Hobby Electronics

45p
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November '79

FREE INSIDE 8 PAGE DATA SUPPLEMENT

The Amiable Automaton

R2D2 Radio
We've Given Him A Voice!

TV Broadcasting
Logi Bared

Miniboards
Holey Projects

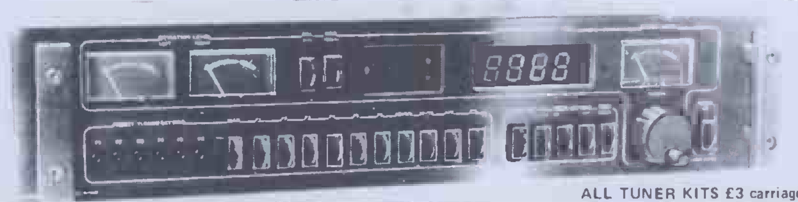
Into Linear ICs
The 555 Explained

Guitar Tuner
No Strings Attached

Tecknowledgey for sale.

The Mark III FM Tuner

DIY Hi-Fi will never seem the same again. Ambit's Mark III tuner system is electrically and visually superior to all others. Some options available, but the illustrated version with reference series modules: £149.00 + £22.35 VAT
With Hyperfi Series modules £185.00 + £27.75 VAT



ALL TUNER KITS £3 carriage

Features of the system.

* Precision construction & design of all parts
* Time frequency display
* State of the art performance with facilities for updates, using modular plug in systems.
* Deviation level calibrator for recording
* All usual tuner features

Digital Dorchester All Band Broadcast Tuner: LW/MW/SW/SW/SW/FM stereo

A multiband superhet tuner, constructed using a single IC for RF/IF processing - but with all features you would expect of designs of far greater complexity. The FM section uses a three section (air gang) tuned FET tunerhead, with ceramic IF filters and interstation mute; AM employs a double balanced mixer input stage, with mechanical IF filters - plus a BFO and MOSFET product detector for CW/SSB reception. Styled in a matching unit to the Mark III FM only tuner, employing the same degree of care in mechanical design to enable easy construction. MW/LW reception via a ferrite rod antenna.

Electronics only (PCB and all components thereon)	£33.00 + £4.95 VAT
Complete with digital frequency readout/clock-timer hardware	£99.00 + £14.85 VAT
Complete with MA1023 clock/timer module with dial scale	£66.00 + £9.90 VAT

Hardware packages are available separately if you wish to house your own designs in a professional case structure. Please deduct the cost of electronics from complete prices.

LW/MW/FM LCD Digital Frequency Display - July PW feature

Update your old radio, or build this into a new design. Or use it as a servicing aid - this low power unit with LCD display reads direct frequency in kHz/MHz, or with usual AM/FM IF offsets for received frequency. Low power LCD means no RFI - 15-20mA at 9v even with the divide by 100 prescalar. FM resolution is 100kHz, AM 1kHz. Sensitivities better than 10mV

Complete kit £19.50 + £2.93 VAT, built and tested module £27.00 + £4.05VAT

Ambit stocks and distributes a wide range of frequency counter LSI for all types of DFM- part two of the catalogue contains details of the MSM5523/4/5/6 range, and the versatile MSL2318 divide by ten or hundred prescalar IC. The DFM1 combined counter for AM,FM SW and direct/clock/stopwatch/timers - details available, but SAE please !

PW SANDBANKS PI METAL LOCATOR

Maintaining our professional approach to home constructor kits, we offer the pulse induction 'Sandbanks'. Now with injection molded casing for greatly improved enviromental sealing. £37.00+£5.55vat

VHF MONITOR RX WITH PLESSEY IC

4/9 channel version of the PW design but using standard (fundx9) crystals, and TOYO 8 pole crystal filter with matching transformers. Coil sets from our standard range to cover bands from 40 to 200MHz.
Complete module kit £31.25 + £4.68 vat

MICROMARKET OSTS overflow:

6800P	650p	8212	230p	2102	170p
6820P	600p	8216	195p	2112	340p
6850P	275p	8224	350p	2513	754p
6810	400p	8228	478p	4027	578p
6852	365p	8251	625p	2114	1000p
8080	630p	8255	540p	+15% VAT	

RADIO and AUDIO MODULES : Consistently the most advanced

FOR FM

EF5801-3-4 series: 6 stage varicap tuning, all with oscillator output

5801	Dual gate MOSFET RF stages, bipolar mixer	£17.45 + 2.61VAT
5803	Dual gate RF/mixer stages, amplified LO out	£19.75 + 2.96VAT
5804	'Hyperfi' series, with internal PIN diode agc, and ultra wide range tuning system	£24.95 + 3.74VAT
EF5402	4 stage varicap tuner with TDA1062 and LO output. Uses FET/IC input. PIN agc	£10.75 + 1.61VAT

FOR 30-200MHz

The EF series are available on special order to cover bands (usually approx 20% of the centre frequency) in the range described. Details in our price list.

FOR FM IFs at 10.7MHz

7030	single 6 pole linear phase filter IF with HA1137	£10.95 + 1.64VAT
7130	two 6 pole linear phase filter IF with CA3189E	£16.25 + 2.44VAT
7230	Hyperfi IF, switched bandwidth, AGC IF preamp, linear phase ceramic filters with diode switched narrow filter	£24.95+3.74VAT

DECODERS for MPX (STEREO)

Various types, guaranteed the world's biggest and best ranges

LARSHOLT FM TUNERSETS

7252	MOSFET front end combined with CA3089 IF	£26.50 +3.97VAT
7252	JFET front end, combined with IF and decoder	£26.50 +3.97VAT

FM/AM tuning synthesiser, see details elsewhere in th is advertisement

COMPONENTS FOR RADIO/COMMUNICATIONS/AUDIO/TV etc.

As usual, Ambit brings you the latest and best, a small selection of which is shown in this advertisement. The Ambit catalogues contain information on most of the devices mentioned here - and an order for the new part three will ensure you stay up with latest developments. Data photocopying service described in pricelist info.

RADIO ICs for FM		vat
CA3089E	1.94	29
CA3189E	2.45	37
HA1137W	2.20	33
HA11225	2.20	33
SN76660N	0.75	11
RADIO ICs for AM/FM		
TDA1090	3.35	50
TDA1083	1.95	29
TDA1220	1.40	21
IF AMPLIFIERS		
KB4406	0.50	07
MC1350	1.20	18
see comms ics also		
COMMUNICATIONS		
KB4412	2.55	38
KB4413	2.75	41
SD6000	3.75	56

SL1600 series		
SL1610	1.60	24
SL1611	1.60	24
SL1612	1.60	24
SL1613	1.89	28
SL1620	2.17	33
SL1621	2.17	33
SL1623	2.44	37
SL 624	3.28	49
SL1625	2.17	33
SL1626	2.44	37
SL1630	1.62	24
SL1640	1.89	28
SL1641	1.89	28
SL6640	2.75	41
SL6690	3.20	48
MC3357	3.12	47
MC1496	1.25	19
NE544	1.70	25

Audio preamps		vat
LM381N	1.81	27
LM382N	1.65	25
KB4436	2.53	38
KB4438	2.22	33
TDA1028	3.50	53
TDA1029	3.50	53
TDA1074	3.75	56
Audio power		
TBA820M	0.75	11
TBA810AS	1.09	16
LM380N	1.00	15
ULN2283	1.00	15
TDA2002	1.95	29
HA1370	2.99	45
TDA2020	2.99	45

FETs, MOSFETs, bipolars. and various others: see PL

2SJ133/2SJ48 £10.00 + £1.50 pr. various high voltage drivers etc from correctly matched Hitachi series transistors. (All 120v types)

OSTS: Remember all OSTS stocks are obtained from BS9000 approved sources - your assurance that all devices are very best first quality commercial types. Some LPSN TTL is presently in great demand, so please check by phone before ordering .

