

# Hobby Electronics

## MOBILE MICROELECTRONICS



**Short Wave Radio**  
Full Coverage Receiver  
**25 Watt Amplifier Modules**  
Sounds Good

**PETting It Together**  
Bits And Pieces

**Touch Switch**  
Digitally Controlled

**PSU Module**  
Transformer Offer

**ambit**  
INTERNATIONAL

# IT'S HAPPENED AGAIN !

## THE PART THREE CATALOGUE IS PUBLISHED & WE HAVE MOVED TO BIGGER PREMISES.

Yes, it's here at last - the all new Part Three Catalogue. Fun for all the family, and the usual update on all that is new, worthwhile and exciting in the world of Radio and Communications. A big section on frequency synthesis techniques covering broadcast tuners, to communication quality transmitter systems. More new products than ever - RADIO CONTROL parts, crystal filters, ceramic filters for 455kHz and the new range of TOKO CF5H low temperature coefficient types for 10.7MHz. Details on new radio ICs, including the new HA11225, the CA3189L lookalike with 84dB signal to noise, and adjustable muting threshold. Radio control ICs - and an updated version of the RCM&E 8 channel FM receiver - now with an Ambit designed screened front end, with 27MHz ceramic bandpass filter, LCD panel clock timer modules - the greatest and best LCD panel DVM yet (only £19.45 each + VAT), the new 5 decade resolution DFM3 for LW HF VHF with LCD readout. The DFM6 with fluorescent display to 10kHz resolution on VHF, 1kHz on SW. A 1kHz HF synthesiser with five ICs - the list is endless. Get your copy of the catalogue now. Post publication price is 60p (inc PP etc). The previous two sections are also required for a complete picture: Parts 1 & 2 £1 the pair, All 3 £1.50. And don't miss our spot the gibbon contest, together with a quiz to see if you can spot the differences between a realistic cave drawing and a circuit diagram of one of our competitor's tuners. (\* Yes, we still haven't learnt how to spell.)

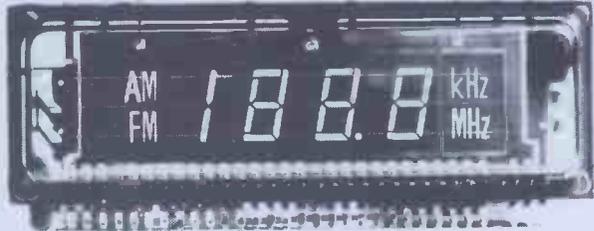
### Updated RCM&E FM radio control RX kit



- 8 Channel RC receiver (FM)
- Single IC RF/IF/Detector
- Single IC decoder
- 27MHz ceramic filter input
- FET RF stage with double tuned bandpass filter
- Dual ceramic filter IF
- Based on RCM&E FM system
- Best quality SLM servo connector block
- ONLY £16.10 inc VAT (kit) (includes new SLM case)

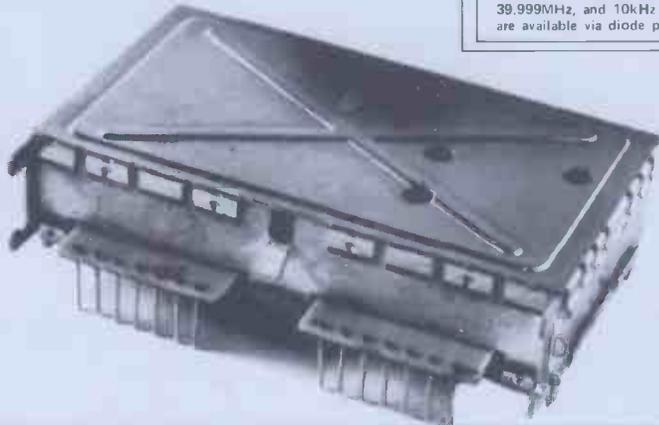
### DOES YOUR ONE GLOW GREEN IN THE DARK ??

Our DFM4 does, since it uses a vacuum fluorescent display for direct readout of MW/LW/FM. Basically the same as the DFM2, (LCD Version). £24.45 kit (inc VAT) Transformer with all necessary windings for DFM4 - £2.50 inc VAT.



Not illustrated here - but also now available is the DFM6. This is a vacuum fluorescent display version of our immensely popular DFM3 (LCD). Resolution is 100Hz to 3.9999MHz, 1kHz to 39.999MHz, and 10kHz to 200.00MHz; all standard IF offsets (inc. 10.7MHz on shortwave) are available via diode programming.

### New series of radio modules in fully screened cans



### UM1181 VHF band 2 VARICAP TUNERHEAD

5 tuned circuit, with image/spurri better than -80dB, buffered LO output, MOSFET RF stage, FET IF preamp, tunes with only 1% to 8v. -9dBm 3rd order intercept. 1off price £12.00 inc VAT. (1000off/ OAI)

911225 FM IF strip with all mod cons for the HiFi tuner: All types use 80+dB S/N Hitachi IC, with muting, AFC, AGC, meter outputs for signal level and centre zero, IF preamp stage.

'A' Dual linear phase ceramic filters, with MOSFET (AGC'd) IF preamp and a 3rd narrow filter with DC filter selection. Dual tuned FM detector stage. £23.95 inc VAT (built)

'B' Dual ceramic filters, single tuned detector stage. £14.95 inc VAT (All 'A' series units are set up with a spectrum analyzer for best THD)

### 91072 AM RADIO TUNER MODULES - DC TUNED and DC SWITCHED Available February '80

All include buffered LO output, mechanical IF filter (TOKO CFMO) 1-10v tuning bias, switching by a single pole to earth

A MW/LW (150 to 350kHz LW range) with ferrite rod antenna  
B As 'A' but also including SW1 or SW2 (specify.)  
SW1 - 1.8 to 4MHz SW2 - 5 to 10MHz

C With both SW ranges

Prices - one off INC VAT

'A' £14.43 'B' £15.90 'C' £17.50 (Custom types OAI)

There is a danger - when advertizing in some magazines - that because we do not find space to list everything we sell in every ad., that some readers forget about half the ranges we stock. So to summarize the general ranges:

**TOKO**  
Chokes, coils for AM/FM/SW/MPX, Audio filters etc  
Filters: Ceramic for AM/FM, LC for FM, MPX etc.  
Polyvaricons  
ICs for radio, clock LSI, radio control MPX decoders etc  
**Micrometals**  
Dust iron cores for toroids for resonant and EMI filters  
Toroid mounts  
**Hitachi**  
Radio/audio/mpx linear ICs  
100W MOSFETs, small signal FETs, MOSFETs and bipolar

And the following groups of products from a broad range of sources:

**Semiconductors** - specializing in radio devices, Plessey SL1600, EUROPE's best selection of AM/FM and communications devices. Power MOSFETs, WORLD'S LOWEST NOISE AUDIO small signal transistors, BAR graph LED drivers for linear and log.  
CD4000 series CMOS, TTL/LPSNTTL, standard linears (741, 301, 3080 etc). MPUs, memories. Small signal transistors from AEG BC237/8/9 families etc. (1000 off BC239C : 5.2p ea)  
LEDs: AEG 3mm/5mm round, 2.5x5mm flat, red, green, orange, yellow. The best prices you will find for quality products.  
**MOSFETs for RF signal processing**, including the BF960 UHF device and 3SK51 for VHF. Varicap diodes for 17:1 capacity ratio tuning

**FREQUENCY READOUT LSI from OKL** with a one-chip answer to most digital frequency display needs (and various modules).

**Crystal and ceramic ladder filters** from leading manufacturers, ferrite rods, various ferrite beads and a range of crystals for 'standard' frequencies and both AM and FM radio control at 27MHz. Trimmer capacitors.

**METERS** - a new range of linear movement types, plus many 'indicator' types for VU, all types of tuning indicators etc.

**SOCKETS** - a new range that are better quality than Texas low profile, yet better priced.

**Modules for AM/FM/STEREO**, complete kits for tuners, audio amplifiers from Larsholt.

**SWITCHES** - complete low cost DIY systems for push button arrays, keyboard switches.

**DOUBLE BALANCED MIXERS** MCL SBL1, replacement for MD108 etc. And cheaper.

OUR LATEST MOVING EXPERIENCE : At last, we have moved to the address below. There is car parking for customers approaching via North Service Road (an extension of North Road Avenue, entrance opposite the Brentwood Fire Station.) Pedestrian access from the High Street (alongside 117 High Street). The new building is six times bigger than our Gresham Road offices, and we will be installing a much expanded sales counter in the fullness of time. NEW TELEPHONE NUMBER (0277) 230909. TELEX NUMBER (as before) 995194 AMBIT G. See you there !

## 200 North Service Road, Brentwood, Essex.

# Hobby Electronics

Vol. 2, No. 5

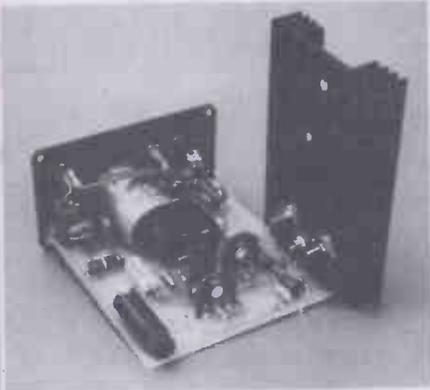
March 1980

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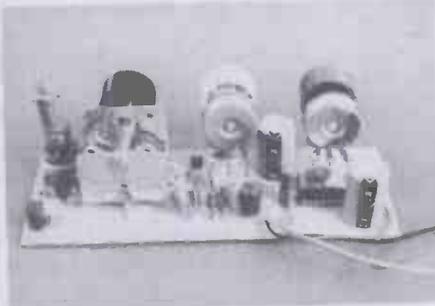
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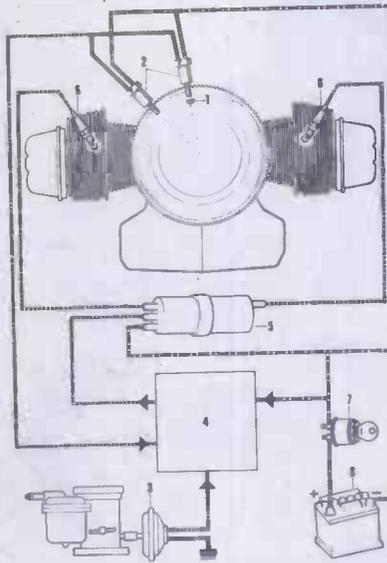
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It's all here

### Hobby Electronics

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Brimm

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# Simply ahead . .

## ILP'S NEW GENERATION OF HIGH



I.L.P. modular units comprise five power amplifiers, pre-amp which is compatible with the whole range, and the necessary power supply units. The amplifiers are housed and sealed within heatsinks all of which will stand up to prolonged working under maximum operating conditions.

With I.L.P. performance standards and quality already so well established, any advances in I.L.P. design are bound to be of outstanding importance — and this is exactly what we have achieved in our new generation of modular units. I.L.P. professional design principles remain — the completely adequate heatsinks, protected sealed circuitry, rugged construction and excellent performance. These have stood the test of time far longer than normally expected from ordinary commercial modules. So we have concentrated on improvements whereby our products will meet even more stringent demands such, for example, as those revealed by vastly improved pick-ups, tuners, loudspeakers, etc., all of which can prove merciless to an indifferent amplifier system. I.L.P. modules are for laboratory and other specialised applications too.

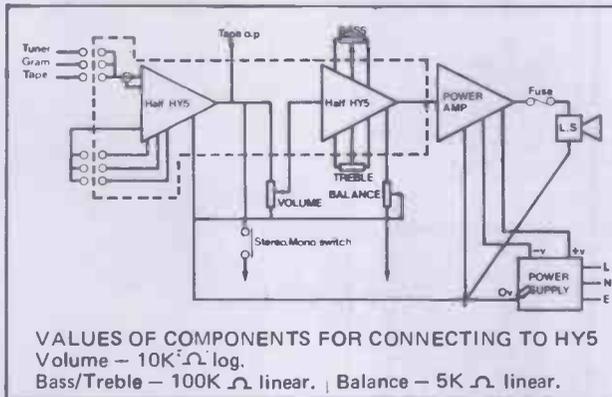
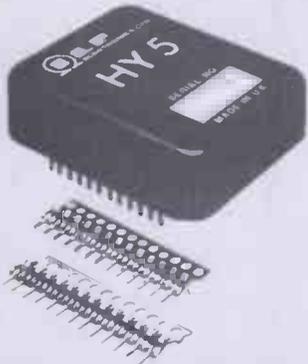
**PRODUCTS OF THE WORLD'S FOREMOST SPECIALISTS  
IN ELECTRONIC MODULAR DESIGN**

ALSO AVAILABLE FROM A NUMBER OF SELECTED APPOINTED STOCKISTS

# and staying there

## PERFORMANCE MODULAR UNITS

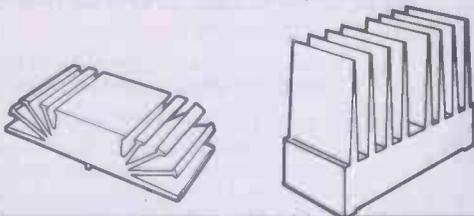
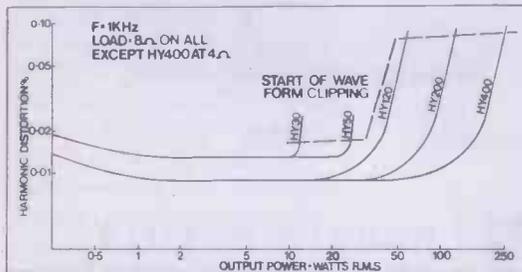
### HY5 PRE-AMPLIFIER



The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz - 0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

£4.64 + 74p VAT

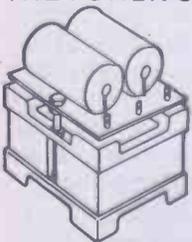
### THE POWER AMPLIFIERS



Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into $8\Omega$	0.02%	80dB	-20 -0 +20	105x50x25	155	£6.34 + 95p
HY50	30 W into $8\Omega$	0.02%	90dB	-25 -0 +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into $8\Omega$	0.01%	100dB	-35 -0 +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into $8\Omega$	0.01%	100dB	-45 -0 +45	114x50x85	575	£18.44 + £2.77
HY400	240 W into $4\Omega$	0.01%	100dB	-45 -0 +45	114x100x85	1.15Kg	£27.68 + £4.15

Load impedance - all models 4 -  $16\Omega$   
 Input sensitivity - all models 500 mV  
 Input impedance - all models  $100K\Omega$   
 Frequency response - all models 10Hz - 45Hz - 3dB

### THE POWER SUPPLY UNITS



I.L.P. Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms - one with circuit panel mounted on conventionally styled transformer, the other with toroidal transformer, having half the weight and height of conventional laminated types.

PSU 30	$\pm 15V$ at 100ma to drive up to five HY5 pre-amps	£4.50 + £0.68 VAT
PSU 36	for 1 or 2 HY30's	£8.10 + £1.22 VAT
PSU 50	for 1 or 2 HY50's	£8.10 + £1.22 VAT
PSU 70	with toroidal transformer for 1 or 2 HY120's	£13.61 + £2.04 VAT
PSU 90	with toroidal transformer for 1 HY200	£13.61 + £2.04 VAT
PSU 180	with toroidal transformer for 1 HY400 or 2 x HY200	£23.02 + £3.45 VAT

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 Telephone (0227) 54778 Telex 965780

Please supply .....

..... Total purchase price £. ....

I enclose Cheque  Postal Orders  International Money Order

Please debit my Account/Barclaycard Account No. ....

NAME .....

ADDRESS .....

Signature .....

# Monitor

## WHATEVER NEXT?

Ignoring for a moment the young lady (if you can) let us describe to you the object of her obvious affection. It is a TR-1200G (as if you didn't know) Tele-Casseiver. (If that sounded like a new word to you, stay tuned). Panasonic, the people who make the TR etc have made up another word for your. More of that later.

The unit contains, deep breath, a 12 inch monochrome TV, FM stereo radio that will also cover MW, SW, and LW, and of course a stereo tape recorder thrown in for good measure. As you would expect the permutations of recordings are such that you can record something whilst doing something else, confusing, isn't it?

Now for new word number two, the manufacturers say that the TR etc is ideal for making the most of 'Simulcast' productions when the TV soundtrack is additionally transmitted on FM stereo radio. Repeat after me, Tele-casseiver, Simulcast, now on your own. Remember them because we may come round your house to test you.

Usually at this point we get to the painful bit, the price. This time, just to be different, the TR etc seems quite reasonably priced. Considering what you get, a full stereo system (5W per channel) plus a telly, £225 doesn't seem too bad. On the other hand if you're like us it could be £25 and you still couldn't afford it. Ah well, we can all dream.

By the way the young lady is not included in the price, she's an optional extra.



## HALVOR GOES WEST

This is the last issue for Hobby Electronics to be edited by Halvor Moorshead. Next month he'll be in ten feet of snow publishing his own magazine in Toronto: the Canadian edition Electronics Today International.

Halvor has been with ETI (HE's big brother) in England since the days when it was a struggling one-year-old. As Editor and Publisher he has been responsible for the phenomenal growth of the magazine and the company. As well as starting the Canadian edition of ETI, back in England Halvor started Hobby Electronics and Computing Today.

Halvor's contribution to the hobby of electronics has been enormous, as any reader of HE, ETI or CT will realise. On behalf of all his friends I wish him success and happiness in North America.

HE's new Editor will be me, Steve Braidwood, currently Assistant Publisher at Modmags. I worked with Halvor on ETI in the old days, and kept in close contact as I did my bit for the colonies on the Australian and Canadian editions of ETI. I returned to London last year and was delighted to work for Halvor once again. So its goodbye Halvor and Hello HE men.

## ROBOTS, ROBOTS AND MORE ROBOTS

The long-awaited Robot revolution seems to be finally taking off. First the latest news on HEBOT.

Sales of HEBOT chassis have been phenomenal, several hundred so far are running about, schools and colleges seem to be taking a particular interest. Lansing Bagnall, the fork-lift truck people, are considering using HEBOT to demonstrate their control systems. Our German and Canadian editions of ETI will be featuring HEBOT, orders for chassis are already coming in. On the home front, Nationwide, the BBC TV current affairs programme, are filming HEBOT for a feature that should be transmitted in early February, HEBOT is now a TV star. One of the more surprising aspects of HEBOT sales has been the number of Microdrives sold, almost twice as many drive units as chassis pans. How about sending us some pictures of your HEBOT and any improvements or adaptations you have made. Best pictures and suggestions will be featured in the coming months.

On a more sinister note, we've just heard that Mullard, the TV tubemakers, are to lay off 850 workers over the next two years, guess what will be replacing them? You've got it — Robots. If HEBOT gets any cleverer the next Editor of HE might just be a HEBOT, watch out Steve Braidwood.

## PROJECTS SPECIAL

Dotted around the mag you will see references to our latest special. Don't miss next month's issue of HE for the full unexpurgated details!

# WATFORD ELECTRONICS

35 CARDIFF ROAD, WATFORD, HERTS., ENGLAND  
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O. OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 30p TO ALL ORDERS UNDER £10. OVERSEAS ORDERS POSTAGE AT COST, AIR/SURFACE. ACCESS ORDERS WELCOME.

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**POLYESTER CAPACITORS:** Axial lead type.  
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n 9p; 18n 10p; 22n, 33n 11p; 47n, 68n 14p; 100n 17p;  
100V: 22n 24p; 33n, 47n 41p; 68n 52p; 1µF 64p; 2µF 82p;  
150V: 33pF, 100n, 150n, 220n 11p; 330n, 470n 18p; 680n, 1µF 22p; 1µ5, 2µ 32p; 4µF 38p.  
1000V: 10nF, 15n 20p; 22n 22p; 47n 26p; 100n 35p; 470n 53p; 1µF 175p.

**POLYESTER RADIAL LEAD CAPACITORS:** 250V:  
10n, 15n, 22n, 27n 5p; 33n, 47n, 68n, 100n 7p; 150n 10p; 220n, 330n 13p; 470n 17p; 680n 19p; 1µF 22p; 1µ5 30p; 2µ 34p.

**ELECTROLYTIC CAPACITORS:** Axial lead type (Values are in µF). 50V: 10 40p; 47 79p; 250V: 100 85p; 63V: 0.47, 1.0, 1.5, 2.2, 2.5, 3.3, 4.7, 6.8, 8, 10, 10p; 15, 22, 47, 32, 50 12p; 63, 100, 27p; 50V: 50, 100, 220, 25p; 470, 32p 1000, 50p; 40V: 22, 33, 10p; 100, 12p; 2200, 3300, 85p; 4700, 88p; 35V: 33, 100, 330, 470, 32p; 1000, 48p; 25V: 10, 22, 47, 6p; 80, 100, 64p; 220, 50p; 470, 64p; 25p; 100V: 33p, 150p, 35p; 220p, 45p; 330p, 82p; 470p, 85p; 1µF: 10, 40, 47, 68, 79p; 100, 125, 85p; 220, 330, 145p; 470, 185p; 1000, 150p; 20p; 2200, 34p; 10V: 10, 6p; 64p, 12p; 100, 14p.

**TAG-END TYPE:** 450V: 100F 180p; 70V: 4700 185p; 64V: 3300 130p; 2500 98p; 50V: 3300 105p; 2200 98p; 40V: 1500 38p; 4700 120p; 4000 82p; 3300 93p; 2500 85p; 2200 85p; 2000+2000 120p; 30V: 4700 90p; 25V: 6400 105p; 4700 95p; 3300 80p; 2200 80p.

**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, 1.0, 2.0V: 1.5, 1.0V: 1.0µF single each; 47, 50K-2MΩ Single gang 27p 50K-2MΩ Single gang D/P Switch 85p 50K-2MΩ Double gang 75p

**MYLAR FILM CAPACITORS** 100V: 0.001, 0.002, 0.005, 0.01µF 7p 0.015, 0.02, 0.04, 0.05, 0.055µF 8p 0.1µF, 0.2µF, 0.5µF, 1µF 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: 25-190pF 33p 100-500pF 45p 1250pF 58p

**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, 68, 75, 82, 85, 100, 120, 150, 180 11p each; 220, 250, 270, 300, 350, 390, 450, 500, 560, 620, 680, 750, 820, 900, 1000, 1200, 1800, 2200 26p each.

**CERAMIC CAPACITORS 50V:** 0.5pF to 100pF 4p; 22n to 100n 6p.

**EURO BREADBOARD £6.50.**

**VOLTAGE REGULATORS**

1A 705	145p	7905	220p
5V 7805	145p	7912	220p
12V 7812	145p		
15V 7815	145p		
18V 7818	145p		

1A TO220	Plastic Casing		
5V 7805	85p	7905	75p
12V 7812	85p	7912	75p
15V 7815	85p	7915	75p
18V 7818	85p	7918	75p
24V 7824	65p	7924	75p

100mA TO92	Plastic Casing		
5V 7805	30p	7905	65p
6V 7812	30p		
8V 7818	30p		
12V 7812	30p	7912	65p
15V 7815	30p	7915	65p

AC3085 85p LM323K 625p TAA550 50p  
LM300M 170p LM325N 240p TBA625B 85p  
LM305H 140p LM326 240p TDA1412 150p  
LM309K 135p LM327 270p 78H05 595p  
LM317K 350p LM723 39p

**JACKSONS VARIABLE CAPACITORS**

Dielectric	0.2 365pF with slow motion Drive	370p
100/300pF	175p	
500pF	205p	00 208/176 with 4511/DAF
6-1 Ball Drive	125p	
Def Drive 4103	125p	motion drive 370p
6.1/36.1	650p	C804-5pF: 10: 15:
Drum 54mm	40p	25: 75p 185p
0.1-365pF	245p	100, 150pF 275p
0.2-365pF	295p	1' 3' 310pF 550p
		00.3x25pF 430p

**DENCO COILS** RDT2 88p 'OP' VALVE TYPE RFC 5 chokes 98p Range 1 to 5 Bl. 45p 20p 24p 8.7 V 85p 13: 14: 15: 16: 17 92p 1.5 Green 105p 104p 'T' 1 to 5 Bl. YL. 18/1.6 114p 18/4.65 114p TOC 1 92p B9A Valve Holder MWSFR 112p Pin Insertion tool 144p

**VEROBOARD** 0.1 0.15 0.15 (copper clad) 31p 2 1/2 x 3 1/2 45p 39p 24p 2 1/2 x 5 50p 24p 3 1/2 x 3 1/2 55p 50p 3 1/2 x 5 62p 67p 43p 2 1/2 x 1 1/2 18p 135p 92p 3 1/2 x 1 1/2 218p 180p 120p 4 1/2 x 1 1/2 28p 18p Pin of 3 pins 22p Spot face cutter 105p Pin Insertion tool 144p

**DIODES** AA119 25 20 BA100 10 BY126 12 CR033 148 OA9 7 OA70 12 OA79 18 OA85 14 OA91 7 OA95 8 OA200 9 OA202 8 IN914 7 IN916 6 IN4001/2 5 IN4003 6 IN4004/5 6 IN4006/7 7 IN4148 4 3A/100V 18 3A/400V 20 3A/600V 27 6A/100V 73 6A/400V 85 6A/200V 78 3A/1000V 30

**ZENERS** Range: 20V to 39V 40mW 0.6A/200V 30 0.8A/100V 30 0.8A/200A 35 1A800V 70 5A300V 38 5A600V 43 8A300V 48 8A500V 58 8A600V 88 12A300V 59 12A500V 92 15A700V 195 2N4444 148 2N5602 29 BC117 23 BC107 11 BC108 12 BC109 11 BC110 11 BC111 23 BC112 36 BC113 36 BC114 26 BC115 26 BC116 26 BC117 26 BC118 26 BC119 26 BC120 26 BC121 26 BC122 26 BC123 26 BC124 26 BC125 26 BC126 26 BC127 26 BC128 26 BC129 26 BC130 26 BC131 26 BC132 26 BC133 26 BC134 26 BC135 26 BC136 26 BC137 26 BC138 26 BC139 26 BC140 26 BC141 26 BC142 26 BC143 26 BC144 26 BC145 26 BC146 26 BC147 26 BC148 26 BC149 26 BC150 26 BC151 26 BC152 26 BC153 26 BC154 26 BC155 26 BC156 26 BC157 26 BC158 26 BC159 26 BC160 26 BC161 26 BC162 26 BC163 26 BC164 26 BC165 26 BC166 26 BC167 26 BC168 26 BC169 26 BC170 26 BC171 26 BC172 26 BC173 26 BC174 26 BC175 26 BC176 26 BC177 26 BC178 26 BC179 26 BC180 26 BC181 26 BC182 26 BC183 26 BC184 26 BC185 26 BC186 26 BC187 26 BC188 26 BC189 26 BC190 26 BC191 26 BC192 26 BC193 26 BC194 26 BC195 26 BC196 26 BC197 26 BC198 26 BC199 26 BC200 26

**DIAC** ST2 25 T28000D 120

## TTL 74

7400	11	74126	32
7401	11	74128	60
7402	11	74132	41
7403	11	74136	55
7404	12	74141	45
7405	13	74142	160
7406	23	74144	250
7407	30	74145	50
7408	18	74147	90
7409	18	74148	80
7410	12	74150	50
7411	14	74151	37
7412	14	74153	37
7413	14	74154	59
7414	21	74155	36
7415	32	74156	36
7416	23	74157	36
7417	26	74159	20
7420	14	74160	45
7421	14	74161	45
7422	19	74162	45
7423	17	74163	45
7424	15	74164	50
7426	10	74165	50
7427	19	74166	60
7428	19	74167	110
7430	12	74170	59
7432	15	74172	340
7433	20	74173	88
7437	17	74175	75
7438	17	74176	75
7440	11	74176	75
7441	52	74177	45
7442	35	74178	53
7443	50	74180	46
7444	52	74181	110
7445	43	74182	33
7446	45	74184	105
7447	43	74185	80
7448	45	74188	175
7450	15	74190	45
7451	15	74191	45
7453	15	74192	45
7454	15	74193	45
7456	13	74194	42
7457	23	74195	40
7458	23	74196	67
7459	15	74197	108
7474	20	74198	150
7475	23	74198	150
7476	22	75150	175
7477	18	75491	92
7478	18	75492	92

## OPTO ELECTRONICS

TL209 Red	13
TL211 Grn	17
TL212 Yellow	16
2" Red	15
2" Yellow Green	18
Square LED	36
ORP12	63
2N5717	45
7 Segment Displays	45
LS400	255
TL312 C An 3"	105
TL313 C Cth 3"	105
TL321 C An 5"	195
TL322 C Cth 5"	195
DL704 C Cth 3"	99
DL707 C A. 6"	180
DL747 C A. 6"	180
FND357	120
NM3840	175
LCD 3 1/2 digit	875
TL307	675

## SWITCHES

TOGGLE: 2A, 250V.	28p
DPDT	38p
4 pole on/off	54p

## SUB-MIN TOGGLE

SP changeover	59p
SPST on/off	54p
DPDT 6 legs	70p
DPDT 7 leg	79p
DPDT 8 leg	115p

## SLIDE 250V:

1A DPDT	14p
1A DP C/OPT	15p
1/2A DPDT	13p
4 pole C/Over	24p

## PUSH BUTTON

Spring loaded	65p
SPST on/off	65p
SPDT C/Over	70p
DPDT 6 leg	85p

## SWITCHES Miniature Non-Locking

Push to Make 15p	Push Break 25p
ROCKER: SPST on/off 10A/250V	30p
ROCKER: Illuminated (white) Chameleon	80p
Lights when on: 3A 240V	
ROTARY: (ADJUSTABLE STOP) 1 pole 12-21	way, 2p/2-6 way, 3p/2-4 way, 4p/2-3 way 41p
ROTARY: Mains 250V AC, 4 Amp	45p

## DIAL SOCKETS (Low Profile - Texas)

8 pin 10p; 12 pin 12p; 16 pin 13p; 18 pin 16p; 20 pin 22p; 24 pin 25p; 28 pin 33p; 40 pin 50p.
------------------------------------------------------------------------------------------------

## 74LS

74LS00	11	74LS126	98
74LS01	11	74LS128	60
74LS02	11	74LS132	41
74LS03	11	74LS136	55
74LS04	12	74LS141	45
74LS05	13	74LS142	160
74LS06	23	74LS144	250
74LS07	30	74LS145	50
74LS08	18	74LS147	90
74LS09	18	74LS148	80
74LS10	12	74LS150	50
74LS11	14	74LS151	37
74LS12	14	74LS153	37
74LS13	14	74LS154	59
74LS14	21	74LS155	36
74LS15	32	74LS156	36
74LS16	23	74LS157	36
74LS17	26	74LS159	20
74LS20	14	74LS160	45
74LS21	14	74LS161	45
74LS22	19	74LS162	45
74LS23	17	74LS163	45
74LS24	15	74LS164	50
74LS26	10	74LS165	50
74LS27	19	74LS166	60
74LS28	19	74LS167	110
74LS30	12	74LS170	59
74LS32	15	74LS172	340
74LS33	20	74LS173	88
74LS37	17	74LS175	75
74LS38	17	74LS176	75
74LS40	11	74LS176	75
74LS41	52	74LS177	45
74LS42	35	74LS178	53
74LS43	50	74LS180	46
74LS44	52	74LS181	110
74LS45	43	74LS182	33
74LS46	45	74LS184	105
74LS47	43	74LS185	80
74LS48	45	74LS188	175
74LS50	15	74LS190	45
74LS51	15	74LS191	45
74LS53	15	74LS192	45
74LS54	15	74LS193	45
74LS56	13	74LS194	42
74LS57	23	74LS195	40
74LS58	23	74LS196	67
74LS59	15	74LS197	108
74LS74	20	74LS198	150
74LS75	23	74LS198	150
74LS76	22	75150	175
74LS77	18	75491	92
74LS78	18	75492	92

## 74ALS

74ALS00	11	74ALS126	98
74ALS01	11	74ALS128	60
74ALS02	11	74ALS132	41
74ALS03	11		

## News from the Electronics World

### BASICALLY ATARI



Hot on the heels of a couple of other telly game manufacturers Atari have announced their version of the personal computer.

The Atari 400/800 series has been designed with expansion in mind. It will happily connect up to all manner of cassette decks, floppy disc and bubble memory devices. The computer comes complete with a full colour display on your own telly, four sound 'voices' and the capability for working light pens and high speed printers.

The 400 model has 8k RAM, expandable up to 48k when it becomes the 800 series. Similarly the standard 8k ROM will go up to the 40k of the 800 series given time, inclination and money. The machine works in something called Atari Basic and is based on the 6502 Micro-processor IC.

Price wise it looks most attractive, just £400 for the 400 series model and £750 for the 800. Launch date should be in June 1980. Impatient people should contact Ingersoll Electronics Ltd (the importers at 202 New North Road, London N1 7BL).

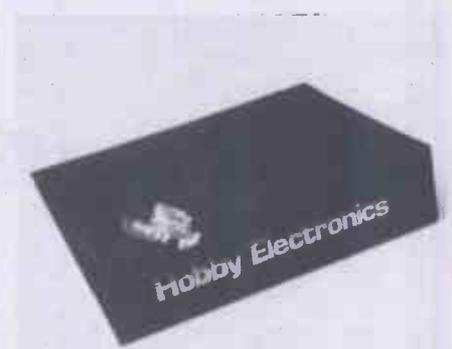
By the way, it will play games if fed with the appropriate programmes.

### BOOK REVIEW

Still puzzled by integrated circuits? You shouldn't be, not after reading HE all these months. If on the other hand this is your first excursion into the world of micro-electronics then you would be well advised to read a new (ish) book called Integrated Circuits, Questions and Answers. It comes from the pen of R G Hibberd and is published by Butterworth, price £1.55 (ISBN 0408004665).

This little book is probably one of the easiest to follow as it is based on a series of questions and answers. You can literally just pick it up and start anywhere. In the past Q and A books have suffered from poor indexing, a maddening aspect of any book. This one seems to have overcome this problem, making it quite suitable for quick reference. A handy book to have around.

### JAWS THE JOB



Have you noticed our new Binders ad? The wording has been changed from the original because of the efforts of one D Bryant. In the original ad we said, (quite lightheartedly)

'Send your cheques, postal order's, gold sovereigns, false teeth or anything negotiable, to.....'

You guessed it, D Bryant sent us his upper set. In return we have sent D Bryant an HE binder, and to discourage anyone else from trying to do the same we have kept his teeth. So if you see a man in the Britsol area walking round with an HE binder in his mouth you'll know why. No more false teeth please, just money (Gold Sovereigns are still OK).

### TV EXHIBITION

50 years ago this March Logi Baird's 'Televisor' was finally on sale. The Science Museum in London are celebrating by holding an exhibition called 'The Great Optical Illusion'. It opens in March 1980. Don't miss it. (Look out for our feature on Narrow Bandwidth TV next month).

### ERRATA

Now pay attention to this one as it is a bit naughty. On page 32 (Feb HE) Infra Red Remote Control, last paragraph, second column should read:—

(1) The **EARTH'S** of the mains input and output

*Not* Neutrals, this would be most inadvisable, not to say dangerous. Sorry.

### TOY CHIPS



Considering the delays we're having getting our single IC radio control system off the ground it was understandably annoying to hear of these new offerings from Plessey.

The pair of ICs in question, (SL490 transmitter and ML928 receiver) were originally developed for remote control systems in TV sets. Much of Plessey's output now ends up in R/C toys, the example shown here is made by a French company, Joustra, who have just ordered half a million of the ICs from Plessey.

These ICs, unlike our proposed system, still need quite a bit of external circuitry, in this respect they are quite versatile, finding a good home in remote control systems using anything from ultrasonics to Infra red.

We have no details of prices as yet but if you would like some more information contact Plessey at: Plessey Semiconductors Ltd, Cheney Manor, Swindon, Wiltshire.

### THIMPLE THERMOMETER

Gone are the days when you were required to squint at a near-invisible line of mercury in a thin, fragile glass tube. By that we mean the electronic thermometer has arrived in all its glory. Latest model to blink its LEDs comes from Simwood Ltd. The SM1 covers the range -55 degrees C to +1250°C. The hand-held unit has a three digit display with an accuracy of  $\pm 0.15\%$  and a resolution of 1.0°C.

