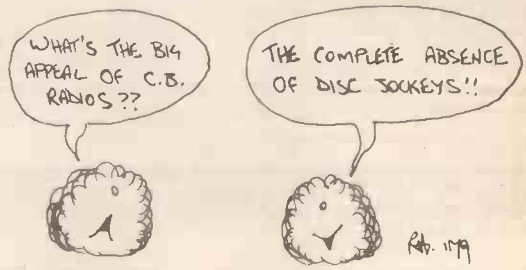
The Weymouth CB Club
Chairman: Ray Howes
39 St Thomas Street, Flat 1, Weymouth, Dorset

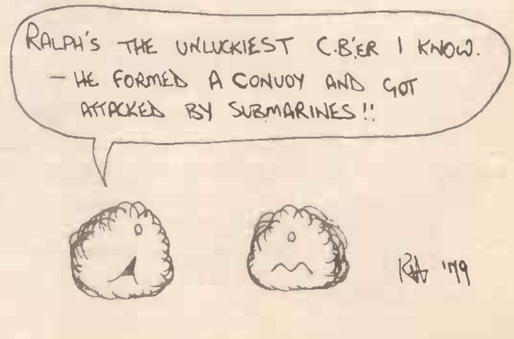
Citizens' Band Radio Action Group
Chairman: Steve James
55 Dartmouth Road
Forest Hill
SE23
Meeting place: Dutch House Pub, SE9, every Wednesday evening.

We won't claim this is a comprehensive list, news of clubs is coming in every day and as this article is prepared during the beginning of the month one or two news items might be a little out of date. So if you have got anything for Breaker one-four make sure it gets to us well in advance. As and when news of clubs arrives we will endeavour to let you know.

Well, that's it for another month, you may have noticed the extra page, that's because of all the extra news, keep it up.

STAY LUCKY AND BREAKER BREAK





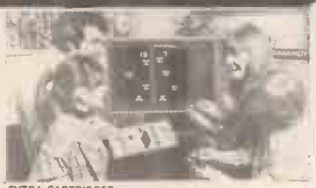
24 TUNE DOOR CHIMES

DOOR TUNES £17.13 + VAT

Waddington's Videomaster announce a doorbell that doesn't go Brrringgg, Ding-Dong or Bzzzzz. Instead it plays 24 different classical and popular tunes. It will play the tune you select for your mood, the season or the visitor you are expecting to call. Door tunes is not only great fun and a wonderful ice breaker, but is also very functionally and beautifully designed to enhance your home. There is something for Christmas, something for your continental visitors or your relations from the states, and even something for the Queen. Door tunes is easy to install and has separate controls for volume, tone and tempo.

T.V. GAMES

PROGRAMMABLE £29.50 + VAT.
COLOUR CARTRIDGE T.V. GAME.



The TV game can be compared to an audio cassette deck and is programmed to play a multitude of different games in COLOUR, using various plug-in cartridges. At long last a TV game is available which will keep pace with improving technology by allowing you to extend your library of games with the purchase of additional cartridges as new games are developed. Each cartridge contains up to ten different action games and the first cartridge containing ten sports games is included free with the console. Other cartridges are currently available to enable you to play such games as Grand Prix Motor Racing, Super Wipeout and Stunt Rider. Further cartridges are to be released later this year, including Tank Battle, Hunt the Sub and Target. The console comes complete with two removable joystick player controls to enable you to move in all four directions (up/down/right/left) and built into these joystick controls are ball serve and target fire buttons. Other features include several difficulty option switches, automatic on screen digital scoring and colour coding on scores and balls. Lifelike sounds are transmitted through the TV's speaker, simulating the actual game being played.
Manufactured by Waddington's Videomaster and guaranteed for one year.

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ROAD RACE – £8.87 + VAT.
Grand Prix motor racing with gear changes, crash noises

SUPER WIPEOUT – £9.17 + VAT.
10 different games of blasting obstacles off the screen.

STUNT RIDER – £12.16 + VAT.
Motorcycle speed trials, jumping obstacles, leaping various rows of up to 24 buses etc.

NON-PROGRAMMABLE TV GAMES

6 Game – **COLOURSCORE II – £13.50 + VAT.**

10 Game **COLOUR SPORTSWORLD £22.50 + VAT.**

CHESS COMPUTERS

STAR CHESS – £55.09 + VAT.
PLAY CHESS AGAINST YOUR PARTNER.

using your own TV to display the board and pieces. Star Chess is a new absorbing game for two players, which will interest and excite all ages. The unit plugs into the aerial socket of your TV set and displays the board and pieces in full colour (or black and white) on your TV screen. Based on the moves of chess. It adds even more excitement and interest to the game. For those who have never played, Star Chess is a novel introduction to the classic game of chess. For the experienced chess player, there are whole new dimensions of unpredictability and chance added to the strategy of the game. Not only can pieces be taken in conventional chess type moves, but each piece can also exchange rocket fire with its opponents. The unit comes complete with a free 18V mains adaptor, full instructions and twelve months guarantee.

CHESS CHALLENGER 7 – £85.65 + VAT.
PLAY CHESS AGAINST THE COMPUTER.

The stylish, compact, portable console can be set to play at seven different levels of ability from beginner to expert including "Mate in two" and "Chess by mail". The computer will only make responses which obey international chess rules. Castling, en passant, and promoting a pawn are all included as part of the computer's programme. It is possible to enter any given problem from magazines or newspapers or alternatively establish your own board position and watch the computer react. The positions of all pieces can be verified by using the computor memory recall button.
Price includes unit with wood grained housing, and Staunton design chess pieces. Computer plays black or white and against itself and comes complete with a mains adaptor and 12 months guarantee.