TTL:Standard AND LP Schottky

All prices listed in pence *

	'N'	'LSN'
7400	13	20
7401	13	20
7402	14	20
7403	14	20
7404	14	24
7405	18	26
7406	38	
7409	17	24
7410	15	24
7411	20	24
7412	17	
7413	30	
7414	51	
7415		24
7416	30	
7417	30	
7420	16	24
7421	29	24
7423	27	
7425	27	
7426		27
7427	27	29
7428	35	32
7430	17	24
7432	25	24
7437	40	24
7438	33	24
7440	17	24
7441	74	
7442	70	99
7443	115	
7444	112	
7445	94	
7446	94	
7447	82	89
7448	56	99
7449		99
7451	17	24
7453	17	
7454	17	24
7455	35	24
7460	17	
7463		124
7470	28	

	'N'	'LSN'
7472	28	
7473	32	38
7474	27	38
7475	38	40
7476	37	38
7478		38
7480	48	
7481	86	
7482	69	
7485	104	99
7486		40
7489	205	
7490	33	90
7491	76	110
7492	38	78
7493	32	99
7494	78	
7495a	65	99
7496	58	120
7497	185	
741XX series		
74107	32	38
74109	63	38
74110	54	54
74111	68	
74112		38
74113		38
74114		38
74116	198	
74118	83	
74120	115	
74121	25	
74122	46	
74123	46	
74124		137
74125	38	44
74126	57	44
74128	74	
74132	73	78
74136		40
74138		60
74139		60
74141	56	

	'N'	'LSN'
74142	265	
74143	312	
74144	312	
74145	65	97
74147	175	
74148	109	191
74150	99	
74151	64	84
74153	64	54
74154	96	
74155	54	110
74156	80	110
74157	67	55
74158		60
74159	210	
74160	82	130
74161		78
74162		130
74163	92	78
74164	104	130
74165	105	
74167	20	
74169		200
74170	230	200
74172	625	
74174	87	120
74175	87	110
74176	75	
74177	78	
74181	165	350
74183		210
74184	135	
74185	134	
74188	275	
74190		92
74192	105	180
74193	105	180
74194	105	
74196	99	110
74197		110
74198	150	
74199	160	
74247		90
74253		105

	'LSN'
74257	108
74260	153
74273	124
74283	120
74293	95
74365	49
74366	49
74367	43
74368	49
74373	77
74374	77
74377	124
74379	130
74393	140

VOLTAGE REGS:

7800 series 1Amp pos	95p
7900 series 1Amp neg	100p
78M series ½Amp pos	90p
78LCP 100mA	35p
78MGT2C variable	175p
79MGT2C variable	175p
723CN variable IC	65p
NE550	73p
L200 variable V and I	195p

MAINS EMI FILTERS
(BS etc approved types)

1 Amp in IEC chassis connector	4.83
6 Amp in IEC	5.83
5 Amp wirein	3.87

(Toroid cores in Cat no. 2)

MISC. Counter/timer, scalar devices............

NE555 30p NE556 78p NE558 180p
LM3909 72p

95H90DC divide by 10/11 to 320MHz	780p
11C90DC divide by 10/11 to 650MHz	1400p
8629 divide by 100 to 175MHz min	420p
MSL2318 divide by 10/100 to 175MHz min	420p
ICM7216BIPI : 8 decade 10MHz DFM counter and full function timer, with direct drive for an LED display (mpx). Uses 10MHz xtal	1982p
ICM7217AIBI ; 4 decade programmable counter with direct LED drive	950p
ICM7207 clock pulse generator	495p
ICM7208 : 7 decade counter display	1495p
ICM7106CP : LCD DVM (3½ digit)	955p
ICM7106CPK : evaluation kit for 7106	24.80
ICM7107CP : LED DVM (3½ digit)	955p
ICM7107CPK : LED DVM kit for 7107	20.65
OKI MSM5523/4 : LED/Fluorescent display driver IC for time/timer/stopwatch/ AM/FM received frequency display and direct counter (use MSL2318 prescalar) inc Crystal	1400p
MSM5525 : AM/FM frequency only couner, for fluorescent displays (6LT06) inc xtal	1100p
MSM5526 : as MSM5525 but for LCD	1100p
4 digit LCD for ICM7106 or MSM5526	1100p
10 LED (2½x5mm) bar graph driver PCB for LOG or LIN (specify). Kit ex leds	300p

IMPORTANT: ALL PRICES SHOWN EXCLUDE VAT - WHICH MUST BE ADDED AT 15% OVERALL. PLEASE NOTE THE REDUCED CMOS/LPSN TTL RANGES DUE TO CURRENT SUPPLY SHORTAGE

CD4000

4000	17
4001	17
4002	17
4006	109
4007	18
4008	80
4009	58
4010	58
4011	17
4012	17
4013	55
4014	95
4016	52
4017	80
4018	80
4019	60
4020	93
4021	82
4022	90
4023	17
4024	76
4025	17
4026	180
4027	55
4028	72
4029	100
4030	58
4035	120
4040	83
4042	85
4043	85
4044	80
4046	130
4048	60
4049	55
4050	55
4051	65
4052	65
4053	65
4055	135
4059	563
4060	115
4063	109
4066	53
4068	25
4069	20
4070	20
4071	20
4072	20
4073	20
4075	20
4076	90

4522	149
4528	102
4529	141
4532	125
4538	150
4539	110
4543	174
4549	399
4554	153
4558	117
4560	218
4562	530
4566	159
4568	281
4569	303
4572	25
4584	63
4585	100

LINEARS

CA3130E	84
CA3130T	90
CA3140E	
CA3140T	72
LM301AH	67
LM301AN	30
LM339N	66
LM348N	186
LM3900N	60
709HC	64
709PC	36
710HC	65
710PC	59
723CN	65
741CH	66
741CN	27
747CN	70
748CN	36
NE531N	105

7 SEG DISPLAYS

HP5082 series........		
Red	7650	233p
	7653	233p
Yell	7660	233p
	7663	233p
Grn	7670	233p
	7673	233p
Fairchild FND	500/507	150p

MORE FROM THE GENERAL AMBIT CATALOGUE RANGES:

Varicap tuning diodes for AM/FM/TV :
1-9 v AM tuning (Cr 15:1) from TOKO–

KV1211	double matched	175p	26p vat
KV1210	triple matched	245p	37p vat
KV1215	triple snap-apart	245p	37p vat
MVAM115	single 15v	105p	16p vat
MVAM125	single 25v	105p	16p vat
MVAM2	double 25v	148p	22p vat
BB204/104	double FM	40p	6p vat
BA102	single AFC etc	30p	4p vat
BA121/ITT210	single afc	30p	4p vat
BB105B	single UHF	40p	6p vat
PIN DIODES, BANDSWITCH types			
BA479	PIN attenuator	35p	5p vat
TDA1061	Pi-form atten.	95p	14p vat
BA182	Bandswitch	21p	3p vat

All RF semiconductors stocked in depth. Please ask for quantity pricing details.

MPU controllable digital freq. synthesiser PCB. Preliminary:
Serial data controlled, with the standard swallow count system for maximum speed of operation. Multiple time constant filters, suitable for AM/FM and other communications/generator applications. Not for beginners. Full preliminary data package £1 + SAE, No phone enquiries answered on this system for the time being. Watch this space........
Projected cost of the controller PCB less than £30: comprises the two modulus counter, prog.div., phase detector, multiple TC loop filter/integrators.

TOP GRADE LEDS by AEG: PRICES ARE EXC. VAT (add 15%)

SIZE	Red	Green	Yello	Orang
5mm	14p	16p	15p	20p
3mm	13p	15p	18p	19p
2½x5	17p	20p	20p	24p

Quantity discounts for LEDs:
10 per type - less 10%
100 per type - less 30%
100 mix in 10s - less 25%

FUTABA FLUORESCENT VACUUM DISPLAYS for CLOCKs etc

5LT02	clock display (static drive) with AM/PM flags	£9 + 1.35
5LT03	DFM display for MSM5525 LSI counter	£9.45 + 1.42 vat
6LT06	5 digit DFM display (GI AY58100) mpxed	£9.75 +1.46 vat

TOKO COILS, FILTERS, CHOKES, etc for AM/FM/TV comms– (please add VAT @15%)

TYPE	Size: 5mm	7mm	10mm	
AM IF	55p	33p	30p	Various for ICs, transistor etc.
FM IF	55p	33p	33p	Various for ICs, transistor etc.
SW coils			33p	Two impedance series
OSC coils	55p	33p	33p	For LW/MW/SW
TV vif/sif			35p	

Various coils in the range 20kHz to 300MHz - see TOKO catalogue

CERAMIC and MECHANICAL FILTERS (inc MURATA TYPES)

CFT455B/ CFT455C 60p; CFX014 180p; CFU455C - 85p
CFT470C - 60p; CFU470C - 65p
MURATA CFU455H and CFU455F cermic block filters 1.95ea
MURATA CFM455 series ladder filters. D,E,F,G,H bandwidths available now (20,16,12,8,6 kHz) £8.35 ea (metal encapsulated)
SFD455B, SFD470B, SFD472B 85p ea
CFM2 series mechanical elements types A,B,C,D (4-10kHz bandwidth) - 65p ea. (As used in RCME feature)

MULTIPLEX/PILOT TONE FILTERS, FM IF FILTERS (see cat and)

CFSE10.7/SFE10.7 - stereo FM IF ceramic filters (sim FM4 etc)	50p
CFSB10.7/SFE10.7MJ - mono bandwidth ceramic FM IF filters	50p
SFE10.7ML - ultra linear phase stereo ceramic IF filters	70p
CDA10.7 - 10.7MHz ceramic discriminator (for CA3089 etc)	70p

Current news: A PCB for the Mullard DC tone and volume control system is now available £3 + 0.45 VAT. HMOS PA modules for 60-100W - kit £14 +£2.10VAT, heatsink £4.10+0.61. FM radio control system crystals £3.75 pair inc VAT (Sept on). MK50366N: static drive clock/timer IC £3.78 + 0.57 VAT. 12½kHz channel spacing 8 pole 10.7MHz XTAL filter by TOYO type H4402 £15.50 + £2.32VAT. A further updated pricelist is now available, and we would like to remind you that enquiries can only be answered if accompanied either by an official business letterhead, or an SAE. STOP PRESS: TOKO's new split-apart triple AM tuning diodes are in stock £2.45 + 37p VAT, (KV1215). S BL1 diode DBM 1-500MHz - £4.25+0.64p.