A switch on the side of the unit is operated everytime a measurement is to be made, battery life is expected to ensure around 2000 operations. In the event of a low battery the display will flash.

The SM1 comes complete with a carrying strap and case. Further details from Simwood Ltd., Garrett's Hall, Shalford Green, Essex.



# STEVENSON

## Electronic Components

CMOS			
4001	13p	4020	50p
4002	13p	4022	50p
4007	13p	4027	13p
4009	30p	4028	45p
4011	13p	4029	50p
4012	13p	4040	55p
4013	28p	4041	55p
4015	50p	4042	55p
4016	28p	4043	50p
4017	47p	4046	90p
4018	55p	4049	25p

FULL DETAILS IN CATALOGUE!

TTL			
7400	10p	7473	20p
7401	10p	7474	22p
7402	10p	7475	25p
7404	12p	7476	20p
7406	22p	7485	55p
7408	12p	7486	20p
7410	10p	7489	135p
7413	22p	7490	25p
7414	39p	7492	30p
7420	12p	7493	25p
7427	20p	7494	45p
7430	12p	7495	35p
7432	18p	7496	45p
7442	38p	74121	25p
7443	38p	74122	35p
7444	45p	74123	38p
7448	50p	74125	35p
7454	12p	74126	35p

OPTO			
LED's	0.125in.	0.2in	each
Red	TIL209	TIL220	9p 7.5p
Green	TIL211	TIL221	13p 12p
Yellow	TIL213	TIL223	13p 12p
Clips	3p	3p	
DISPLAYS			
DL704	0.3 in CC	130p	120p
DL707	0.3 in CA	130p	120p
FND500	0.5 in CC	100p	80p

SKTS			
8pin	8p	18pin	14p
14pin	10p	20pin	16p
16pin	11p	22pin	17p
3 lead T018 or T05 socket	10p	each	
Soldercon pins:	100:50p	1000:370p	

PCBS			
Size in.	0.1in	0.15in.	Vero
2.5 x 1	14p	45p	Cutter 80p.
2.5 x 3.75	45p	45p	
2.5 x 5	54p	54p	Pin insertion tool 108p
3.75 x 5	64p	64p	
3.75 x 17	205p	185p	
Single sided pins per 100	40p	40p	
Top quality fibre glass copper board. Single sided. Size 203 x 95mm. 60p each. 'Dato' pens. 75p each. Five mixed sheets of Affac. 145p per pack.			

RESISTORS			
E12 series. 4.7 ohms to 10M. Any mix:			
0.25W	1p	0.9p	1000+
0.5W	1.5p	1.2p	1p
Special development packs consisting of 10 of each value from 4.7 ohms to 1 Meg-ohm (650 res) 0.5W £7.50. 0.25W £5.70.			
METAL FILM RESISTORS			
Very high stability, low noise rated at 1/4W 1%. Available from 51ohms to 330k in E24 series. Any mix:			
0.25W	each 4p	100+ 3.5p	1000+ 3.2p

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LINEAR			
LF356	80p	NE531	98p
LM301AN	26p	NE555	23p
LM308	60p	NE556	60p
LM318N	75p	NE567	100p
LM324	45p	RC4136	100p
LM339	45p	SN76477	230p
LM378	230p	TBA800	70p
LM379S	410p	TBA810S	100p
LM380	75p	TDA1022	620p
LM3900	50p	TL081	45p
LM3909	65p	TL084	125p
LM3911	100p	ZN414	80p
MC1458	32p	ZN425E	390p
MM57160	590p	ZN1034E	200p

TRANSISTORS			
AC127	17p	BCY72	14p
AC128	16p	BD131	35p
AC176	18p	BD132	35p
AD161	38p	BD139	35p
AD162	38p	BD140	35p
BC107	8p	BFY50	15p
BC108	8p	BFY51	15p
BC108C	10p	BFY52	15p
BC109	8p	MJ2955	98p
BC109C	10p	MPSA06	20p
BC147	7p	MPSA56	20p
BC148	7p	TIP29C	60p
BC177	14p	TIP30C	70p
BC178	14p	TIP31C	65p
BC179	14p	TIP32C	80p
BC182	10p	TIP2955	65p
BC182L	10p	TIP3055	55p
BC184	10p	ZTX107	14p
BC184L	10p	ZTX108	14p
BC212	10p	ZTX300	16p
BC212L	10p		
BC214	10p		
BC214L	10p		

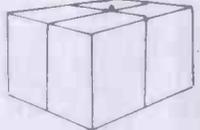
DIODES			
1N914	3p	1N4006	6p
1N4001	4p	1N5401	13p
1N4002	4p	BZY88	8p
ITT Full size product			
1N4148	£1.40	100	

CAPACITORS			
TANTALUM BEAD			
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 & 2.2uF @ 35V			8p
4.7, 6.8, 10uF @ 25V			13p
22 @ 16V, 47 @ 6V, 100 @ 3V			16p
MYLAR FILM			
0.001, 0.01, 0.022, 0.033, 0.047, 0.068, 0.1			3p
			4p
POLYESTER			
Mullard C280 series			
0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1			5p
0.15, 0.22			7p
0.33, 0.47			10p
0.68			14p
1.0uF			17p
CERAMIC			
Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF to 0.047uF			2p
RADIAL LEAD ELECTROLYTIC			
63V	0.47	1.0	2.2
			4.7
			10
			22
			33
			47
			100
			220
			330
			470
			1000

CONNECTORS			
JACK PLUGS AND SOCKETS			
2.5mm	unscreened 9p	screened 13p	socket 7p
3.5mm	9p	14p	8p
Standard	16p	30p	15p
Stereo	23p	36p	18p
DIN PLUGS AND SOCKETS			
	plug	chassis socket	line socket
2pin	7p	7p	7p
3pin	11p	9p	14p
5pin 180°	11p	10p	14p
5pin 240°	13p	10p	16p
1mm PLUGS AND SOCKETS			
Suitable for low voltage circuits, Red & black. Plugs. 6p each Sockets: 7p each.			
4mm PLUGS AND SOCKETS			
Available in blue, black, green, brown, red, white and yellow. Plugs: 11p each Sockets: 12p each			
PHONO PLUGS AND SOCKETS			
Insulated plug in red or black			9p
Screened plug			13p
Single socket	7p	Double socket	10p

### SPECIAL OFFERS

A range of special offer items valid during February. All orders placed for these items must be received during February.



Pack of 3 x LM380	225p	200p
Pack of 30 x 1N4001	120p	100p
Pack of 4 x FND500	400p	350p
Pack of 15 x 2N3702	120p	100p
Pack of 15 x BC107	120p	100p
Special pack of nuts + bolts containing over 600 4BA + 6BA nuts, bolts and washers	330p	250p
Pack of 4 red + 4 black crocodile clips	64p	50p
Mixer control knobs, per 100 (mixed) colours to suit	1400p	1300p

### MULTIMETERS

A really smart looking multimeter with an impressive specification for such a small size. The very clean scale in white and green on a black background makes this meter very easy to read. The D.C. Impedance of this meter is 4K ohms per volt which is exceptionally good compared with the vast majority of multimeters of a similar size. £5.95 each.



SPECIFICATION	
DC Volts	5V 25V 250V 500V (4K ohms/V)
AC Volts	10V 50V 500V 1000V (2K.ohms/V)
DC Current	250uA 250mA
Resistance	0 - 600K (7K ohms centre)

### PANEL METERS



High quality 2" wide view meters. Zero adjustment. Back illumination wiring. Available in 50 uA, 100 uA, 500 uA, 1mA, 100mA, 500mA, 1A. £4.95 ea. VU meter similar style. £1.50 ea.

### SLIDE POTENTIOMETERS

Good quality 60mm travel slider with 80mm fixing centres. Available from 5k - 500K in log and linear. 55p each. Suitable black knobs 6p ea. Coloured knobs 10p ea.



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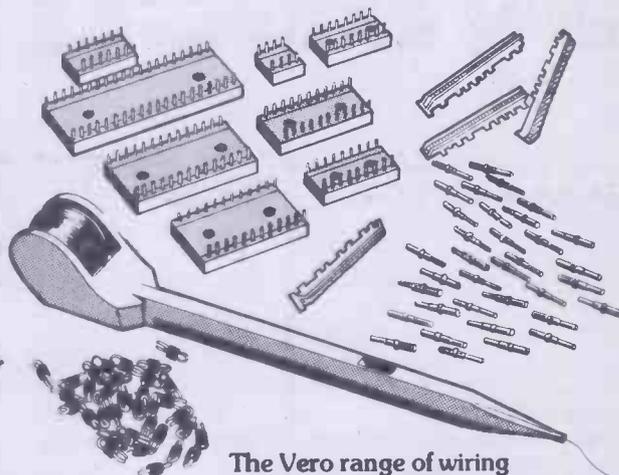
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## Wiring Accessories



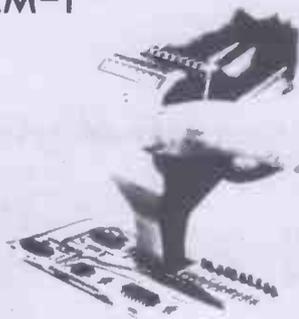
The Vero range of wiring accessories are all highest quality 'professional' products, carefully selected to ease your interconnection problems. There's a full range of pins and DIP sockets (including low-profile) for solder or wire wrapping techniques and the popular Verowire prototype wiring system. Add these to our established range of boards, boxes, frames and cases and you've got all you need for your project. It's all in our catalogue — just send 40p. and it's yours by return.

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LM-1



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LM-1 finds its own power.

LM-1 cuts out guesswork, saves time, and eliminates the risk of short circuits.

LM-1 is suitable for all dual-in-line logic ICs.

LED on = logic state 1 (high), LED off = logic state 0 (low), and each LED is clearly numbered 1 to 16 in the conventional IC pattern.

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# System 5080A

**HE introduces a brand new amplifier system beginning with the 5080A POWER AMPLIFIER module.**

THE HE 5080A POWER AMPLIFIER MODULE is the first part of an exciting new system in modular amplifiers, which on completion will provide the builder with a first rate stereo amplifier of 25 watts per channel into a speaker impedance of 8 ohms. Elsewhere in this issue is the 5080 PSU — the second part of the system and finally, in a couple of months' time the design will be completed with the pre-amplifier module.

The main advantage of a modular amplifier is that each module can be built separately. This suits the builder who cannot afford a complete kit of components all at once, or the builder who is not too sure of his constructional capabilities and who wishes to test each stage as he progresses. An important secondary advantage of such a method of manufacture is the reduction of interference (causing mains hum) from one device to another. The pre-amplifier in any amplifier system is particularly susceptible to pickup from the power amplifier and power supply and the only real way to eliminate this is to separate them — the HE 5080 does this.

The overall objectives of the 5080 are that each module, be self-contained, be easy to construct and look good. These aims do not, however, override the quality of the amplifier as a whole, the specifications and performance being within the criteria of "High Fidelity" audio systems.

To this end, distortion (an amount of which is inevitable in any amplifier) in the 5080A power amp module is so low as to be inaudible and the frequency response of it is well above and below the human hearing range.

To any experienced amplifier constructor, the circuit will look fairly conventional, ie the power stage is a Class AB type and the pre-driver stage is a common collector type to provide a higher input impedance to the source. This is not to say that modern techniques have not been utilised in its design. For example, "state of the art" output stage protection is provided by FS1, which prevents excessive current flow due to faults or short circuits in the speaker connections. In the past, there has been a tendency to use semiconductor type current limits which resume normal operation after the fault has



*A fine pair, the 5080 Power Amplifier and PSU modules.*

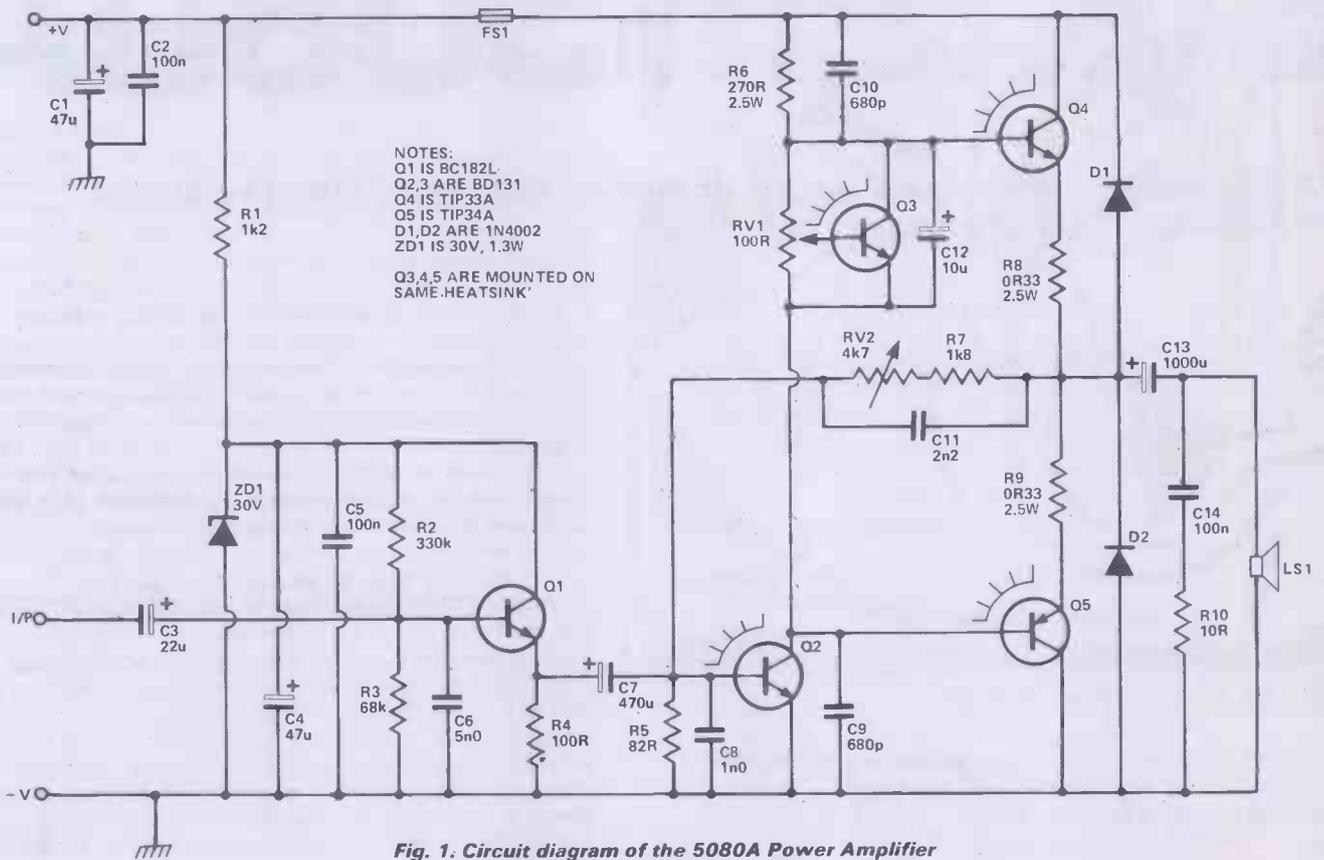
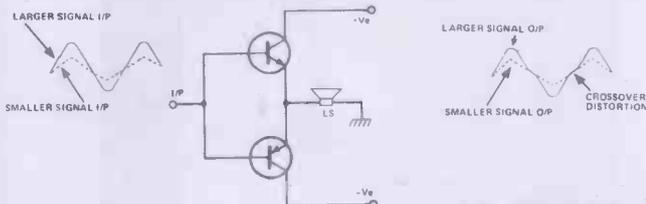


Fig. 1. Circuit diagram of the 5080A Power Amplifier

## How it Works

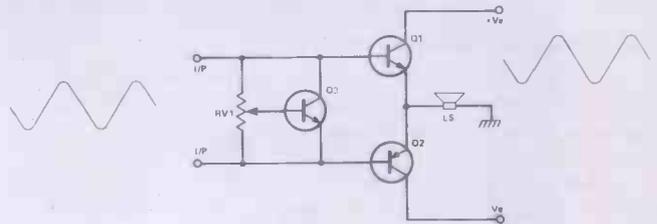
THE 5080A power amp consists of a Class A input stage followed by a Class AB output stage. A class A transistor amplifier is shown in figure 2. As can be seen, a similar configuration is used in the circuitry around Q1 in the 5080A. The transistor is biased permanently half on so that the output waveform is identical to that at the input. Class A amplification is, however, very wasteful of power because the transistor is always conducting a certain amount of current even when there is no I/P signal, ie, under quiescent conditions. This is not normally important except in power amps, where a large amount of power stands to be lost. So, in the power O/P stage we must turn to a more efficient method of amplification.



In a Class B amplifier the transistors are biased to their cut-off point so that they conduct only over one half of the signal waveform. Therefore, without an I/P signal the power loss is zero (meaning greater efficiency). Obviously one transistor is

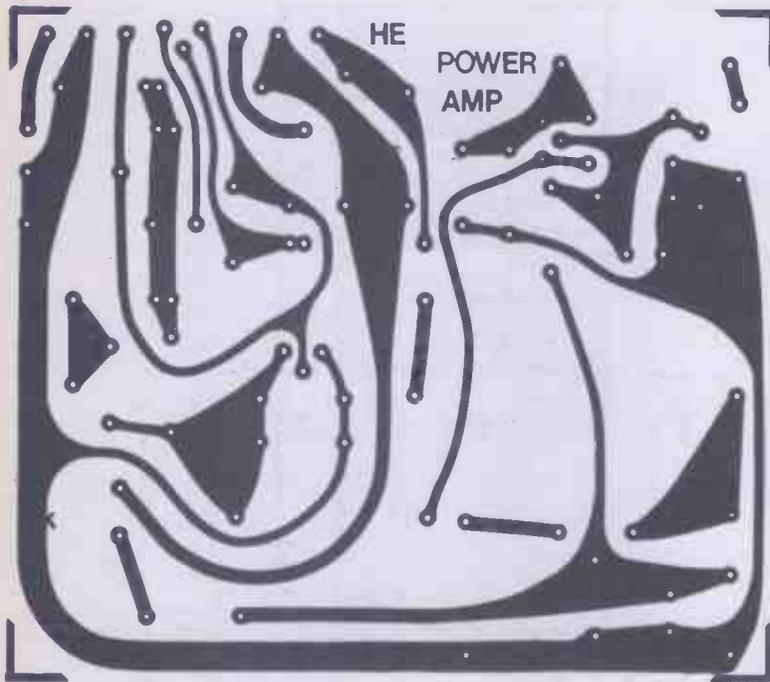
needed for each half of the waveform, as in figure 3.

But, a transistor's characteristic is not linear near the cut-off point, resulting in crossover distortion where the changeover occurs between each transistor. Moreover because the distortion stays the same size irrespective of the signal size, the relative percentage of distortion increases with a smaller signal.

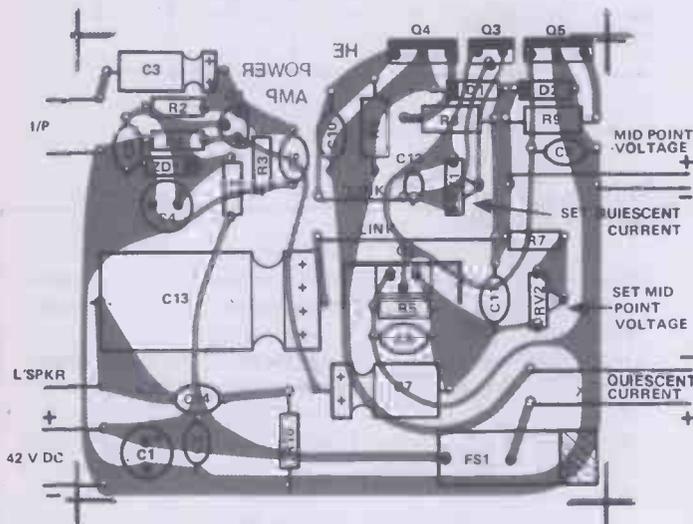


The answer to the problem is to introduce enough bias to eliminate this distortion. The overall effect is a mixture of Class A and Class B amplifications (called Class AB).

The HE 5080A power amplifier does this by means of a simple voltage regulator around Q3 and RV1. Class AB operation does mean that a certain amount of quiescent current is necessary. This is not, however, enough to represent a great heat loss and therefore this mode still maintains a high efficiency.



Above: PCB foil pattern for the 5080 PA



Above: Overlay diagram of the 5080A

been rectified, but consequently the circuit becomes increasingly more complicated. Most amplifier designers are now turning towards fuse protection as the better method.

Another ultra-modern protection technique is in the use of D1 and D2 — included to protect both the output

transistors and the speaker against sharp transients. The loudspeaker being partially a reactive load can cause large back EMFs to occur around the output stage area, which these diodes eliminate.

Also, our designers' minds turned to the problem of appearance — well, what's the use of a gadget if it doesn't look good? You can't show it off to the neighbours if it looks like a tobacco tin radio, can you? And, it has got to be neat — as few wires and cables as possible hanging all over the place, tripping you up and bring the specifications down. No — a compact, good looking module is required, as good as or better than those that can be bought.

The case which we used is just the job, constructed of metal it can be used to shield the amplifier from pickup and also be used as the amplifier's own heatsink. The printed circuit board was, in fact, designed specifically for this case and it does provide the amplifier with very smart and functional protection, although it is by no means essential that the same case is used.

## Parts List

### RESISTORS (All 1/4W, 5% except where stated)

R1	1K2
R2	330K
R3	68K
R4	100R
R5	82R
R6	270R 2.5W
R7	1K8
R8,9	0R33 2.5W
R10	10R 1W

### CAPACITORS

C1	47µF 63V PCB elect
C2,5,14	100n polyester
C3	22µ 25V elect
C4	47µ 40V PCB elect
C6	5n polystyrene
C7	470µ 10V elect
C8	1n polystyrene
C9,10	680p polystyrene
C11	2n2 polystyrene
C12	10µ 16V Tantalum
C13	1000µ 40V elect (see text)

### SEMICONDUCTORS

Q1	BC182L
Q2,3	BD 131
Q4	TIP 33A
Q5	TIP 34A
D1,2	1N4002
ZD1	30V 1.3W

### MISCELLANEOUS

Heatsink  
PCB fuseholder + 1 amp quick blow fuse  
Phono socket  
2mm sockets — 1 black, 1 red  
Rubber grommet  
Case — see Buylines.

## Buylines

First off, let's get the case out of the way. It is available from West Hyde Developments and is their "Sink Box" of length 100 mm. Their telephone number is Aylesbury (0296) 20441.

PCB mounting electrolytic capacitors are available from Electrovalue.

We cannot foresee any more problems with component supply.

## CONSTRUCTION

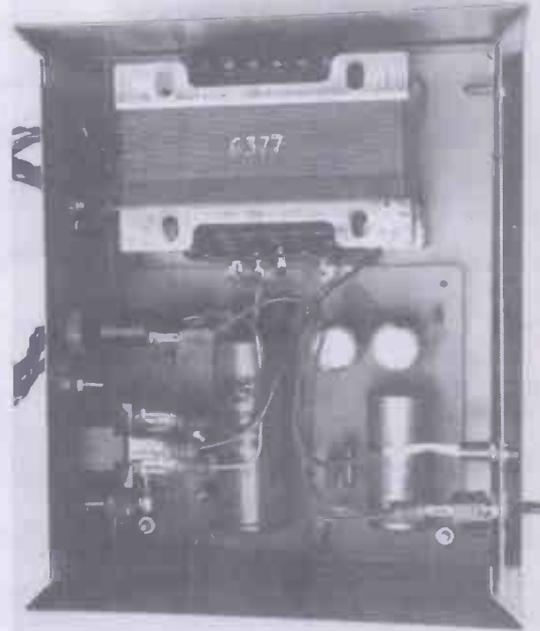
Using our design of printed circuit board, construction is straightforward. Consultation of the layout will tell you that the whole effect is one of neatness. C1 and C4 are PC mounting capacitors — if you have trouble obtaining them a suitable source is mentioned in Buylines. C13 is specified as 100  $\mu$ F 40 volt electrolytic, but it does need to be quite small (a maximum of 40mm in length). Various miniature types are available, eg ITT, Plessey etc, but if you cannot obtain one small enough then buy a smaller capacitance value — 680  $\mu$ F or 470  $\mu$ F — do *not* be tempted to use a capacitor of lower working voltage than 40 volts. By using a smaller capacitance value the only effect will be to slightly diminish the bass response, it will probably not even be noticeable.

Q2 is mounted on its own heatsink (plastic package transistor type — see photographs).

Q3, 4, 5 are all mounted on a large heatsink. If you use the same type case as you will find that the case can be used as the heatsink and does make for a good looking, neat module.

Whatever heatsink is used the transistors must be mounted using mica washers so that each transistor is electrically isolated from each other and also from the case. It is worth checking with a resistance meter that no electrical connections occur before switch on. The PCB can be bracketed to the end panel of the box and I/P phono, speaker O/P plugs and power lead can be made through this panel. Note that all external connections to the board are made from this end, meaning that all leads are kept very short, minimising the possibility of untidy flying leads and pickup. The power supply connection can be made with a small plug and socket as in our modules, or to keep cost down via a long lead with a rubber grommet in the case.

We used a PCB mounting finger release fuse-holder in order that, when the module is cased, the fuse can be



Inside the 5080 PSU module. For constructional details see page 19.

removed or inserted easily. Ordinary PCB types can be used but these make the removal of fuses more awkward. Alternatively a panel mounting fuseholder can be used, connected to the board with flying leads.

## SETTING UP

Do *not* attempt to use the amplifier without heatsinks! A heatsink of some description must be fitted before power is applied, either the module case or any ordinary heatsink.

Turn both presets fully anti-clockwise, looking from the end away from the connection panel. Insert a 1 amp quick blow fuse in the fuse holder.

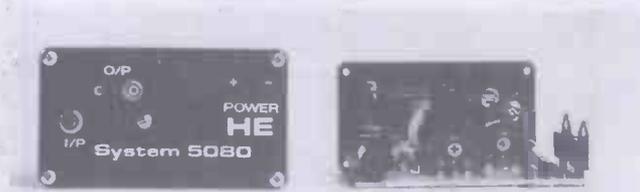
Next, connect the quiescent current test points using a short wire link. There are now two measurements to be taken:

1) The output voltage should be at about half the power supply potential. This is adjustable by RV2 and should be the first test, using a voltmeter connected to the appropriate test points.

2) The quiescent current, adjustable by RV1 and measured using an ammeter connected to the bias current test points (taking the link off first) should be set so that crossover distortion is eliminated. The current with RV1 turned fully anti-clockwise should be no more than 100 mA and is the current through the biasing chain R6, RV1, Q3 and Q2. About 50 mA of quiescent current should be added to the bias current and the final reading should therefore be about 140 to 150 mA, adjusted by RV1.

Finally resolder the link across the test points. If any audible crossover distortion occurs when an audio I/P and a loudspeaker is connected, then turn RV1 a shade further clockwise. But bear in mind that the more the quiescent current is increased the hotter the amplifier will run even with no input signal.

All of these measurements can be made with the board in its case and only the end panel taken off. HE



Two 5080 Amplifier modules removed from their cases.



Close-up of the rear panel of one of the amplifier modules.

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1505	.2 LED Diffused	GREEN	£0.11
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1506	.2 LED Diffused	YELLOW	£0.11
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SJ82	.2 LED Clear Illuminating	RED	£0.10
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SPM120/55	55v Stabilised supply - suit 2 x AL80, PA200 £5.80	
SPM120/65	65v Stabilised supply - suit 2 x AL120, PA200, 1 x AL250, PA200	£5.80
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BA173	£0.13	OA90	£0.08	IN4007	£0.09
BAX13	£0.05	OA91	£0.08	IN5400	£0.12
BAX16	£0.06	DA95	£0.08	IN5401	£0.13
OA200	£0.06	IN34	£0.06	IN5402	£0.14
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SJ4	60	1/2 watt resistors mixed values	0.50
SJ5	50	1-2 watt resistors mixed pot values	0.50
SJ6	50	Precision resistors 1-2" tol. mixed	0.50
SJ7	30	5-10 watt wirewound resistors mixed	0.50
SJ11	150	Capacitors mixed types & values	0.50
SJ12	60	Electrolytics all sorts mixed	0.50
SJ13	50	Polyester / polystyrene capacitors mixed	0.50
SJ14	50	C280 type capacitors mixed	1.00
SJ15	40	High quality electrolytics 100-470mf	1.00
SJ16	40	Low volts electrolytics mixed up to 10v	0.50
SJ17	20	Electrolytics transistor types mixed	0.50
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SJ20	2	Large croc clips 25A rated	0.30
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SJ57	6	100K log 40mm slider pots	0.50
SJ58	6	1K lin 40mm slider pots	0.50
SJ59	6	5K lin 40mm slider pots	0.50
SJ60	4	5K log 60mm single	0.50
SJ61	4	100K log 60mm single	0.50
SJ62	6	15mm chrome knobs standard push fit	0.50
SJ63	1	Instrument knob - black winged (29 x 20mm) with pointer 1/4" standard screw fit	0.15
SJ64	1	Instrument knob - black / silver aluminium top (17 x 15mm) 1/4" standard screw fit	0.12

### METAL CASE DUAL SLIDER POTS: 45mm travel

SJ65	10K log	0.25 each	
SJ66	100K lin	0.25 each	
SJ67	Chrome slider knobs to fit	0.10 each	
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SJ69	30	ZTX600 type transistor PNP pre-formed for P/c Board colour coded white - all perfect	1.00
SJ70	25	BC107 NPN to 106 case perfect transistors code C1359	1.00
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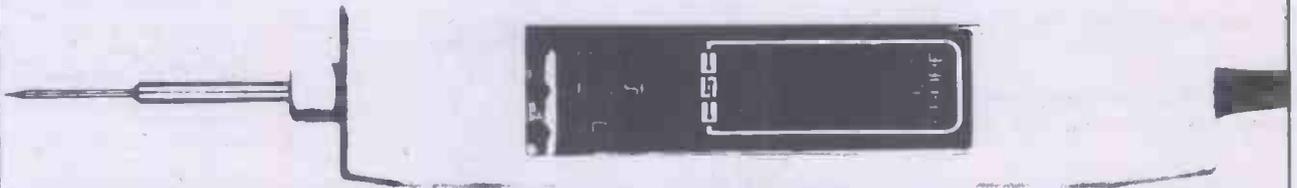
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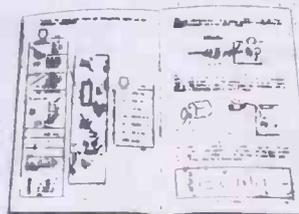
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# Clever Dick

Questions from abroad this month. A prize for the correct translation. At the other end of the scale a problem concerning noisy woodworm. Where will it all end?

RIGHTY-HO, brains in top gear, eyes down for another in our series of answers to burning questions. Jonathan Hill is first away this month.

Dear CD,

As issues 1, 2, 3, 6 and 7 of HE are now unobtainable why don't you start a photocopying service for readers. Your sister magazine ETI runs such a service for around 50p per article. If you would consider this idea I am sure many readers would take advantage of this service.

Jonathan Hill,  
Northampton

Actually we were considering offering a photocopying service but this was planned for next year. We have been genuinely surprised at the speed at which back numbers have sold out. In response to your request we will be offering photocopies of articles. More details next month.

A quick one from Gavin Cawley now.

Dear Dick,

Is it possible to put the Multi-Siren and R2D2 radio in the same case, sharing the same power supply and speaker?

Gavin Cawley  
Coventry

A quick answer for you Gavin, yes. There will have to be a double changeover switch (DP changeover) to switch from one circuit to the other but apart from that it should be OK. By the way, it won't fit into the original R2D2 case, you'll have to find a larger model for that.

Now for something slightly different. Copies of HE reach all over the world, even Belgium. A gentleman called O. Lecoq wrote to us the other day. This is his letter, as he wrote it.

Dear Dick Clever,

In the issue HE of January p.22, you announce projects of negativ ion generators. I made one and I feel no well being, only a weight on the chest when I let, it function during a night in my bedroom.

I think you will be interested by the article "The Invisible Enemy" I join. It was published in the Luxemburgish newspaper "LUXEMBURGER WORT" of the 20.11.79.

O. Lecoq,  
Arlon-Frassem, Belgium



Now to the problem. Mr Lecoq writes English much better than we read Luxemburgish. In fact none of us read this or any other language for that matter. (We even have difficulty with English.) The copy of the article is printed below, can any of your read it, if so could you supply us with a translation. First correct entry receives a brand new HE binder.

Incidentally, we are hoping to review a Negative Ion Generator kit in the next month or two. We'll let you know if we feel any well being.

Der unsichtbare Feind:

## Ozon ist kein Gesundbrunnen

Unter dem Titel „Ozon ist kein Gesundbrunnen“ veröffentlichte die bekannte „Süddeutsche Zeitung“ am 6. Oktober 1976 einen aufschlußreichen Bericht über ein Symposium, das in Düsseldorf 250 Wissenschaftler und Experten aus 10 Staaten abhielten, um die Gesundheitsrisiken des Ozons zu untersuchen und Schutzmaßnahmen auszuarbeiten.

Wir lesen: „Ozon gilt manchen Menschen noch immer als ‚Gesundbrunnen‘. Wäre dem so, so gäbe es für Ozon keinen MAK-Wert (maximale Arbeitsplatzkonzentration während eines achtstündigen Arbeitstages: 0,2 Milligramm im Kubikmeter Luft) und keinen MTK-Wert. Mengen von 0,15 Milligramm Ozon je Kubikmeter Luft dürfen als halbstündiger Mittelwert nicht überschritten werden.“

Natürlich stellen diese Grenzwerte, vom Gesetzgeber festgelegt, keine wünschenswerten Ozonkonzentrationen dar, sondern geben an, welche Ozonmengen den Arbeitenden überhaupt zugemutet werden können.

Wir lesen weiter: „Ozon beeinträchtigt unmittelbar Mensch, Tier und Pflanze.“

Da Ozon mit in der Luft enthaltenen Kohlenwasserstoffen reagiert, entstehen neue Folgeprodukte, Oxidantien genannt. Wir erfahren:

„Unter diesen (Oxidantien) sind besonders zu nennen die toxischen Stoffe PAN (Peroxyazetylinitrat) und PPN (Peroxypropioninitrat), die unter anderem Aktivitätsstörungen bei Enzymen bewirken, das heißt das Blutbild ändern können. (...) Nur 0,028 Milligramm PAN im Kubikmeter (mg/cbm) Luft genügen, um Pflanzen nach zweistündiger Einwirkung zu zerstören; PPN ist fünfmal so wirksam.“

„Gefährlicher aber ist die unmittelbare biologische Wirkung von Ozon, da es generell schon lange vor den Oxidantien in hohen Konzentrationen auftreten kann und zu 90 Prozent vom menschlichen Organismus aufgenommen wird: 0,16 Milligramm je Kubikmeter schwachen bereits die Infektionsabwehr, bei vorbelasteten Bronchien schädigen Ozon plus Oxidantien bereits im MTK-Wert-Bereich (= 0,15 mg/cbm) das Lungengewebe und die Lungenfunktion.“

Über die Einwirkung auf gesunde Erwachsene erfahren wir: „Akute Ozon-

wirkungen zeigen sich allerdings beim gesunden Erwachsenen spätestens bei Mengen von 0,4 Milligramm je Kubikmeter: ‚trockener Mund und Rachen, Atembeschwerden, Asthma und hartnäckige Kopfschmerzen sind Folgen.“

„Ozon ist nicht nur giftiger als PAN, sondern im Gegensatz zu PAN greift es vor allem die tiefen Atemwege an.“

Interessant ist es, zu erfahren, daß die Riesenstadt Los Angeles (USA) einen Ozonwarnplan für die Bevölkerung praktiziert: „Bei einer Konzentration von 0,2 mg/cbm (in der Außenluft) sind die Fenster zu schließen und Kinder im Haus zu behalten.“

Soweit aus diesem Fachbericht.

Über Ozon erfahren wir weiter im Buch von Prof. Dr. med. Lucas: „Das Neue Große Gesundheitsbuch“, Verlag „Südwest“, Ausgabe 1979, Seite 73, unter dem Kapitel „Wetterfähigkeit.“

„Dem Ozongehalt der Luft (Gehalt an verdichtetem Sauerstoff) besonders in Bodennähe, soll ein entscheidender Einfluß zukommen.“

Die Encyclopaedia Universalis bezeichnet Ozon als giftig, selbst bei schwachen Konzentrationen (Band 19, Seite 1434.)