OTHER CHESS COMPUTERS IN OUR RANGE INCLUDE:
CHESS CHAMPION – 6 LEVELS £43.95 + VAT.
CHESS CHALLENGER – 10 LEVELS – £138.70 + VAT.
BORIS – MULTI-LEVEL TALKING DISPLAY £163.04 + VAT.

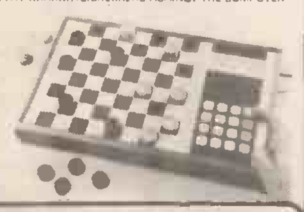
ELECTRONIC CHESS BOARD TUTOR £17.17 + VAT

A special bulk purchase of these amazing chess teaching machines enables us to offer them at only £19.75 less than half recommended retail price. The electronic chess tutor is a simple battery operated machine that can actually teach anyone to play chess and improve their game right up to championship level. This machine is not only for total beginners but also for established players wanting to play better chess. Unit contains the electronic chessboard with 32 chess pieces, a 54 page explanatory booklet and a set of 32 progressive programme cards including 6 beginners cards, 16 check mate positions, 9 miniature games, 5 openings, 3 end games, 28 chess problems and 2 master games.

DRAUGHTS COMPUTERS

CHECKER CHALLENGER 2 LEVELS £43.98 + VAT.
4 LEVELS £80.09 + VAT.

PLAY DRAUGHTS/CHECKERS AGAINST THE COMPUTER



The draughts computer enables you to sharpen your skills, improve your game, and play whenever you want. The computer incorporates a sophisticated, reliable, decision making microprocessor as its brain. Its high level of thinking ability enables it to respond with its best counter moves like a skilled human opponent. You can select offence or defence and change playing difficulty levels at any time. Positions can be verified by computer memory recall. Machine does not permit illegal moves and can solve set problems. Computer comes complete with instructions, mains adaptor and twelve months guarantee.

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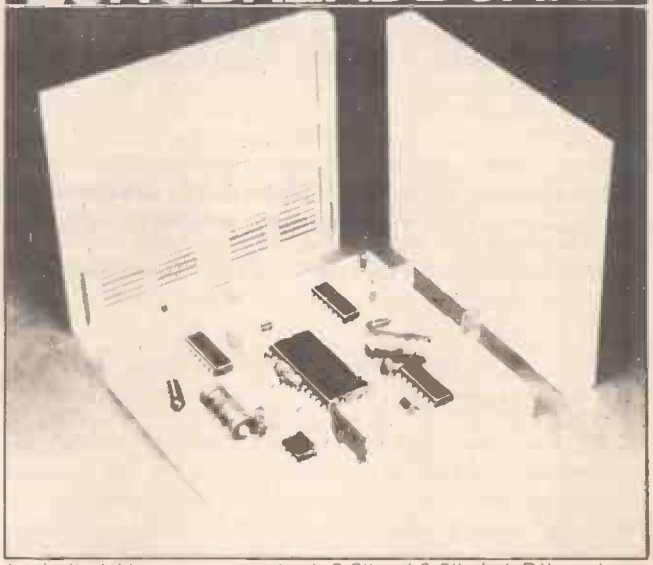

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Into Linear ICs

By Ian Sinclair Part 4

Continuing with our old friend the 741, Ian Sinclair takes a look at Comparator action, as always these practical circuits can be tried out on a Eurobreadboard, location numbers are given on each circuit.

ONE OF THE MANY ADVANTAGES we obtain by having two separate inputs to the 741 amplifier IC is comparator action. An electrical comparator is a circuit which has two inputs and whose output depends on which input is at a higher voltage. Many control systems use forms of comparators which are not electrical — a thermostat, for example, gives a signal which is off or on depending on whether the bending of a bimetal strip is enough to overcome the tension of a spring. Non-electrical comparators can now be replaced by the action of the 741.

To see how the 741 can act in this way, think back to the action of the two inputs. Imagine a 741 connected to its supplies (Fig. 4.1). Ideally, if we connected both + and — inputs to earth, the output voltage would also be at earth. Because of slight differences in the components inside the IC, however, this may not happen, and the output voltage can be above or below earth voltage, even when the inputs are both at earth. The output voltage can be corrected by using the offset balance control circuit which was noted in Part 3 and is recalled in Fig.4.1a.

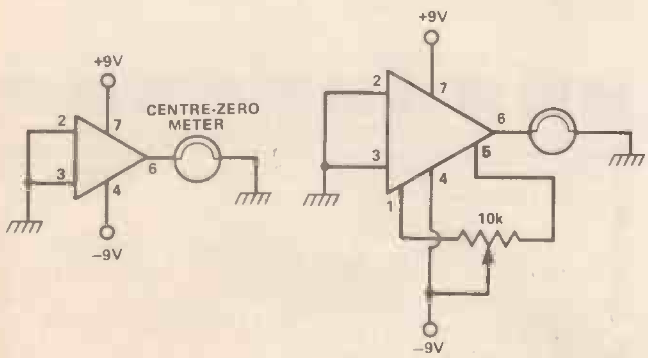


Fig. 4.1 Offset — the output of a 741 may not be at zero volts when both inputs are at zero (a). Using an offset balance potentiometer (b) allows us to zero the output. This adjustment is seldom required.

Suppose, then, that we've fixed both the inputs at earth voltage and that the output is also at earth voltage. If we now raise the voltage at the + input very slightly, the output voltage will rise, usually to somewhere around positive supply voltage. If we change the voltage on the + input in the other direction, the output voltage will fall, and can go almost as low as the voltage of the — supply. We get the same sort of action if we keep the + input fixed at earth voltage and then change the voltage of the — input slightly. In this case, though, the action is inverted — the output voltage goes to near + supply voltage when the — input voltage is lowered, and the output voltage goes to around — supply when the — input voltage is raised relative to earth.

COMPARATIVELY SPEAKING.