Terms: CWO please. Account facilities for commercial customers OA. Postage 25p per order. Minimum credit invoice for account customers £10.00. Please follow instructions on VAT, which is usually shown as a separate amount. Overseas customers welcome - please allow for postage etc according to desired shipping method. Access facilities for credit purchases.

Catalogues: Ambit. Part 1 45p. Part 2 50p 90p pair. TOKO Euro shortform 20p. Micrometals toroid cores 40p. All inc PP etc. Full data service described in pricelist supplements.

Hours/phone: We are open from 9am -7pm for phone calls. Callers from 10am to 7pm. Administrative enquiries 9am to 4.30pm please (not Saturdays). Saturday service 10am to 6pm.

AMBIT catalogues are guaranteed to contain the most up-to-date and best informed comment on modern developments and advances in the field of radio and audio. There is no competetive publication that even approaches the broad range of parts/information on modern techniques.

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Hobby Electronics

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PROJECTS

FEATURES

NEWS AND INFORMATION

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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.

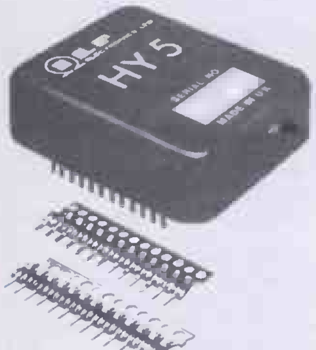
With I.L.P. performance standards and quality already so well established, any advances in I.L.P. design are bound to be of outstanding importance – and this is exactly what we have achieved in our new generation of modular units. I.L.P. professional design principles remain – the completely adequate 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.

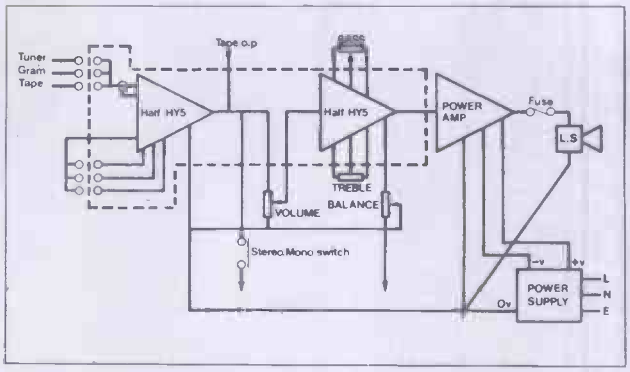
PRODUCTS OF THE WORLD'S FOREMOST SPECIALISTS IN ELECTRONIC MODULAR DESIGN

and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER

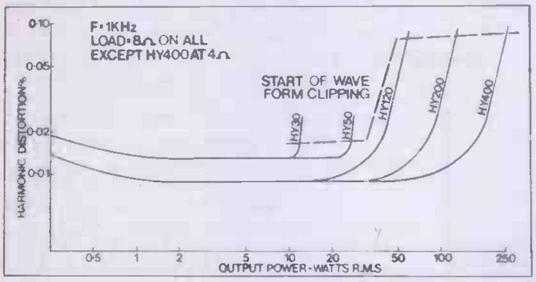


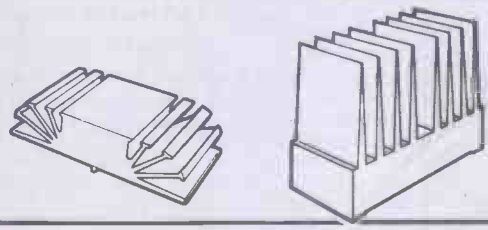


The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/ Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion 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

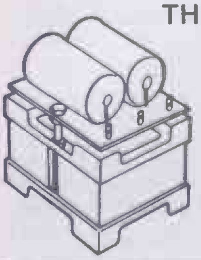
THE POWER AMPLIFIERS





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 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0- +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	**£15.20** + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114x50x85	575	**£18.44** + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	**£27.68** + £4.15

Load impedance — all models 4 - 16 Ω
Input sensitivity — all models 500 mV
Input impedance — all models 1·00 K
Frequency response — all models 10Hz - 45KHz - 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 using toroidal transformer to halve weight and height.

PSU 36	for 1 or 2 HY30's	£8.10 + £1.22 VAT
PSU 50	for 1 or 2 HY50's	£8.10 + £1.27 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
PSU180	with toroidal transformer for 1 HY400 or 2 x HY200	£23.02 + £3.45 VAT
PSU 30	± 15V at 100mV to drive up to five HY5 pre-amps	£4.50 + 68p VAT

NO QUIBBLE 5 YEAR GUARANTEE
7-DAY DESPATCH ON ALL ORDERS
BUILT-IN PROTECTIVE CIRCUITRY
BRITISH DESIGN AND MANUFACTURE
FREEPOST SERVICE — see below

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GENERATION GAME

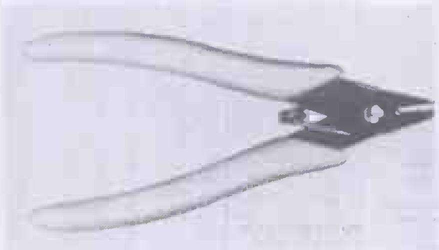
How long would you say TV games had been around, eight years, maybe ten? Wrong, domestic TV games have only been with us for three years the 'pub TV 'tennis' game for perhaps a couple of years longer. In those five or so years things have moved pretty fast, already we are being warned of the imminent invasion of the *fourth* generation of TV games. (The first were the 'pub game, the second was the 'dedicated' domestic game that could be hooked up to the home telly, then came the 'programmables', offering an almost limitless supply of games). Now we have the 'computer' games, these offer a degree of user access to the on-board microprocessor, ultimately enabling the budding gamesters to 'write' their own games.

Being an incredibly influential magazine we have managed to get our hands on one of the first examples of the new games in the country. This was the offering from Phillips and came courtesy of our friend Ian Jones at Videotime (Wise man that Mr Jones, we would have skinned him alive if he'd given it to anyone else).

The games we had for review,were to be fair, not the best we had seen though. We were definitely spoiled by the excellent Atari so perhaps we shouldn't be too harsh. We did have a lot of fun with it. The computer facility is the interesting part, a full-touch-operated, alpha-numeric keyboard is used to enter the various programmes. It surprised us by employing the Hexadecimal code, somewhat slow and difficult for the absolute beginner to use, perhaps BASIC is on the way. The computer was rather limited in that it could only work on 99 programme steps but the excellent colour graphics and TV sound more than made up for that. If it had come from anyone other than Philips we might have been more impressed but we felt that for Phillips first excursion into the tele-games market it could have been a whole lot more exciting. To become the proud owner of one of these machines first equip yourself with £149.95 plus £13.95 for the cartridges and get yourself along to Videotime at: 56 Queens Road, Basingstoke, Hampshire. Now how about that new Matell game Mr Jones?

CUTTING CORNERS

Perhaps, if you've never experienced the delight of using a new pair of side-cutters you'll wonder what we're on about. There really is nothing like it, the almost sensuous way a sharp pair of side-cutters slips effortlessly through wires, fingernails, bolts, in fact almost anything to hand, for a couple of days anyway, until the novelty wears off or they become blunt. So now, enough of all that, its time to tell you all about the new Microshear 11 from the USA, lovely tools these, they are very thin so they'll get into those awkward corners that seem to frequent electronic projects. Anyone familiar with the original Microshears will testify to their usefulness. If you think these are for you why not have a word with the Welwyn Tool Co Ltd, who are the sole UK importers at: Stonehills House, Welwyn Garden City, Herts.