Schlußfolgernd kann gesagt werden, daß Ozonproduktion in geschlossenen Räumen, besonders aber in kleinen Räumen wie Küche und Badezimmer zu vermeiden ist, da es hier besonders schnell zu hohen toxischen Konzentrationen kommen kann.

Wo Ozon unvermeidlich ist, z.B. beim elektrischen Bogenschweißen, ist für eine gute Belüftung zu sorgen.

The article from Luxemburger Wort

To say we get some unusual requests would be something of an understatement. Take this one from Cliff Robertson for instance.

Dear Dick,

Some time ago I heard about the grubs of woodworm beetles gnawing their way through furniture until they were fat enough to emerge and start on the next lot. One can see the exit holes of the beetles on affected furniture, but there may or may not be younger members of the family still munching away inside. Could you devise a microphone/amplifier/headphone set which would enable a doubtful purchaser of a genuine antique to listen to the ravages of the creatures within? Using my tape recorder microphone and stereo headset, possibly with an adaptor to transfer the sound from the Sheraton to the microphone, or perhaps one of the advertisers in HE might like to adopt the idea!

Cliff Robinson,  
Isle of Wight

What a brilliant idea! This was put to the project team who shook their wise heads in disbelief. After picking them up from the floor it transpired there may be one or two practical problems. The first would be calibration, how noisy are woodworm? Would they oblige by holding the microphone? Would they eat the microphone? We have decided to throw this knotty problem over to you. Best suggestions will be published in a month or two.

Our last letter this month comes from one J. F. Button. Getting extremely good value for money has asked three questions. This just goes to prove flattery will get you everywhere.

Dear Dick,

I am writing for three reasons:

- 1) To suggest that every now and then you print the names and photos of various members of the staff at HE and ETI.
- 2) That you design several projects which would all fit onto one big PCB and all use LEDs. (Really just a mini optical effects unit).
- 3) To congratulate you on running the best electronic magazines there are, namely HE and ETI, which I read and enjoy very much. Keep up the good work.

J. F. Button  
Winchester

PS: I thought your stand at Breadboard '79 was the best — congratulations.

Letters of this calibre are always given priority treatment. Who can argue with the truth? Seriously though, your first request has to be denied, most of the staff at HE and ETI are either too ugly or are camera shy. You'll just have to be content with the odd pix that creep into articles and projects now and again. Number two is a little easier, we have published several projects along the lines you suggest and will be designing many more in the months to come. Although we have no definite plans for combining them all onto one PCB it is quite possible that it's something we shall consider.

Lastly, thank you very much for number three and the PS. What more can we say . . . . . **HE**

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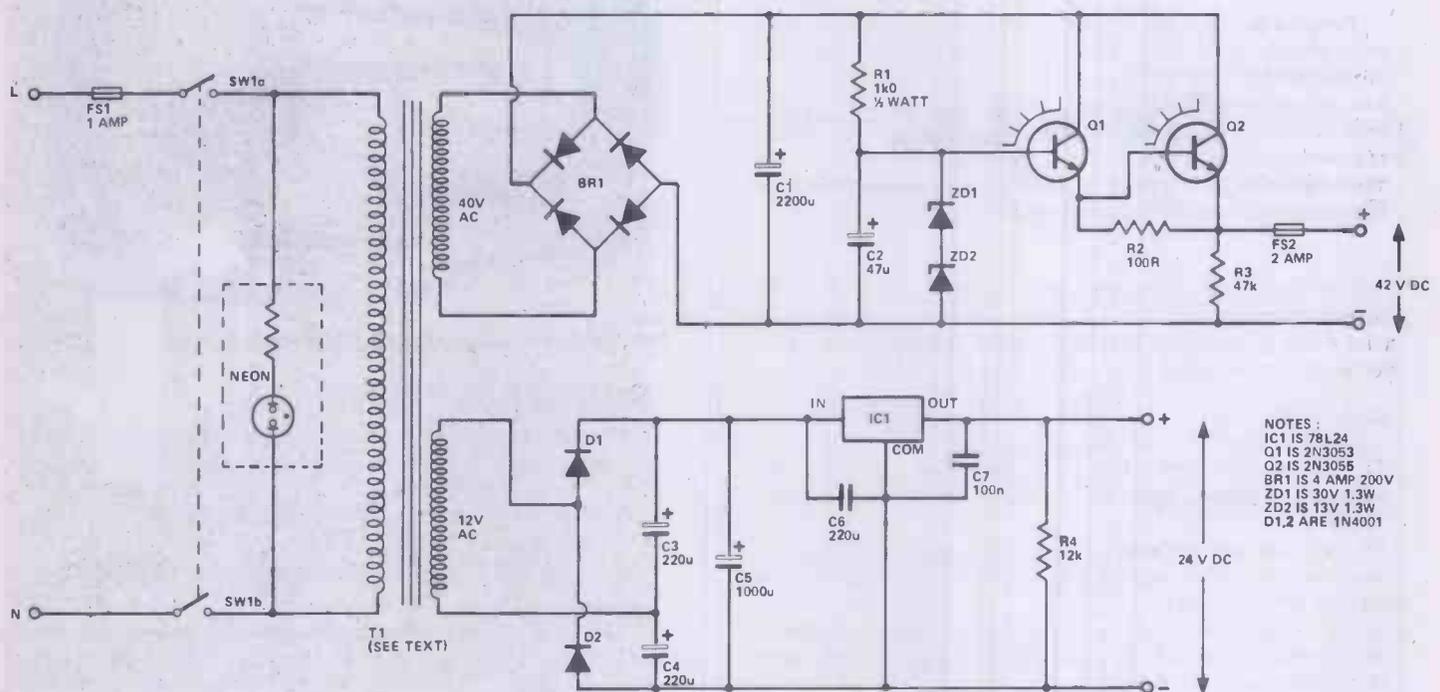
# PSU Module

**If you haven't already got a supply for your 5080A power amp modules then you will need one! The 5080 PS is designed for the job.**

THERE IS NOT AN AWFUL LOT one can say about a power supply unit. It is a pretty boring project really. Yet most electronic gadgetry just will not work without one. It actually is the work-horse of any mains powered equipment, but is generally forgotten about by most people. The HE 5080 PSU power supply, we hope, will be no exception to the rule. Designed to be trouble free

and easy to build, the supply can be built, tested and used without much fuss.

The 5080 PSU features a dual regulated voltage output of 42 volts DC and 24 volts DC so that it can power two of the 5080A power amplifier modules along with the 5080 Pre-Amplifier module which is still in design stages and will follow in a couple of months time.



**Fig. 1. Circuit diagram of the system 5080 PSU module. Photographs of the module are featured in the 8080 Power Amplifier project on page 11**

## How it Works

The circuit can be divided into two main parts — the 45 volt DC supply, which is a fairly standard transistorised voltage regulator providing a stable supply for up to two 5080A Power Amplifier modules — and the 24 volt DC supply providing a very stable supply for the future pre-amplifier module in the 5080 system.

The 42 volt supply consists of the usual bridge rectifier and smoothing capacitor. A stable 43 volts is given by the series combination of ZD1 and ZD2. Q1 and 2 form a Darlington pair in a series pass regulator configuration to allow the high current

output necessary with power amps.

The 24 volt supply is somewhat more unusual in that a voltage doubler rectifying stage is used around D1, 2 and C3, 4 so that over 24 volts DC is available from 12 volts AC. IC1 is a 24 volt regulator providing up to 100 mA at that voltage — quite ample for most pre-amplifier applications.

FS2 is quoted as a 2 amp fuse — this is essential when the PSU is to supply two power amplifier modules of the 5080A type. If only one power amplifier is to be run, then lower the fuse rating of the power supply to 1 amp.

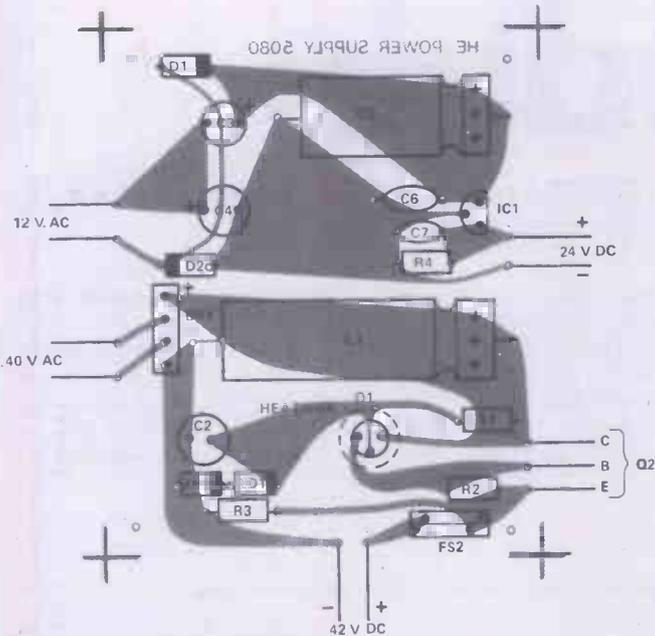


Fig. 2. Component overlay

## Parts List

RESISTORS (All 1/4W, 5% unless otherwise stated)

R1	1KO 1/2W
R2	100R
R3	47K
R4	12K

CAPACITORS

C1	2200 u 63 volt Elect.
C2	47 u 63 volt PCB Elect.
C3, 4	220 u 25 volt PCB Elect.
C5	1000 u 40 volt Elect.
C6	220 n polyester
C7	100 n polyester

SEMICONDUCTORS

IC1	78L24
BR1	4Amp 200V bridge rectifier
Q1	2N3053
Q2	2N3055
ZD1	30 V 1.3Watt zener
ZD2	13 V 1.3Watt zener
D1, 2	1N4001

MISCELLANEOUS

Panel mounting fuseholder + 1 amp fuse  
 PCB mounting fuseholder + 2 amp fuse  
 Neon mains indicator  
 Radiating fin heatsink for TO5 transistor  
 Case (see Buylines)  
 T1 50 VA or 100 VA mains transformer with 40 volt AC and 12 volt AC windings. (See buylines).

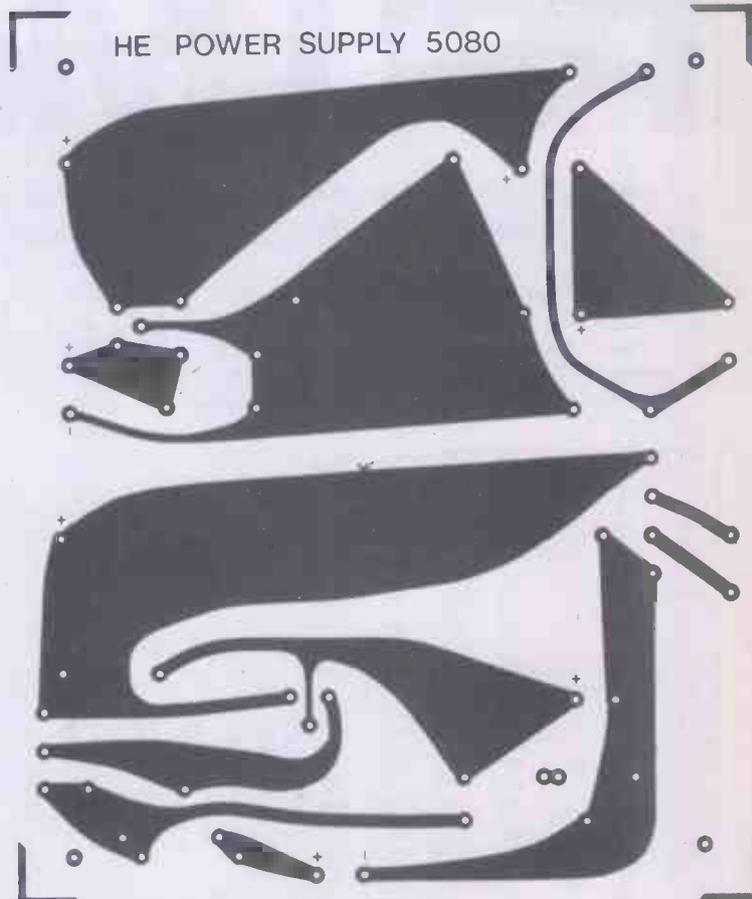


Fig. 3. PCB foil pattern for PSU Module.

## CONSTRUCTION

The main construction work concerns the building up of the circuit board, which is fairly spacious and therefore shouldn't be too difficult. C2, 3 and 4 are P.C.B. mounting capacitors and a suitable source in case of difficulty is given in Buylines.

Q1 heatsink is a radiating fin type, to fit a TO5 transistor.

Q2 is mounted on to the metal chassis of the case using the usual mica washer and heat sink compound to provide electrical isolation — check that this is so before you switch on.

SW2 is mounted on the circuit board in fuse clips FS1 however, should be panel mounted on the case, along with SW1 and the neon indicator.

Finally as with any mains powered device, make sure that the chassis case of the power supply is taken to mains earth, with bolt on connection. This is a safety measure in case of any fault.

HE

## Buylines

If printed circuit board mounting capacitors are hard to come by, you might try Electrovalue. All other components should be easy to obtain.

Our case was type FP 1B. This is available from Watford Electronics. This case was found to be ideal when a 50 VA transformer was used. If a 100 VA transformer is used, the next case up in the range might be necessary.

Transformer T1, although easily obtainable, may

present some cost problems to your pocket. If this is the case (and even if this is not the case) look at the ad on page 23 of this issue of Hobby Electronics, where lo and behold you will come across the answer to your dreams. Either of these transformers can be used in the 5080 PSU. It would appear that these transformers were purpose-built for the power supply (the truth is that we designed the PSU to suit the transformers).

BY TEXAS		74251	140p	4018	83p	93 SERIES	
7400	11p	74259	250p	4019	45p	9301	160p
7400	11p	74278	290p	4020	45p	9302	318p
7400	11p	74279	110p	4021	110p	9303	110p
7401	12p	74283	160p	4022	100p	9310	275p
7402	14p	74290	150p	4023	22p	9311	275p
7403	14p	74293	150p	4024	50p	9312	180p
7404	14p	74298	200p	4025	20p	9314	180p
7405	18p	74305	100p	4026	20p	9316	225p
7406	32p	74367	100p	4027	50p	9321	225p
7407	32p	74368	100p	4029	100p	9334	360p
7408	11p	74390	200p	4030	55p	9368	200p
7409	18p	74390	200p	4030	55p	9370	200p
7410	15p	74430	225p	4033	180p	9374	200p
7411	24p	74490	225p	4034	200p		
7412	20p	74500	14p	4035	110p		
7413	50p	74502	16p	4036	295p		
7414	100p	74503	18p	4037	115p		
7416	27p	74504	18p	4038	120p		
7417	27p	74505	22p	4040	100p		
7420	17p	74508	25p	4041	80p		
7421	40p	74510	20p	4042	80p		
7422	40p	74511	40p	4043	80p		
7423	40p	74513	40p	4043	80p		
7425	30p	74514	72p	4046	110p		
7426	40p	74515	46p	4047	100p		
7427	36p	74520	20p	4048	56p		
7428	17p	74524	20p	4049	40p		
7429	17p	74527	38p	4049	40p		
7432	30p	74530	20p	4050	48p		
7433	40p	74532	27p	4052	80p		
7437	35p	74542	70p	4053	80p		
7438	35p	74547	70p	4054	150p		
7440	17p	74551	20p	4056	125p		
7441	70p	74555	30p	4056	135p		
7442	60p	74573	80p	4056	135p		
7443	112p	74574	36p	4060	115p		
7444	112p	74575	40p	4063	120p		
7445	100p	74583	110p	4066	55p		
7446	93p	74584	110p	4067	450p		
7447	50p	74585	100p	4067	450p		
7448	80p	74586	40p	4068	22p		
7450	17p	74590	40p	4070	22p		
7451	17p	74593	80p	4071	22p		
7453	17p	74596	110p	4072	22p		
7460	17p	745107	45p	4073	22p		
7470	36p	745109	80p	4076	107p		
7472	30p	745112	100p	4081	22p		
7473	36p	745114	45p	4082	22p		
7474	36p	745122	80p	4086	72p		
7475	30p	745123	70p	4089	138p		
7476	35p	745124	80p	4094	250p		
7481	100p	745125	60p	4095	95p		
7482	84p	745132	95p	4096	95p		
7483	90p	745133	95p	4097	340p		
7484	100p	745134	95p	4098	107p		
7485	110p	745136	55p	4099	200p		
7486	34p	745138	75p	40100	220p		
7489	175p	745139	95p	40101	132p		
7490A	30p	745143	120p	40102	180p		
7491	80p	745147	220p	40103	180p		
7492A	46p	745148	175p	40103	180p		
7493A	30p	745151	100p	40105	95p		
7494	84p	745153	60p	40107	80p		
7495A	70p	745155	60p	40107	80p		
7496	80p	745156	60p	40108	470p		
7497	180p	745157	60p	40108	100p		
74100	130p	745157	60p	40110	100p		
74104	65p	745158	90p	40114	250p		
74105	65p	745160	130p	40111	1100p		
74107	34p	745162	140p	4502	120p		
74109	55p	745163	100p	4503	70p		
74110	85p	745164	120p	4507	56p		
74111	70p	745165	120p	4510	95p		
74116	200p	745185	160p	4510	95p		
74118	130p	745191	110p	4511	150p		
74119	210p	745174	110p	4512	80p		
74120	110p	745175	110p	4514	265p		
74121	28p	745181	320p	4516	110p		
74122	48p	745182	320p	4516	110p		
74123	48p	745190	280p	4518	100p		
74125	55p	745191	100p	4520	100p		
74126	70p	745193	100p	4521	105p		
74128	75p	745195	140p	4527	105p		
74130	50p	745196	120p	4528	100p		
74136	75p	745197	120p	4538	120p		
74137	50p	745240	175p	4543	180p		
74141	50p	745241	175p	4553	480p		
74142	200p	745241	175p	4556	480p		
74145	90p	745242	170p	4560	250p		
74147	190p	745243	170p	4569	250p		
74148	150p	745245	195p	4572	40p		
74150	100p	745247	140p	4583	80p		
74151A	70p	745248	140p	4584	80p		
74153	70p	745248	140p	4724	250p		
74154	100p	745249	140p	40014	90p		
74155	90p	745251	140p	40085	200p		
74156	90p	745253	140p	40097	90p		
74157	70p	745257	120p	14411	1100p		
74159	180p	745258	160p	14412	1100p		
74160	100p	745259	160p	14433	1100p		
74161	100p	745266	100p	14500	700p		
74162	100p	745273	175p	14599	290p		
74163	100p	745298	240p	CD22100	350p		
74164	120p	745321	200p	CD22101	700p		
74165	130p	745324	200p	CD22102	700p		
74166	120p	745348	200p				
74167	200p	745365	200p	ICs			
74170	240p	745368	100p	DM8123	175p		
74172	480p	745373	180p	MC1488	100p		
74173	120p	745373	180p	MC1489	100p		
74174	90p	745374	195p	25510	350p		
74175	85p	745378	200p	75107	160p		
74176	90p	745390	160p	75150	175p		
74177	90p	745393	160p	75154	175p		
74178	180p	745445	180p	75182	230p		
74180	83p	745568	100p	75322	300p		
74181	180p	745569	100p	75324	375p		
74182	90p	745670	400p	75325	375p		
74184A	150p	4000 SERIES		75361	300p		
74185	150p	4000 SERIES		75363	300p		
74186	500p	4001	17p	17365	350p		
74188	325p	4002	17p	75451	72p		
74190	90p	4006	95p	75491/2	95p		
74191	90p	4007	18p	8726	26p		
74192	90p	4008	80p	8728	300p		
74193	90p	4009	40p	8735	200p		
74194	90p	4010	50p	8737	200p		
74195	95p	4011	17p	81LS95	140p		
74196	95p	4012	18p	81LS96	140p		
74197	80p	4013	50p	81LS97	140p		
74198	150p	4014	84p	81LS98	140p		
74199	150p	4015	84p	81LS99	140p		
74200	110p	4016	45p	9602	220p		
74221	180p	4017	80p	9603	180p		

VERBOARDS		O.1	O.15
AC126	25p	AC127	25p
AC127	25p	AC128	25p
AC128	25p	AC129	25p
AC129	25p	AC130	25p
AC130	25p	AC131	25p
AC131	25p	AC132	25p
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AC194	25p	AC195	25p
AC195	25p	AC196	25p
AC196	25p	AC197	25p
AC197	25p	AC198	25p
AC198	25p	AC199	25p
AC199	25p	AC200	25p

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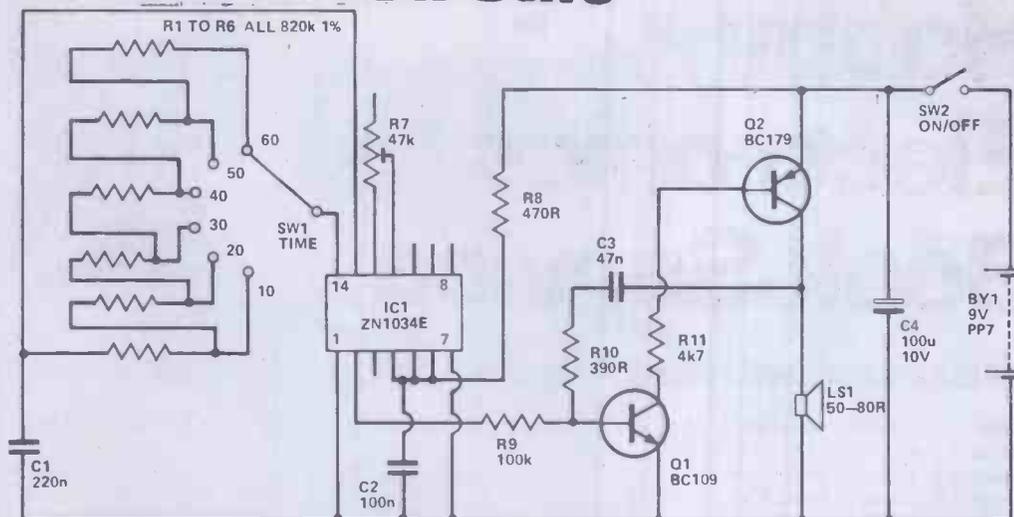
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# Short Circuit

## ZN1034E TIMER

Long timing periods are difficult or even impossible to obtain using most simple timing circuits, such as those using the well-known 555 timer IC. The problem is that such circuits usually provide a timing period of only about 1CR seconds, and times of more than a very few minutes require unrealistically high values for the time resistor and capacitor. The ZN1034E device is specifically intended for applications where long times are required, and using an oscillator, a 14 stage binary divider (divide by 4,096 circuit), and a logic control section, an output time of between about 2,700 and 7,500CR seconds can be attained! This enables times of hours or even days to be obtained, and times of a few minutes to a few hours can be obtained without having to use an electrolytic timing capacitor, giving excellent reliability and accuracy.



This simple timer circuit provides an audible alarm at the end of the timing period which can be varied from 10 to 60 minutes in 10 minute increments. C1 is the timing capacitor, and the timing resistance is formed by whichever of the series of resistors (R1 to R6) is switched into circuit using SW1. The timing resistors all have the same value, and so if one resistor gives a time of 10 minutes, two produce a time of 20 minutes, three give 30 minutes, and so on. The timing period can be varied

from about 2,700CR to 4,100CR seconds using R7, and in practice this is adjusted by trial and error to give a suitability high level of time accuracy.

The ZN1034E has an internal 5V. shunt regulator, and R8 is the load resistor for this. The trigger input (pin 1) is connected to the negative supply so that circuit is triggered at switch on. The not Q output at pin 2 goes low during the timing period, cutting off both Q1 and Q2. These two devices, which form the basis of an audio oscillator

driving LS1, are biased into operation at the end of the timing period when pin 2 goes high, causing the alarm to sound.

The circuit consumes about 8 mA under quiescent conditions, rising to about 16 mA when the alarm is operating. The times provided by the unit can be varied to suit individual requirements by changing the timing component values, but the timing resistance should be no more than about 10 megohms, and the timing capacitance should not be less than 3.3nF.

# TRANSFORMER OFFER (PSU)

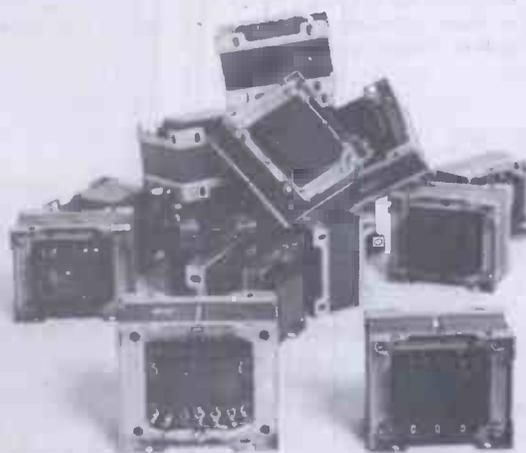
If you are contemplating building the 25 watt amplifier and PSU modules in this month's HE (page 19) then you may be interested in our special Readers Offer this month. We have a fairly limited supply of transformers suitable for the PSU module. These are the same types as used on our prototype. We have two types on offer, the larger of the two is a 100 VA device, it has two 12 V windings and one 40 V winding. The primaries are both rated at 240 V AC. (The smaller model also has a 220 V tapping on the primary).

Both types are available for just £6, that includes VAT and postage and packing. (Postage on the larger one is nearly £1.50!) so as you can see it is a very good deal indeed.

When ordering please specify which type you need (S or L). As stocks may be limited we reserve the right to send you the alternative model, so order early.

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# PETting It Together



***If you think PETs are small furry animals, then read on. Rick Maybury has been looking around the Commodore factory in California where PETs are made.***

'SILICON VALLEY: that conjures up all sorts of images. What the papers and TV programmes fail to tell you is that it is an area some 200 miles long. To locate one particular place requires a little more than a vague map and a tentative invitation.

Heedless of these 'minor' problems HE went in search of the Mecca of microcomputers, that well known manufacturer of watches, calculators and of course PET computers, Commodore.

Commodore, or at least, the place where they make PET are to be found in what might be called the heart of Silicon Valley, Santa Clara. Santa Clara, and particularly the Commodore complex is about as easy to find as a proper English chip (potato that is) in the USA.

Having finally arrived we were greeted by our genial host Neil McElwee who conducted our visit.

Before we launch into graphic descriptions of how PETs get put together some information on other Commodore products. The watch and calculators bearing Commodore badges are mostly built in the Far East, however, LCD displays for which Commodore are justly renowned are put together in their Texas plant. Right, back to sunny California.

PET, or Personal Electronic Transactor, (not sure what it means either) has become synonymous with home computing. They first sprang upon the unsuspecting

world during 1977, bringing computing in real terms into the home. During these past two or three years Commodore have managed to knock out something like 80,000 PETs, surpassed only by the amazing Radio Shack (Tandy to us limeys) who claim an impressive 100,000 TRS 80s on the streets.

## **SOLAR POWERED**

The PET is a rather unholy mixture of modern and 'ancient' technology. On the one hand we have the relatively old fashioned monitor, the telly bit on the top coupled up to the very latest (well, pretty new considering) IC microprocessor technology. Just to complicate matters, a mechanical tape deck is thrown in for good measure. To date the PET is still the only all-in-one computer system on the market. This curious combination is reflected in the factory complex.

The Commodore factory boast one of the most advanced solar heating and air conditioning systems in the world. (Why they should need any kind of heating in California must remain a mystery). Within this ultra-modern complex the PET computers are virtually assembled by hand. In fairness though they hope to be using automatic insertion machines for the main PCBs in

the very near future.

From beginning to end a PET takes about three days to come together, a bit slow when you consider the average family car is built in just a few hours. Much of the three days period is taken up by what the Americans call 'burn time'. We call it 'soaking', it involves putting the various assembled PCBs through a continuous test cycle for up to 36-hours.

## BIG SCREEN

Looking round the factory it's surprising to see how many varieties of PET there are. Apart from the various permutations of memory size, 8k, 16k and 32k they also have an intriguing machine called Teachers PET. Far from being designed for whiskey manufacturers it is specifically intended for schools and colleges. To look at it is pretty much the same as a standard PET. Though we're told it has a couple of features that will make teaching the intricacies of computer programming a lot easier. (Classrooms full of sceptical students, we wish them luck). Most of the PETs under construction now sport the green screen, this is the 9 inch, 40 column item. Commodore are currently introducing a 12 inch screen model, capable of displaying 80 columns and supporting up to 64k of memory. That means it will be even smarter. Fascinating as this doubtless is, we tend only to be interested in how good the games are.

Apart from the PET, Commodore also assemble a noisy device called a line printer. In reality they only manufacture the electronics, the mechanics are off-the-shelf items. The same goes for the Floppy Disk units, only the electronics are assembled on-site.

It was interesting to see the PETs undergoing their final checks before packing. A test involves a programme being loaded into the machine from a floppy disk and a trained operator looking at the results on the screen. This must be one of the most boring jobs imaginable, peering day in, day out at rows of meaningless alphanumeric and graphic characters flashing on the screen. Boring or not, their rejection rate and after sales failure rates are impressively low. There is a chance for us humans yet.

The entire factory (the Americans call it a 'facility') is staffed by only 300 people, most of them concerned with PET manufacture. Whilst we were there a lorryload of PETs was being packed up for the UK market, though informed sources at Commodore now predict the next big market to be in Germany.

Commodore are basically a hardware manufacturer, that is to say they have very little interest in the software side, the programmes written for PET. However, at the time of our visit the Gentlemen at the facility were taking great pains to impress us with their new Word Processor package, and most interesting it sounded too. This

*Below. The Commodore factory. The sloping roof acts as a solar collector. Inside much of the air-conditioning and heating is also solar-powered. The entire complex is staffed by only 300 employees, most of the component parts of the PET, i.e. metal work is fabricated in other plants.*



preoccupation with business use emphasised the current US trends in microcomputing and doubtless the way, we in Europe will be going in the next year or so.

## **BUSINESS USERS**

When PET first came onto the scene most of them went to what we would call the hobbyist market. That is the chap (and probably a good few ladies too) who sit at home writing and running programmes purely for personal use. Today we have the situation where the majority of machines are being brought for business use. Many small companies unable to justify spending thousands of dollars on time sharing or a mainframe system are turning to devices like PET to solve all their paperwork and financial problems. For a very modest outlay a small company can buy a complete package of hardware and software capable of dealing with such diverse subjects as payroll, stock control and invoicing yet still play a creditable game of Star Trek, all at the flip of a cassette tape or floppy disk. Commodore confidently predict this will be the way of minicomputers in the next few years. To this end they are preparing to tool up for the CBM Business system a somewhat serious version of the ordinary PET.

Naturally everyone at Commodore were a little reticent (to say the least) to discussing the future but one helpful gentleman steered us towards a shiny booklet, Commodore's annual report. Without committing himself too heavily he pointed out three very

interesting paragraphs which he assured us might answer one or two burning questions. The first states;

*"... and work is moving forward on a large area LCD (Liquid Crystal Display) to be employed in computers and selected consumer products"*

Could this be a thin screen TV?

The second paragraph is a little more down to earth.

*"Other computer enhancements under development during fiscal 1980 will expand the capability of PET systems to a point where they will be able to talk, listen and draw. Development of a next generation computer is scheduled for completion during 1979-80 and introduction by the end of the fiscal year"*

Whatever next? A talking PET. Our office PET could tell a tale or two.

Our last clue to the future is a little more concrete, PET owners will be delighted / frustrated to know that;

*"... a low cost colour controller to be introduced in fiscal 1980 with the PET system and available for sale to outside customers by the Electronic Components Division"*

We are tempted to ask whether combining all of these features, speech, etc, will produce a PET with an LCD display and some very colourful language. Watch this space.



**Above.** The sloping roof of the factory acts as a solar collector.

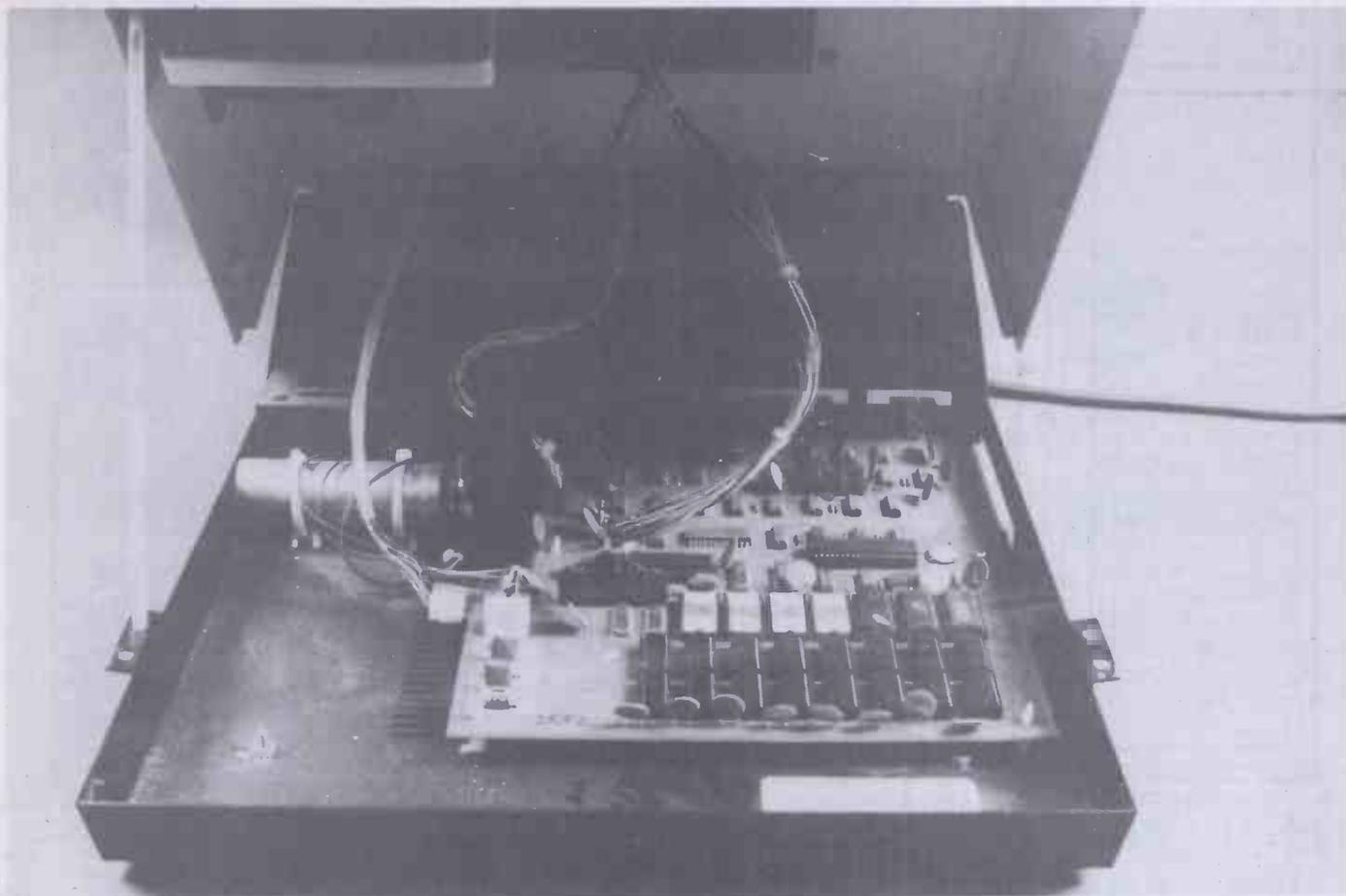


**Left.** Inside the reception area. The area is space-heated and air-conditioned by the solar system.



**Right.** Inside one of the assembly shops. The PET's are built on an assembly-line though much of the work is still completed by hand.

# PETting It Together



*Inside a typical PET. The main processor board can be seen on the right hand side of the cabinet. The rows of ICs at the front are the RAMs. The hefty power supply can be seen on the rear, right hand side. The large smoothing capacitor is just below the mains transformer.*

All of the current range of PETs share a common chassis. The case is fabricated from mild steel, making it very robust and unfortunately quite heavy.