This is the comparator action which we need — when one input voltage is changed so as to equal the other, there is a large change of output voltage. A simple example of this comparator action is shown in the light-meter circuit of Fig. 4.2. In this particular circuit,

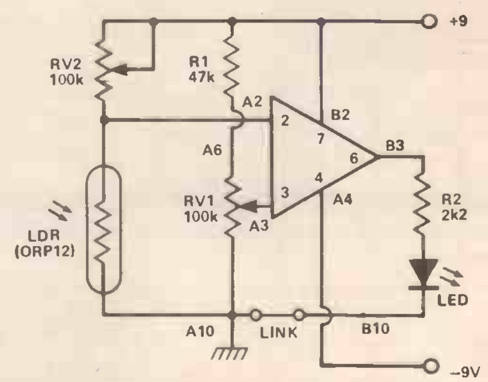


Fig. 4.2 A simple light meter. RV2 presets the range of light values which can be read, and RV1 is used to measure the light by adjusting RV1 until the LED just changes over (lit to unlit, or unlit to lit).

the — input is connected as shown to the junction of the preset RV2 and the photoresistor LDR1. The photoresistor, as its name suggests, has a resistance value which depends on the amount of light which strikes it;

the greater amount of light the lower the resistance. In darkness, the LDR has a high resistance, around 1M, so that in our circuit, the voltage at the — input is high in darkness. This voltage is limited by RV2. RV1 supplies the + input steady voltage, so that this voltage can be varied by turning the shaft of the potentiometer RV1.

In darkness, LDR1 will have a high resistance, but with the component values shown, the voltage at the + input cannot be set to such a high value, and the voltage of the — input will be higher than the voltage of the + input at any setting of the potentiometer. Because of this, the output voltage will be low, and LED1 doesn't glow. If some light now reaches LDR1, however, the resistance of the LDR drops, and the voltage of the — input will also drop. By adjusting the potentiometer setting, we may be able to set the voltage at the + input equal to, or slightly greater than, the voltage at the — input. Just as the voltages at the inputs equalise, the output voltage will rise sharply, so that the LED will start to glow. A different amount of light reaching the LED will mean that a different setting of RV1 is needed to make the LED just switch on. We can fit a pointer knob to RV1, and use a scale under the pointer to indicate light level readings. One useful application of this circuit is to compare the amounts of light falling on photographic paper under an enlarger when very different amounts of enlargement, or different negatives, are used. When the light meter is used in this way, a diffusing slide, or a piece of tracing paper should be held momentarily under the lens of the enlarger to prevent the focused image from striking the LDR.

ONE DEGREE MORE.

The circuit of Fig. 4.3 acts as an electronic thermometer, making use of a combination of linear amplification and comparator action. The diode D1 is, like all silicon diodes, temperature sensitive, so that a small temperature change will cause the voltage across the diode to change.

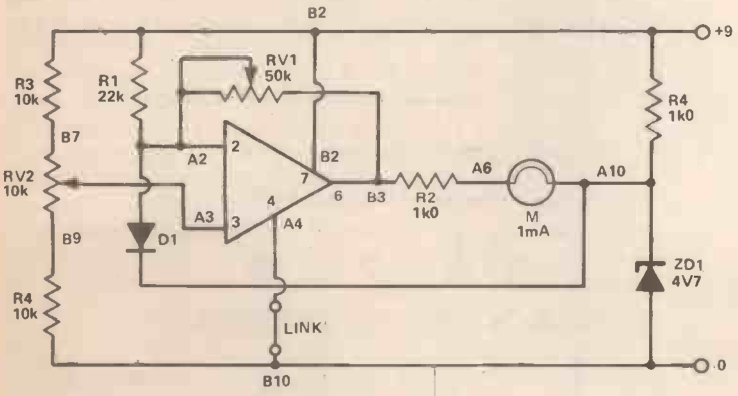


Fig. 4.3 An electronic thermometer circuit. RV1 is a sensitivity control, and RV2 is the 'set-zero' control. Don't forget the A 4-B10 link.

The negative feedback circuit, through RV1, keeps the — input at the same voltage as that of the + input but because only a fraction of the output voltage is fed back, the output voltage changes much more than the input voltage — there is voltage gain. This causes the meter M to deflect, providing the temperature reading.

The two variable resistors act to set the scale of the thermometer. RV2 is used as the zero set; it is adjusted when the diode is at the lowest temperature of its desired range so that the meter reads zero at this temperature. RV1 is a sensitivity control which affects the gain of the amplifier. When the diode is at the highest temperature of the desired range, RV1 can be adjusted so that the meter reads full-scale. Every thermometer must be calibrated at two temperatures, and these two adjustments make this possible. If a Celsius scale (NOT Centigrade, even if the BBC doesn't know any better) is needed, the meter can be scaled 0 to 100, and the calibration made with the diode in melting ice for the 0°C point and in the steam over boiling water for the 100°C point.

We don't always need precise temperature readings, very often all we need is a warning of some dangerous temperature level, like freezing point or boiling point. For warning devices, we can use more sensitive detectors and much more amplification, as in the frost-warning circuit of Fig. 4.4 This is a circuit which