ALIEN

The gentleman (we think) in the centre of our picture with the hole in his chest is featured in a new film that you may have heard of from 20th Century Fox, called ALIEN. The call of duty and a couple of free tickets prompted us to go along to the press showing of this intriguing new film. Firstly we must say this film is definitely not for the squeamish. It's difficult to review a film when half the time you've got you're eyes tightly shut but suffice it to say it really is a great film.

Without revealing too much of the plot it involved the 'accidental' invasion of a large space freighter by a somewhat unpleasant alien character who takes it upon 'himself' (again that's just supposition) to 'do away' with the members of the crew, all very gory and very exciting. Don't miss it. By the way, the creature in the picture is not the alien, he's just had a visit, as shown by the hole in his chest.

News from the Electronics World

WOODEN METAL DETECTOR

Believe it or not, someone has actually gone to the trouble of developing a metal detector for use on wood, sounds daft, doesn't it? Well, things aren't always what they seem, sawmill operators can lose thousands of pounds if a log or trunk containing some stray metal (nails etc) should come into contact with one of their very expensive saw-blades.

This new all British (and about time too) instrument comes from a company called Protovale Research Ltd. It's called the 'Totalscan' and it employs the pulse induction technique to locate very small metal (ferrous or non-ferrous) objects deep inside most non-metallic materials. The unit has only two controls incorporating a 'self-tuning' feature and is powered by re-chargeable Ni-Cad batteries. Signal strength indicated on an built-in meter and loudspeaker. If you're in the market for such a device, why not give Protovale a call at: Unit S11 SE, Rectory Lane Industrial Estate, Kingston Bagpuize, Abingdon, Oxfordshire.

DISCO SYNDRUM

If you have ever wondered how "That Sound" which you hear on a lot of recent disco records is produced, (You know that peuoom-peuoom noise — well, how would you spell it?) featured on "Ain't No Stopping Us Now", "You Can Ring My Bell" and many others). Hobby gives you the answer. The instrument is called SYNARE 3 (Drum Synth) and is marketed by STAR INSTRUMENTS INC.

Although seemingly complicated to operate at first, (having some 11 controls), a few minutes practice with it should find you proficient enough to repeat any required sound within seconds.

With it's futuristic saucer shape and a wide range of control knobs, other effects can be obtained by controlling oscillators, filters and envelope shapers, the various sounds can then be built up as desired i.e. from thunder to falling rain — to put it mildly.

Insertion of a standard ¼in Jack Plug automatically turns it on so don't leave yer plugs in or yet batteries will be flat. (What shape should they be?). For anyone with the required £370.00, (and that does include a stand) they may be obtained from: Boosey & Hawkes (St. Giles Music Centre), 16/18 St Giles High St, London WC2 8LN. Our thanks to Steve Bruce for lending us a set for review.

TRITIUM TIME

Commodore, one of the more reputable (though somewhat conservative) manufacturers of electronic timepieces are proud to announce a new range of competitively priced LCD watches. (Does anyone still make LED watches?) At the lower end of the range is the 5633 Chrono model, all the standard timekeeping functions plus a chrono, measuring down to one-Hundredth of a second. Retail price is expected to be as low as £13.00 or less.

At the top of the range is an interesting looking Alarm/Chrono featuring a Tritium display, a clever variation on the LCD theme involving a very small (and safe) piece of radioactive material illuminating the 'screen' at night, effectively doing away with the cumbersome backlight. Price again is refreshingly low at around £25.00.

The third, and intermediate model is the excitingly titled 153A, this boasts a cunning feature called a 'Snooze Alarm', this will bleep at the appointed hour and if it is ignored, will give a repeat performance some five minutes later, there are two options of this model sporting either four or six digit displays, prices are expected to be around £11 for the four digit version and £15 for the six digit model. The three new additions to the range can be seen on the left of the pic, from left to right, 5673 (Tritium display), 153A and 5633. If you have any difficulty in obtaining a particular model. Commodore now live at: 818 Leigh Road, Slough Trading Estate, Slough, Berks.

BOOK REVIEWS

We have had quite a few books come in for review over the past few weeks, so we thought it was about time we did something about it.

Our first offering is titled: Electricity, Principles and Applications. (ISBN 07-055572-9 McGraw-Hill, Price £8.40 Author Richard J. Fowler). It is a very large book by current standards, hard bound and very well presented. It covers all the basics of Electrical theory and progresses into simple electronic principles. The Appendix and Glossary at the back is a superb source for reference and is almost worth buying for that alone. A superb book, well worth adding to your workshop shelves.

Number two this month is called: The Challenge of Microprocessors. (Michael G Hartley and Anne Bickley. Published by Manchester University Press. ISBN 07-190-0757-7. Price £7.95). We thought it was not so much a technical book, rather a look at the way 'micros' will affect our lives in the years to come, definitely one for the sociologists, a bit too heavy for us.

Our old friend Ian Sinclair is responsible for book number three. Electrical & Electronic Principles (ISBN 408-00433). Newsnes-Butterworth. Price £3.25) Something of a change of style for Mr Sinclair, he is adopting the American presentation which we must confess is quite attractive. The book is aimed at students on TEC course (unit 76/359) but it could equally apply to City and Guild courses as well. A very worthwhile text book for any student interested in electrical/electronic theory.

Lastly, by coincidence we have another TEC course book, called Electronics for Technicians Level 2, this time covering Electronics II U76/010. (ISBN 0-340-23441-5 Hodder & Stoughton. Authors B. Gillman & B. Hudgell. Price £2.95).

The book delves a little deeper into the world of electronic theory covering such diverse subjects also as, oscillators, logic and power supplies. Semiconductor theory and transistors are also covered in considerable depth. A must for TEC students on this particular course.

ERRATA

We must be getting better only a couple of little ones this month. The Hobbytune first, we omitted to show the connections for the supply connections, these can be taken to the connections on the capacitor C1. The second problem was with the Multi Option Siren, on the overlay diagram Fig. 3. the connection for SK1 was mixed up with the connection SW1, in fact the wire coming from the junction of R12, R13 should be marked SK1 *not* SW1.

Lastly we have the problem of the missing Short Circuit. The particular example we gave on page 36 was a case of right text, wrong diagram (or vice-versa, depending how you look at it) anyway this month we've re-published both Short Circuits, this time the right way round (we hope).

COMPETITOR

Sorry about the delay in publishing the results of the 'scope competition, we've only just received the prizes from the manufacturers. Full story next month.

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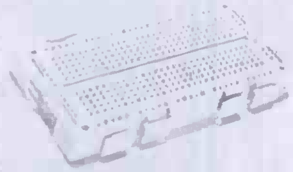

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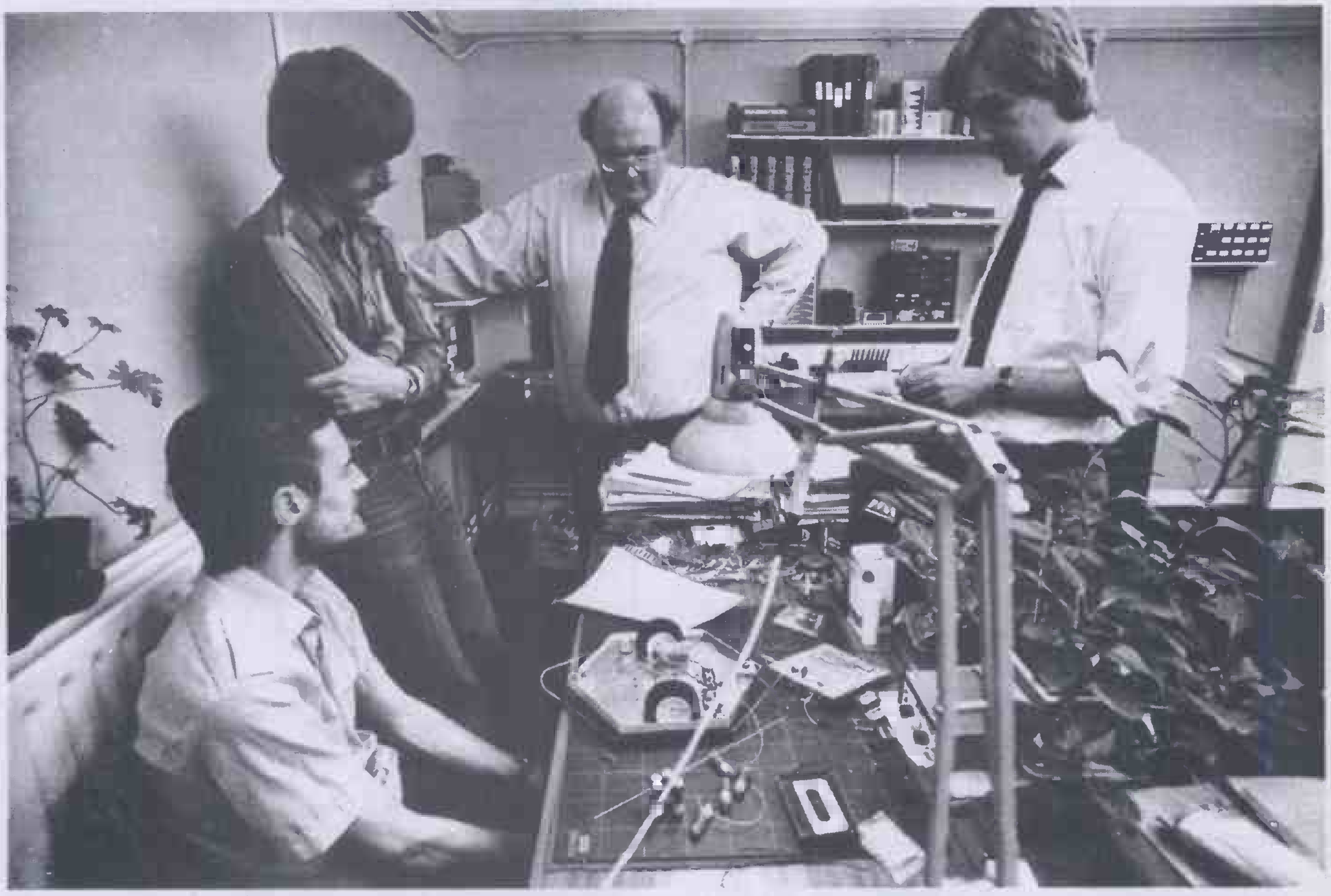