The electronics are divided into three sections. The main board, that does all of the clever stuff. It sits in the bottom part of the case. This board holds all of the digital bits, an array of large and small ICs in neat rows just beneath the keyboard.

Sitting next to this is the mains power transformer. The incoming mains is stepped down to the various supply levels needed to drive the electronics. The supply for the monitor circuitry also originates here, so it is a pretty hefty device.

The final section is the monitor. This is housed well away from delicate ICs in the top section of the case. It gives an interesting contrast to the neat digital stuff below, looking somewhat similar to a birds nest, made by a blind bird.

We were interested to ask why Commodore opted for the all-in-one concept. The answer came as something of a surprise. In the US the controls over using UHF modulators are very strict. So rather than

running foul of the all powerful FCC they decided to supply a monitor built in. Incidentally this has a number benefits. Fewer problems arise as a result of poor interconnections between computer and display and the character definition is much better.

As it turned out the in-built monitor was a wise choice. Texas lost several months in getting their computer on the market, purely as a result of having to obtain FCC approval for their modulator.

Another aspect of this unconventional design is the ease of service. Literally everything is readily accessible. The top half of the cabinet tips up into the service position, a very good idea.

It is difficult to comment upon the PETs design, after all 80,000 people can't be wrong. Many lesser computer companies have gone bust building machines with extravagant claims.

The durability of PET is unquestionable though this may work to Commodore's detriment. Newer designs appear almost daily, hopefully PET will also move with the times and a new model should be appearing soon.



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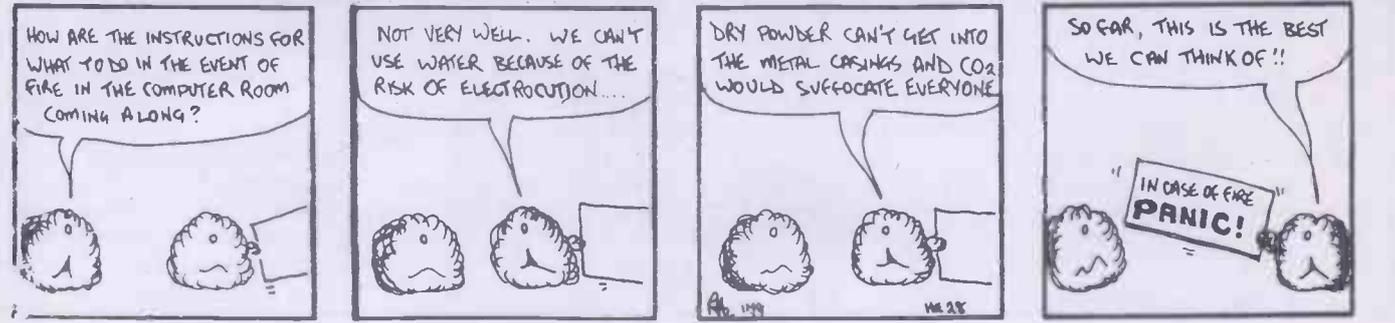
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# Kit Review

## INTEGREX 2020 TA

***Without doubt the most ambitious and one of the most expensive kits we've ever reviewed. Was it worth it? Read on and find out.***

QUITE POSSIBLY the most rewarding kit we've ever built, extravagant claims? We think not, after soldering up some two hundred or so components and to have said kit work first time, how satisfying can you get?

The kit in question is the Integrex S2020 TA Stereo Amplifier Tuner. Integrex are past masters at audio kits, specialising in designs published in a certain 'venerable' electronics journal. Our kit was chosen carefully from their range, taking into consideration cost, specifications and apparent ease of construction. Obviously we had to avoid any previously published designs so we settled for the 2020. The kit will arrive on your doorstep for just £59.95, not bad at all.

### **BEGINNER BEWARE**

From the outset it must be said this kit is not for the faint-hearted or clumsy solderers. It is a kit on the grand scale. The instructions assume a basic familiarity with electronics, quite the opposite philosophy to Heathkit

who reckon that if you can read you can build their kits. (And rightly so for their instruction manuals are the best we've ever seen.)

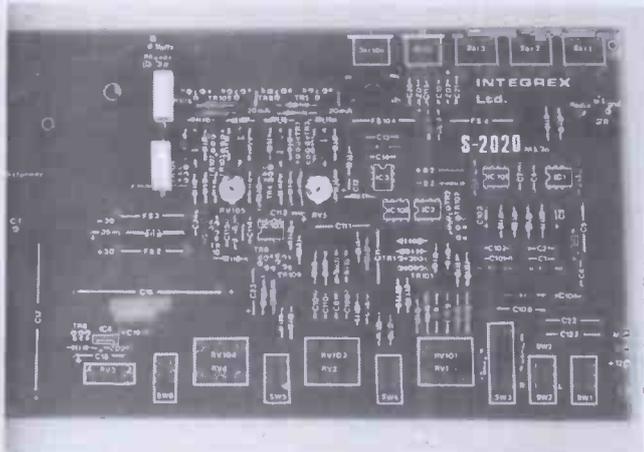
Now for the gripes, the kit arrives carefully boxed, all of the electronic components neatly packaged in the obligatory plastic bag. Unfortunately none of the dozen or so bags bore any identification labels, confusion reigned. Worse was to come. Having warmed up the HE soldering iron and selecting what seemed to be the appropriate plastic bag, construction commenced. About half way through the first hundred or so resistors it appeared that the bag being used had more bits than was necessary for the first stage, indeed several bits did not seem to belong anywhere. We still have a couple of resistors, three transistors and good few nuts, bolts and round things left over. We've often discovered things missing in the past but never a surplus, even allowing for the modifications Integrex suggest for the unit they still remain a mystery. Perhaps they are spares, if this is so then this is a trend we shall encourage.



***As it arrives. Unfortunately none of the plastic bags bear any labels, confusing isn't it?***

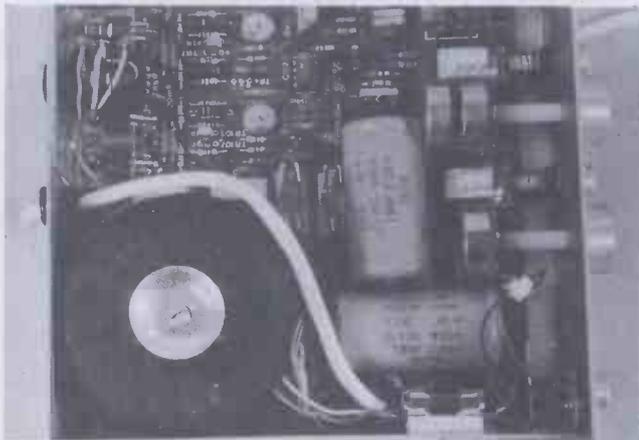
## THE ELECTRONICS

Back to business, the electronics are all built up onto two glass fibre PCBs, one for the main amplifier and a much smaller one for the tuner. (Incidentally the amplifier is available as a kit on its own). The PCBs deserve a mention, they are plated, screened and a component legend printed on the topside. All this makes them a positive delight to work with. Construction of the electronics is to work with. Construction of the electronics is the longest job, allow two or three evenings for this and don't forget to tick the bits off as you go along.



*The PCB with the first batch of resistors soldered down. Note the excellent component legend.*

One or two comments about the electronics before we get to the metal work. The toroidal transformer, a splendidly made device, was just a touch too big, probably this was only the thickness of the covering material but it did necessitate making the mounting hole a shade larger. Secondly, Integrex would be well advised to supply some IC holders in the kit, they would add pennies to the cost but might save hours fault-finding. Lastly the holes for the PCB mounting pots were too small, they had to be opened out at quite a late stage making life a bit difficult. Small points but they are so easily remedied.



*The mains supply area. The toroidal transformer was a slightly 'snug' fit.*

### BOLT UP

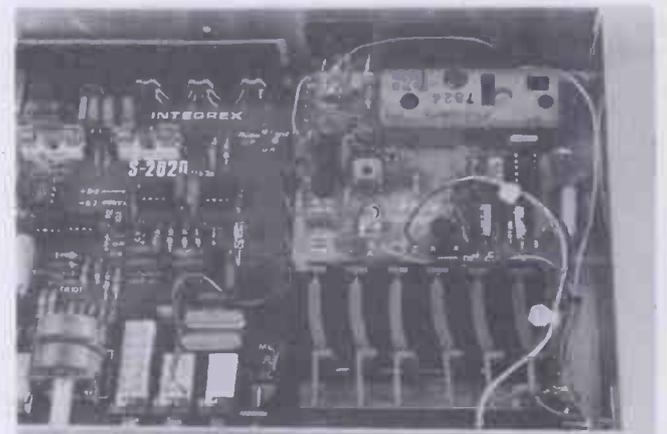
On the home stretch now, the well made aluminium chassis pan accepts all of the various bits and pieces. The channel selector assembly is a trifle fiddly to bolt up

and align with the front panel. Apart from that everything just falls together. Integrex suggest that when mounting the pots the front panel should be used to ensure that everything lines up properly, we didn't, and suffered the consequences accordingly.

Once assembled, and before the tuner section is connected the amplifier is set up. This could not be easier, consisting of about four current and voltage readings and two preset pot twiddlings. Everything checked out OK first time. How about a fault check-list for the not-so-fortunate Integrex?

Next, the tuner section is connected, this is based on a pre-aligned tuner head, the only adjustments to be made are for AFC and background noise. Both are made by ear so no problems here, again a first time success.

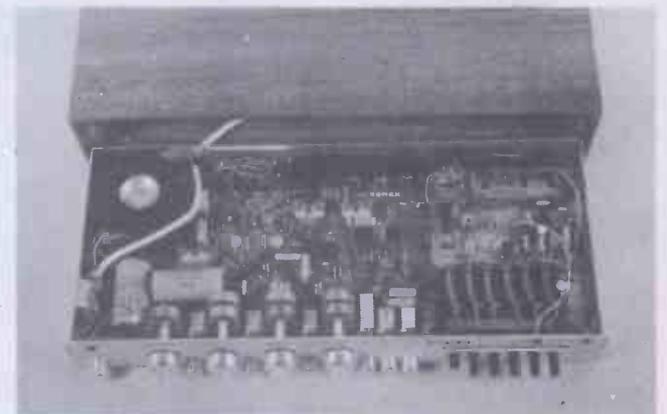
All that remains is to bolt up the front panel and slide the whole unit into its attractive solid mahogany case. Our front panel was just a little too long for a comfortable fit, a couple of strokes with a file soon cured that.



*The tuner area. The pre-aligned tuner head saves a lot of trouble.*

### VALUE FOR MONEY

So, to the important bit. It works extremely well, consensus in the office was most favourable, the claimed 20 watts per channel all seemed to be doing their stuff. Generally it seemed to live up to its



*The completed amplifier/tuner prior to sliding into its case.*

specifications and produced a very pleasing sound. The tuner section was comparable with any other set we have heard, costing up to three or four times as much. The use of a varicap tuner makes it very convenient to use. How about a little light behind the tuning scale Integrex?

Conclusion? The kit represents very good value for money, if you are in the market for a stereo tuner amplifier look no further. One or two little things outlined earlier need to be looked at by the manufacturers but apart from that we have no hesitation in recommending it. Remember though, it is not for the absolute beginner you at least need to know how to solder. All of the components supplied are of the highest quality and should give years of trouble-free service. In case of problems Integrex offer a repair service. The amplifier specifications are given below. Integrex can be found at: Portwood Industrial Estate, Church Gresley, Burton on Trent.

## SPECIFICATIONS

### Amplifier Specification

**Sensitivity** to give 20 watts into 8Ω

Magnetic pick up 2.5mV

Tape input 130mV

Radio 130mV

**Input impedance** 47k @ 1kHz

**Tape output** (low level output) 130mV via 4.7kΩ unaffected by tone or volume controls

### Tone controls

Treble + 10-12dB at 15kHz

Bass ± 16dB at 30Hz

**Balance** ± 8dB one channel relative to other

**Unweighted signal-to-noise** of complete amplifier with full amplifier bandwidth  
— 60dB magnetic pickup  
— 72dB radio

### Power Output (both channels)

> 20+20 watts into 8Ω intermittent sine wave

16+16 watts into 8Ω continuous sine wave

15+15 watts into 15Ω continuous sine wave

### Harmonic distortion

15 watts into 15Ω 0.05% at 1kHz

20 watts into 8Ω 0.09% at 1kHz

### Low level distortion

0.16% at 1kHz 50mW into 15Ω

0.07% at 1kHz 50mW into 8Ω

### Frequency response (16+16 watts into 8Ω)

— 1dB 14Hz to 22kHz

— 3dB less than 7Hz to 35kHz

**Stability** — will drive electrostatic loudspeakers

**Output impedance** less than 1 milli ohm

### Dimensions (sleeve)

Width 391mm 15.4in

Height 69mm 2.7in

Depth 170mm 6.7in

HE

# 20Hz to 100MHz - £77.55

(+ VAT 15% & P & P. £90.91) Export + 10%



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We've also designed the MAX-100 around the latest in LSI technology; and built-in high sensitivity, with a 30mV trigger level; protection against high transients; and an outstanding accuracy of 3ppm. (What performance!)

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your MAX-100 could be on its way, today! (Continental are great performers, too.)

For data, please use our enquiry number.

**Specification** \* Frequency range 20Hz to 100MHz \* Input impedance 1 megohm shunted by 56pF \* Sensitivity 30mV to 300mV r.m.s., from 20Hz to 100MHz \* Timebase accuracy 3ppm \* Temperature stability 0.2ppm per °C \* Max. ageing rate 10ppm per year \* Overfrequency indication \* Low battery power alarm \* Operates from a.c. mains, dry or rechargeable cells, or 12Vd.c. auto battery \* Dimensions 45 x 187 x 143 mm. \* **Options:** 12V auto. cigar lighter adaptor; battery eliminator/charger; r.f. antenna; low-loss r.f. tap; and carrying case.

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## S-2020TA STEREO TUNER AMPLIFIER KIT

**SOLID MAHOGANY CABINET**

**A high-quality push-button FM Varicap Stereo Tuner combined with a 24W r.m.s. per channel Stereo Amplifier.**

As reviewed in this issue.

**Brief Spec.** Amplifier Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc.), THD less than 0.1% at 20W into 8 ohms. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section uses 3302 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88-104MHz. 30dB mono S/N @ 1.2µV. THD 0.3%. Pre-decoder 'birdy' filter.

**PRICE: £59.95 + VAT**

We guarantee full after-sales technical and servicing facilities ★ High performance Amps, Tuners and Dolby units available.

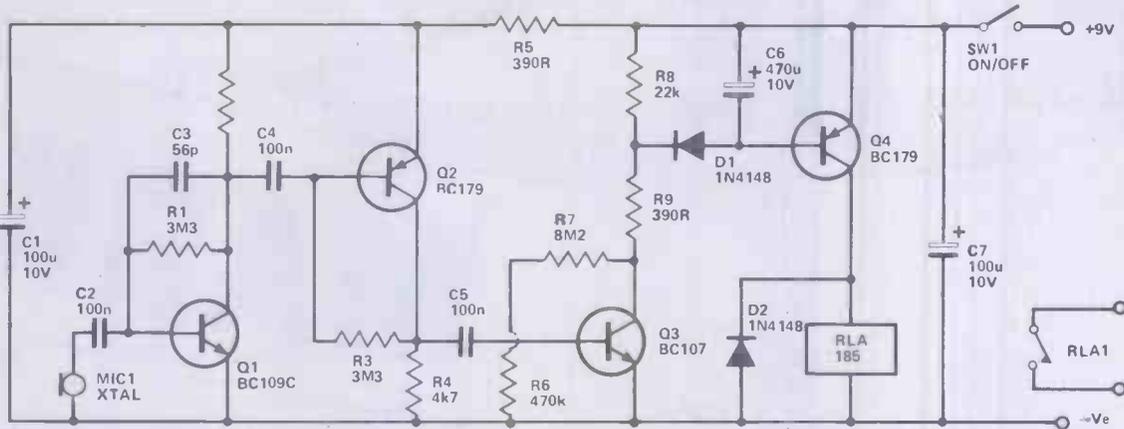
Prepare for B.B.C. Quadrophonic Broadcasts — Send for details of our Ambisonic H.J. decoder

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Please send SAE for complete lists and specifications  
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 Burton-on-Trent, Staffs DE11 9PT  
 Burton-on-Trent (0283) 215432 Telex 377106



# Short Circuits



## SOUND OPERATED SWITCH

Sound activated switches are used in many applications, some typical examples being voice operated tape recorders, baby alarms, burglar alarm systems, and VOX (voice operated switching) systems of radio transmitting/receiving installations. The simple circuit shown here will operate at a distance of up to about 2 or 3 metres

from a voice of average volume (slightly less if the xtal microphone insert is replaced by a medium or high impedance dynamic type).

Signals produced by the microphone are amplified by a high gain amplifier which uses two stages of common emitter amplification. These two stages are based on Q1 and Q2 and use a straight forward capacitively coupled arrangement. Both transistors are operated at low collector currents in order to give a low noise level and quiescent current consumption. C3 rolls off the high frequency response of the circuit and aids good stability.

The output from Q2 is coupled

to a third common emitter stage by C5. This third stage is based on Q3, and is biased by R6 and R7 to a point where Q3 is virtually cut off. There is thus very little voltage developed across load resistor R8, and the input voltage fed to Q4 via D1 is insufficient to switch on this device and activate the relay which forms its collector load. However, when sounds are received by the microphone, a strong signal is received at Q3's base, causing it to conduct heavily on positive going input half cycles. This produces a series of strong negative pulses across C4, charging up this component to an adequate level to switch on Q4 and the relay. A pair

of relay contacts are used to control the supply to the slave equipment.

C4 charges via the fairly low impedance of Q3 and R9, giving the circuit a fairly fast attack time. C4's discharge path is through the relatively high impedance of Q4's base emitter junction giving a decay time of a second or two. Thus the circuit responds rapidly when a signal is initially received, but the relay does not cut out during the brief pauses that occur during normal speech.

The quiescent current consumption of the circuit is only about 250  $\mu$ A, but this rises to about 35 mA when the relay is activated.

## TRANSISTOR TESTER

This very simple transistor tester measures DC current gain in three ranges, with full scale values of 10, 100 and 1,000. It will also show whether or not the device under test has a high leakage current.

The basic tests for a transistor are very simple and in order to test for high leakage, it is merely necessary to connect a voltage across the emitter and collector terminals of the test device, and then measure the current flow. In this circuit BY1 is the voltage source, and ME1 registers the current flow. R4 is a current limiting resistor which protects ME1 and the test device from passing an excessive current.

Silicon devices have extremely low leakage currents, and if there is any deflection of ME1 when testing a silicon transistor it certainly means that device is not functional (or is connected incorrectly). Germanium devices have somewhat higher leakage currents, and a very small deflection of ME1 is acceptable when testing this type of transistor.

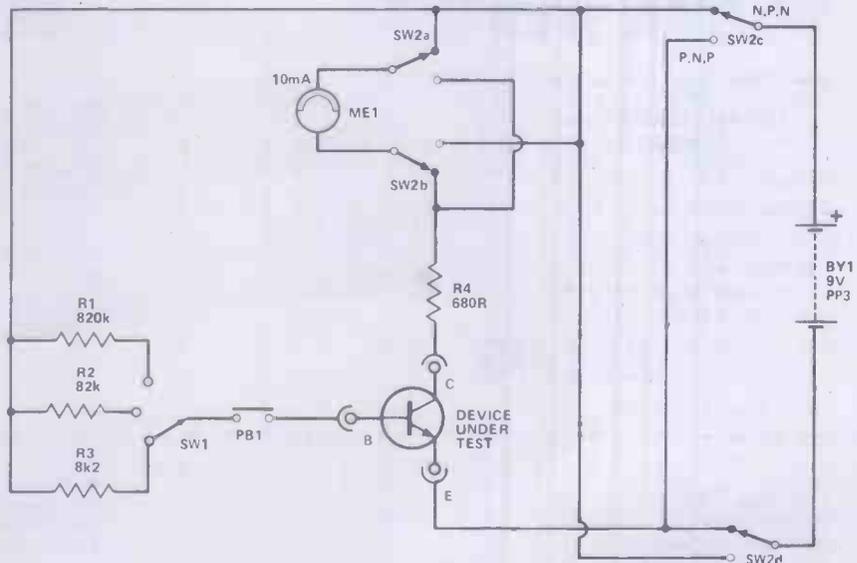
The test for DC current gain (Hfe) is basically the same as for leakage testing, except that a cur-

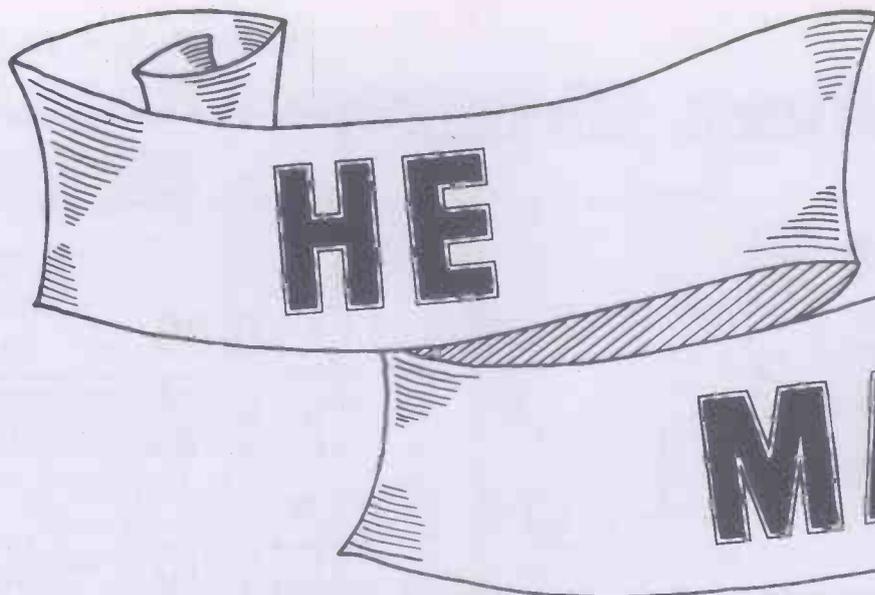
rent is fed into the base terminal of the test device. This causes a larger current to flow in the collector circuit of the transistor, and the current gain is equal to the collector current divided by the base current. If SW2 is depressed, a base current will be provided to the test device by whichever resistor (R1 to R3) is selected by SW1.

With SW1 in the "10" position, a nominal base current of 1 mA is fed to the test device, and it must have a current gain of 10 in order to produce a collector current of 10 mA and give full scale deflection of ME1. Lower levels of current gain give a proportionately lower meter reading. With SW1 in the "100" and "1,000" positions, the base

current is reduced to 100  $\mu$ A and 10  $\mu$ A respectively, giving the correspondingly higher full scale gain values.

PNP and NPN transistors require opposite supply polarities, and SW3 is used to switch the supply polarity to suit the type being tested and to connect ME1 with the correct polarity.





### LCD CHRONO



We feel we've got to tell you carefully about this offer. 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 couple of seconds and you have a highly accurate stopwatch and 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.

**£11.95**

### ALARM-CHRONO LCD



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 0.1 secs. short of thirteen hours.

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# PLACE

## 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.

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

**£10.60**

## 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 another 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**

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## Car Audio

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Full medium and long wave tuning. Complete with speaker and mountings. Suitable for positive or negative chassis. Latest model.

**£10.25 + £1.00 Post**

### Push-Button MW/LW



One LW, four MW buttons plus manual tuning. Complete with speaker and mountings. Latest model, negative chassis only.

**£15.95 + £1.00 Post**

### Stereo FM/Cassette + MW



Standard cassettes and FM in stereo plus medium wave. Tone and balance controls. Fast forward facility on tape. Adjustable shafts. Suitable for 4 or 8 ohm speakers (not supplied). This model is discounted elsewhere at £50 up.

**£40.95 + £1.00 Post**

### Stereo Speaker Set



Suitable for above stereo unit. Good quality in surface mounted casing, 5W nominal, 8W peak.

**£4.00 (pair) + 70p Post**

### Telescopic Car Antenna

Multi-section standard type, suitable for angled mounting with locking key.

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## Metal Detector



### ★ Induction Balance Model

Built with sensitivity up to 10in on single coin; fitted with speaker and meter; PP3 battery; 7in dia. search head. Telescopic stem. Excellent pin-pointing, positive reaction to non-ferrous, negative reaction to iron. This model's normal price is £39.95!

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Richard Torrens. The projects can be split down into simple building blocks which can be recombined for ideas of your own.

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F. G. Rayer. Divided into 'No Soldering Projects,' Radio and Audio Frequency, Power Supplies and Miscellaneous.

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F. A. Wilson. A valuable reference for the home and laboratory, containing all the most frequently used, and some of the less well known electronic formulae and calculations.

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R. A. Penfold. A collection of the most popular types of circuits and projects using modern, inexpensive and freely available components.



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Adrian Michaels. Covers most popular types and gives details of packaging, families, functions, country of origin and manufacturer.

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Note that all prices include postage and packing. Please make cheques etc. payable to Hobby Electronics Book Service (in Sterling only please) and send to:

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Maidenhead, Berks.**

**Essential Theory for the Electronics Hobbyist** ..... £1.55  
G. T. Rubaroe gives the hobbyist a background knowledge tailored to meet his specific needs.

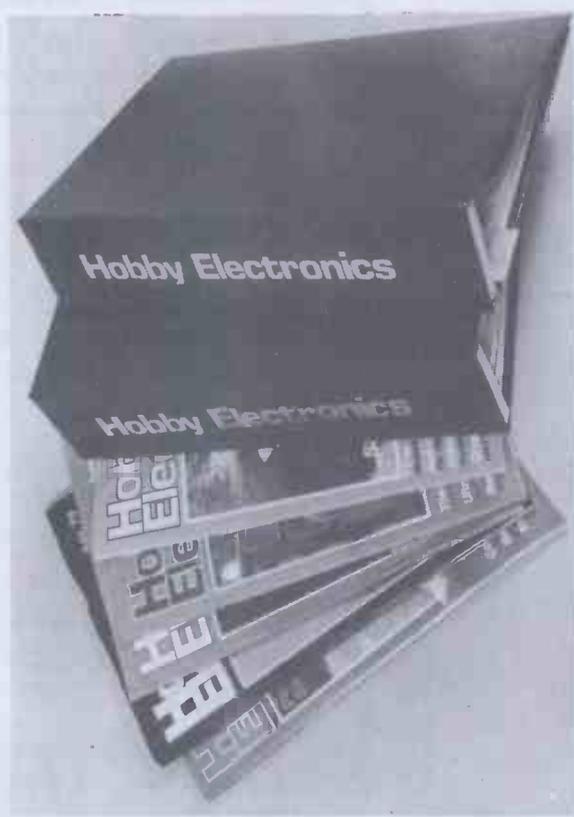
**Beginners Guide to Building Electronic Projects** ..... £1.65  
R. A. Penfold. Covers component identification, tools, soldering, constructional methods and examples of simple projects are given.

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## HE Binders



Now that Hobby Electronics is in to its second volume the need for a good strong binder is greater than ever.

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- (5) A hat for HEBOT.

Of course, you could use them for keeping those valuable copies of HE in pristine condition, but that's up to you.

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**Next  
Month**

# Hobby Electronics

## DIGITAL FREQUENCY METER

# HE OFM

The most sophisticated piece of test gear to appear in HE so far! Don't let that put you off, our main project next month will be very simple to build and will cost a fraction of a commercially made unit. Once calibrated (that's a doddle too) it will accurately measure frequencies up to 10 MHz in a series of switched ranges. Now you will be able to measure the output of those oscillators, calibrate test gear, even use it to indicate frequency on Long Wave and Medium Wave radios. Why wait any longer? This one is for you.

## RADIO CONTROL SPEED CONTROLLER

Don't worry. The radio control system is coming, meanwhile, how about this neat and simple solid-state motor speed controller for existing systems. If you've got an R/C car with electric motor drive this will be just what you're waiting for.

## PROJECTS SPECIAL

Next month we hope to bring you news of the Hobby Electronics Projects Special — Volume 1. After months of research we have come up with what we believe will be the last word in specials, and all for just £1.25.

## INTERCOM

Until CB gets legalised you will have to content yourself with this really superb intercom. Practise your 10 code, try some slang, we guarantee it will not contravene any Post Office regulations. Seriously though, a really good two-wire design that will not leave you so poor that you can't afford the batteries. It features a calling facility and a massive 2 watt audio output. Perhaps we should have called it a PA system!

## SLOW SCAN TV

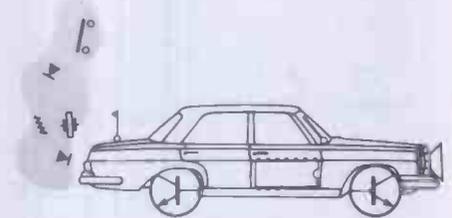


Almost exactly 50 years ago a new invention was demonstrated for the first time. It consisted of an unweirdy mixture of bits and pieces that would not have looked out of place in a scrapyard.

This invention was called a 'Televisor' and by now you may have guessed the inventor's name, Logi Baird. His system for transmitting moving pictures unfortunately lost the race for commercial success to the all-electronic system, the forerunner of our present system.

If you thought the Baird system is now little more than a historical curiosity you would be sadly wrong. Unbeknown to most of us development of the Baird system has been plodding along steadily these past fifty years. The improvement in available technology has made further investigation very worthwhile and we're sure you'll find next month's feature on Slow Scan Television very interesting. It is one of the few fields where the amateur can still make an important contribution.

## ELECTRONIC IGNITION



After this month's feature on automotive electronics we are following it up with a really professional design for an electronic ignition system. We won't make any extravagant claims for this unit, we don't have to, it will speak for itself.

## NEGATIVE IONS

Next month we go into the health business, with a review of a kit that will change your life.

We've had a steady stream of inquiries about negative ion generators in recent months. So, by popular request, before your very eyes, we will review the latest in personal negative ionisers. Called the 'Fusion', the ioniser is available both in kit form and ready built. It's a compact (4½inx2½inx1¼in), battery operated unit complete with a magnetic fixing pad, so you can even use it in your car.

The claims of the effects of negative ions are many and various. Once we've got our soldering iron out of hock and built the box of tricks, we'll see how many of these claims we can verify.

It's well known that increasing the density of negative ions hurtling around your ears can make you feel more awake and alert and dispell the gloom of a smoky atmosphere. They have to be negative, mind you. Positive ions have the opposite effect.

It is also claimed that negative ions can, in some cases, alleviate asthma, allergies and migraine. We have our doubts, but we're going to try it out anyway. By inhibiting the growth of bacteria, they are also supposed to cut down infections caused by air-borne germs. Well, that's a lot to live up to, but watch this space next month (give or take a few pages) for our findings on this new kit.

## The April issue will be on sale March 14th

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

# Electronics On Wheels



The basic concepts of the internal combustion engine have changed very little in the past 80 years. Today, however, electronics are beginning to make considerable inroads into the car industry. Motoring journalist Tom Bentley looks at some of the latest developments.

AS AN INDUSTRY, the world's car manufacturers have always been a pretty conservative bunch. That's not to say that they don't expend a great deal of money and effort on research and development, but the fact is that the nature of their market makes them extremely reluctant to take any risks in terms of putting untried innovations into production. Mud sticks in the automotive business, and a reputation for unreliability due to malfunction of some insufficiently tested piece of equipment would be as easy to acquire as it would be hard to shake off. With very few exceptions, then, the motor industry prefers to tread a safe path and use only technology that has been proven in practice over a long period.

The potential for the utilisation of electronics in motor vehicles is enormous. In all probability, but for the caution and reticence of the major auto makers, many of the possibilities could have been realised in practical use sooner than they have been. Both specialist electronics companies and 'in-house' research departments of the car firms have devised numerous auto-related applications for microprocessors and other types of electronic components, in some instances replacing conventional systems but in others creating entirely new functions. Only in the last few years have these ideas filtered through on to the production line, and then mainly due to outside influences.

Taking a broad view, development has been going on in all three of the world's main motor production centres — the USA, Europe and Japan — but local conditions and pressures have tended to concentrate efforts in differing directions. For instance, due to more congested roads and higher fuel prices, European and Japanese

cars have always been designed in a way which makes them much more fuel-efficient than their American counterparts. Oil shortages and ever tightening engine emission controls in the last few years have left the Stateside giants frantically scrabbling for radical alternatives to keep their own products viable in the face of competition from the imports. Along with lighter, smaller, aerodynamically cleaner bodies and advances in mechanical engine design, electronic ignition and fuel control systems offer them salvation. In Japan, even more stringent emissions regulations have preoccupied the local manufacturers. In Europe, by comparison, much less outside pressure has been brought to bear, certainly in terms of governmental legislation, although of course the overall energy situation has been just as prominent in the designers' minds. Consequently, implementation of electronic options has been more selective and deliberate. A further difference between Europe and the US is that few European car companies have extensive in-house electrical and electronics departments, unlike their American counterparts, though major independent electronics firms have divisions specifically given over to automotive work.

## HISTORY

The history of electronics in cars goes back to the late Fifties, when the old DC dynamo-type generator began to be replaced by the alternator, which incorporated at least a semiconductor rectifier, if not at first an integral electronic voltage regulator. Alternators caught on in an increasingly big way, but nothing else of note happened until 1967 when the first electronically controlled fuel

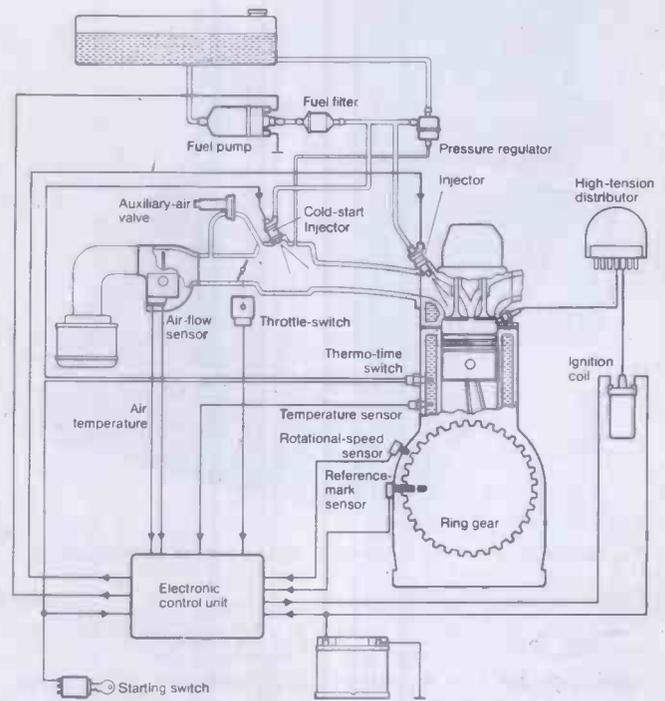
injection system went into mass production. Bendix in America had patented the idea in the mid-Fifties but it was the German company Bosch who put theory into practice.

Electronic ignition was the next major development. Transistor ignition systems using an induction pulse generator had been introduced as early as 1959 but it was the end of the next decade before any entered series production, and then to begin with only 'transistor-assisted' types retaining the mechanical contact-breaker points. Contactless designs came next and many kinds of both inductive and capacitive discharge variants proliferated on the accessory market. As original equipment, contactless transistor ignition became almost universal on the US scene by 1975 but is still only slowly infiltrating the European assembly lines.

Alongside the primary components in the late Sixties and early Seventies came a sprinkling of ancillary devices — electronic turn signal flasher units, wind-screen wiper intermittent switching systems and quartz clocks, for instance — but the widely predicted electronic revolution did not materialise. There was a steady trickle of electronic gadgetry on to the accessory sidelines but, until very recently, no large-scale breakthrough in the OE field.