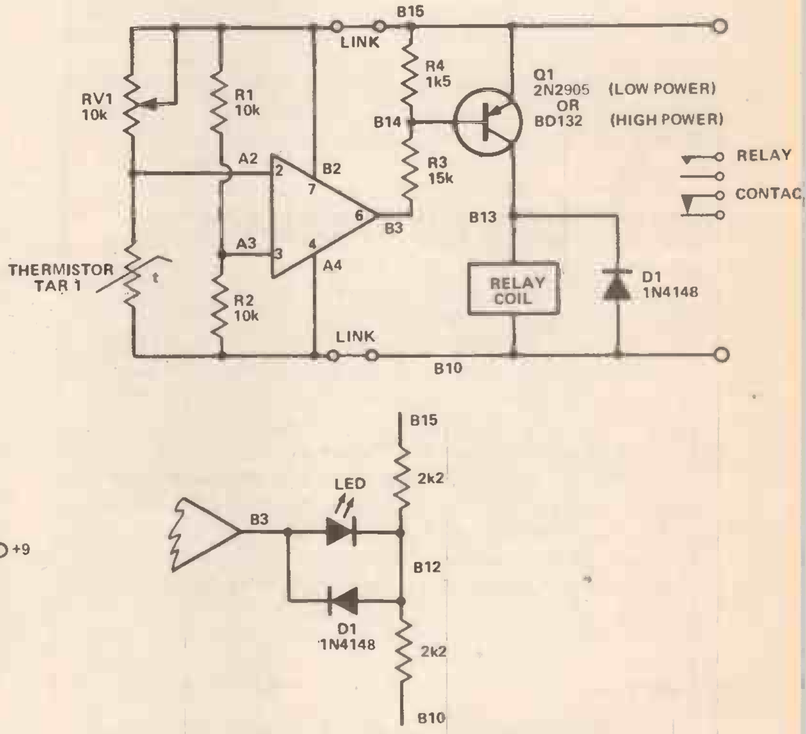


Fig. 4.4 Frost warning. This circuit (a) operates a relay when the temperature drops to a value set by RV1. For a car-mounted frost warning (b) the LED is used in place of the relay. Both versions are show for 12 V operation.

operates a relay at some low temperature, so that heating can be switched on (in a glass-house, for example) or alarm bells sounded. The same basic circuit can also be used as a car ice alarm, with the detector mounted on the bumper and the indicator LED on the dash.

FROST WARNING

The temperature detector device for this circuit is a thermistor, an NTC type, whose resistance increases greatly as it is cooled. Such a thermistor is not suitable for temperature measurements because of resistance plotted against temperature is nothing like a straight line. This shape of graph suits us very well for the detection of small changes of temperature, however, so that we can make use of thermistors for this sort of task. In the circuit of Fig.4.4 the + input of the 741 is held at a steady voltage, which is earth when dual supply voltages are used, or +6 V when a car battery is used (as shown) as the supply for the 741. The thermistor is connected in a potential divider circuit with the variable RV1, and the pot can be adjusted so the voltage across the thermistor just rises above the voltage of the + input when the thermistor is at the danger temperature. Since the voltage across the thermistor is the voltage at the — input of the 741, this slight rise in voltage is enough to cause the output voltage of the 741 to drop to a level near that of the — supply (near zero volts in the car-battery version. For an LED warning, this is all that is needed, but for switching other circuits the relay-driving transistor Q1 may be added. This is a PNP transistor which is cut off when the output voltage of the 741 is high, but which conducts when the 741 output voltage switches over. The resistors, R3 and R4 prevent too much current from flowing in the base circuit of this transistor when the output voltage of the 741 is low. Relay RL1 is operated when Q1 conducts, and diode D1 protects the transistor from the voltage surge, caused by the inductance of the relay, when the transistor switches off.

USING POSITIVE FEEDBACK

One disadvantage of the comparator action of the 741 is that it is too sensitive for a lot of purposes. Imagine, for example, a 741 comparator being used in a washing-machine in a thermostat circuit for the hot water. The action of the thermostat is to start the motor (which agitates the clothes) when the water reaches the correct washing temperature. If we used a straightforward 741 comparator, the motor would certainly be started whenever the temperature was equal to the setting on the dial, but if the temperature dropped slightly, even by one tenth of a degree, as the water was stirred about, then the comparator would switch back again, stopping the washing action until the temperature rose again. This stop- and-start action would continue for a long time, causing annoyance, wear on the motor and drive belts, and causing the wash cycle to be much longer than it need be.

How can we get round this? The solution we have used for as long as we have had mechanical thermostats depends on what is called hysteresis. Hysteresis means that switch-on and switch-off don't occur at the same position, or voltage, or setting or whatever. Take an ordinary light switch, for example — it doesn't tremble between on and off when you hold the switch knob half-way over. The switch is fitted with a spring which causes it to snap-over. When you switch on, the snap-over happens at about two-thirds of the movement; but to switch back again you need to move the control knob to about two-thirds over in the other direction (Fig. 4.5). A mechanical thermostat also has this snap action, which prevents small changes of temperature from causing the contacts to open and close alternately in the way our 741 comparator would act. Is there any way we can modify a comparator circuit so as to have this desirable hysteresis?

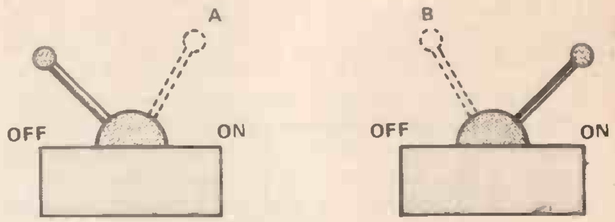


Fig. 4.5 Hysteresis in a light-switch. From the OFF position, the lever has to be pushed to position A to snap over and switch ON. From the ON position, the lever has to be pushed to position B before it snaps to OFF.

There is indeed, and the method uses positive feedback in small quantities. A comparator circuit which includes some positive feedback is shown in Fig. 4.6,

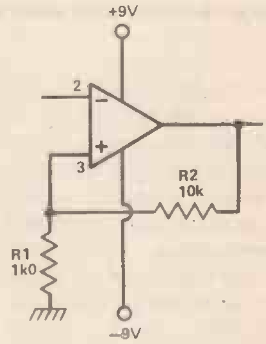


Fig. 4.6 Adding some hysteresis to a comparator (dual supply voltage).

with R2 added to the basic circuit. If we remove R2 for the moment, the circuit is of an ordinary comparator, which will switch over when the input (to the — input of the 741) is at earth voltage. Because the — input is an inverting input, the output voltage is high while the — input voltage is lower than earth voltage, and the output voltage is low while the — input voltage is higher than earth voltage. Now let's see how it works when R2 is fitted in. We'll make it easier by taking some actual values — make R1 = 1K and R2 = 10K, and see what happens. Imagine that the — input voltage is low, below earth voltage. That means that the output voltage is high, around +9 V. Now the potential dividing action of R2, R1 will make the voltage at the + input equal to 9 x 1/11, which is 0.82 V, so that nothing can change until the voltage at the — input reaches this level. That's the first change, then, the input voltage that's needed to switch the output from high to low is now +0.82 V instead of 0 V.