Discussing **HEBOT** *in our workshop. John FitzGerald (seated) designed and built it, with Henry Budgett (Computing Today), Halvor Moorshead (HE's Editor) and Steve Braidwood (Assistant Publisher). In case you've any doubts, the* **HEBOT** *is the one on the table.*

OF COURSE, the pressing question is, 'will **HEBOTs** ever replace the family cat?'. Well. We are happy to be able to tell all the feline fanciers out there that the days of the family moggy are not numbered yet. Nonetheless, **HEBOT** represents the most sophisticated and versatile robot project to be offered to the hobbyist to date throughout Europe. (The Americans have a small robot but it requires an umbilical link to a controller. The Japanese probably did it smaller and cheaper five years ago.)

Hobby Electronics has co-operated with Remcon Ltd, one of the country's leading manufacturers of radio control equipment, to produce a 'classy chassis' we feel sure will become a 'standard' for many years to come.

The cornerstone of the design is a hexagonal aluminium chassis pan which carries the micro-drive units, batteries, sensors and PCBs on which are mounted the electronic components. We tried a number of different collision sensors and discovered, as Edison used to put it, an awful lot of ways NOT to do it. Our prototype features microswitches whose lever arms have been extended with pre-formed lengths of piano wire. However, the production kits from Remcon will probably feature sensors mounted integrally with the chassis pan. Another point worthy of note is our use of a perspex cover for the prototype. The production kit will feature a pre-formed three piece aluminium cover as the perspex version costs more than all the other components put together.

The microdrive units feature a fully enclosed gearbox and five pole motor with the drive wheel mounted on a steel shaft integral with the gearbox. Typical motor drive current is around 150mA giving between one and two hour's life from 450mAH capacity nicad cells (AA size). The chassis can turn on its own axis and will carry a payload of up to five pounds weight. Previously published robot designs in other magazines have been let down by poor mechanical design or the use of difficult to obtain or reproduce electronic components. The precision engineered design from Remcon which has resulted from our consultation with them removes one of the main pitfalls of any project of this type.

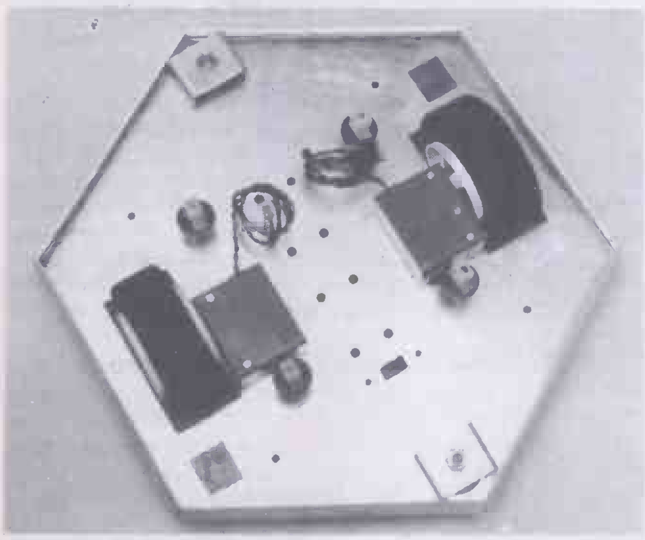
SUPERLATIVE

If HEBOT's chassis is good (which it certainly is), then words cannot do justice to the electronic design. Though composed of largely conventional circuit elements, the circuit represents a breakthrough in systematic design facilitating development and operation.

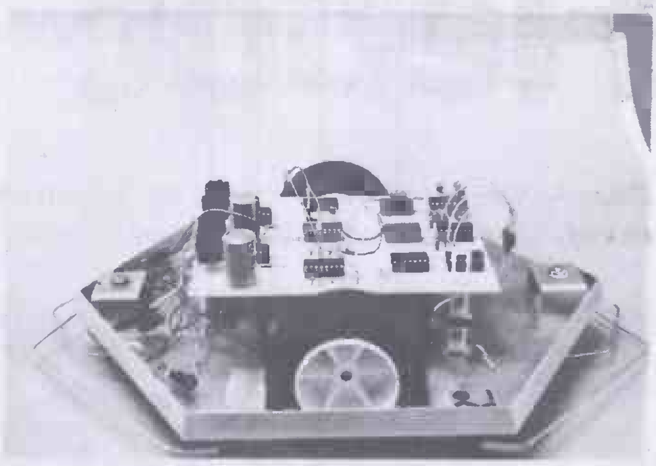
The novel feature of this system is the separation of executive and control signals. In a maximal system, up to eight pairs of motor control signals may be present simultaneously with **HEBOT** 'choosing' between them according to the state of 'priority' input sense lines. A possible arrangement might be.

7	↑
6	
	external control
5	
4	↓
3	**'avoid' manoeuvres**
2	**tracking**
1	**searching**
0	**random walk**

Level seven has highest priority and zero lowest priority. Assuming **HEBOT** was not under external control and was neither tracking nor searching then a random walk would be executed. Following any collision, priority sense input three would become active and **HEBOT** would manoeuvre himself out of trouble before returning control to level zero; random walk. Of course, there is nothing special about the control signals chosen



Our prototype chassis showing micro-drive units.



We mounted the PCB above the micro-drive units. The batteries are sited underneath.

and any group of signals could be assigned priorities and connected to the appropriate inputs. Control levels may vary between +5V (Full forward) and −5 V (full reverse) with intermediate voltages giving variable speed and zero volts halting the machine. As described here, **HEBOT** executes all manoeuvres at full speed.

We are presenting **HEBOT** in three parts. This article deals with simple forward motion and manoeuvres following collisions. Part two will describe how to make **HEBOT** sensitive to specific sources which it will approach or flee from. In part three **HEBOT** will be internally sensitised to monitor the state of charge of his battery supply and when necessary find and use the recharging station.

HEBOT is an open-ended project whose scope is limited only by your resources of imagination, skill, time and (inevitably) money. Accordingly, the schedule may be changed to accommodate design developments and should in any case be used only as a springboard for your own ideas.

CONSTRUCTION

The chassis, aluminium cover and mechanical components are available from Remcon. The electronic components are mounted on one PCB which is supported from the chassis pan by plastic 'clik-fit' pillars.

There are a large number of wire links on the PCB which MUST be soldered into place first as many of them pass beneath components. Integrated circuit sockets are recommended for the IC's and normal CMOS precautions should be observed to avoid destruction of the chips by static charges. Flying leads are used to interconnect some of the IC's and should be soldered into place after the other components have been mounted but before inserting the chips. It is impossible to give precise constructional details for this project which ideally will be developed by the constructor. However, you should find our photos helpful.

If, initially, only four inputs are required then IC5 may be omitted. Uncommited inputs of IC3 should be tied low (to the −5 V rail) and not left floating. We used heat sinks on the motor driver transistors though they hardly get warm at all.

HEBOT opens the door to home robotics. The constructors of today are the engineers of tomorrow. There is not a moment to lose.