## ENVIRONMENTAL PRESSURE

The last couple of years have brought far-reaching and dramatic changes, particularly on the other side of the Atlantic. Environmentalist pressures, and those of rapidly increasing petrol scarcity and price, have made electronically governed fuel injection systems such as Bosch's several 'Jetronic' variations more and more attractive to designers of spark-ignition engines. Such set-ups enable very precise and effective control of a petrol engine's fuel supply. In conjunction with devices which monitor exhaust gas content, closed-loop feedback can be established so that an engine's fuel/air mixture can continuously be regulated at the optimum

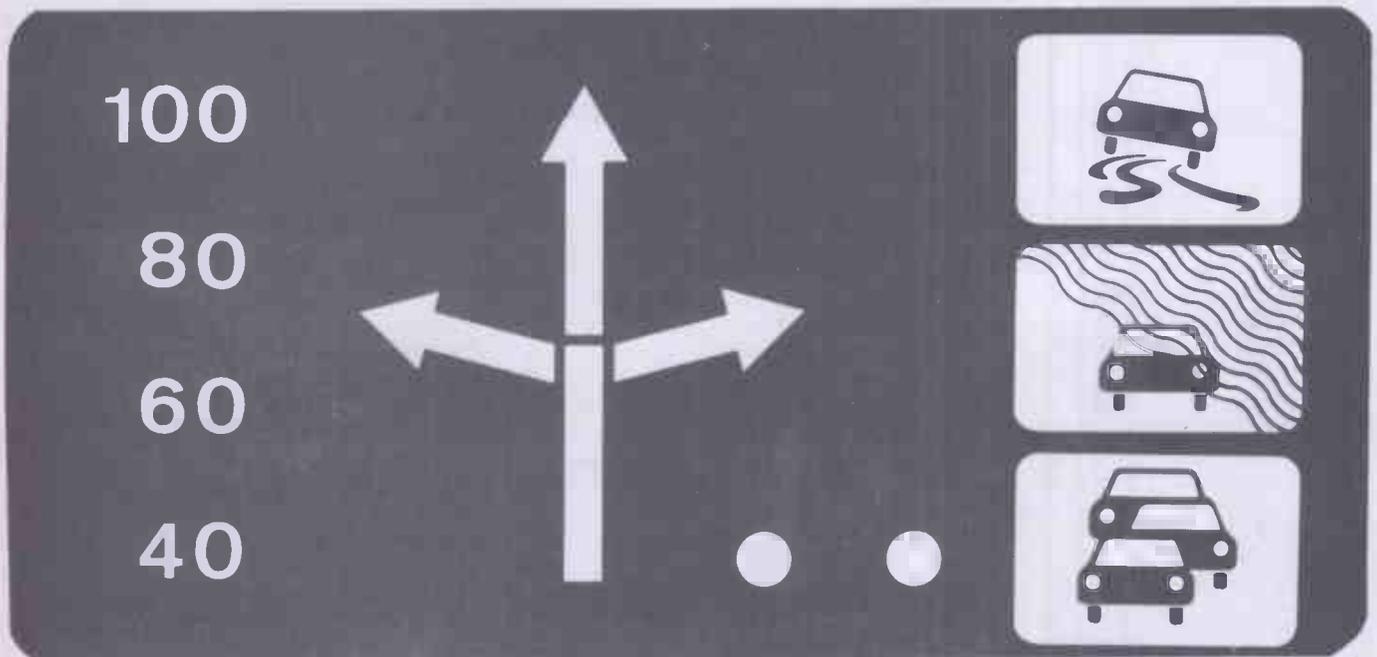


*Simplified diagram of the Bosch 'Motronic' system.*

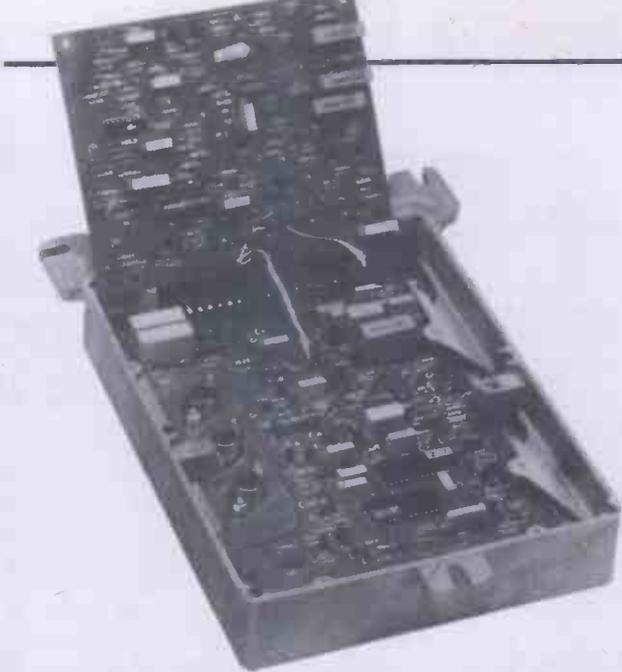
point for emissions and economy. On the ignition front, too, a major transition is in progress — from merely contactless ignition to a much more sophisticated type which, as well as creating and supplying a powerful spark, replaces conventional mechanical timing adjustment by a fully self-governing electronic timing system.

## ENGINE MANAGEMENT

Partly thanks to technology derived from the US space programme, there is now a sufficiently strong electronic armoury to deal with the difficulties of in-car service. The



*The prototype display for ALI. It shows both directional instructions and pictorial warnings of potential road hazards.*



*The control box for the Lucas electronic Fuel Injection system.*

motor vehicle environment puts relatively tough demands on semiconductors, and perhaps one reason for the delay in introduction of major systems was the former dearth of reasonably-priced and dependable parts. Such components are now available and, together with the perfection of LSI (large-scale integration) circuitry, they have made viable the installation of an on-board microprocessor, so designed as to regulate both the fuel/air and ignition systems simultaneously and in complementary fashion. This is the 'electronic engine management system' or 'integrated engine control', which will be seen on increasing numbers of European cars in the next few years.

If a vehicle has engine management plus other, subsidiary electronic components, the idea of combining all together in a 'central electronic system' is attractive, for reasons of both cost-effectiveness and function. Where a number of information inputs from various points on the engine and running gear of a vehicle are required by different systems, feeding them all into a central electronic processor obviates the need for wasteful duplication of individual sensors and connections. For example, an input for engine speed is required not only for ignition timing but also for fuel injection, as well as automatic transmission if the vehicle is so equipped.

Taking the idea a step further, intermediate information from the electronic data-processing of one sub-system may be utilised as the input for others. Dividing the inlet airflow by the engine speed, for instance, gives data about engine load, which may be usefully employed as an input signal for electronic ignition and an electronically-controlled automatic transmission. The central electronic system will enable many functions to be dealt with in more sophisticated ways than at present. Common use of housings, connectors and even complete functional 'blocks' will yield not only cost reductions but increased reliability.

The possibilities are exciting. A variety of separate functions (e.g. anti-lock braking, cruise control) can be handled by a central system. So too can all the information currently given by conventional instrumentation, plus additional computations outside the scope of normal gauges. Vehicle speed, engine speed, water temperature, oil pressure and temperature, distance travelled and so on can easily be derived and displayed,

and only simple computations are necessary to produce further data such as ETA at a given destination, fuel consumption at any instant or projected quantity of fuel necessary to complete a journey. Additional sensors can add warning capability for things like incorrect level of fuel, oil, coolant, brake fluid, etc, brake lining wear and even tyre pressure; monitoring operation of all bulbs and lamps is equally simple. A check can be fed into a central electronic system of virtually every sub-system and function on the vehicle. To avoid baffling the driver with too much information at once, a single panel display can group the various items of feedback according to relative significance or potential danger and suppress those not wanted for normal driving, only displaying them when a malfunction arises in the relevant area or when requested to do by the driver.

## **COMPUTER CONTROL**

Until recently, the circuitry used in car electronics was largely analogue type. Increasing use will be made of digital circuits, as in modern computer equipment, facilitated by LSI. Currently, two distinct methods of realising the central electronic system concept are being explored, termed a) 'single purpose computer' and b) 'microprocessor' systems. Both consist of MOS (metal oxide semiconductor) based LSI components and so-called 'peripherals' (pick-ups, sensors, etc).

In the single purpose computer system, each individual function has a separate computer circuit, while a central storage element holds only the data for the specific vehicle along with certain fundamental functions which bring about effective interaction of the various individual data processors. The whole system can be built from standardised parts and be expanded without difficulty.

The microprocessor system uses one central computer for all its range of component systems: this holds not just the vehicle data but programmes for each of the individual functions. The main benefit of this type of design is one of economy both of cost and space when a large number of sub-systems are required; it is also highly flexible, as the programme can be altered by a simple change in the central element.

## **HERE TODAY**

There you have an overall view of trends and likely developments. Much has already been achieved, and some of the specific points mentioned deserve a closer look. The name 'Bosch' has already cropped up once or twice, and certainly this firm is in the forefront of the European, if not world, scene. Two of their most interesting projects that have reached production are 'Motronic' and 'ABS'.

Motronic is already in service on the BMW 723i. It is an integrated engine control system consisting of a microprocessor, data and programme memory and input/output circuit. Sensors provide it with information on inlet airflow, engine speed, crankshaft position, and engine and intake air temperatures: it then interprets these data and continually, at minute intervals, regulates the quantity of fuel being injected and the point in the combustion cycle at which ignition is taking place, by reference to predetermined programmes. In other words it provides highly accurate and stable management of the two essential engine processes.

Advantages to the driver stem from Motronic's ability

to distinguish particular engine conditions — idling, cold-running, over-running and accelerating — from 'normal' running, and compensate accordingly. In practice this means instant starting and totally smooth running during warm-up, regardless of changes in load, circumstances or ambient conditions, the engine operates without any 'flat spots' or hesitation immediately it is set in motion, in winter and summer. Advantages to everyone include impressive reductions in fuel consumption and pollution.

The Motronic system is designed to match the life of the engine, and needs no servicing whatsoever. In fact the only maintenance requirement left on the electrical side of the engine is routine renewal of spark plugs. Motronic additionally makes it possible to adapt engine control to deal with possible future requirements, such as use of alternative fuels or compliance with revised exhaust emission standards.

ABS means, if you untangle the German initials, anti-skid braking. Under development since 1970 in conjunction with BMW and Mercedes-Benz, it utilises sensors to measure the speed of wheel revolutions and send signals to an electronic control unit, which distinguishes whether the wheels are tending to lock as the brakes are applied or are still turning. In the light of this information, the appropriate amount of braking force is then applied or removed from the relevant wheels by a hydraulic unit.

On the road, ABS shows to greatest advantage under wet conditions, when stopping distances are often greatly improved. The system is especially useful in compensating for clumsy or unskilled driving, as it helps maintain directional stability even if the brakes are applied whilst cornering. Technically the circuitry is fail-safe: if a fault in the electronics should by some chance occur this is detected before the brakes are applied, a warning light is activated and the brakes revert to full normal operation. Bosch claim that, in safety terms, ABS is 'the most important development since the seat belt'.

## ALI

Another Bosch project which is still at the research stage but could rapidly be put into operation if given the nod by government is known as ALI. Don't ask what the initials stand for this time, but the concept is of a driver aid that gives up-to-the-minute traffic reports and information about weather conditions on the roads ahead. The computers this time are not in the car but are linked to series of inductive loops set into the surfaces of major roads. As an ALI-equipped car passes over each of these loops, a bleep from its information receiver alerts the driver and reminds him to check his ALI screen for updated information — it may, for instance, advise him to turn off at the next junction. All the driver has to do to get continual route guidance is, when commencing his trip, to switch on the device and key in numbers corresponding with his destination.

Installation of ALI would, its makers estimate, cost about £30,000 per mile on the current motorway and major road network, or about 1% of the cost of road-building (only a fraction of which would be accounted for by the actual electronic hardware). The on-vehicle equipment should cost between £70-100 on a mass-produced basis, and in view of impressive-sounding estimates of an up to 10% overall fuel saving on a motorway network, plus a reduction in both driver

frustration and accidents, the whole system ought to pay for itself within a few years.

## HOME GROWN

The leading British auto-electrical company is, without a doubt, Lucas. They, too, have extensive past experience with electronic ignition and petrol injection systems including a joint project with Bosch, the L-Jetronic fuel injection. Foremost among their own current developments is their latest microprocessor controlled injection system which is based on digital circuitry of the type mentioned earlier, rather than analogue as on previous variants. The control unit incorporates the latest LSI techniques, using just two chips to contain all the main fuelling functions. The digital design, Lucas claim, provides more precise control of the fuel supplied to each engine cylinder than was previously attainable. The new system is already in production for Jaguar XJ12 and XJS models, in which applications it has met with a warm reception from the motoring press, and is also being fitted to SD1 Rovers for the US market.

In the near future Lucas propose their own version of the total 'engine management' package, combining ignition control with the injection on one microprocessor. They point out the comprehensive diagnostic facility this will allow, and make the bold prediction of fuel consumption gains of as much as 25%. They emphasise that to make optimum use of the instantaneous logic available, adjustments based on it must be made as quickly as possible — to this end, they have developed a solenoid with an operation time of well under half a millisecond, which they expect to play a big part in actuating engine control functions in the future.

## STILL TO COME

A couple of more mundane applications of electronics are also just around the corner. Lucas are at present working on electronic control of conventional carburetors to bring some of the benefits of the more sophisticated fuel systems to cheaper cars. Vehicle Condition Monitoring ('VCM') will be available for smaller cars within the next year or so; this will provide an illuminated readout for such things as fluid levels and brake lining wear, and give a check on correct operation of bulbs.



Interior shot of the Aston Martin Lagonda instrument panel. Most of the secondary controls are operated by the labelled touch pads on the console.

## ASTON MARTIN

Aside from the work being performed by the big auto-electronics specialists, some car firms in Europe have already taken an initiative by buying-in electronic systems from elsewhere. First, and most brave, were Aston Martin Lagonda. Their unique Lagonda — the world's most sporting limousine or most luxurious sports car, depending on which way you look at it — has featured a fully electronic instrumentation system right from the start. (When the car was initially announced it was intended to incorporate a trip information computer too, but problems in those early days with electromagnetic interference caused that idea to be shelved; now, with the available improved technology, it could be reinstated.)

The Lagonda's instrumentation package was designed exclusively for AML by a small firm in the USA. It uses a single PCB mounting all instruments and warning lights: these include speedometer, tachometer, clock, total and trip odometers, along with readouts for battery voltage, fuel level, water temperature, oil pressure, oil temperature, plus both internal and external air temperature. The speedometer and odometer readings may be selected in miles or kilometres per hour at will. Two binoculars house touch-sensitive switchgear.

The display panel is blank when 'switched off', lighting up with red LEDs when in operation. Instead of facing the whole gamut of data all the time, the driver can touch a switch to select 'essential instruments' only, reducing the information in front of him/her to speed, time and fuel tank contents. In this mode, the rest of the display only makes itself visible if a problem arises, in the event of which the relevant readout flashes to attract attention.

AML use Lucas Opus electronic ignition at the moment, and, regarding integrated engine control systems and the like, take the view that they will adopt what their suppliers develop. One thing they do predict is the use of LCDs in instrumentation.

## EUROPEAN ELECTRONICS

Talbot (ex-Chrysler Europe) were in a good position while they were still a subsidiary of the American parent Chrysler Corporation to keep tabs on what was going on in the Stateside industry. Their Alpine models were among the first in the popular mass market to feature contactless ignition as standard, and now the SX versions of Horizons and Alpines are equipped with electronic trip computers which, at the touch of a button, give readouts for journey time elapsed, distance covered, fuel consumed, average speed and average rate of fuel consumption.

By contrast, Citroen had no transatlantic connection. The totally electronic completely distributorless ignition system fitted to the downmarket Visa and LN twin-cylinder models was conceived entirely within France, in collaboration with the Thomson company. It consists merely of two proximity detectors, a vacuum sensor, a coil and — the important bit — a computer. This proximity detectors respond to the passing of a metallic 'slug' attached to the engine flywheel, sending a pulse to the microprocessor with each revolution. The vacuum sensor signals the varying state of engine load. The electronic control centre then chooses the appropriate timing, according to engine speed and inlet manifold depression, for the coil to send HT current to the spark

plugs, at the same time ensuring that it (the coil) is fed sufficient primary current to produce the desired secondary voltage. The system is cheap, absolutely maintenance-free, and produces improvements in almost all aspects of engine behaviour: fuel consumption, exhaust pollution, low-speed torque and acceleration, and cold starting (even with a partially discharged battery for it needs to be cranked at only 20rpm to produce a spark). Work is continuing on versions for larger engines.

## CRYSTAL CONTROL

Other ideas being muttered about on the European scene at the moment include piezo-electric actuation of the injector valves in fuel injection systems, and replacement of the conventional wiring harness or loom with a single feeder wire, multiplexed signals and a decoder at each 'service' point. For instrument displays, electroluminescence seems likely to be the in-vogue medium, with digital circuitry but analogue-type visual presentation. Talking gauges will surely come — Texas Instruments are already developing them in the States.

As repeatedly hinted at, the Americans are ahead of us at least in implementation of a number of the possibilities. Right now a wide range of electronic add-on toys is available for fitment to their cars. If you happen to live on this side of the big pond but find the lure of accessories such as electronic combined analogue/digital display instruments and trip computers irresistible, don't despair. At least one British concern is importing them: Hatton Enterprises, of Langwood House, Epsom Road, Ashted, Surrey, who handle 'Avatar' instruments and 'Prince On-Board Computers'. Thanks to the conservation-orientated pressures existing in the USA, virtually every car emerging from Detroit in 1980 has (as well as transistor ignition) some kind of electronic fuel metering device, from a basic 'feedback' carburettor system to full analogue or digital electronic fuel injection. Other electronics applications proliferate — electronic level control, electronically tuned radios, electronic speedometers, electronically coded door and boot locks are just a selection of the stock and optional equipment available on vehicles in dealer showrooms this year. Ford give the value of all the electronic components on a 1980 Lincoln Continental Mark VI as around \$1800 or nearly 10% of its retail price.

The trend can only continue upwards. Another authoritative American source estimates that the world automotive industry will use about \$600 million-worth of semiconductor devices in the 1981 model year, rising to \$1 billion-worth per year by 1985 — a compound annual growth rate of close to 30%. European crystal-gazers are hardly more cautious: Volkswagen, for instance, talk in terms of electronics constituting about 7% of the average car's manufacturing cost by 1988, compared to around 2% today.

I started this article by talking about the car industry's early reluctance to accept electronics. I'll finish by saying that today it couldn't do without them. Computers are now extensively used in designing new models. They're even running the assembly lines (you must have seen Fiat's brilliant 'Hand-built by Robots' advertising campaign). If there's any way to solve the automotive problems of the next two or three decades, electronics will be the key.

HE

# Electronic Circuit Design

## No. 1

Selected Reprints from **electronics today**

### Introduction

Since ETI was originally launched in Britain in April 1972 we have published nearly 5000 pages of editorial matter: much of this has been devoted to editorial projects of course. In our history we have republished the best of these projects in Top Projects No 1-No 7, we have also reprinted the Tech-Tips and other circuits in Circuits-It's-Easy is now on its third reprint.

We have not however, until now, brought together the best features dealing with electronic design. Nearly

1500 pages have been devoted to this in recent years and this special is the first of a series of three which will bring together the best 250-300 of these.

Although some features are from quite early issues they have only been included because we feel that 'age has not withered them'.

We hope that the contents help the reader understand at least some of the aspects of electronic circuit design.

Halvor Moorshead  
Editorial Director — ETI

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# Touch Switch

**Bet you'll think this project's a touch of genius. Ten sequential outputs, or build it like a bistable. All under perfect, personal, fingertip control.**

TOUCH SWITCHES have begun to appear in all kinds of places . . . lifts have them, TVs have them; even personal computers have them. Well, now you can have one too, for the price of a couple of chips and a handful of discrete components.

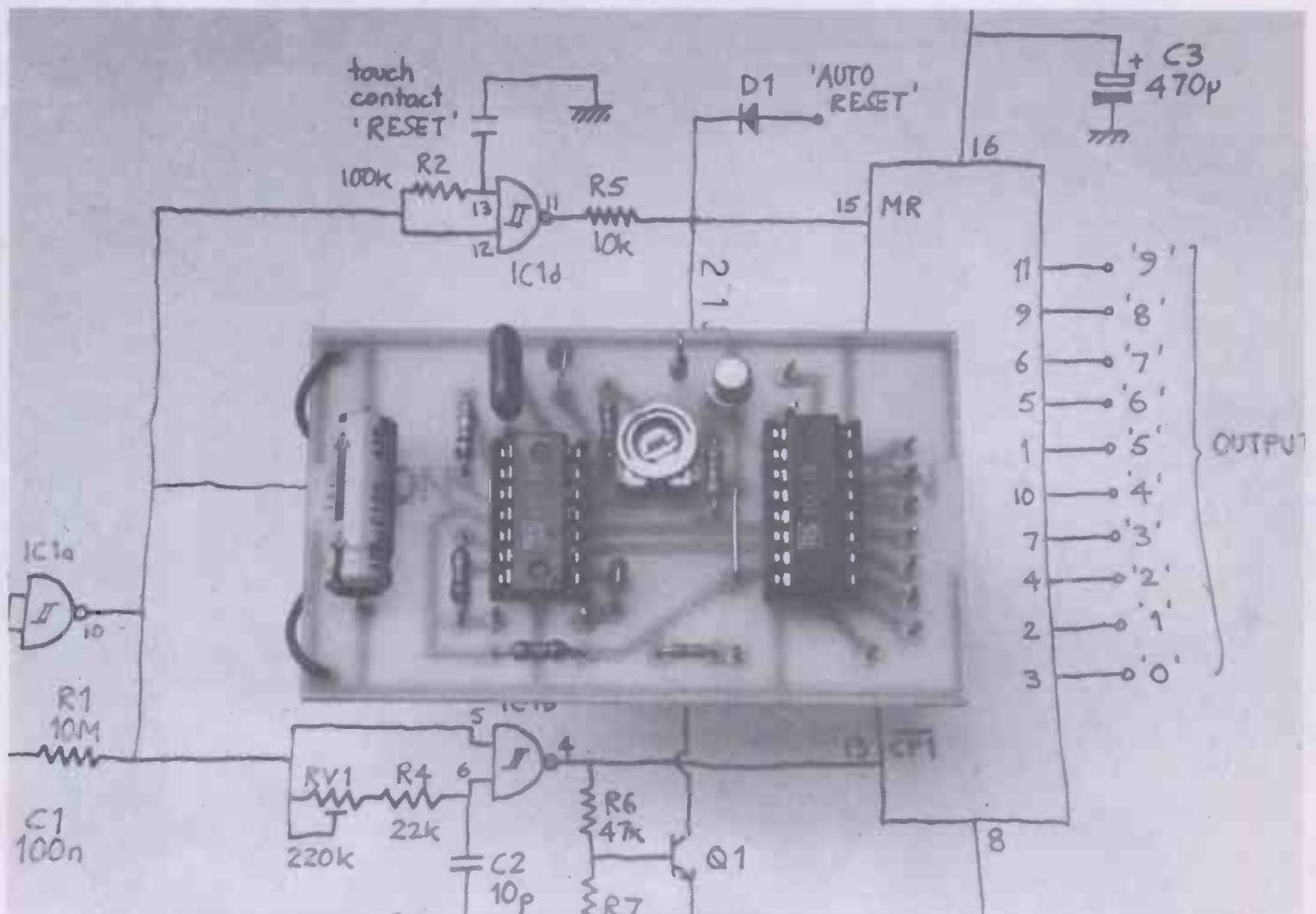
Now is your chance to get the world under your thumb. Featuring up to ten sequentially selected outputs and an overriding reset input, the project is a cinch to build. Make one for fun or control your radio, Hi-Fi, goldfish, etc.

Many commercial touch sensors rely on the electrical mains for an energising field. This circuit can be powered from a single nine volt battery, a PP3 will do, has low current consumption, uses only a few cheap components and is simple to construct. Also, above all, it is safe.

## CONSTRUCTION

To avoid the introduction of stray circuit capacitances and ensure reliable and repeatable operation, we strongly recommend that our PCB design is used. It is very small and should be quite easy to make or cheap to buy. There is only one link to make on the board. Make sure you get the diode and electrolytic capacitor the right way round. That goes for the integrated circuits too. It is quite okay to use sockets, in fact we would recommend it. That way you can always use the chips again and anyway, sockets make substitution easy if (horror of horrors!) the project fails to work first time.

You can try different layouts for the touch sensors. We made up a special board. At its simplest, a touch sensor could consist of a piece of unetched PCB split



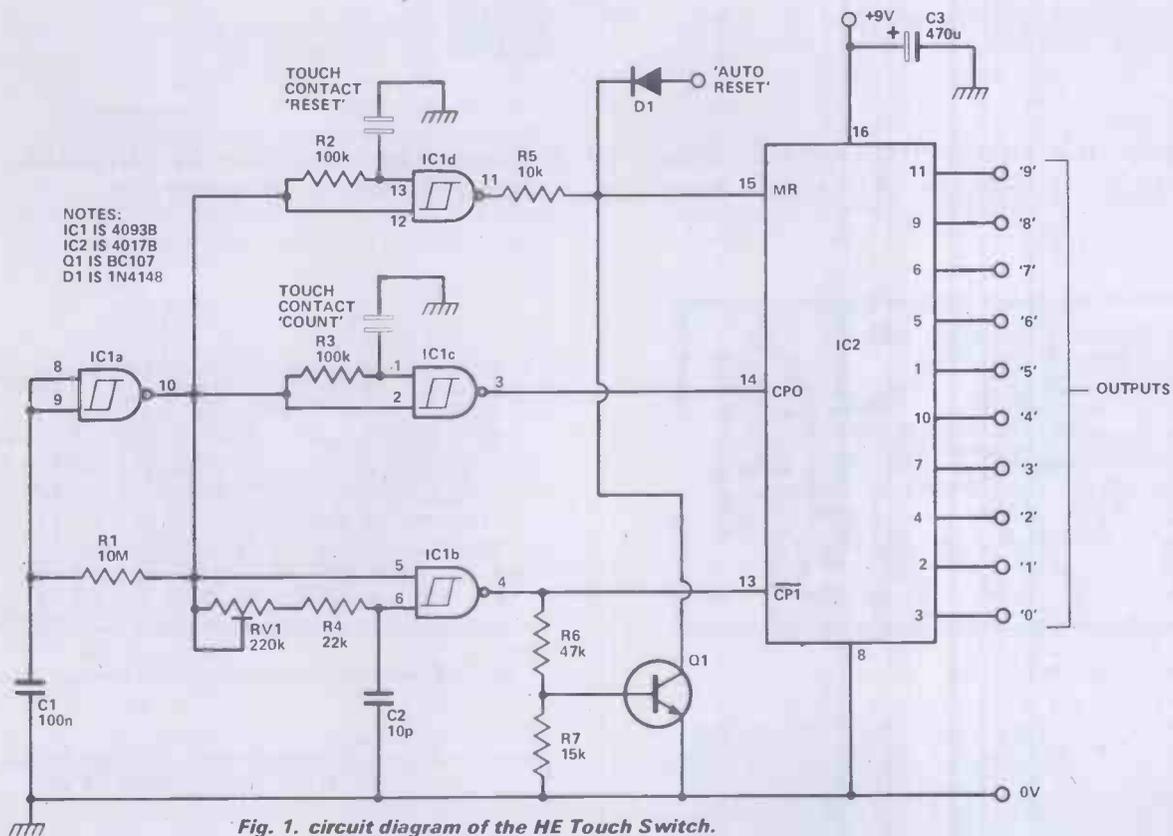


Fig. 1. circuit diagram of the HE Touch Switch.

## How it Works

The circuit operates by using the hand as part of a capacitor in a critical timing circuit. When the detector contacts are touched, the extra capacitance introduced has the effect of delaying the transmission of a clock edge. The circuitry is driven by one single phase clock generated by IC1a whose output consists of a continuous stream of pulses at about one Hertz with a nominal fifty percent duty cycle. A delayed and inverted clock is generated from this signal by IC1b whose output drives one of the clock inputs of decade counter-decoder IC2.

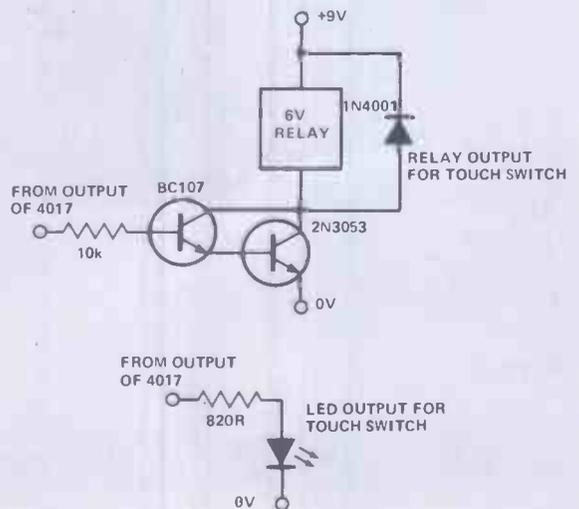
This chip does all the work of decoding the clock signals and provides a reset input which can be controlled from the touch circuitry or driven directly by one of the outputs of the chip. For example, to reset to zero after the 'fifth' count has been reached, just connect output 'six' (pin 5, IC2) to the 'auto reset' input at the anode of D1. If no connection is made to D1 then the circuit will cycle through all ten outputs. By connecting output 'two' (pin 4, IC2) to 'auto reset' and taking an output from 'one' or 'zero' (pins 2, 3 IC2), the circuit will operate as a bistable: one touch turning the output on; another touch resetting the output to off. The 'reset' touch contact may be left disconnected in this case.

A certain delay will always be introduced by IC1c, d owing to stray capacitance from the circuit board and connecting leads. This may be nulled out by adjustment of RV1 which should be set to

minimum resistance consistent with reliable operation.

Two suggested output circuits are shown. The first lights a LED when the appropriate output is selected, the other circuit will drive a small relay whose contacts may be used to switch more power.

The touch 'reset' circuit operates in a similar manner to the 'count' circuit. A glance at the timing diagram should make things clear.



# Touch Switch

into two copper lands by scoring or filing a line down the middle breaking the copper, but leaving the insulating board intact. Make sure no copper whiskers remain to bridge the copper lands as these would prevent the circuit from working at all. Sensitivity will depend to an extent on the physical size of the touch contacts and the area covered by, for example, the thumb or palm. Reliable operation was obtained using the prototype with the touch contacts covered by a layer of adhesive

plastic film. Use of a coloured film like the sort used to cover books could make an attractive addition to the project. Use your imagination and do not be afraid to experiment. Finally, a word of caution to anyone thinking of controlling mains powered equipment. This is okay so long as you make sure you use a relay whose contacts are rated for the job and keep all mains wiring away from the rest of the project. Build one now and give your projects a little touch of class!

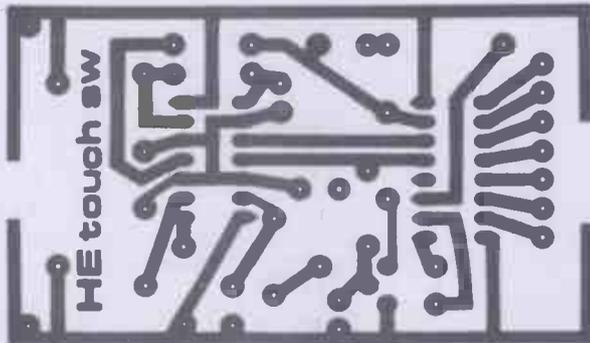


Fig. 2. PCB for the Touch Switch

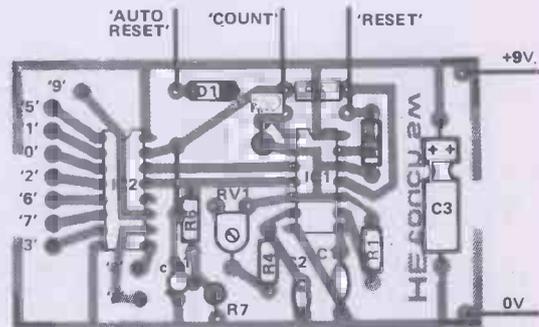
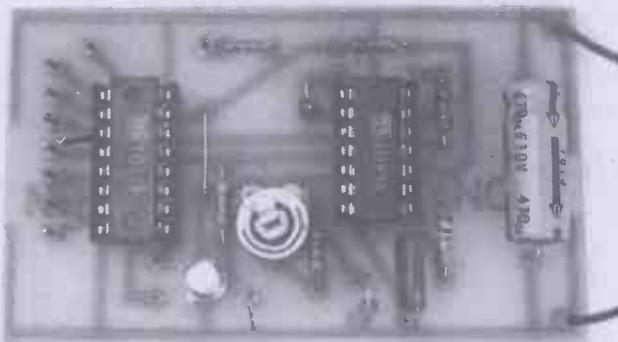


Fig. 3. Overlay diagram for the Touch Switch.



The assembled board, clean and compact



Good soldering pays off. Practice makes perfect



Use of a PCB makes construction a snap!

## Parts List

### RESISTORS (All 1/4W, 5%)

R1	10M
R2, 3	100k
R4	22k
R5	10k
R6	47k
R7	15k

### POTENTIOMETER

RV1	220k submin. horiz. preset
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### CAPACITORS

C1	100n polyester
C2	10p polystyrene
C3	470 $\mu$ electrolytic

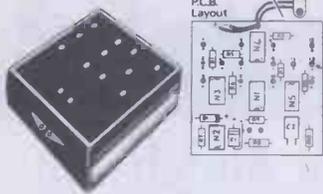
### SEMICONDUCTORS

Q1	BC107
IC1	4093B
IC2	4017B

## Buylines

All the components for this project should be readily available from the larger mail-order suppliers.

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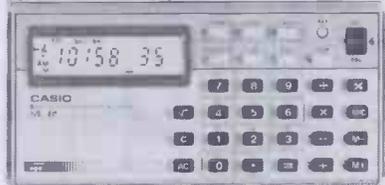
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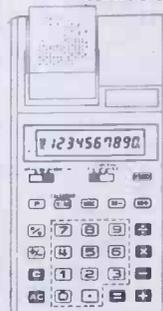
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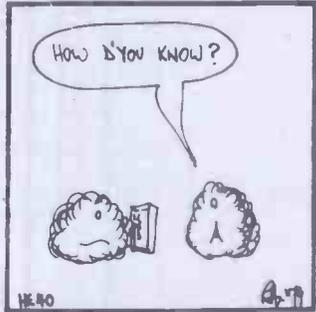
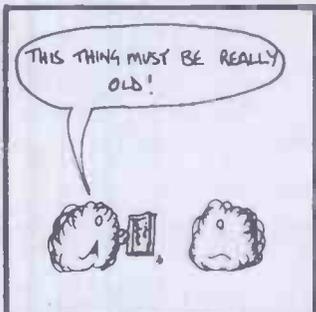
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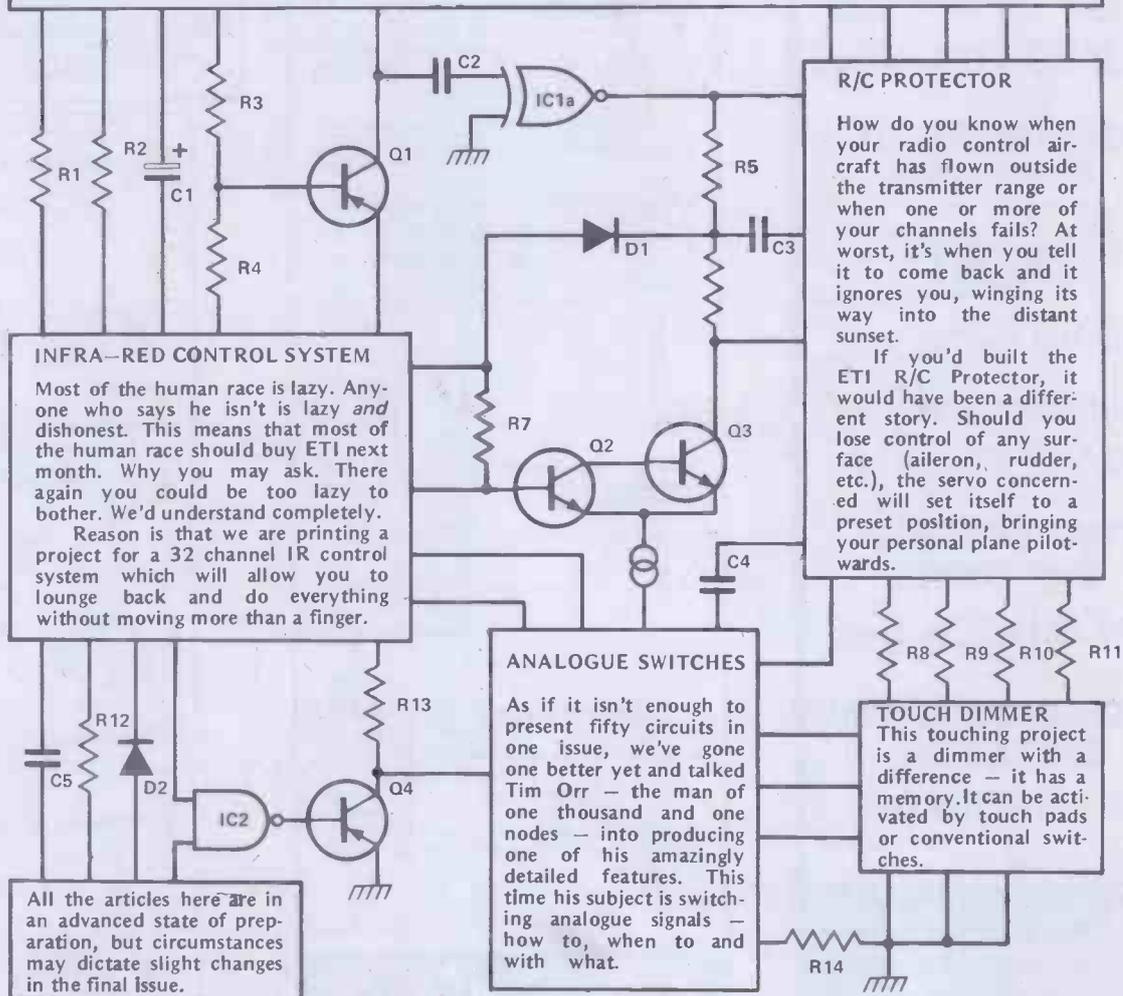
What to look for in the April issue: on sale March 7th

## CIRCUIT SUPPLEMENT

Next month's ETI carries something really special — a SIXTEEN PAGE circuit supplement for the experimenter. All the circuits have been tried and tested by us, making this the most reliable reference yet. If there is anything you need a circuit for or any circuits you need something for this is the place to find it. No less than 50 in all. Half a hundred of the best you'll find anywhere.