CONTROLLED HYSTERESIS

When the 741 switches over the output voltage will drop to around —9 V. Now that makes the voltage at the + input one eleventh of —9 V, which is —0.82 V, and that's the voltage which the — input will have to get to if it's to switch over the output voltage again. There's now some hysteresis in the comparator circuit, 0.82 V in each direction, so that the comparator, once it has switched over in one direction will not be switched back by a small change at the input. We can control the amount of hysteresis by changing the amount of positive feedback. The greater the division ratio of the potential divider, R1, R2, the less feedback we have, and also the less hysteresis. Fig. 4.7 shows an example of positive feedback used to produce hysteresis in a comparator which is used with a single-ended voltage supply.

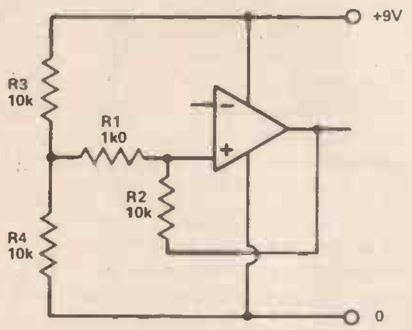


Fig. 4.7 How to arrange for hysteresis when a single supply is used.

The battery-state indicator of Fig. 4.8 makes use of a very small amount of positive feedback, causing hysteresis, to obtain a snap-over action. The circuit is intended to give a visible warning of low battery voltage, and the voltage at the — input of the 741 is set by a zenor diode, ZD1 at a value which is less than half of the voltage of the battery whose state is to be monitored — the example is for a car battery of nominal 12 V. A value of about one third of battery voltage is suitable for this 12 V application. The "BATTERY CHECK" input is taken to a potentiometer, RV1, whose tap is connected to the + input of the 741. The positive feedback is provided by a 2M2 resistor which is connected between the output and the + input of the 741. This large value resistor provides a small amount of positive feedback which is enough to ensure that the indicator does not flicker on and off as the load on the battery changes.

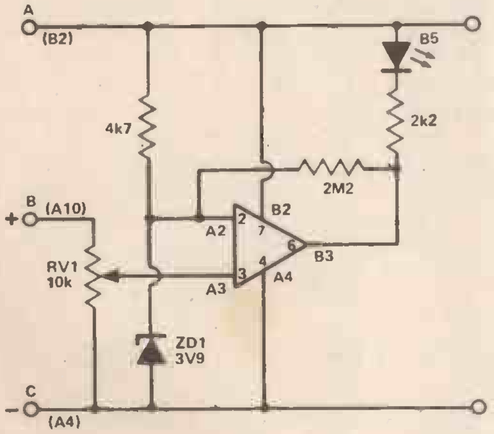


Fig. 4.8 A battery checker. As a self-contained battery checker, the batter to be checked is connected between B and C. For use as a built-in car battery checker, A and B should be linked, and the unit powered from the car battery.

To set up the circuit, a voltage equal to that of a run-down battery is connected to the CHECK terminals, making sure that the polarity is correct. The potentiometer RV1 is then adjusted until the LED just glows. A fresh battery should then cause the LED to turn off — if it doesn't. then a larger value should be used for R2. Once the circuit has been set up, the state of any 12 V battery can be checked by connecting to the CHECK terminals. If the LED glows, the battery is exhausted.

jby connecting the free end of RV1 (at B) to the + supply, the circuit can be used to check its own battery. In this form, the circuit can be used as a built-in battery warning which can be installed on the dash of a car.

OSCILLATOR CIRCUITS

When positive feedback is used in a circuit, oscillation is possible if some timing circuit exists to set the frequency of oscillation. There are quite a number of possible timing circuits, each of which works in a rather different way, so that a large number of possible oscillator circuits exist. One such circuit is the phase-shift oscillator, named after the networks of resistors and capacitors shown in Fig. 4.9. This network consists of three

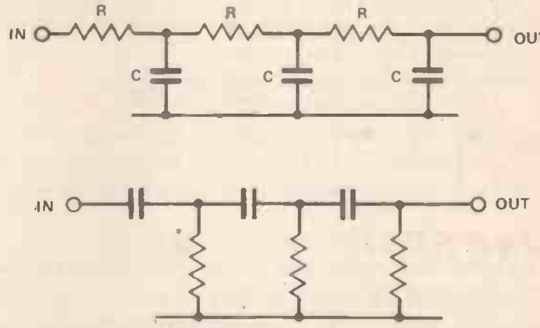


Fig. 4.9 Two forms of a resistor-capacitor phase-shift circuit.

potential dividers, each one consisting of a capacitor and a resistor. Each of these potential dividers not only attenuates (reduces the amplitude of) a signal at its input, it also changes the phase of the output signal as compared to the input. Three such potential dividers connected together will therefore cause considerable attenuation, and also considerable phase shift.