How it Works

Circuit operation may be most easily understood by considering the operation of three units separately; the motor servo amp, signal multiplexer and manoeuvre logic. Power for all three is derived from two five volt batteries. If the voltage seems strange, it is because each battery is made from four nickel-cadmium (nicad) cells each having a nominal voltage of 1.25 volts. You do not have to use nicads, ordinary HP7 dry cells will power the circuit quite happily though battery life will be restricted to a couple of hours' operation or less.

The integrated circuits are powered from plus and minus five volts giving an effective voltage of ten volts. The junction of the batteries (0V) is used only as a bias point for the non-inverting inputs of IC1 and IC2 and as a return for the motors.

The servo amplifiers formed around IC1 and IC2 could hardly be simpler. Each op-amp functions in a standard inverting amplifier configuration with a gain of one (ie the output voltage equals the input voltage but is of opposite polarity). Transistors Q4, 5 and Q6, 7 function as complementary emitter followers and supply the motor drive current; about 150mA. IC1 and IC2 deserve a special mention. These chips are BIMOS op-amps and feature CMOS output stages enabling the output to swing very close to the supply rails, very important in this application. Ordinary 741 op-amps could be used but would have a very limited and unequal output voltage swing giving low motor drive and loss of torque. The 3130 is a high speed uncompensated device and capacitors C1, 2 are essential to prevent high frequency oscillation which would cause excessive dissipation in the semiconductors and could result in overheating in the motors. Using the circuit shown and our PCB no problems should be experienced.

Control voltages are applied to the servo amps via input resistors R1 and R2. If you follow the connections from these resistors, you will see that they disappear mysteriously into IC4 and IC5. In fact these chips do not alter the control voltages passing through them at all. They are simply multiplexers; an electronic rotary switch used to select control signals. Each chip functions like a four-way two pole switch whose 'position' is determined by the state of three control lines at pins 6, 9, 10. The binary 'address' on pins 9 and 10 selects one pair of four pairs of inputs. The most significant address line from IC3 is used to select either IC4 or IC5 by driving the 'enable' inputs of those chips.

As this signal is inverted by Q1 before being passed on to IC5, only one chip is enabled at any time. The disabled chip behaves as though it were a disconnected switch and exhibits a very high resistance between all inputs and outputs. This arrangement enables any pair of eight possible pairs of control signals to be selected according to the control signals from IC3 and used to drive the servo amps.

IC3 is an eight-input priority encoder. The operation of the chip is quite straightforward. There are eight individual inputs and a single 'enable' input (pin 5) which is tied high to enable the chip. The eight input lines should be held normally low. When any input is asserted high (ie connected to +5V), the group select (GS) output goes high, enable (E) output goes low and the binary address of the selected input appears on pins 9 (lsb), 7, 6 (msb). For example if input '3' (pin 13) is asserted high then 110 will appear on pins 9, 7,

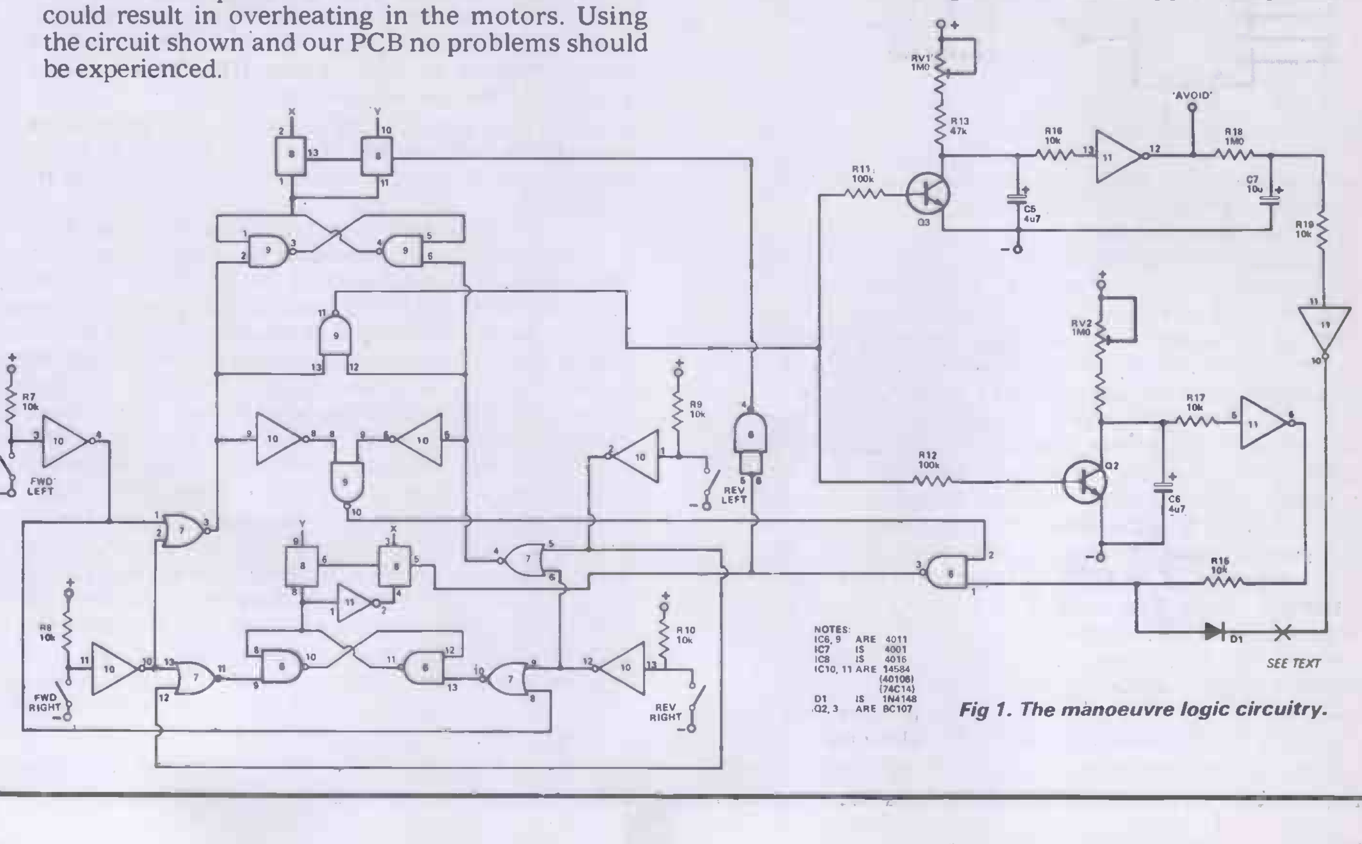


Fig 1. The manoeuvre logic circuitry.