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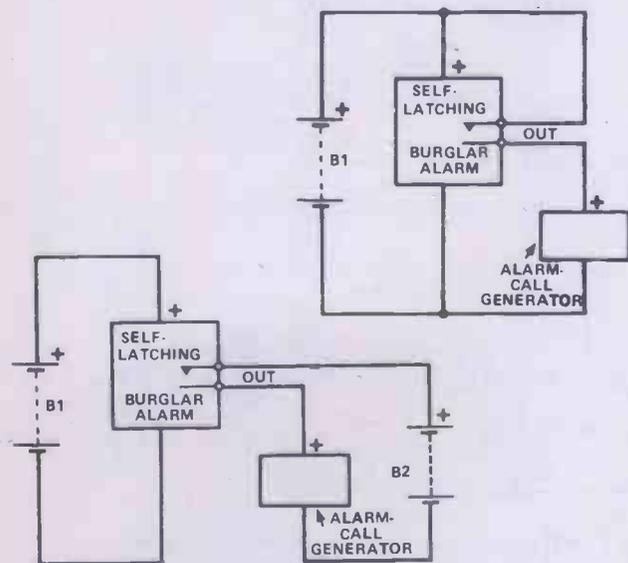


# Hobby Chit~Chat

**As a follow-up to last month's 'Chit-Chat', we look now at alarm-call generator circuits and methods of connecting them up to self-latching burglar alarms.**

IF YOU BUILT or intend to build any of the relay-output burglar alarm circuits described in last month's 'Chit-Chat' feature, you'll need to couple your circuit up to a suitable alarm-call generator (a bell, siren or electronic siren) in order to make a working burglar alarm system. This month's 'Chit-Chat' tells you how to make those connections and describes some practical 'electronic siren' circuits that you can build.

An alarm-call generator may use the same battery supply as the actual burglar alarm (see Fig 1a) or may be powered from its own supply battery (Fig 1b). The rules for deciding which alternative to use are quite simple. First, if the burglar alarm and the generator voltages are not the same, you must obviously use individual supplies for each. Second, if the burglar alarm is NOT self-latching via a pair of relay contacts, you should use separate supplies: the reason for this is that the alarm-call generator impresses a lot of 'noise' on its battery supply and this noise may cause malfunctioning of a non relay-latching burglar alarm that uses the same supply.



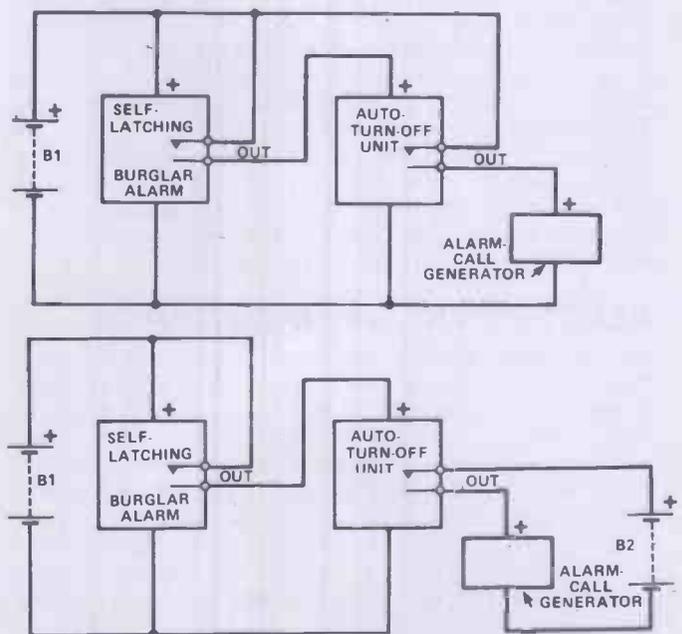
**Fig. 1. Interfacing a direct-action alarm call generator (bell, siren etc) to a self-latching burglar alarm using (a) common or (b) individual supply batteries.**

Thus, you can safely use a common supply only if the burglar alarm is self-latching via a relay contacts and if it

has the same voltage rating as the alarm-call generator. Four of the burglar alarm circuits described in last month's 'Chit-Chat' were of the self-latching 'relay' type, so from this point on we'll confine the discussion to this type of alarm circuit.

## **AUTO-TURN-OFF ALARM ACTION.**

Once a self-latching alarm has been activated it sounds the generator until the systems batteries run flat if the connections of Fig 1 are used. An alternative action, in which the generator sounds for only a pre-set period (typically 5 to 15 minutes) can be obtained by interposing an auto-turn-off unit between the burglar alarm and the alarm-call generator, as shown in Fig 2. This unit incorporates a relay that closes and completes the generator circuit as soon as the burglar alarm activates, but then automatically turns off and disables the generator after some pre-set period. Fig 2 shows alternative ways of interconnecting the three units when (a) common or (b) dual supply batteries are used.



**Fig. 2. Interfacing an alarm call generator to a self-latching burglar alarm via an auto-turn-off unit, using (a) common or (b) individual batteries.**

Figure 3 shows the practical circuit of an auto-turn-off unit that gives a basic timing period of 8 minutes: the period is proportional to the C1 value and can be doubled (for example) by giving C1 a value of 200n.

The operating principle of the Fig 3 circuit is quite simple. IC1 is a 555 'clock' generator and IC2 is a 14-stage binary counter which changes state on the arrival of each 8192nd clock pulse. When power is first applied to the circuit the output of IC2 is set to the 'low' state via C2. As the output goes low the relay is driven on via Q1 and contacts RLA/1 close and complete the

oscillator on and off. The resulting pulsed tone signal is amplified by Q1 and Q2 and reproduced at a level of several watts in the speaker. The available power output of this circuit is limited by the '18 volts maximum' of the supply line.

The permissible maximum voltage (and thus the available power output) of the above circuit can be increased by modifying the circuit so that the supply to IC1 is limited to 12 volts by a resistor and zener diode, as shown by R4 and ZD1 in Fig 5. This particular circuit generates a 'dee-dah' warble-tone alarm, similar to a

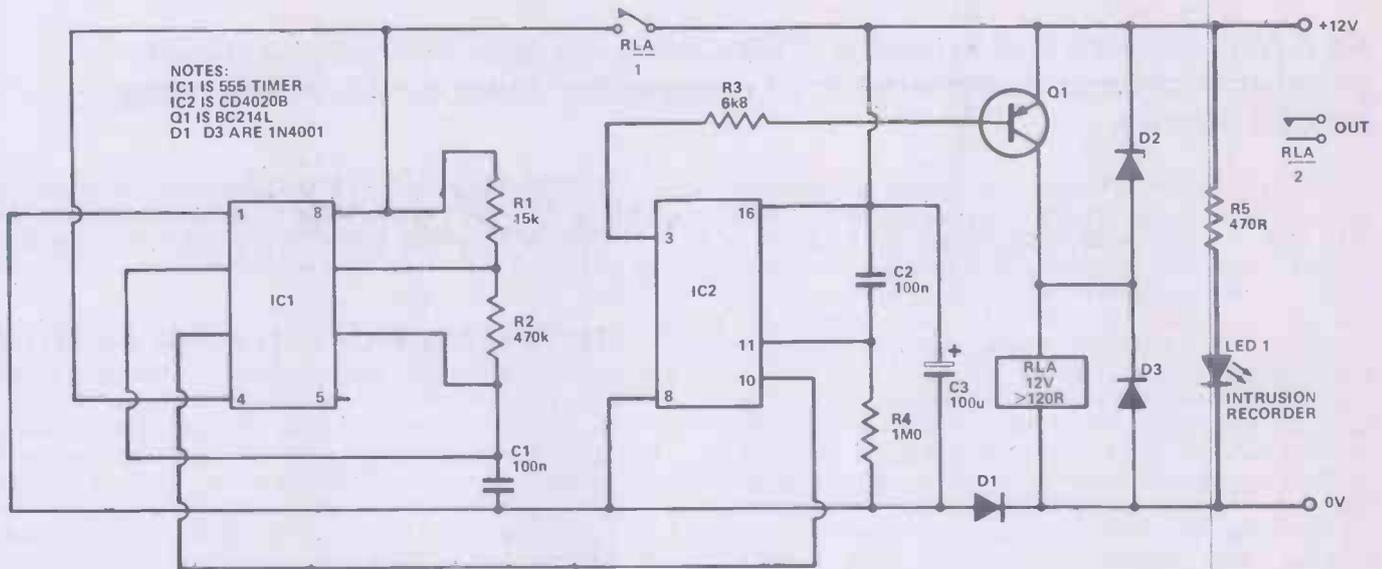


Fig. 3. A practical auto-turn-off unit giving a delay of about 8 minutes. The delay can be increased by using a larger value for C1.

supply connections to the IC1 clock generator, which then starts operating. On the arrival of the 8192nd clock pulse (after roughly 8 minutes with the component values shown) the output of IC2 flips high and turns the relay off via Q1, thereby opening contacts RLA/1 and breaking the supply connections to the clock generator. The operating sequence is then complete.

Note in this circuit that LED1 illuminates so long as a voltage supply is connected to the output of the self-latching burglar alarm. The LED thus acts as a visual 'Intrusion Recorder' which continues to glow even when the alarm-call generator has switched off.

## ELECTRONIC SIREN CIRCUITS

An alarm-call generator can take the form of an electro-mechanical bell or siren or of an electronic siren or sound generator. In some cases it may be an advantage to use two types of generator, either operating directly in parallel or operated simultaneously via a multi-contact relay. An electronic siren may, for example, be used to sound inside a house while an alarm bell sounds outside.

Electronic 'sirens' can take a number of different forms and may be designed to generate quite distinctive sounds. Figures 4 to 8 show five useful designs that can easily be built by the electronics hobbyist.

The Fig 4 circuit generates a 'bleep-pause-bleep-pause' pulsed tone signal. IC1a-IC1b form a 1Hz astable multivibrator which alternately gates the IC1c-IC1d 1kHz

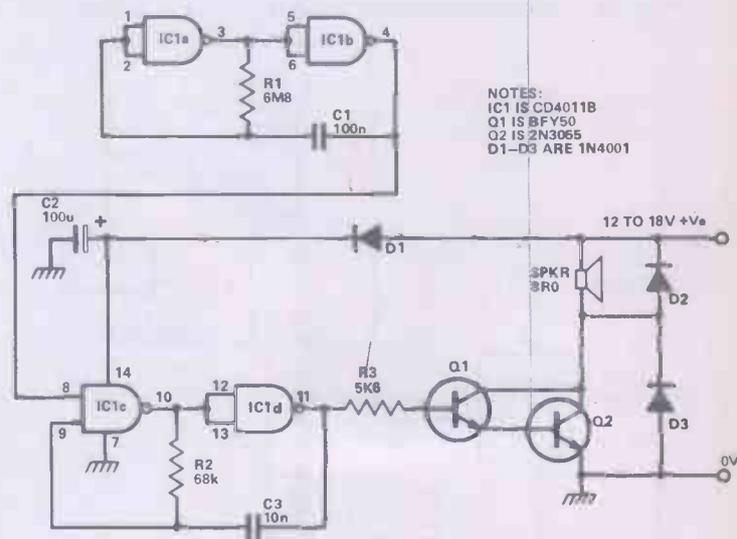


Fig 4. Higher power pulsed-tone alarm call generator.

British police car siren. The circuit is similar to that of Fig 4, except that the 1Hz astable is used to frequency-shift the IC1c-IC1d oscillator.

The frequency-shift 'symmetry' of the circuit

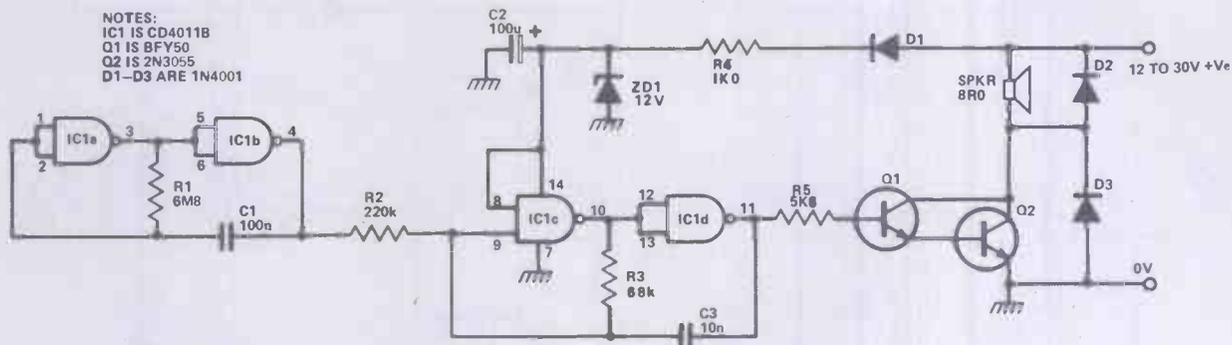


Fig. 5. High-power warble-tone alarm call generator.

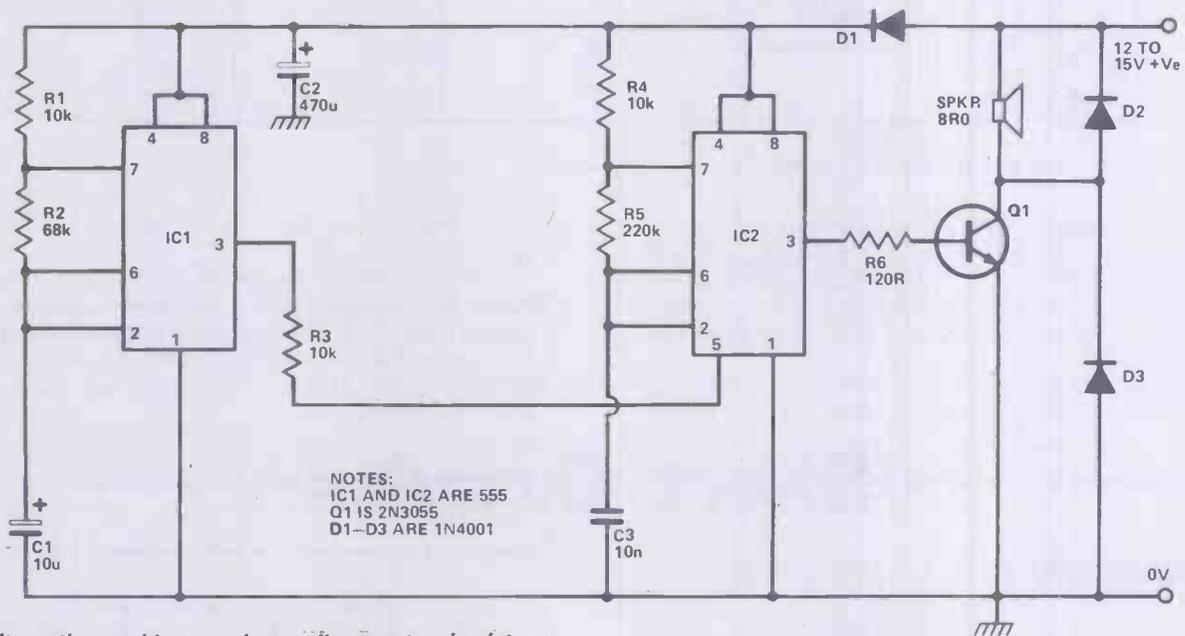


Fig. 6. Alternative warble-tone alarm call generator simulates a British police car siren.

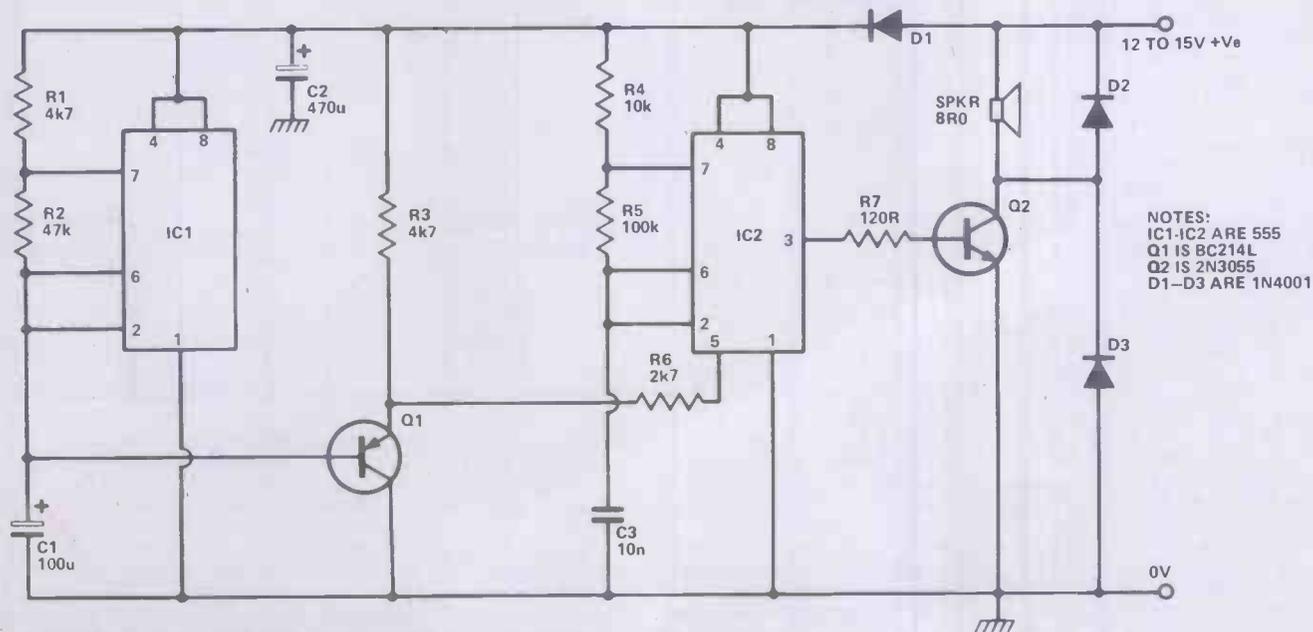
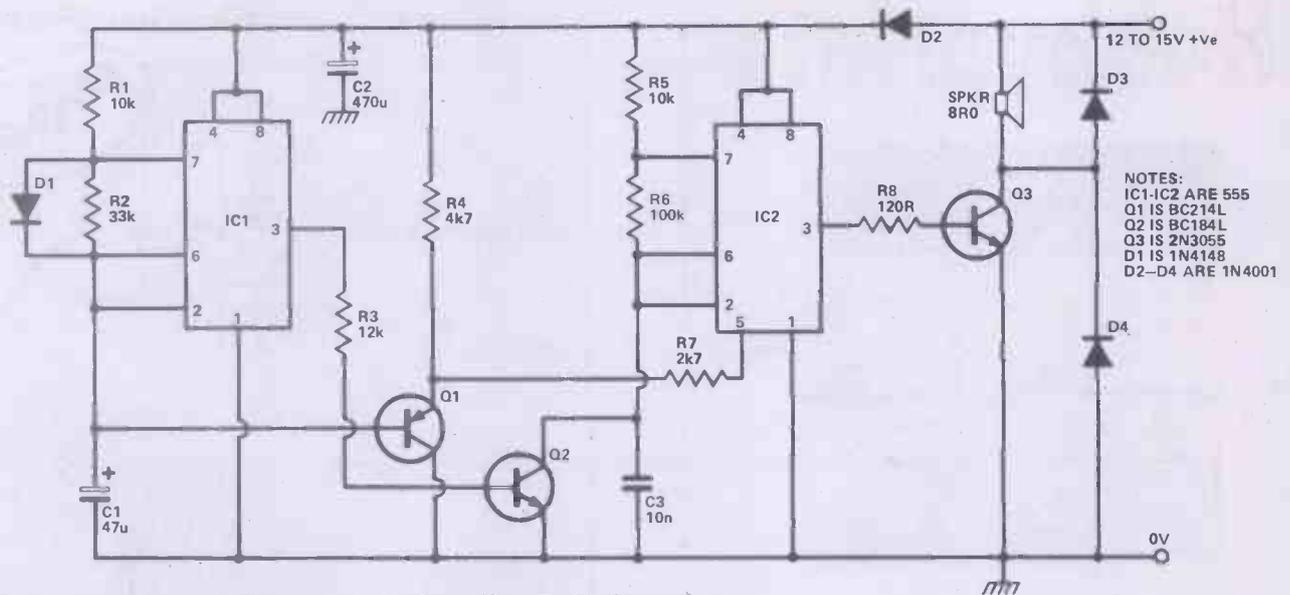


Fig. 7. 'Wailing' alarm call generator simulates an American police siren.



NOTES:  
 IC1-IC2 ARE 555  
 Q1 IS BC214L  
 Q2 IS BC184L  
 Q3 IS 2N3055  
 D1 IS 1N4148  
 D2-D4 ARE 1N4001

Fig. 8. 'Red-Alert' alarm call generator simulates 'Star Trek' alarm signal.

depends somewhat on the characteristics of the individual chip that is used in the IC1 position. Figure 6 shows an alternative warble-tone generator that does not suffer from this defect. The modulation frequency of this circuit can be varied via R2 and the 'tone' frequency can be varied via R5.

Figure 7 shows a variation of the above circuit. This particular design generates a 'wailing' or alternately

rising and falling tone, similar to that of an American police car siren.

Finally, the Fig 8 circuit generates a 'zeep-zeep' sound that is similar to the 'Red Alert' alarm signal used in the 'Star Trek' programme. The period or interval of this signal can be varied via R2 and the tone can be varied via R6. This circuit is an ideal project for the experimenter. **HE**

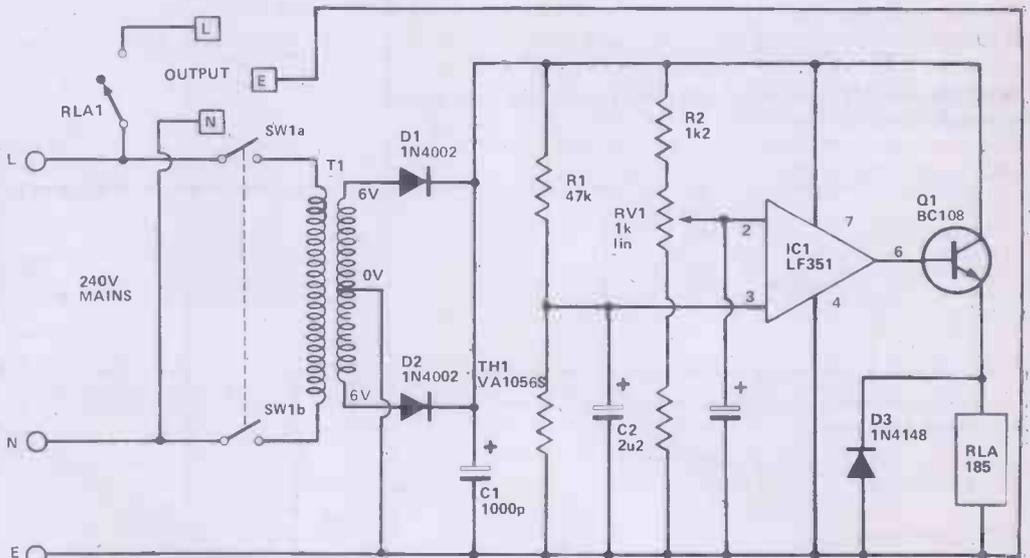
## Short Circuits

### THERMOSTAT

This simple thermostat will stabilise temperatures to within a fraction of one degree Centigrade. It covers a range which extends from a few degrees C to over 35 degrees C, and is therefore suitable for use as a room thermostat, a thermostat for photographic solutions, etc.

The circuit uses IC operational amplifier IC1 as a voltage comparator. If the voltage at its non-inverting (+) input is higher than that at the inverting (-) input, the output goes to virtually the full positive supply voltage. If the comparative input states are reversed, the output assumes a very low voltage. The inverting input is fed with a reference voltage which is taken from the slider of RV1; the latter acting as the temperature control. The non-inverting input is fed a potential divider which consists of R1 and Th1.

Th1 is a negative temperature coefficient thermistor, and its resistance varies according to its temperature, with increased temperature causing decreased resistance. If the voltage produced by Th1 and R1 is less than that set at RV1's slider, IC1's output will go high,



switching on the relay which is controlled from this output via an emitter follower buffer stage which utilizes Q1. Power is then connected to the heater by RLA1, and the room temperature (or whatever) starts to rise. This causes a reduction in the resistance of Th1, and the voltage fed to IC1's non-inverting input. This voltage soon

falls below that fed to the inverting input, causing IC1's output to go low, the relay to de-energise, and the heater to be switched off. The temperature then falls, causing Th1's resistance to increase, and a higher voltage to be fed to the non-inverting input of IC1. This soon results in IC1's output going high again, and the heater being

switched on. In this way the required temperature stabilisation is obtained.

Make sure that the relay contacts are capable of handling the currents involved (which will probably be quite high). The thermistor must be fitted in a watertight probe if it is to be used in photographic solutions.

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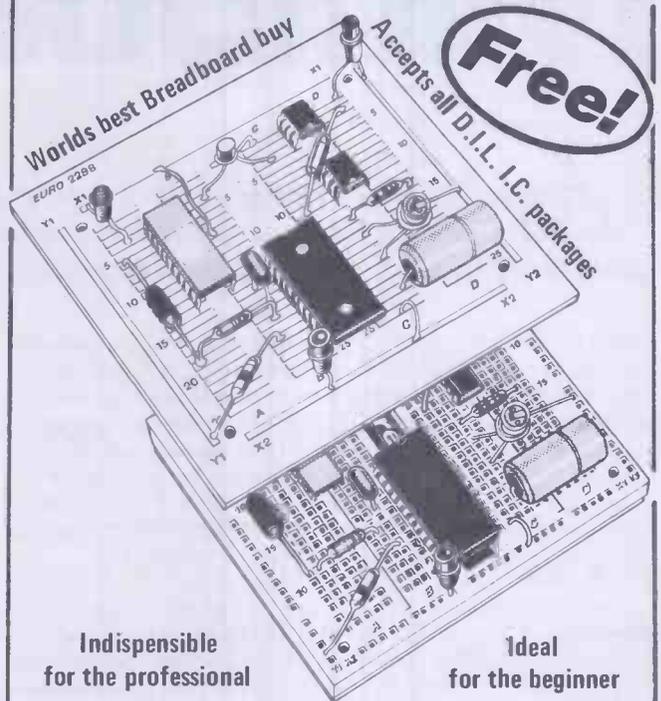
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**A state-of-the-art project to terrify intruders and pussy cats. A police-like "de-dah" alarm that produces a 6-watt output in an 8 ohm speaker when powered from a 12-volt battery supply.**

THIS NIFTY LITTLE DESIGN uses the very latest advances in semiconductor technology to implement a very compact, inexpensive, yet exceptionally powerful alarm-sound generator unit that can easily be incorporated into an existing burglar alarm system or similar "security" device. The alarm produces a police-like "dee-dah" signal at levels up to 6-watts in an 8 ohm speaker when powered from a 12-volt battery supply and incorporates a number of unusual features.

The alarm circuit incorporates a basic alarm-signal generator, followed by a power amplifier stage. The alarm-signal section of the unit is designed around an inexpensive CMOS integrated circuit that consumes virtually zero "standby" power. The power amplifier stage is a real state-of-the-art device, a low-cost VMOS power FET which also consumes virtually zero current when in the "standby" mode. Consequently, the unit does not need a separate on/off switch and can be left permanently connected to a 12-volt battery supply. The

alarm can be activated either by closing push-button switch PB1, or by applying +12 volts to the junction of R1 and R2 (the low end of PB1).

### CONSTRUCTION AND USE

The unit uses relatively few components and can be built in less than one hour. The components are assembled on a standard 1 inch x 2½ inch strip of Veroboard, as shown in the photos. Start construction by breaking the copper strips as indicated and then solder the nine wire links into place. Next, solder a suitable IC holder into position and then assemble the rest of the components, taking care to observe the polarities of C1, D1, IC1 and Q1.

When construction is complete, double-check all wiring and then connect the unit to a suitable 8Ω speaker and a 12 volt battery supply, connect PB1 in place and give the unit a functional check by closing the switch. The unit should produce an ear-splitting "dee-

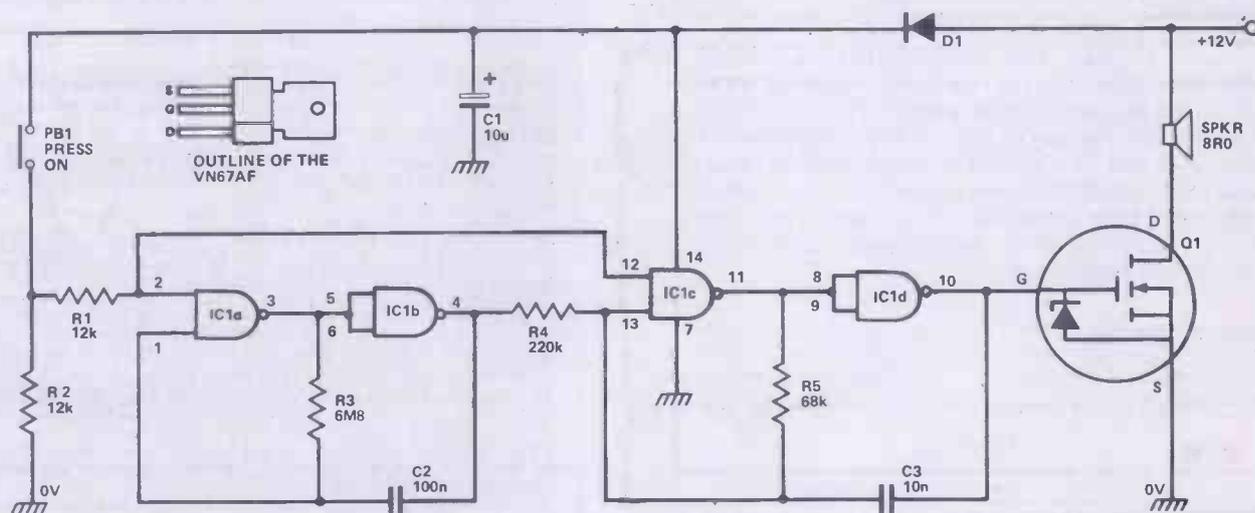


Fig. 1. Circuit diagram of the 6 watt siren.

NOTES:  
D1 IS 1N4001  
Q1 IS VN67AF  
IC1 IS CD4011B

## How It Works

IC1a and IC1b are wired as a slow astable multivibrator and IC1c-IC1d are wired as a fast astable. Both these astables are "gated" types, which can be turned on and off via PB1. The output of the ICa-IB1b slow astable is used to modulate the frequency of the IC1c-IC1d fast astable, and the output of the fast astable is fed to the external speaker via the Q1 VMOS power FET amplifier stage.

Normally, with PB1 open, both astables and Q1

are inoperative and the circuit consumes virtually zero standby current. When PB1 is closed both astables operate and the frequency of the fast astable is modulated by the slow astable to produce a "dee-dah" signal, which is passed to the speaker via the Q1 power amplifier stage. D1 and C1 are used to ensure that the astable actions are not adversely influenced by voltage transients induced into the battery supply leads via the speaker.

dah" alarm sound. Note that the speaker used in the system must be an 8RO type with a power rating greater than 6 watts.

If you want to use this unit in conjunction with an existing burglar alarm system, you can either replace

PB1 with a set of relay contacts that are activated via the burglar alarm system, or possibly can use the burglar alarm to activate the generator directly by applying 12 volts to the R1-R2 junction under the "alarm" condition. **HE**

## Parts List

MINIBOARD No. 7

RESISTORS (All 1/4w, 5%)

R1, 2 12k  
R3 6M8  
R4 220K  
R5 68K

CAPACITORS

C1 10µ 16V Electrolytic  
C2 100n Polyester  
C3 10n Polyester

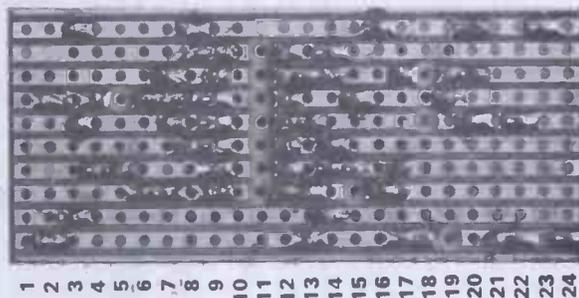
SEMI-CONDUCTORS

D1 1N4001  
Q1 VN67AF  
IC1 CD4011B.

MISCELLANEOUS

SPKR 8RO, 10 watt  
PB1 Push button switch

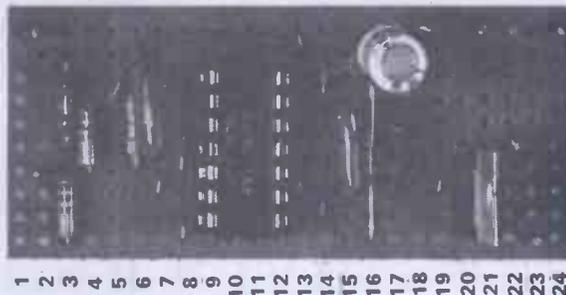
A  
B  
C  
D  
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F  
G  
H  
I  
J



Above. Component insertion layout. Note the orientation of Q1.

Below. Underside of the Miniboard 6 watt siren. Ensure that cuts in the track are made in the correct places.

J  
I  
H  
G  
F  
E  
D  
C  
B  
A



## Buylines

The only component that is difficult to find is Q1, the VN67AF VMOS power FET. It can be obtained from J. W. RIMMER, 367 GREEN LANES, LONDON N4 1DY. For price, phone 01-800 6667.