One of the unique things about a sine wave is that when it passes through a phase-shifting circuit, its shape is not affected. As a result, when a sinewave is phase-shifted by 180°, the effect on the shape is exactly the same as that if inverting the sinewave (Fig. 4.10). When

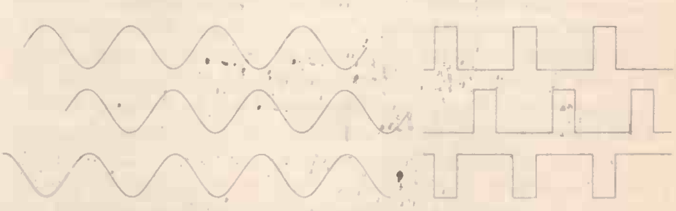


Fig. 4.10 The effects of 180° phase shift (b) and inversion (c) on two different wave shapes. Both inversions and 180° phase shift have the same effect on a sine wave — but not on other waveforms.

we use three stages of phase-shifting, it is fairly easy to get a total phase shift of 180° (that's 60° per divider) at one frequency — but not at any other frequencies. If such a phase-shift network is now connected between the output and the — input (yes, the — input!) of a 741, then at most frequencies the feedback will be negative but at the frequency which is shifted by 180° the feedback will be positive.

A typical circuit is shown in Fig. 4.11, using a single-ended power supply. The +input is connected to the half-supply voltage which is provided by the potential divider action of R1, R2. The resistors R3, R4, R5 in the phase-shift network are also used for bias, since there is feedback of DC through them; this DC feedback is not affected by the capacitors C1, C2, C3. For AC waves, however, C1, C2, C3 along with R3, R4, R5 cause phase shifts which at one particular frequency will cause the feedback to be positive instead of negative. In

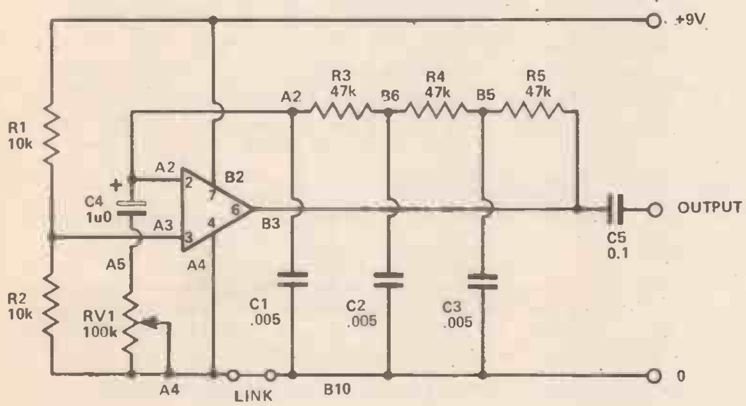


Fig. 4.11 Phase-shift oscillator circuit. RV1 should be adjusted so that the circuit is just oscillating.

this simple design, RV1 controls both frequency and waveshape; as the value of RV1 is increased, the frequency of oscillation drops and the amount of feedback increases. Increasing the amount of feedback, however, causes the waveshape to distort, and RV1 should be adjusted so that the circuit is just oscillating. The output signal can be heard by connecting a crystal (NOT magnetic) earpiece to the output, or by using the output from C5 to drive an amplifier.

By contrast, the circuit of Fig. 12 uses quite a different network called the Wien bridge, and formed by C1R3, RV2, R4 and C2. This circuit has the peculiar property of having no phase shift at one particular frequency; the frequency is selected by the values of the components which are used. In the circuits shown, the frequency can be varied by varying RV2, a double-ganged potentiometer. With this Wien bridge network connected between the output and the input of the 741, the feedback will be positive only at the frequency which is **not** phase-shifted, and this will therefore be the frequency of oscillation. The bias is set by R1 and R2, C3 is a bypass capacitor which prevents any feedback signal from being phase-shifted by R2.

Unlike the phase-shift oscillator, there is no potentiometer used in this circuit continually to control the amount of feedback, because the gain of the 741, once correctly set, is controlled by feedback to the —input. This negative feedback through RV1 is of both DC and signal, and the signal feedback is also potential divided by the connection of Lp1 to the —input. Lp1 passes only signal currents because of the use of the isolating capacitor C4. In practice, RV1 is set so that the waveshape is good, and this potentiometer need not be adjusted again.

How does it work? Well, we've explained the oscillation part of it already, but not the negative feedback part. The bulb Lp1 is, like any light bulb, a resistor whose value gets greater as the current heats up the filament. With a small output signal, the resistance of Lp1 is low, so that RV1, Lp1 act as a potential divider which feeds only a small fraction of the output signal back to the —input. That means that the gain of the 741 is large, so that the positive feedback action will start an oscillation whose amplitude will increase at each cycle. As the signal amplitude increases, however, more current flows through Lp1, making the resistance greater and so causing the potential division to be less. That, in turn, means less gain, so decreasing the amplitude of oscillation. The circuit then settles down with a fixed and stable amplitude of oscillation. Why stable? If the amplitude increases, there's more signal current through Lp1, causing more resistance and so more negative feedback, less gain — and so less amplitude. If the amplitude decreases, there's less signal current through Lp1, causing less resistance, less negative feedback, more gain — and so more amplitude. That ' stability, meaning that the amplitude of the output signal will not change when we alter the frequency by adjusting RV2. If the amplitude was correctly set by RV1 so that the output is a pure sine wave, then that's how it will stay even when the frequency is adjusted. The diode limiter shown in Fig. 4.12b is useful for a fixed-amplitude output.