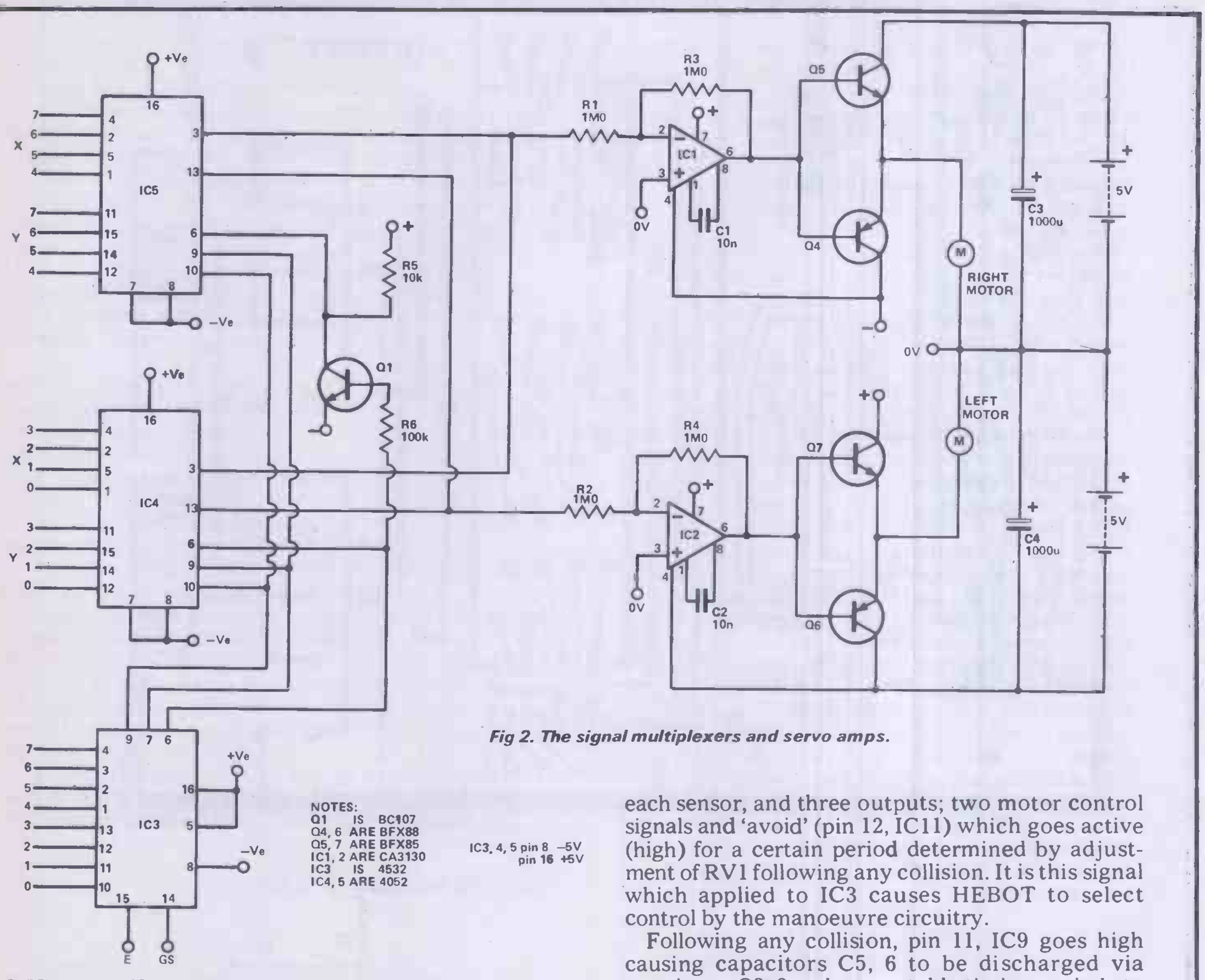


Fig 2. The signal multiplexers and servo amps.

6. However, if — while '3' is still high — '5' is also asserted high then the address output will change to 101 as five has a higher priority than three and the inputs corresponding to that number will be connected to the servo amp by multiplexer IC5. In this way, the motors are controlled by signals from one set of inputs until a higher priority line becomes active at IC3 when the address will change and another set of inputs will be selected.

In our prototype, input '2' (pin 12, IC3) is connected to +5V. Motor control inputs 2X and 2Y (pins 2, 15, IC4) are connected to +5V via 560k resistors giving a slow forward speed. Following any collision, a signal from the manoeuvre circuitry asserts input '3' (pin 13, IC3) high and motor control inputs 3X and 3Y are selected. The X and Y outputs (pins 2, 3 and 9, 10, IC8) from the manoeuvre circuitry are connected to inputs 3X and 3Y and these signals are used to steer HEBOT out of trouble. Following the manoeuvre, control is returned to the next lowest priority level which is currently high; in this case level 2 — slow forward.

The manoeuvre logic has four inputs, one for each sensor, and three outputs; two motor control signals and 'avoid' (pin 12, IC11) which goes active (high) for a certain period determined by adjustment of RV1 following any collision. It is this signal which applied to IC3 causes HEBOT to select control by the manoeuvre circuitry.

Following any collision, pin 11, IC9 goes high causing capacitors C5, 6 to be discharged via transistors Q3, 2 and monostable timing periods to be initiated.

The overall manoeuvre time is adjusted by RV1 while RV2 sets the duration of straight motion before a turn is executed. If RV1 is first set then adjustment of RV2 will alter the degree of turn. HEBOT chooses forward or reverse and the direction of turn by examining internal registers which 'remember' which sensor signalled a collision. The registers comprise bistable latches formed by parts of IC6 and 9 which are set or reset by associated gates. If there are 'too many' collisions within a certain period then pin 10, IC11 will go low. This output may be optionally connected to pin 1, IC6 where it will cause HEBOT to execute a turn immediately following a collision without any straight motion. The usefulness of this strategy will depend on the settings of RV1, 2 which may be optimised for different obstacles. The circuitry has been designed to enable a flexible and versatile system to be developed and there may be many changes which can be made to adapt HEBOT's behaviour to his environment.