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TV GAMES AY-3-8500 + kit £7.26. Rifle kit £8.27. AY-3-8600 + kit £17.28. Stunt cycle chip + kit £18.89. AY-3-8603 chip £13.83. TRANSFORMERS 6-0-6V 115A £2.80. 9-0-9V 75ma 7p. 1A £2.22. 2A £3.84. 12-0-12V 100ma 8p. 1A £2.80. IC AUDIO AMPS with pcb. JC12 6W £2.08. JC20 10W £3.14. BATTERY ELIMINATORS 3-way type 8/7 1/2 9V 300ma £3.14. 100ma radio type with press-stud 9V £3.87. 9+9V £4.78. Car converter 12V input. output 4 1/2 6/7 1/2 9V 800ma £2.88. BATTERY ELIMINATOR KITS 100ma radio types with press-studs 4 1/2 6/7 1/2 9V £1.48, 6V £1.48, 9V £1.48, 4 1/2 + 4 1/2V £1.82, 6+3V £1.82, 9+3V £1.82. Stabilized 8-way types 3/4 1/2 5/7 1/2 9/12/15/18V 100ma £2.50, 1A £3.30. Stabilized power kits 2-18V 100ma £2.88, 1.30V 1A £6.20, 1-30V 2A £11.24. 12V car converter 6/7 1/2 9V 1A £1.35. T-DEC AND CBC BREADBOARDS s-dec £3.79, t-dec £4.88, u-dec £4.99, u-dec £7.15, exp-4b £2.64, exp300 £6.61, exp350 £3.62, exp325 £1.84. BI-PAK AUDIO MODULES s450 £28.08. AL80 £6.08. pa100 £17.33. spm80 £4.74. bmt80 £6.08. Stereo 30 £21.87. AL30A £4.08. pa12 £9.38. pa12 £1.58. ma60 £38.27.

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Official and overseas orders welcome. Lists 24p. post free. Mail order only.

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We won't guarantee HE Tee-Shirts will make your soldering any better, we won't even claim it will make your projects work first time. What we will say is that it will protect your body from harmful Ultra-Violet radiation from the sun, embarrassing Tomato Ketchup stains on your hairy chest and overweight wallets (if bought as directed in sufficient quantity).

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From deep inside the HE specials department comes this once-in-a-lifetime opportunity. You could be one of the first to own a copy of this special re-publication containing 25 of Hobby Electronic's most popular projects. Cover price will be just £1.25. If you missed them first time around then this is your big chance.

More details next month.



HE CANTRUM AMPLIFIER



# COMING SOON!

## DISPLAY LIGHTING KITS

Each unit has 4 channels (rated at 1kW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto isolated audio input.

### DL 1000K

This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control. £14.60

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A lower cost version of the above, featuring unidirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum. £8.00

Optional Opto Input DLA1 60p



## INTEGRATED CIRCUITS



555 Timer	21p
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LM3795 Dual 6W Amp	£3.50
LM380 2W Audio Amp	80p
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LM1830 Fluid Level Detector	£1.50
LM2807 Inverter	£1.40
LM3909 LED Flasher / Oscillator	55p
LM3911 Thermometer	£1.20
LM3914 Dot / Bar Driver	£2.10
MM57160 (staq) Timer	£5.90
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ZN1034E Timer	£1.80

All ICs supplied with data and circuits. Data sheets only 5p.

## DIGITAL VOLTMETER / THERMOMETER KIT



Based on the ICL7106. This kit contains a PCB, resistors, pre-sets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer, using a single diode

as the sensor. Requires a 3mA 9V supply (PP3 battery) £20.75

## LEDs

0.1" Red	8p
0.1" Green	12p
0.1" Yellow	12p
0.2" Red	9p
0.2" Green	12p
0.2" Yellow	12p
0.2" clips	3p
Rectangular Red	18p
Rectangular Green	20p
Rectangular Yellow	21p



## DISPLAYS



DL304 Red 0.3" c.c. pin compatible with DL704	70p
DL307 Red 0.3" c.a. pin comp	70p
DL707	70p
DL847 Red 0.8" (pin comp. DL747) c.c.	£1.80
DL850 Red 0.8" c.c. (pin comp. DL750)	£1.80
DL727 Dual 0.5" c.a. Red	£1.50

## MINI TRANSFORMERS



Standard mains primaries 240V a.c. 100mA secondaries

6.0-6V	80p
9.0-9V	85p
12.0-12V	90p

## D.I.L. I.C. SOCKETS

8 pin	8p	18 pin	17p
14 pin	12p	28 pin	26p
16 pin	14p	40 pin	36p

Soldercon Pins 50p/100

## 24 HOUR CLOCK / APPLIANCE TIMER KIT



Switches any appliance up to 1kW on and off at preset times once per day. Kit contains AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, PCBs & full instructions. £14.90

CT1000K Basic Kit £14.90  
CT1000KB with white box (56 x 131 x 71mm) £17.40  
Ready Built £22.50

## CAPACITORS

Polyester 250V			
0.01	6p	0.22	12p
0.002	6p	0.33	12p
0.0033	7p	0.47	15p
0.047	7p	0.68	18p
0.068	7p	1.0	24p
0.1	7p	1.5	27p
0.15	11p	2.2	31p

## Electrolytics A Axial R Radial

63V				16V				
1.0 R	3p	10 R	3p	1.0 R	3p	10 R	3p	
2.2 R	3p	2.2 R	3p	2.2 R	3p	2.2 R	3p	
4.7 R	4p	4.7 R	4p	4.7 R	4p	4.7 R	4p	
10 R	5p	10 R	5p	10 R	5p	10 R	5p	
47 R	8p	47 R	8p	47 R	8p	47 R	8p	
100 A	6p	100 R	6p	100 A	6p	100 R	6p	
110 A	9p	10V	47 A	6p	6p	10V	47 A	6p
470 A	16p	100 A	47 A	6p	6p	100 A	47 A	6p
1000 A	20p	220 A	220 A	6p	6p	220 A	220 A	6p

## Tantalum (bead)

35V 0.1	7p	10V 22	12p
0.22	7p	6.3V 33	12p
0.47	7p	3V 47	14p
1.0	7p	3V 100	14p
2.2	8p		
4.7	9p		
10	12p		

## VOLTAGE REGULATORS



Available in 5V, 12V & 15V versions.  
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79L series 100mA neg. 60p  
78 series 1A pos. 62p

LM317T adjustable 1.2V-37V 1.5A £1.80

## MINI KITS

These KITS form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB short instructions and all components.

**TEMPERATURE CONTROLLER/THERMOSTAT**  
Uses LM3911 IC to sense temperature (80°C max.) and triac to switch heater. PCB (4 cm sq.) potentiometer, plus all other components included with instructions. 500W £3.20 1KW £3.50

**SOLID STATE RELAY**  
Ideal for switching motors, lights, heaters etc. from logic. Opto isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. £2.60

**BAR/DOT DISPLAY**  
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indicators etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. £4.75

**BURST FIRE/PROPORTIONAL TEMPERATURE CONTROLLER**  
Based on the TDA1024 Zero Voltage Switch this kit contains all the components required to make a "burst fire" power controller or a "proportional temperature" controller enabling the temperature of an enclosure to be maintained to within 0.5 C. 1.5KW £5.25 3KW £5.85

## BOXES

Moulded in high impact ABS. Supplied with lids and screws. Black or white.



B2 95 x 71 x 35mm 65p  
B3 115 x 95 x 37mm 78p

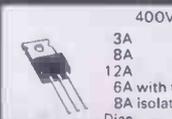
## RESISTORS

## ZENER DIODES

400mW 3.3V-30V 15p  
1.3W 7.5-27V 8p

1/4W 22ohm-10M Pack of 10 (one value) 10p  
10 Packs (10 values) 80p

## TRIACS



400V Plastic Case (Texas)  
3A 49p 16A 90p  
8A 58p 20A 165p  
12A 70p 25A 190p  
6A with trigger 80p  
8A isolated tab 65p  
Diac 18p

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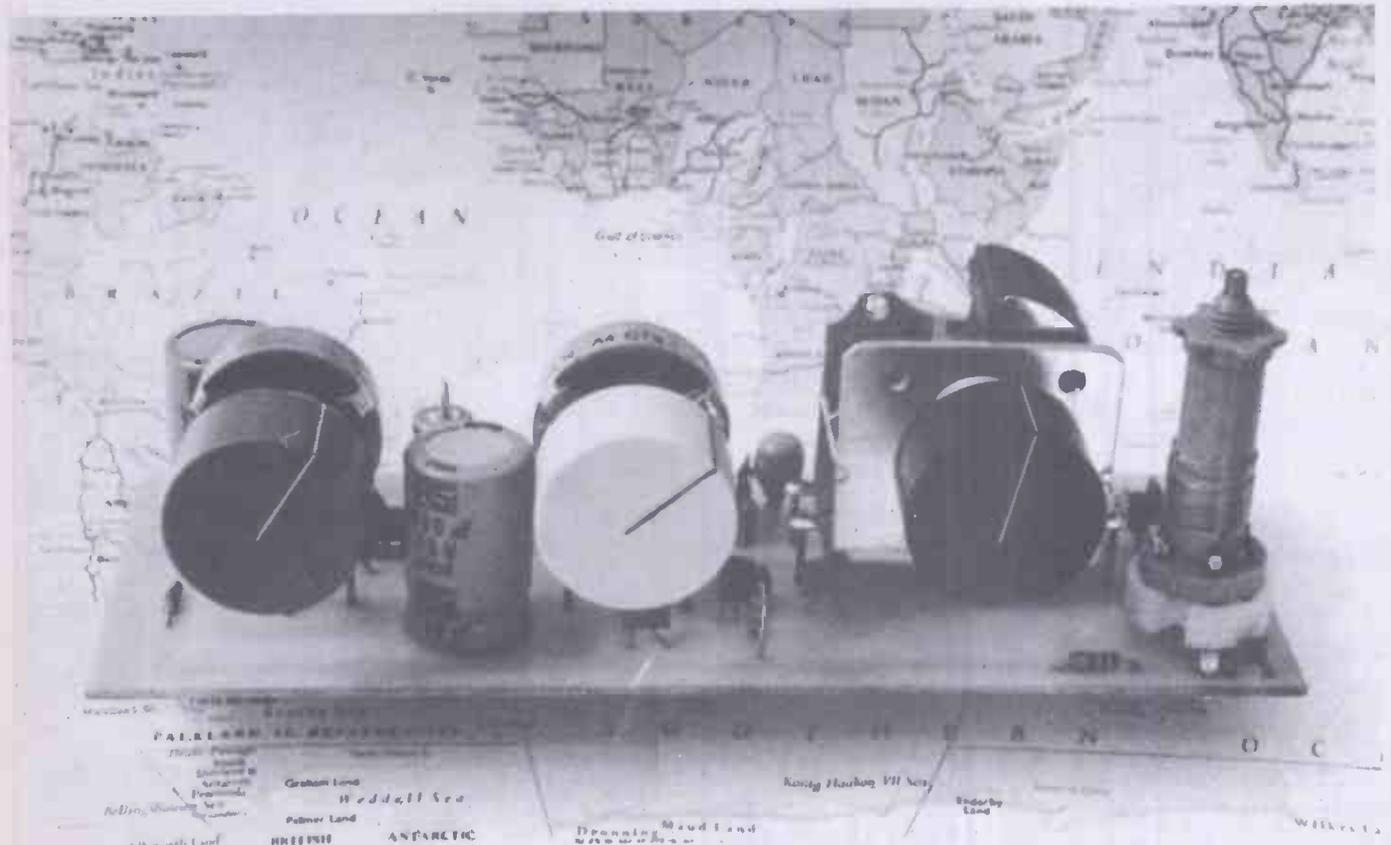


# Short Wave Radio

*Far away places with strange sounding names . . . Eavesdrop on the ether with this great project. 1 to 30 MHz in three sensitive and selective ranges.*

IN THE BAD OLD DAYS OF RADIO, sometime after the appearance of crystal sets but before the superhet became a practical proposition a breed of radio receiver became popular called a TRF. The letters stand for 'Tuned Radio Frequency' and the circuits usually contained several tuned (that is highly selective) stages of radio amplification. As superhet (short for superheterodyne) receivers were developed the humble TRF became less popular. Superhets mix a local oscillator signal generated inside the receiver with the received signal to convert all signals to an arbitrary intermediate frequency before amplifying and detecting them. The advantage of this arrangement is that the IF amplifier can be optimised for one particular frequency giving a narrow 'passband' and good selectivity. The vast majority of

modern radio receivers now use superhet circuits, even the cheap transistor pocket portables. Over the years, the radio spectrum has become increasingly crowded; especially the Short Wave bands and this has led to the development of a number of different modes of transmission. Amplitude modulation (AM) where the carrier wave is modulated in strength by the audio signal, is still used universally by commercial broadcasting stations at frequencies below VHF and very simple receivers, even a crystal set, can detect transmissions in this mode. However, many radio amateurs use continuous wave (CW) for morse code and single sideband (SSB) for speech. These signals are best resolved through the use of special detectors or with a direct conversion receiver. Many commercial short wave



*The HE short wave radio spans the world.*

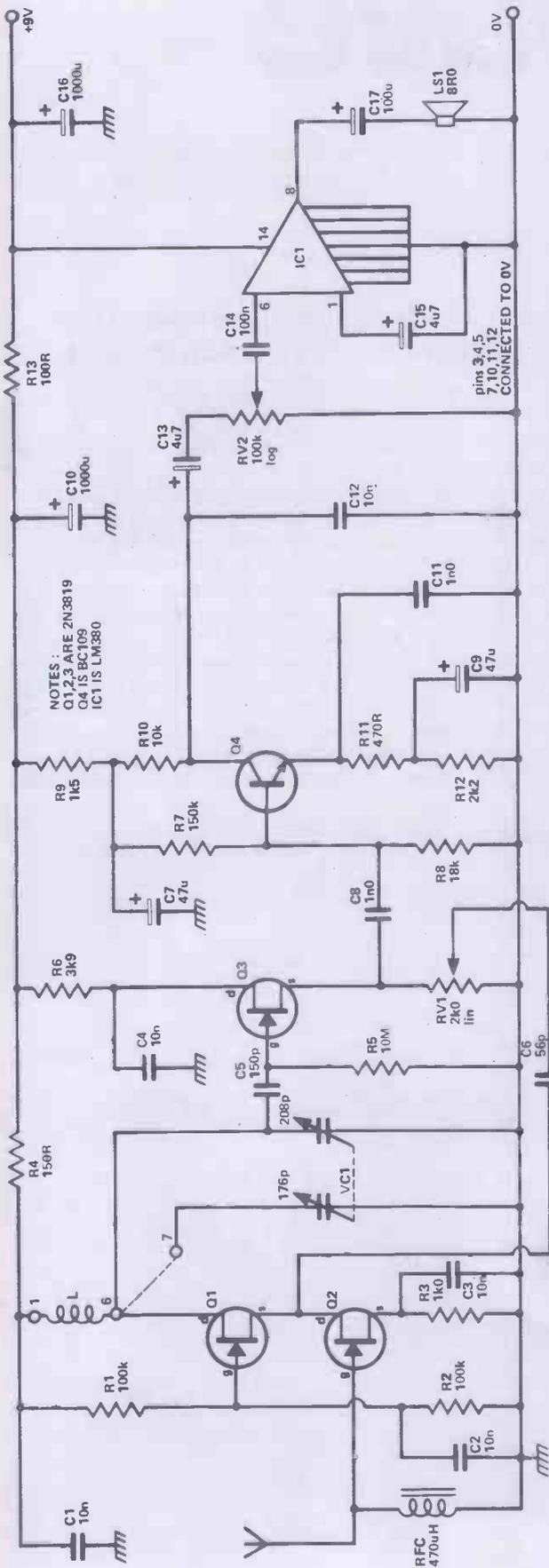


Fig. 1. Circuit diagram for the HE Short Wave Radio. For complete coverage of the SW Band you will need the three range coils (L), see parts list.

## How it Works

Q1 and Q2 form a broadband radio-frequency amplifier whose output is tuned by L (the Denco tuning coil) and VC1 (the variable capacitor). The circuit arrangement of Q1, Q2 may be unfamiliar. It is called a 'cascode' amplifier and has the advantage of minimising the effects of junction capacitance in the transistors which can restrict gain at high frequencies and may cause instability owing to unwanted phase shifts. Resistors R1, 2, 3 set the bias for the stage with the RF choke providing a DC return for the gate of Q2. Capacitors C2, 3 provide RF decoupling at appropriate points to the whole stage; preventing unwanted signal feedback down the supply line.

The amplified RF signal 'tuned in' by VC1 is coupled to the gate of source-follower Q3 by C5. R5, 6 and RV1 set the DC conditions for this stage which acts as a buffer between the tuned circuit and the detector stage Q4. Reducing the loading on the coil makes the receiver more selective, especially important on the crowded Short Wave bands. A portion of the signal is tapped off from

RV1 and fed back to the RF amplifier via C6. This technique, called 'regeneration', increases the gain of the stage and further improves the selectivity. The buffered RF signal at the source is coupled to Q4 by C8. Transistor Q4 is connected as a conventional common emitter stage with bias provided by R7, 8. Decoupling at RF is provided by C11, 12 while C9 decouples the stage at audio frequencies. This circuit has the advantage over a simple diode detector of providing some audio amplification. In fact, with a short aerial and a good earth there is sufficient output to drive a crystal earpiece directly. Just connect one wire to the collector of Q4 and the other wire to 0 V. R9 and C7 provide decoupling for the whole stage.

The audio output from Q4 is coupled to RV2 via C13. Potentiometer RV2 acts as the volume control and a portion of the signal across it is coupled to the input of audio amp IC1 via C14. Circuitry inside IC1 is decoupled by C15 and the audio output is coupled to the loudspeaker via C17. Capacitors C10 and C16 provide overall decoupling and help to prevent instability and spurious oscillations.



Use of shielded cable for the loudspeakers avoids instability problems.



No case is necessary, but use of our PCB is really essential.

# Parts List

RESISTORS (All 1/4W, 5%)

- R1, 2 100k
- R3 1k0
- R4 150 R
- R5 10M
- R6 3k9
- R7 150k
- R8 18k
- R9 1k5
- R10 10k
- R11 470R
- R12 2k2
- R13 100R

CAPACITORS

- C1, 2, 3, 4, 12 10n Ceramic
- C5 150p Ceramic
- C6 56p Ceramic
- C7, 9 47u Tantalum
- C8, 11 1n Ceramic
- C10, 16 1000u Electrolytic
- C13 4u7 Electrolytic
- C14 100n Ceramic
- C15 4u7 Tantalum
- C17 100u Electrolytic

POTENTIOMETERS

- RV1 2k0 Lin
- RV2 100k Log

VARIABLE CAPACITORS

- Jacksons 00 208/176 SM. Dual ganged
- 208p-176p with slow motion drive.

INDUCTORS

- RFC PCB Mounting miniature 470uH choke
- Denco 'Blue' dual purpose coil. Ranges 3, 4, 5

SEMICONDUCTORS

- Q1, 2, 3 2N3819
- Q4 BC109
- IC1 LM380

MISCELLANEOUS

- B9A PCB mount valveholder. PCB,
- 8R speaker, 9 V battery (PP9 or similar)

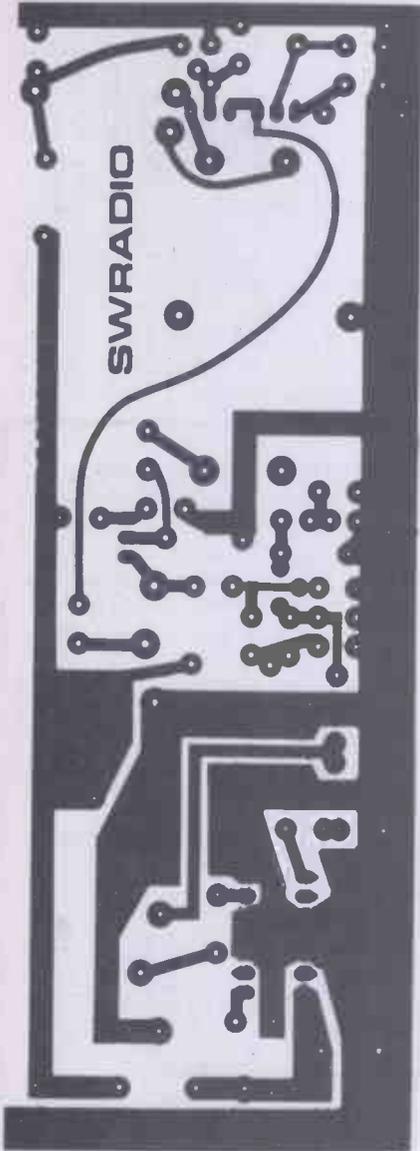


Fig. 2. The PCB foil pattern for the SW Radio. We strongly recommend you use our design.

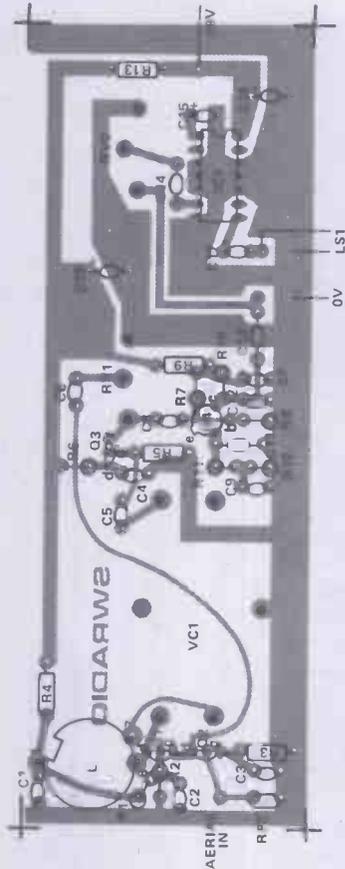
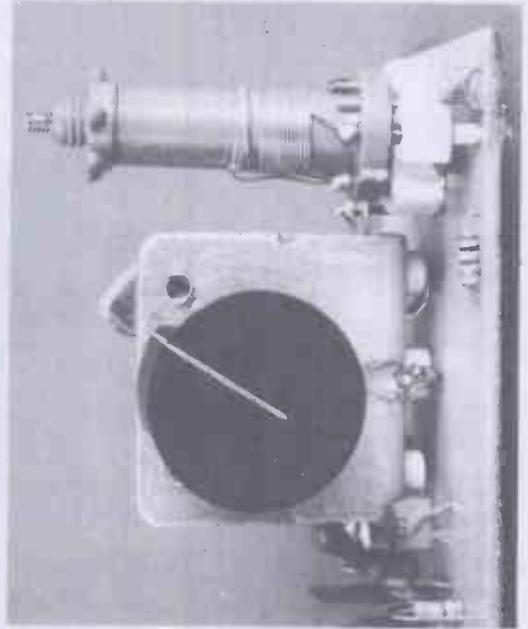


Fig. 3. Overlay diagram for the SW Radio.

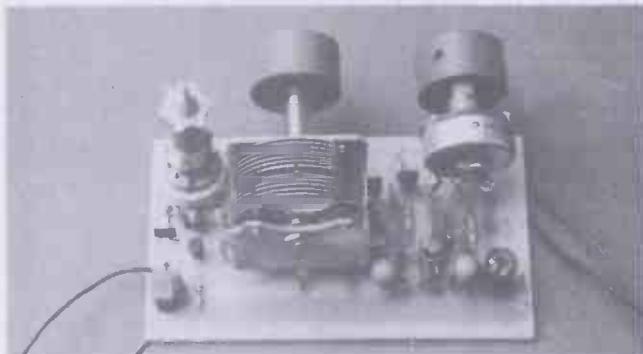
## Buylines

The majority of the components used in this project should be readily available from your usual supplier. However, the variable capacitor, choke and tuning coils may be more difficult to obtain. Watford Electronics should be able to supply these components as well as the more common ones.

Use of plug-in coils avoids complicated and expensive switching.



receivers incorporate two or three detection systems and can cope with most modes of transmission. They may also feature a digital frequency readout covering 0.5 to 30MHz. Sounds great doesn't it? Of course, such a receiver might cost several hundred pounds.



*This version drives a crystal earphone directly. Even cheaper!*

## CHEAP AND CHIRPY

By contrast, you can listen to the wonderful world of squawk, crackle and pop (music) with the Hobby short wave radio for about a 'tenner'. If you are happy with earphone reception or have your home Hi-Fi handy it will cost even less! You should be able to tune the whole Short Wave band from about 1.5 to 30 MHz using three plug-in coils. Use of a TRF circuit means that no alignment is needed and though there is only one tuned circuit, the receiver is made quite sensitive and selective by applying variable positive feedback: 'reaction' or 'regeneration'. By increasing the feedback until the circuit is just oscillating, it is possible to resolve CW morse transmissions and with care SSB.

Our chart shows what you are likely to find on the short wavebands and where. Although it looks rather sparse, you will probably find that there is not an empty spot on the dial until about 15 or 20 MHz. By far the most interesting reception is provided by the range 4 coil covering about 5 to 15 MHz. You should be able to receive broadcast transmissions from many foreign stations throughout the range. Using the prototype, we received English language transmissions for Cuba, Israel, Moscow, America, Vatican City, Canada and, of course, the BBC World Service to name but a few. Most stations identify themselves on the hour. Reception will vary during the day and according to the time of year but it is always possible to pick up something and there are numerous beacons and code transmissions scattered around the dial.

## CONSTRUCTION

Use of the specified components and our PCB is essential to ensure stability. Radio frequency waves are awkward little things and find their way into everything. Indeed, at very high frequencies they will not even travel down a wire, preferring instead to run along the outside of a conductor.

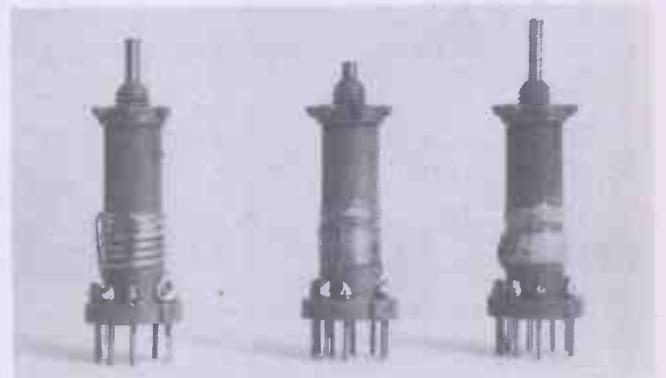


*Our chart shows the principal broadcast and 'ham' bands, but there's more out there than you think.*

The variable capacitor and two potentiometers are mounted on the PCB supported by stiff pieces of wire. All the other components with the exception of the loudspeaker mount directly on the board, keeping the component legs as short as possible. Our photo's should give you the general idea.

A mixture of capacitor types is specified. They are chosen both for their physical size and electrical characteristics and you should try to obtain the right types. None of the components are very out of the ordinary. Q1, 2, 3 are conventional junction FETs and no special handling precautions are required.

The coils plug into a modified B9A PCB mount valveholder. Simply remove the centre spigot and the connectors for all the pins except 1, 6 and 7. A short wire link can be soldered between pins 6 and 7 on the range 3 (low frequency) coil effectively connecting both sections of VC1 to the coil when range 3 is selected. In this way, a greater tuning range is obtained. Do not worry that there are no connections to pins 8 and 9; this coil is not used. To change range, simply plug in the appropriate coil. VC1 should be the slow motion drive component. Although it costs a little more, it is worth the extra expense and obviates the need for a bandspread control.



*Three plug-in coils cover all your favourite bands.*

If you do not need the audio amplifier stage, the output from the negative side of C13 will drive an external amplifier or a crystal earpiece directly. The cheaper 8 Ohm magnetic earphones will not work here. Connect the ground or shield of your amplifier input to 0V and the other wire to C13. A hole is provided on the board for this connection.

In use, the regeneration control RV1 should be advanced until just before the circuit begins to oscillate (stations will be received as whistles when the set is oscillating); this is the most sensitive state. The setting of the 'regen' control will vary over the tuning range and according to the coil in use. To receive morse code CW and SSB, advance RV1 just past the point of oscillation. The SSB transmissions sound like Donald Duck voices and considerable care is needed to resolve them.

The Hobby SW radio offers an economical and simple solution to the problem of getting your ears on the world out there. Build it now and happy listening!

# WE DID WARN YOU!

Nobody likes to gloat, but nearly six months ago we warned you about our diminishing stocks of backnumbers. The ones shown here are all that are left! Hobbyprints are *still* available.

Shown here are all of the backnumbers still available. They are **£1.00 each** inc. P&P. When ordering please quote the issue number, i.e. Nov. 78 is issue 1 Vol. 1. Next to each issue is the relevant Hobbyprint code letter, please note that Hobbyprints are still available for every issue.

Please send me the following back issues Nos .....

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**145 Charing Cross Road, London WC2H 0EE**

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### 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 Ohmmeter.  
**Features:** Cassette Decks and Tapes, Binary Numbers, Fixed Resistors, Short Circuits Special, etc.



### AUGUST 79 (Hobbyprint J)

**Projects:** Home Security Sound 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.



### OCTOBER 79 (Hobbyprint L see Hobbyprint Ad)

**Projects:** Tantrum, Hobbytune, Analogue Frequency Meter, Multi Siren.  
**Features:** Home Computing, Electronic Games, Microwave Cooking, Breaker One-Four.



### DECEMBER 79 (Hobbyprint N)

**Projects:** Scalextric Controller, Ring Modulator, Bargraph Voltmeter, Hebot II.  
**Features:** TV Receivers, Project Fault Finding, Data Supplement.



### JANUARY 80 (Hobbyprint O)

**Projects:** Hebot III, La/p Counter, Crosshatch Generator, Digi-Die.  
**Features:** Mini TV Survey, CMOS Spread, Spacelab.



### FEBRUARY 80 (Hobbyprint P)

**Projects:** Passionmeter, Infra-Red Control, Win Indicator.  
**Features:** Short Circuit Special, Kezy Does It, Power to the People.

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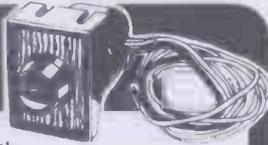
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Hobby Electronics,  
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**At last, the winners of the Tape Competition and the famous K 40 review.  
Plus, some more clubs for your notebook.**

## **NCLCBB**

That stands for the National Committee for the Legalisation of CB. It was set up at the meeting last December as reported in BOF. The committee held its first meeting early in January. The members of the committee have not wasted any time in setting the ball rolling. A demonstration is planned for April the 27 the venue is unclear at the moment but probably around Trafalgar Square London. The next meeting of the committee is planned for Saturday the 9th February. Contact your local club chairman for details.

The demonstration planned for the 26th of January appears to have been a hoax, unfortunately HE goes to press a few days prior to this so we won't know until it's too late. If anyone has got details of CB events please by all means tell us but please no more wind ups.

## **CHANNEL CONFUSION**

Have you ever wondered why this feature is called Breaker One Four? Simple, or least so we thought. Channel 14 has been the English breaker channel for about as long as we can remember, except in areas where 14 is unusable due to local interference. It now transpires that most areas north of Birmingham have been using channel 19. Sorry to all concerned but it's a little too late to change the title.

## **CLUB NEWS**

News of clubs is still trickling in. Just. Remember if you want a mention in BOF just drop us a line giving details of your club and where you meet if possible. On to this month's offerings.

CBA-SW  
Chairman D J Bennet  
7 Wookey Hole Road,  
Wells,  
Somerset. Tel. 75306.

Harrow and Wembley Citizens Band Group  
Secretary, Bill Ridgeway  
7 Sandringham Crescent,  
Harrow,

Middlesex. HA2 9BW.

Meeting place: Queens Arms High St Harrow 7.30pm  
1st and 3rd Wednesdays each month.

## **CALIFORNIA TEAMING**

After BOFs recent jaunt to the USA last year we were surprised to hear from an American Breaker that we

spoke to in the 'States. As we were using CB quite legally we did not mind giving out details of our address in England. A postcard from the 'States arrived just before Christmas giving details of our chat. This is almost the same as the Ham QSL in fact many European countries do send QSL cards for CB contacts.

This set us thinking, we know HE does get around the world, most countries in Europe can buy HE on the bookstalls. So, if we have any CBers in other countries who would like to send us an example of their QSL card we will reciprocate. As it's not illegal to listen to foreign CB we may get some special HE QSL cards made up so we can reply to any overseas stations. Well, how about it.

## **TAPE COMPETITION**

The entries for the competition were a little disappointing, not from the quality but the number. The answers to the questions are as follows:

- (1) Channel 14 is 27.125 MHz
- (2) SWR stands for Standing Wave Ratio.
- (3) A 'Firestick' is a make of CB antenna.

The suggestions for new slang for (a) a production line car, (b) the police and (c) the Home Office were quite good. Alongside the name of each winner we have printed their best suggestion.

K Bareham, Surrey. The Home Office-Wave Rovers.  
Lance Brake-Whitley, Croydon. Production line car-Road Beater.

M D Barson, Whitstable. Home Office-Desk Jockeys.

M. Jay London. Home Office-Gear Grabbers.  
T. Jenkins Devon. Car-Breaker Taker  
Dave Finch Southampton. Police-Charlie Clore  
(Rhyming slang-Law)

E. Peters Dulwich, Home Office-Earwigs

M. Dilton Newcatle. Car-Mouthmobile.

Peter Raines London Police — Blues

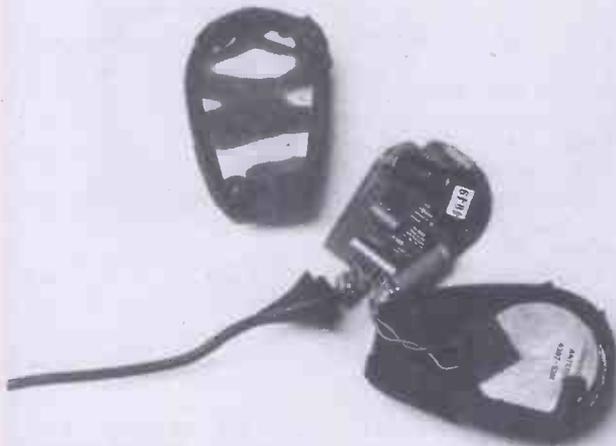
J. Wilson Glasgow. Car-voice box

## **K 40 REVIEW**

Bet you're thinking 'How can they test a CB mike when CBs are illegal.' Well, it just so happens we can, almost. Here at HE we have a licensed radio amateur, he comes complete with a transceiver. Problem solved, a genuine 

'on air' test. We decided to hook up the K 40 to the rig and try it out on the 11 metre amateur band. (27 MHz is around 10 metres so we're pretty close.)

Before we get to the test proper a few words on what is supposed to happen. You may be familiar with power mikes, they usually incorporate an audio amplifier to 'boost' the level of audio to the rig's input and driver stages. This would hopefully increase the level of modulation giving a stronger signal, in theory at least. The trouble arises when these are coupled up to modern rigs that incorporate compression circuits, designed to reduce the level of strong peaks from the microphone. Result, the signal from the power mike often gets severely clipped and distorted making it worse than ever.



The K40 opened up for inspection

The K 40 works on a different principle. Within the mike case lurks a purpose designed op-amp IC. This 'looks' at the output from the microphone and amplifies the portions of the signal that are below a pre-determined level. This increases the amount of signal that reaches the modulator stage resulting in a stronger (though not louder) signal.

The really clever bit of the K 40 design is the FET controlled charging circuit. The K 40 circuitry does not require batteries, instead an electrolytic capacitor is charged from the rigs existing mike leads. When the mike is keyed the IC is powered from the internal capacitor. When the rig is in the receive mode the capacitor re-charges. The current consumption is so low that a two second period of receive will power the mike in the transmit mode for around three minutes.

As an added bonus the K 40 has a 'Hi Lo' switch that increases the treble content (Hi) for operation in crowded cities. The higher frequencies stand a better chance of punching through the mush. Limiter circuits in the mike also maintain a constant input to the rig whether the mike is half an inch or two feet from the mouth. This, is it claimed is especially useful to truckers who have a high level of background noise in their cabs. They just hold the mike as close to the mouth as possible and the background noise is cancelled out.

Finally, the mike has a permanent magnet built into the rear of the case, no hooks or clips needed, just stick it to any metal surface when not in use.

So, does all this fancy stuff live up to the manufacturers claims? In short yes. Our Ham friend reported

excellent 'copies' from as far away as Germany. A comparison test involving the standard mike and the K 40 was favourably reported from the other end. We will continue to review the K 40, this time on a mobile 2 metre rig under noisy conditions. In the meantime we would like to thank Wintjoy for the opportunity to test the K 40 and say that for around 40 quid it's a touch pricey but well worth looking into.