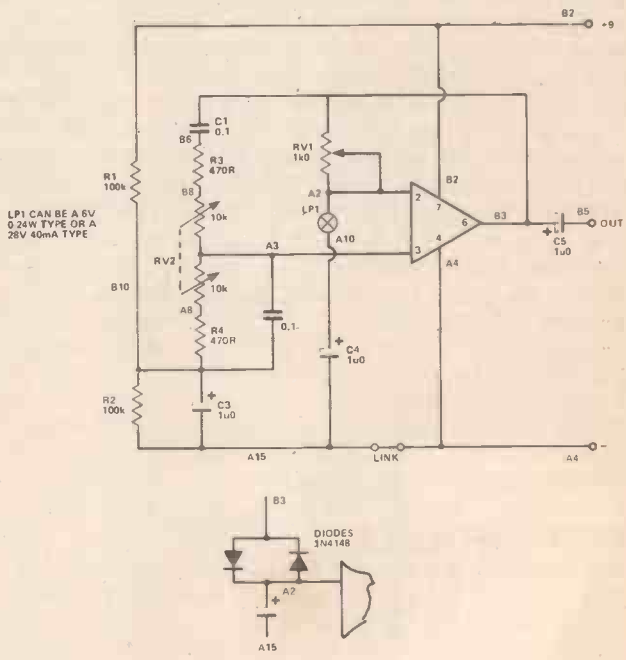


Fig. 4.12 (a) Wien-bridge circuit (b) A diode stabilising network which can replace Lp1, RV1 to give 1 V p-p output.

SQUARE-WAVE AND PULSE CIRCUITS

Just to show how versatile this 741 circuit is, we can use it in a variety of applications which generate square waves and pulses by making use of both positive and negative feedback. The circuit of Fig. 4.13 is a square wave generator with a single supply voltage. R1 and R2 form a potential divider which sets the voltage across R2 to half of the supply voltage, and the chain of resistors R4, RV1, R3 feed back a fraction (Set by RV1) of the output voltage to the +input. A bit of the output voltage is also fed back through R5 to the —input but the voltage at this input can't rise or fall instantly because C1 is connected between the —input and earth.

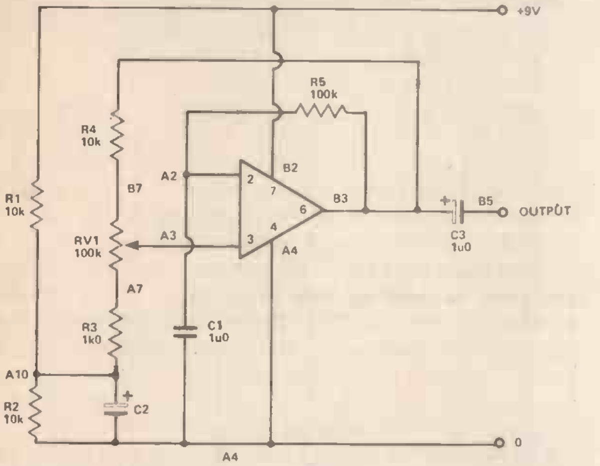


Fig. 4.13 A square-wave oscillator. RV1 is the frequency control.

Imagine that the voltage at the output has been low, and has just switched high. The voltage at the —input will be higher than half of supply voltage because of the positive feedback through R4, RV1, R3; but the voltage at the —input will be about as low as it was before the changeover because C1 has had no time to charge. C1 will now charge through R5, and the voltage at the —input will rise steadily. When the voltages at the two inputs are equal, the output will switch low again. The positive feedback will now ensure that the voltage of the +input is now less than half of the supply voltage (it's that hysteresis again), but the voltage at the —input can't switch over suddenly. C1 now discharges through R5 and the voltage at the —input drops steadily until it's enough to allow the circuit to switch over again. The output is therefore a squarewave whose frequency is decided by the values which are used for R5 and C1. Values of 470K and 6µ8 give very low frequency square waves, so that the switching action can be followed by a multimeter connected to the output, or by a LED and limiting resistor similarly connected.

MONOSTABLE

A monostable is a circuit which generates a single pulse (Fig. 4.14) of voltage when it is triggered by an input. The importance of the monostable is that the duration and voltage of the output pulse can be controlled, but any suitable input pulse will cause the trigger action, so that it converts tired old pulses into bright new ones. It's used in car-engine rev-counters, in digital clocks, in radar and in most circuits which make use of pulses. It's also used to generate time delays, so that an output pulse is delivered some time after an input (trigger pulse).

Fig. 4.15 shows a 741 monostable circuit, which is a bit more complicated than most of the circuits we've used so far. Since it uses a single-ended voltage supply, R1 and R2 are needed to set that vital half-supply voltage for biasing both inputs. Diodes D1, D2 are connected between the inputs and the bias supply, so that the voltages at the inputs can't rise much above half supply voltage, but can freely fall below this voltage. The capacitor C1 which is connected between the —input and the half-supply voltage point also prevents the —input voltage from changing rapidly. R6 and R3 form a potential divider which provides hysteresis by feeding a fraction of the output back to the +input.

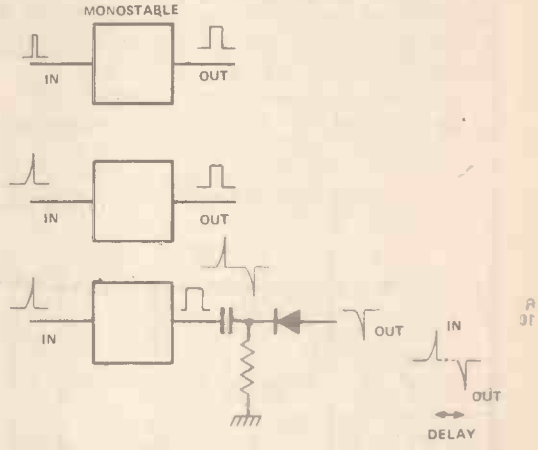


Fig. 4.14 The monostable action (a) A trigger pulse in produces a pulse of definite time (pulsewidth) out, even if the trigger pulse is poorly shaped (b). An output which is delayed with respect to the input (c) can also be obtained.