## 15 PENCE = LEGAL CB?

Our penultimate item this month comes from that well known personality of the Airwaves (Rumour has it he's a licensed amateur) 'Mack The Hack'. He writes to us with a very worthwhile suggestion.

*Would you spend 15p to help get CB legalised? I'm sure you are all screaming 10-4 for sure.*

*In the recent Commons debate on CB. It was stated that 'The Minister (Home Office) has received 3,300 letters on the subject since May. That will be a drop in the ocean compared to the number of letters he will receive during the next few months'.*

*It has been suggested that all interested persons send post cards, (No not QSL cards), to the Minister.*

*The one I sent with views and greetings from London had this message. 7th Jan. 1980. 1140am GMT. 10-20 Victoria embankment, in 10-33.*

*Dear William,*

*10-50 (accident) Blackfriars underpass, traffic tailback to your works 10-20 (Parliament Square) wish you'd been there. If **Citizens Band Radio** was legal I would have been forewarned and able to have taken alternative route.*

*Yours faithfully, Mack the Hack.*

*CB4 UK NOW (please).*

*This postcard cost 7p and the stamp 8p (2nd class) and was sent to Mr William Whitelaw, House of Commons London.*

*Whenever I see a situation where CB could have helped I think that I'll send the Rt Hon William Whitelaw another postcard.*

*Now why don't you do the same. It will only cost you 15p and less time to write than it takes you to read this. Mack the Hack.*

We can see nothing wrong with that idea. How about sending a postcard. It might just make the difference.

## AND FINALLY . . . .

Lastly a couple of items from Wintjoy Ltd who seem to be just about the biggest dealers of CB accessories in the UK at the moment. They are compiling a map of Great Britain showing each town with its calling channel. If you would like to drop them a line giving details of your local 10.20 they would be most grateful. (This is not as sinister as it sounds, more about this next month). Finally, they would like to apologise for the breakdown of their phones earlier last month. Phone bill has been paid and they've now got their ears on.

## LATE NEWS

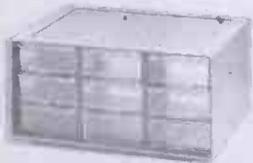
Just managed to get this in, in the nick of time. A major demo is planned for Sunday, February 23rd. Venue should be Hyde Park, Speakers Corner again. The march should commence around 11 am. See you there.

HE

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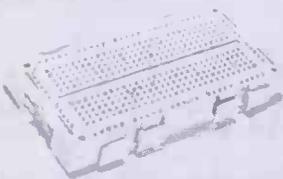
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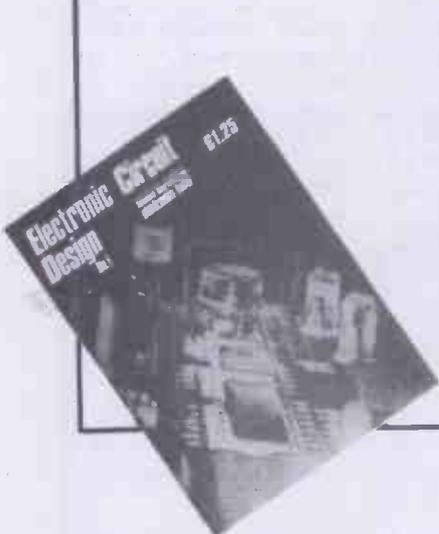
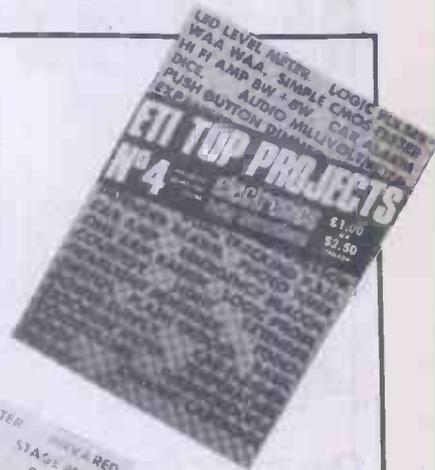
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# FROM THE

# Into Electronics

## Construction

### Part 2 BY IAN SINCLAIR

*The most fundamental device in electronic construction — the transistor. This month Ian Sinclair takes a close look at this and other important components.*

YOU ENDED UP LAST MONTH with a working circuit, which flashed a couple of LEDs on and off. What makes this circuit electronic as distinct from just electrical is the fact that there are no moving parts in the circuit to cause the flashing, it's all done by these remarkable transistors along with the capacitors, resistors and LEDs.

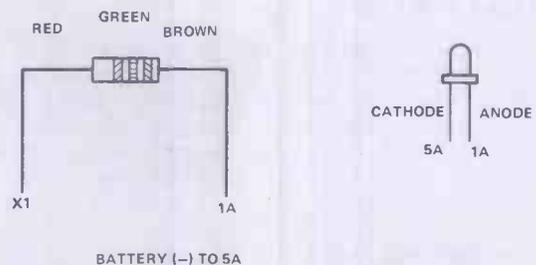
This month we're going to spend some time finding out what a transistor does, and learning a bit about how it does what it does. One way of learning would be to read every book about transistors you could lay your hands on — but the HE way is easier, just stay with us. What we'll do is to build a circuit that helps to explain what the transistor is doing in the circuit, then we'll take it from there.

To work then. Take the components off the board, gently pulling the leads out of the Eurobreadboard holes. Don't pull the leads out violently, because we want to be able to use these components over and over again. Providing you don't get the leadout wires too badly kinked at the ends, they should last out this course and still be useful to you for years to come. I find that a pair of tweezers is very useful for taking components off, and also for inserting the leadwires into the holes. Unlike pliers, tweezers can be used in one hand, and they're not so heavy to hold either.

#### SIMPLE STARTERS

The first circuit is a very simple one. The table of connections is shown in Fig. 2.1, it's just a LED with its cathode connected to the negative (—) lead of the battery — the part of the circuit we usually call earth — and its anode connected to a 1K5 resistor. There's no connection between the other end of the 1K5 and the battery positive (+) lead. Now if you clip the battery on, but leave the + lead free, not plugged anywhere into the board, nothing happens. If you now plug the battery + lead into the board at X1, the LED lights. What does this tell us? The LED lights when an electric current flows through it and current flows only when there is a complete circuit. All familiar stuff, you say? Yes, but we need to bear it in mind when we make the next step.

The next step is to see if enough current will flow through you — yes; you. Touch the lead of the 1K5 resistor which is plugged into X1, and with the other



**TABLE 1**

X1: 1K5 to 1A  
1A: LED Anode; 1K5 from 1A  
5A: LED Cathode; B (—)

**Fig. 2.1 A simple LED and resistor circuit.**

hand hold the battery + connection. Does the LED light now?

Why not? It's because your resistance is too high. A 6 V battery simply won't pass enough current through you to light the LED. The voltage of a battery measures how much push it can give to an electric current, and 6 volts isn't much of a push. It's just as well, in fact. If a 6 V battery could push enough current through you to operate the LED, you wouldn't feel very comfortable. To be precise, you would suffer electric shock, which is what happens if you touch a high voltage which *can* pass quite a lot of current through you.

OK, so you have a lot of electrical resistance, and a 6 V battery doesn't pass enough current through you to light an LED. Now set up the circuit which uses the table of connections shown in Fig. 2.2. This time we've used a transistor, the 1K5 resistor, and the LED in the circuit.

**TABLE 2**

X1: 1K5 to 1A; B (+)  
1A: LED Anode; 1K5 from 1A  
5A: LED Cathode; Transistor collector  
7A: Transistor base  
10A: Transistor emitter; B (—)

**Fig. 2.2 Using a transistor to control the LED.**

The battery + connects to one end of the 1K5 resistor at line XI, and the battery negative connects to the emitter of the transistor at line 10A. At the moment, the base of the transistor isn't connected anywhere, just plugged into line 7A. Now there's an electrical circuit present here. Current could flow from the battery + through the 1K5 resistor, through the LED, through the transistor collector and emitter leads and so back to the battery. Why doesn't it? We know that current can pass through the resistor and the LED, so it must be the transistor which stops the current. The transistor works in this circuit like a large resistance — it won't allow enough current to flow to light the LED.

Watch this now. Plug a piece of wire into line 7A, so that it connects with the base leadout wire of the transistor. Remember you don't have to force both wires into one hole, any hole in line 7A will do. Hold a bit of this bare wire in one hand (don't let it come against any other part of the circuit) and touch the battery + terminal with the other hand. What happens? What's more important, why does it happen?

## RESISTANCE

The glowing LED indicates that there is current flowing between the collector and the emitter leads of the transistor. This didn't happen before, and we reckoned then that the transistor must have a high resistance between its collector lead and its emitter lead. Now it looks as if it has a low resistance between these two leads. Stop touching the wires — and the LED goes out again.

It looks as if a connection to the base lead of the transistor can make the difference between a transistor being a high resistance and being a low resistance. We've found already that we have a high resistance between our hands — we can't pass enough current to light an LED. That small amount of current which passes from one hand to the other seems to be enough, however, to make the transistor change over from being a high resistance to being a low resistance. All it has to do is to flow into the base leadout wire.

Try moistening your fingers, then hold them on the wires again. The LED glows a bit more brightly this time. You don't feel any current flowing through you, though, so you can only be passing a very small amount of current, much less than the transistor allows to pass through the LED.

Stop to gather breath and ideas. A circuit which includes connections to a transistor collector and emitter doesn't pass current unless there's a small amount of current flowing into the base terminal from a positive voltage. That's the way these particular transistors work — they're all of a type called NPN which conducts when both the base and the collector are connected to positive voltages. What this little lot has shown is that the transistor acts as a tap for electric current. A small amount of current flowing through you has caused the transistor to pass a much greater current through the LED. You can think of the base lead of a transistor as acting like a tap which controls the flow of current between the collector and the emitter.

## TRANSISTOR TAP

There's an important difference, though. The transistor, unlike a tap, is controlled electrically. The amount of current which flows into the base controls the amount of

current which flows between the collector and the emitter. The name 'transistor' comes from the original name 'transfer resistor', because the discoverers of transistor action noticed that the resistance between the collector and the emitter changed when the amount of current flowing into the base changed. The word 'controls' doesn't just mean that the current can be switched on and off, either. Let's look for a moment at an experiment that we can't do (without a lot of expensive equipment) but whose results are important. Fig. 2.3 shows what's involved. A transistor is connected with its collector and emitter in one circuit, complete with a meter to measure the current (a milliammeter) which flows through the transistor from collector to emitter. There's another meter too, a current meter of the type called a microammeter, which can measure very small currents. This meter is connected to the base of the transistor, and to a current regulator which can control the amount of current which passes.

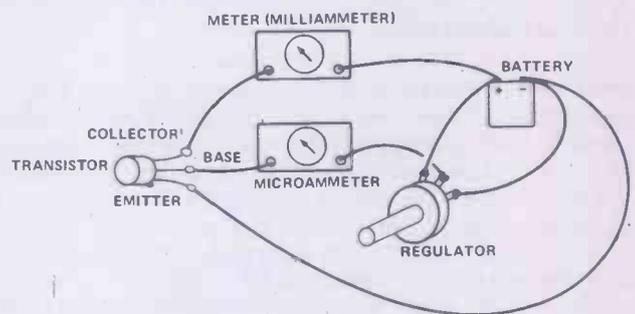


Fig. 2.3 The arrangement which shows how a transistor controls current. You don't need to do this one, but you should know about it.

What happens? Well, as you'd expect, passing some current into the base of the transistor causes current to flow between the collector and the emitter. That much we knew already. What is new is how these currents change when we alter the regulator. We'll find that, for example, doubling the amount of current into the base terminal causes the other current, the current between the collector and the emitter, to double also. In fact, any change we make to the base current causes an exactly proportional change to the collector-emitter current. Mathematically, this is simple proportion, so that the collector-emitter current is directly proportional to the base current. If we drew a graph, plotting collector-emitter current in one direction and base current along the other direction, the graph would be a straight line.

That's very convenient, because it means that the ratio:—

$$\frac{\text{collector-emitter current}}{\text{base current}}$$

is constant. Suppose, for example, that the ratio happens to be 100. A ratio of 100 means that the collector-emitter current is one hundred times the base current — always. If the base current happens to be 10 microamps, for example, then the collector-emitter current is  $10 \times 100$  microamps, which is 1000 microamps (equal to one milliamp). Can we work this the other way around? Yes, if the collector-emitter current is 10 milliamps, then the base current has to be one hundredth of this,

$$\frac{10}{100} \text{ milliamps, or } 0.1 \text{ mA.}$$

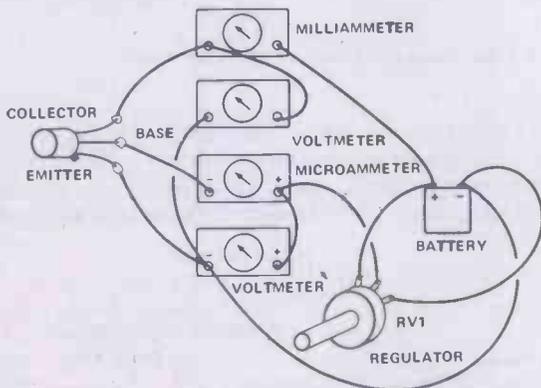
# Into Electronics Construction

## VARIABLE VOLTAGES

OK so far? The action of the transistor is sometimes called current amplification, because a small amount of current into the base controls a larger current between the collector and the emitter. Notice one very important point — amplification of this sort doesn't mean making current greater — it means using a small current to control a large one, like making a large-scale copy.

So far, we've been working with just one electrical quantity, current, and we've been relying on the voltage of a battery to keep the current flowing. Will the current flow at any voltage, or do we need a certain amount of voltage to keep current flowing through a transistor? Once again, we can discover this by experiment only if we have suitable measuring instruments, so we'll describe what happens.

Suppose we set up voltage measuring instruments, called voltmeters, to measure the voltage between the base and the emitter and also between the collector and the emitter of a transistor, as in Fig. 2.4. We'll keep the current measuring meters in place also, so that we know when there is a current flowing, and we'll regulate the voltages, not the currents. What would we expect to read from these meters?



**Fig. 2.4** Another one you don't need to do for yourself — it shows how the voltage between the base and the emitter of a transistor controls the current.

Well, the first thing we would notice with this small fortune in measuring instruments is that no current flows at all when the voltage reading at the base is only around a quarter of a volt (0.25 V). The meter is connected between the base and the emitter, so that this is the base-to-emitter voltage. That's one important difference between a transistor and a resistor, because a resistor passes current when any voltage is placed across it. The transistor behaves as if there's some sort of switch inside, preventing current flowing.

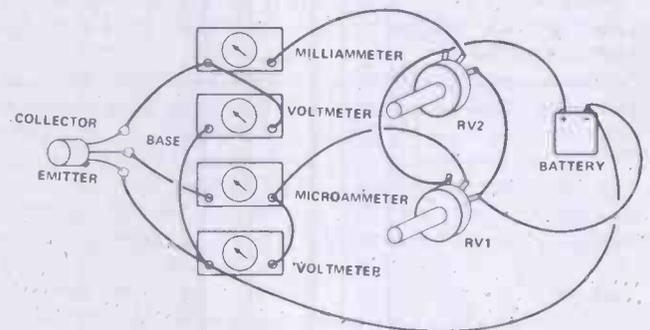
If we jack up the voltage, slowly and steadily, we see the current start to flow at somewhere around half a volt, between 0.5 V and 0.55 V. Can't we be more precise? No, we can't, because the voltage at which the transistor starts to conduct varies — it depends on the temperature of the transistor for one thing, and also on the transistor itself. That doesn't just mean what type of transistor, but which individual transistor you use. They're not as alike as peas in a pod as far as this is concerned, and even transistors which were made on the same production line and at the same time from the same materials show these differences. It's just something we have to live with.

## CURRENT

When current starts to flow in the base-to-emitter circuit, current will also flow in the collector-to-emitter circuit, just as we have now come to expect. Now for another measurement. Let's suppose that the current which flows into the base is a small quantity, ten microamps (written as  $10 \mu\text{A}$ ), and that we needed a voltage of 0.5 V to make this amount of current flow. How much voltage do we need to make 100  $\mu\text{A}$ , ten times as much, flow? If we were dealing with a resistor, the answer would be simple — ten times as much, 5 V would be needed. How much voltage does the transistor need? Just 0.06 V more, that's all. In our example, that's a rise of voltage from 0.5 V to 0.56 V.

Far from making life difficult, this makes transistor electronics rather simpler. When a small transistor is conducting, its base to emitter voltage will be somewhere between 0.5 and 0.6 V, whether the current is large or small. We've said 'small', because some large power transistors may need a volt or so between the base and the emitter if they are to pass really large currents; we shan't be using that size of transistor in this series.

There's one more trick left up the sleeve. Suppose the measuring circuit is changed to the arrangement shown in Fig. 2.5. The new variable resistor RV2 lets us control the voltage at the collector. Up till now we've left that voltage at 6 V, because the battery supplies 6 V. What happens if we set the transistor conducting, and then start winding this voltage down? The answer, surprisingly, is practically nothing! Once we set the current flowing, using RV2 to regulate the current in the base-emitter circuit, the collector voltage has very little effect, until the voltage drops right down to about 0.2 V.



**Fig. 2.5** This is the last of 'em! It shows how the voltage between the collector and the emitter of the transistor affects (or doesn't affect) the current.

Only when the voltage drops this low (the figure of 0.2 V is called the saturation voltage) does the current suddenly start to drop. What do we make of the show so far? Let's list what the transistor does.

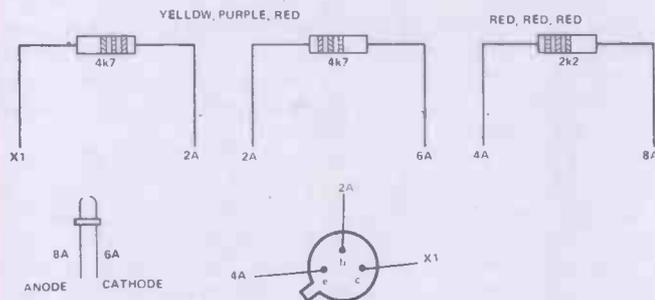
1. The current that flows between the collector and the emitter is always a fixed amount times the current that flows between base and emitter. This 'fixed amount' varies from transistor to transistor.

2. The voltage between the base and the emitter has to be around 0.5 to 0.6 V to keep the transistor conducting.

3. The amount of current isn't affected much by the voltage at the collector, unless this drops to about 0.2 V or less.

## LIGHT LED

Now let's try a circuit. Fig. 2.6 is the table of connections on the Eurobreadboard, which should result in a circuit which lights the LED. The transistor collector is connected to +6 V, and the emitter connects to the 2K2 resistor and then to the LED. When current flows, then, it flows through the transistor, the 2K2 resistor, and the LED, causing the LED to light.



**TABLE 6**

X1: B(+); 4K7 to 2A; Transistor collector  
 2A: Transistor base; 4K7 to 6A; 4K7 from X1  
 4A: Transistor emitter; 2K2 to 8A  
 6A: B(-); 4K7 from 2A; LED cathode  
 8A: 2K2 from 4A; LED Anode

**Fig. 2.6** How the components are connected for an "emitter-follower" circuit.

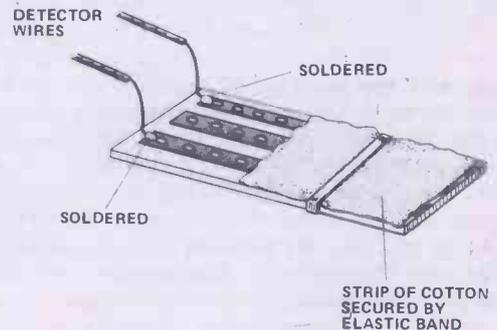
All right? The LED lights when it's connected to the emitter of the transistor. Now change the connections, by taking the end of the 2K2 resistor which was plugged into 4A and now plugging it into 2A. This is the connection to the base of the transistor. Does the LED light here too?

It does, and the experiment shows that the voltage at the base must be about the same as the voltage at the emitter. This is a different type of transistor circuit, called an emitter-follower, in which we connect the collector of the transistor to the + supply voltage, but we don't connect the emitter of the transistor to the negative supply voltage. Instead, the emitter is connected to a 'load', the resistor, LED or whatever it is we're controlling with the transistor. We'll look at these different connections again in the next part when we learn a bit more about circuit diagrams. The emitter-follower circuit makes use of the fact that the voltage between the emitter and the base of a transistor is always low, about 0.5 to 0.6 V.

## WET CURRENTS

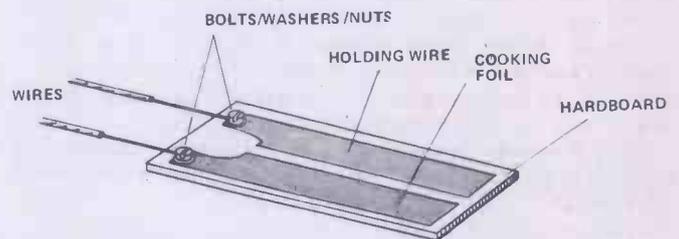
Now for this month's project circuit, which makes use of all that we've learned about transistors so far. The circuit is for a moisture detector, useful for showing when your plants are well watered, or if the washing-machine is dripping water, unseen, on the floor underneath. The principle is very simple, it makes use of the first experiment you tried out this month. A very small current into the base circuit of a transistor will cause a much greater current to flow between the collector and the emitter of the transistor. Now water doesn't conduct electric current very well, but it conducts a lot better than air or most dry materials. If we have a couple of wires, one

connected to the positive of the battery and the other to the base of a transistor any slight current which passes from the positive terminal to the base will cause a much larger current to flow through the transistor between the collector and the emitter. The 'slight current' can be caused by water touching both wires, so that the wires act as a sensor or detector of water or steam. One useful way of making this more sensitive is to use two of the copper strips in a sheet of Veroboard (Fig. 2.7) with the wires soldered to the strips, and a piece of cotton fastened across the board. Cotton retains moisture, so that current leaks quite happily from one track to another if any water falls on the detector.



**Fig. 2.7** One form of the water detector board.

If you're not too happy with soldering yet (wait until Part 5) then try the scheme shown in Fig. 2.8. This uses a wood or hardboard base with aluminium cooking foil glued to it. The foil is cut with a modeller's knife so that



**Fig. 2.8** A version of the water-detector board which doesn't need any soldering.

it's in two separate pieces, with a thin wooden track between them. Electrical connections are made from the aluminium foil into our circuit by bolting the connecting wires to the foil, using small-gauge nuts and bolts and large diameter washers. Remember that only single-coil wire should be plugged into the Eurobreadboard.

That settles the detecting part of it, which can be a long distance from the rest of the circuit if you like. The electronics part of it all consists of two transistors, three fixed-value resistors, an LED, a silicon diode and a component you haven't met before — a 10K potentiometer. The potentiometer, usually referred to as a pot is a type of resistor with an extra contact whose position can be varied. The one we've used is called a 10K pot because there's a resistance of 10K (more about these units later) between the two end connections, and this value of resistance is fixed. There's another connection, though, to a contact which can slide over the resistor

# Into Electronics Construction

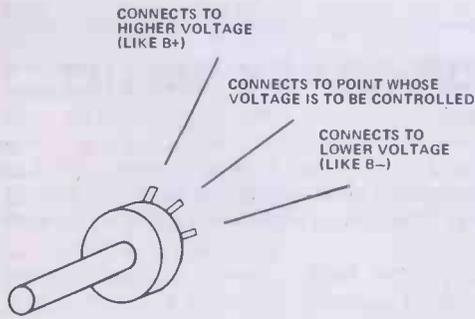


Fig. 2.9 The potentiometer.

materials, and the position of this contact can be set anywhere between one fixed contact and the other by turning the shaft of the pot. Suppose, for example, we connect this pot to +6 V at one end and to zero at the other. We can move the sliding contact to the zero end, making the voltage at the middle contact equal to zero. We could set the contact to the +6 V end, making the voltage at the middle contact equal to +6 V. We can also set the contact half-way, which makes the voltage of the middle terminal equal to +3 V, and we can set the contact so that the voltage of the middle terminal can be any value between 0 and +6 V.

## CONNECTIONS

It's a very useful device, and we'll be using it again later in the series. The connections are always the same on these rotary potentiometers. They are set in a row, and when you're looking from the front, looking down the shaft of the potentiometer, then the end which connects to the higher voltage is on your left and the end which connects to the lower voltage is on your right. The moving contact is between them in the middle. That's the way it's going to be connected in this circuit, and that's the way it's connected in most circuits.

The connections can be made by stripping the insulation from an inch or so of single-core wire, and wrapping this bare end several times tightly round one of the potentiometer terminals. This doesn't give as good a connection as soldering, but it'll do for experimenting with provided you don't allow it to loosen too much by moving the whole potentiometer around too much. Fig. 2.10 shows these leads labelled, so that you can see where they plug into the board.

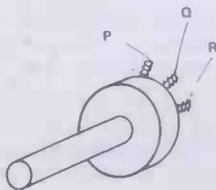


Fig. 2.10 Making the connections to the potentiometer for the water-detector circuit.

The rest of the connections are shown in the table of Fig. 2.11. Remember that the transistors must be connected the right way round — you should know by now how to identify the emitter lead of this type of transistor by its metal tab. The LED also has to be the

right way round — though the circuit will still work with the LED connected the wrong way round, there's a chance of damaging the LED. The diode also has to be connected the right way round, otherwise the LED will never light and may possibly be damaged.

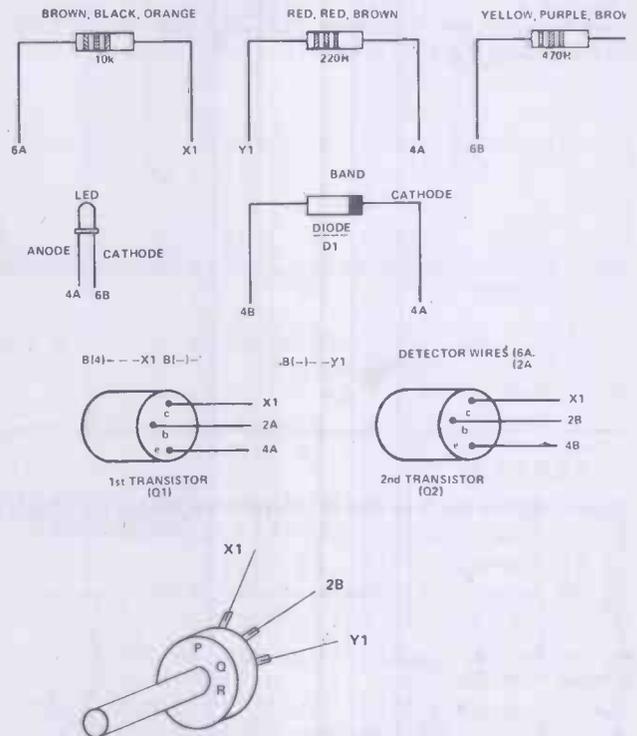


TABLE 11

X1:	10K to 6A; Collector Q, Collector Q; Potentiometer P; B (+)
2A:	Base of Q; Detector wire 1
4A:	Emitter of Q; Anode of LED; Cathode of D1; 220R to Y1
6A:	10K from X1; detection wire 2
Y1:	220R from 4A; Potentiometer R; B (-)
6B:	Cathode of LED; 470R to 4B
4B:	470R from 6B; Anode of D1; Emitter of Q
2B:	Base of Q; Potentiometer Q

Fig. 2.11 The connections for the water-detector circuit.

## SETTING UP

How do we use it? The pot adjusts the sensitivity of the circuit for detecting water. You can, for example, place the detector where you want to detect water and turn the potentiometer shaft fully clockwise. If you've connected it the right way round, the circuit should now be at its maximum sensitivity, and a drop of water on the detector plate bridging across the contacts should cause the LED to glow.

Sometimes you don't need so much sensitivity. You can use two bare wire leads in a plant pot, for example, and adjust the potentiometer so that the LED just switches off when the soil is damp enough. Now if you add too much water, the LED glows to warn you!

Suppose you want to use the unit to warn of dryness? It's easy, you just reverse the LED and the diode

# Into Electronics Construction

connections as shown in Fig. 2.12. Now you set the potentiometer so that the LED just switches off when the moisture around the detector is getting a bit low, and the LED will shine a warning to you when things are too dry. It would never light in my local!

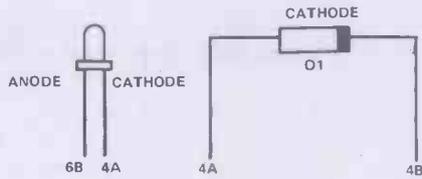


Fig. 2.12 How to plug in the LED and the diode so that the unit warns of dryness.

Next month — circuit diagrams, and a big step forward in circuit construction.

## ADDITIONAL SHOPPING LIST

### Part 2

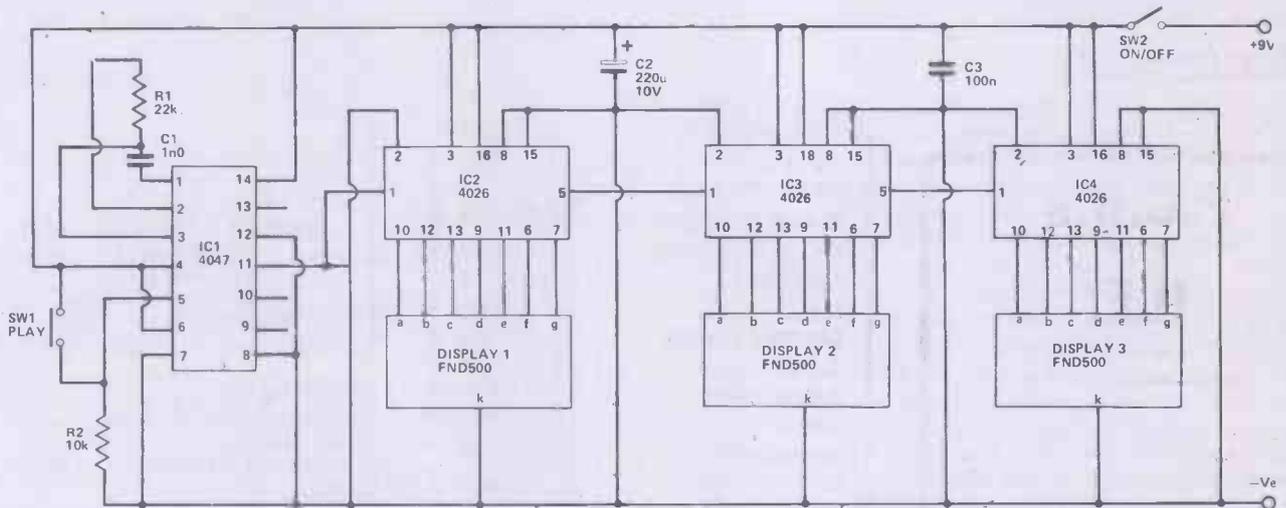
These are the extra components which you'll need to add to last month's list for the new work this month.

Resistors:  
 1 × 220R  
 1 × 470R  
 1 × 2K2  
 2 × 4K7  
 1 × 10K

Potentiometer: 10K miniature type  
 Hardware: small strip of Veroboard or hardboard (see details in text).

HE

## Short Circuit



### ONE ARMED BANDIT

This circuit is designed to give an approximate simulation of a one armed bandit fruit machine, and is only intended for home-entertainment purposes. The unit has three seven segment LED displays, and when a pushbutton is depressed, all display segments appear to light up. When the button is released, a random number is displayed. The idea of the game is to obtain a row of three identical numbers in the display, with (say) 1 point being scored for "000", two points for "111", etc., up to 10 points for "999". The object of the

game is to score as many points as possible in an agreed number of attempts, say 25 or 30.

The circuit consists basically of a clock oscillator using IC1 and a three stage counter which uses IC2 to IC4. The 4047 CMOS device used in the IC1 position is a monostable/astable device which is used here in the true gating astable mode. Under quiescent conditions R2 takes the gating input (pin 5) low, and prevents the circuit from oscillating. Depressing SW1 takes the gating input high, and starts the circuit oscillating at a frequency which is controlled by R1 and C1. The specified values give an operating frequency of about 10kHz, although the exact frequency is unimportant, it just

needs to be reasonably high.

The display section uses three CMOS 4026 decade counter/ seven segment decoders, which can be used to directly drive high efficiency common cathode displays such as the FND500, DL704, etc. The three display circuits are connected in series, in the normal way, so that one thousand clock pulses take the display through every number from "000" to "999", and then back to "000" again.

Thus, when SW1 is operated the display cycles through every number about ten times per second, with all the display segments appearing to switch on continuously as the action of the display is too fast for a human

observer to perceive. When SW1 is released, the display is "frozen" at whatever number it happened to be displaying when IC1 ceased oscillation. There is, of course, no way of operating SW1 to definitely obtain one of the winning numbers, and it is purely a matter of chance whether or not one of these is displayed, as is the case with a real one armed bandit machine.

IC1 to IC4 are all CMOS devices, and normal CMOS handling precautions should be observed when dealing with these. The current consumption of the unit can be over 50 mA when certain numbers are displayed, and a large battery such as a PP9 should be used as a power source.

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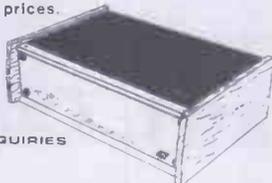
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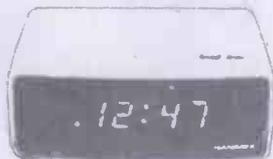
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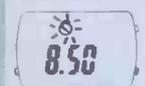
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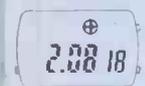
Alarm Chronograph  
(incredible watch)



Count-down Timer



Alarm



Time Zone



Chronograph

5 independent working modes, day of week in English, French or German (just select the one you like). Hours, mins, secs, day, date, countdown alarm, dual time zone, 1/100th sec. stopwatch. Lap/split time, 1st and 2nd place times. Melody test function.  
**34 Functions**



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**M30**

**CASIO CHRONO  
95QS-32B**

Stainless steel case, water resistant to 66 feet. Hours, mins, secs, am/pm, year, month, date, day. Auto-calendar pre-programmed until the year 2029. 12/24 hour. Stopwatch function. Range 7 hours. 1/100 sec. (Mode) Net time/lap-time/1st-2nd place times. Dual time function. Accuracy 15 secs per month. Battery life approx 4 years.



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**M22**

**CASIO F-200  
Sports Chrono**

Attractive Man's watch in black resin with mineral glass. Hours, mins, secs, am/pm. Month, date, alpha-numeric day. Auto-calendar set 28th Feb. Stopwatch working range 1 hour, units 1/100 sec. Mode. Net Time/lap/time/1st-2nd place times. Accuracy approx 15 secs per month. Battery 12 months.



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**M24**

**CASIO ALARM  
CHRONO  
81CS-36B**

Hours, mins, secs, day, and also day, month and year perpetual automatic calendar. 100th sec chronograph to 7 hours. Net time/lap/time/1st and 2nd place times. User optional 12/24 hr display. 24 hourly chime. Alarm. User optional. Backlight, mineral glass, stainless steel. Water resistant to 100ft. Battery life approx 4 years.



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**M25**

**CASIO F-8C  
3 Year Battery Life**

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**M36**

**SEIKO  
CHRONOGRAPH  
NEW STYLE**

Hours, mins, secs and day of the week. Month date and day of the week. Stopwatch display — Hours, mins, secs up to 12 hours (mins, secs, 1/100'secs up to 20 minutes). Lap timing. Continuous time measurement of two competitors. Stainless steel, mineral glass.



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£39.95**  
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**M33**

**SEIKO Alarm  
Chronograph**

With WEEKLY Alarm. Hours, mins, secs, month, date, day, am/pm. Weekly alarm — can be set for every day at designated time e.g. 6.30 am on Mon, Wed and Friday. Alarm set time displayed above time of day. Full stopwatch functions, lap time, split etc.



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**M10**

**SEIKO DIGI-ANA  
CHRONOGRAPH**

Time and Calendar function. Analog part display; hr, min, sec. Digital part display; hr, min, sec, date, day and colon. Calendar-month, date, day. Stopwatch — hr, min, sec, 1/100 sec. Lap/stop and stop marks. Counter function. Time and calendar setting function.



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**M62**

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