When the circuit is switched on, the voltages will adjust themselves so that D1 and D2 are just conducting, and the output voltage is just a bit higher than half supply voltage — and it can stay that way, biased steadily and not oscillating. If we now have a signal input consisting of a short negative pulse, the voltage at the + input will drop momentarily. Because of the voltage gain of the 741, the output voltage will also drop, and the positive feedback through R6, R3 will keep things that way. D2 is now cut off, and the output voltage keeps the + input biased low. Meanwhile at the —input, C1 slowly discharges through R5, and the voltage drops steadily,

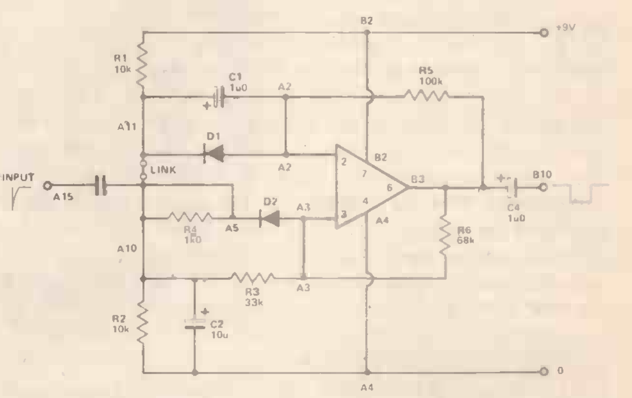


Fig. 4.15 A monostable circuit using a 741. The values of C11 and R5 are chosen so as to produce a long output pulse, but values such as.001 uF and 47K could be used to produce a very brief pulse.

so that D1 is also cut off. When the voltage at the —input equals the + input, the circuit switches over. The voltages (output and both inputs) start to rise. The voltage at the + input rises until D2 conducts and then can't rise any higher. The voltage at the —input rises more slowly, and is then also caught and held by D1, preventing another cycle of oscillation. **HE**

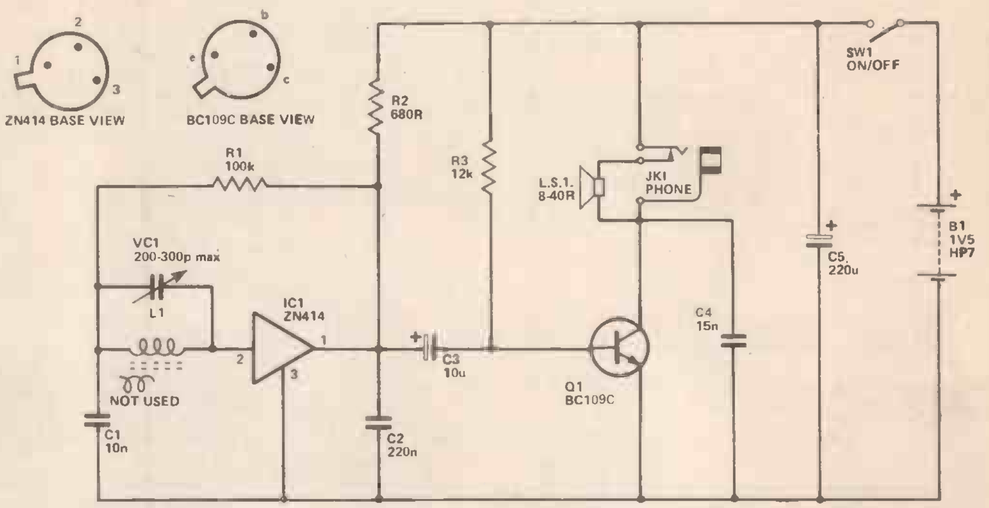
Short Circuit

BEDSIDE RADIO

This very simple MW radio provides low but adequate loudspeaker volume for use as a bedside set, and also has provision for a low impedance magnetic earphone. The radio frequency (RF) circuitry is based on a ZN414 IC which provides considerable amplification for the signals picked up in ferrite aerial L1. VC1 is the tuning capacitor and R1 is a bias resistor for the ZN414. C1 provides an RF path to earth for the "cold" end of L1. The ZN414 has a transistor detector stage at the output, but this requires discrete load resistor R2 and RF filter capacitor C2 in order to give an audio output signal. When strong signals are received there is a slight drop in the voltage at the output of IC1, effectively reducing the supply voltage fed to the device and giving a fall in gain. This produces a crude but reasonably effective form of automatic gain control (AGC) which reduces the possibility of overloading and gives a more consistent audio output level when tuning to stations of differing signal strengths.

The output stage is a simple common emitter class A type based on Q1. Interstage coupling is provided by C3 and R3 is the base bias resistor. The speaker or earphone form the collector load for Q1, JK1 is a normal 3.5mm jack having a single break contact which is used to automatically mute the speaker when the earphone is plugged in. Ideally the speaker should have an impedance of about 15 to 26 ohms, but any unit having an impedance in the range 8 to 40 ohms can be used. C4 filters out any RF signal that breaks through to the output and which might otherwise cause instability. S1 is the on/off switch and power is very economically obtained from an HP7 1.5v cell.

The layout of the unit is not too critical, but C2 should be mounted physically close to IC1. As with any set having a ferrite aerial and internal speaker, the two should not be positioned very close to one another as this could cause instability. A metallic case cannot be used as it would shield the aerial and prevent any significant signal pick up. Large metallic components positioned right along side the aerial coil can have a similar effect.



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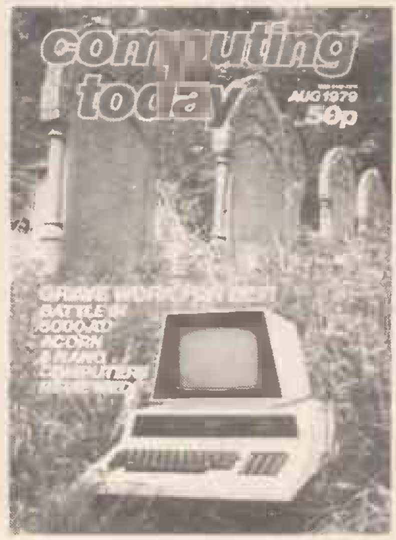

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