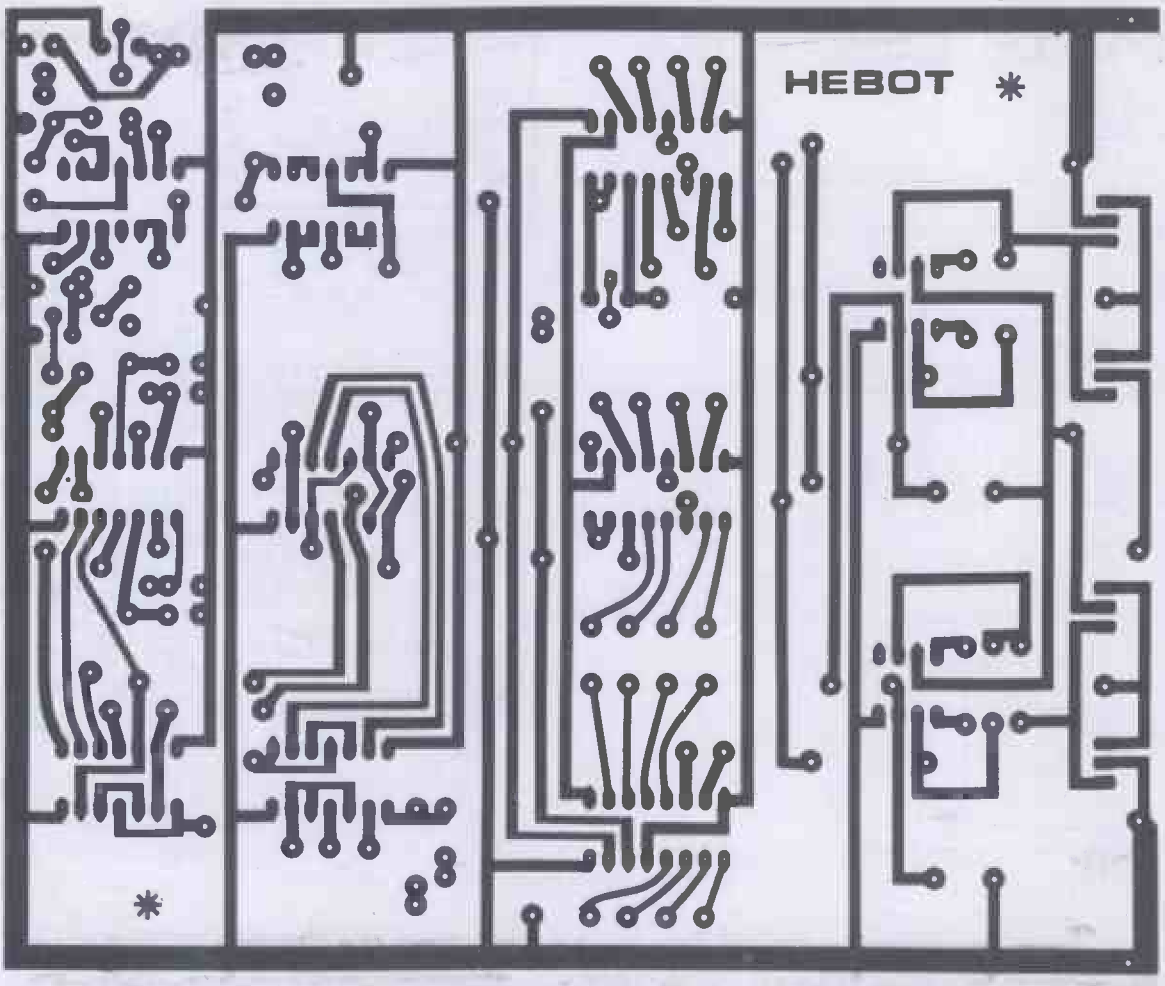


Fig. 3. PCB foil pattern for **HEBOT**

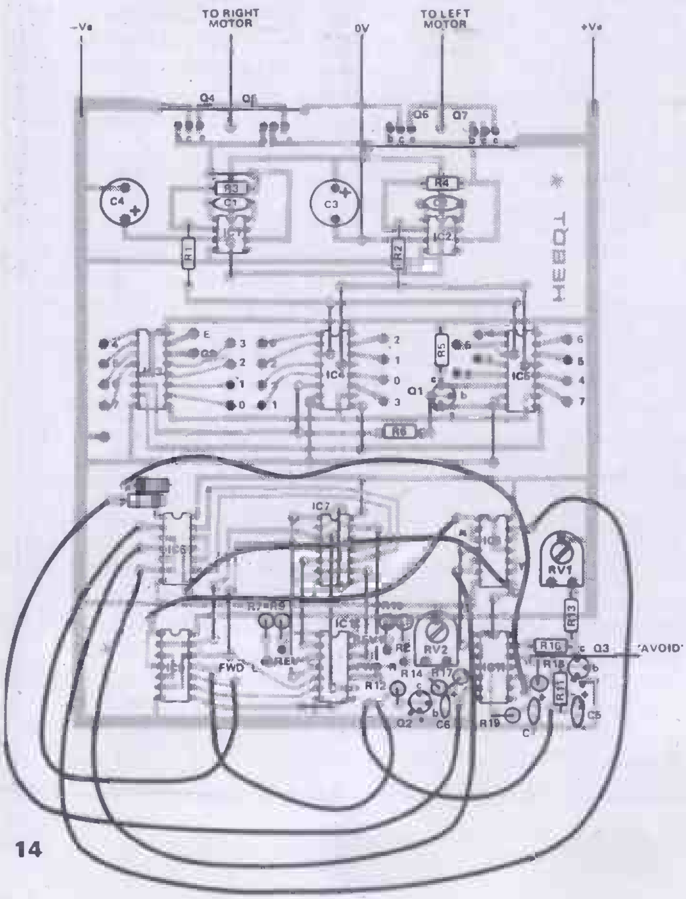
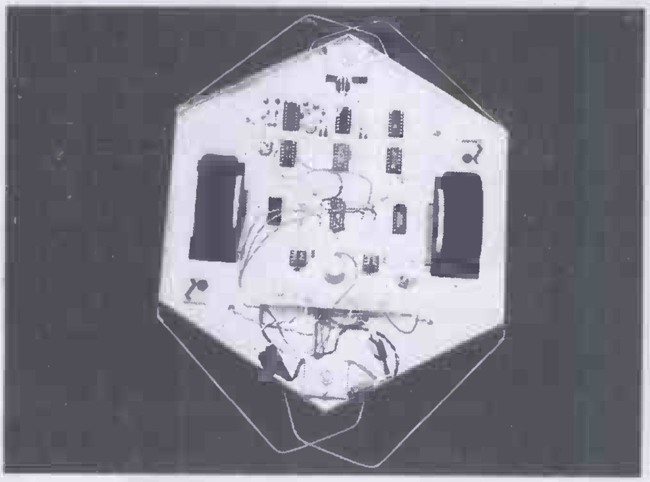


Fig. 4. PCB overlay for **HEBOT**

Our prototype used wire collision sensors.



Parts List

RESISTORS (all ¼W 5%)

R1, 2, 3, 4, 18	1MO
R5, 7, 8, 9, 10	
15, 16, 17, 19	10k
R6, 11, 12	100k
R13, 14	47k

POTENTIOMETERS

RV1, 2	1MO preset

CAPACITORS

C1, 2	10n polyester
C3, 4	1,000µ electrolytic
C5, 6	4µ7 tantalum
C7	10µ tantalum

SEMICONDUCTORS

Q1, 2, 3	BC107
Q4, 6	BFX88
Q5, 7	BFX85
D1	1N4148
IC1, 2	CA3130
IC3	4532
IC4, 5	4052
IC6, 9	4011
IC7	4001
IC8	4016
IC10, 11	14584 (40106, 74C14)

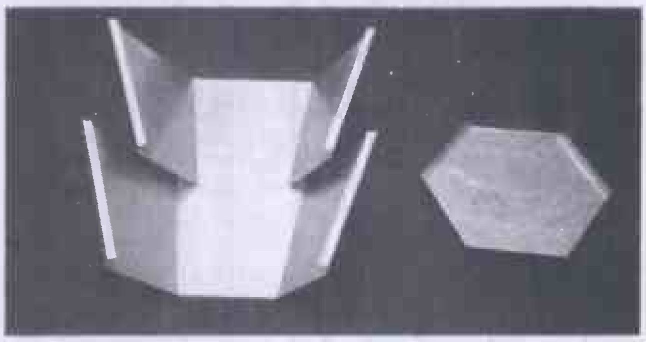
All CMOS 'B' series.

Buylines

The electronic components should be readily available from any of the larger mail order companies.

The chassis and associated mechanical components are available from Remcon.

The castors used on the production version of **HEBOT** *differ slightly from the ones shown on our prototype*



Remcon's three-part aluminium cover which will be supplied with their production kits.

HEBOT *demonstrates its amazing(!) ability to negotiate a labyrinth.*

APPROXIMATE SPECIFICATION

Main chassis pan.	Anodised Aluminium 18g. thick. 10″ across flats with ½″ flanges all round. Ready punched for all electro mechanical hardware. Will carry loads of at least 5lbs evenly distributed.
Cover.	Ready formed in aluminium, to fit over chassis flange, and give internal height of 6″ approx.
Microdrives.	Copolymer moulded gears and gearbox for long life, driven by micromotor 4-6v dc, current consumption 120/150ma each. Anticipated duration from two 500mah batteries 3/4 hrs. Sponge tyre wheels 3″ dia keyed to output shaft by square fit. Will operate on any smooth surface including low pile carpet. Level ground speed 9″/sec. Will climb slopes approaching 1 in 1.

Prices (excluding VAT at 15%)

Complete mechanics kit as detailed below or separately	£35.00 P&P £2.00
Main Chassis and instructions	£6.50 P&P 75p
Microdrive units wheels and couplings, per pair	£19.50 P&P 50p
Ballbearing stabilizers and fixings per pair	£3.00 P&P 50p
PCB standoffs — 12 supplied	£1.00 P&P 25p
Ready formed cover for easy assembly	£7.00 P&P £1.50

To use Robot One for the 'Hebot' design you will also require kit HE101 comprising four fibre-glass switch arms, springs and pivots — price to be announced. PCB (kit HE102) is also available for £4.25 plus P&P 25p.

Available from: Remcon Electronics, 1 Church Road, Bexleyheath, Kent. DA7 4DD.

Hobby Chit~Chat

In this month's 'Chit-Chat,' project editor Ray Marston writes about Robots and simple test gear circuits.

YOU MAY REMEMBER that in the September edition of 'Chit-Chat' I slammed a book called 'Build Your Own Working Robot,' by D. L. Heiserman, as THE most awful electronics book of all time. You many conclude two things from those comments. First, that I didn't like the book, and second, that we at HE are very interested in Robots and robotics. Now, two months later, you can see proof of our interest in Robots in the form of HEBOT.

HEBOT is, without doubt, the best 'build your own Robot' project ever published in either Europe or the USA. In contrast to all previously published Robot projects, HEBOT has been well conceived and planned as a total entity, has excellent electronic circuitry, and most important of all, is based on a superb specially-developed Robot chassis that is being made available commercially in ready-built form at a reasonable price. We at HE are all very proud of HEBOT.

A GOOD ROBOT BOOK

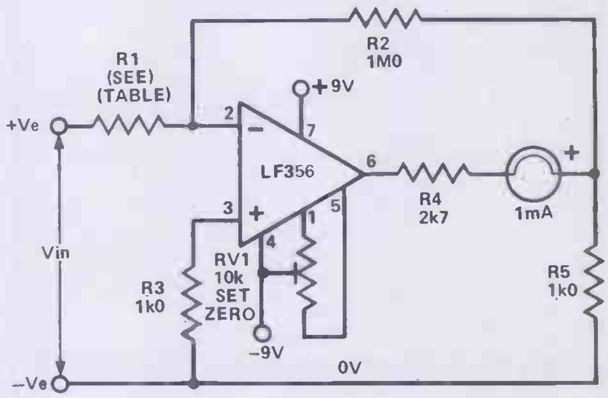
Another 'Robot' book landed on my desk recently. This is a good one. It is called 'How to Build a Computer-Controlled Robot,' by Tod Loofbourrow, and describes a monstrosity (it weighs 200 pounds!) called MIKE.

Unlike HEBOT, MIKE is rather badly conceived, has lousy mechanics, and costs several hundred pounds to build. Never-the-less, MIKE is well worth reading about. He uses an on-board microprocessor unit (a KIM-1) to process sensor and other data and control motor movements. He uses ultra-sonics to detect obstacles, and can (it is claimed) recognise certain spoken words. Unfortunately, the ultra-sonics don't work too well, and the speech-recognition circuitry is decidedly temperamental. In spite of these setbacks, the book presents lots of thought-provoking ideas.

The MIKE book is published by the Hayden Book Company of America, and is being imported into this country by N.I.C., 27 Sidney Road, London N22 4LT. It costs about £6. If you want more details, give N.I.C. a ring on 01-889 9736.

TEST GEAR CIRCUITS

If you want to design or experiment with your own Robot, or home computer, or (for the less adventurous) a one-transistor amplifier, you'll need to acquire various bits of test gear. Trouble is, test gear is expensive. To help you overcome the 'expense' problem, Figures 1 to 6 show a few practical test gear 'measurement' circuits that you can build for very little cost.



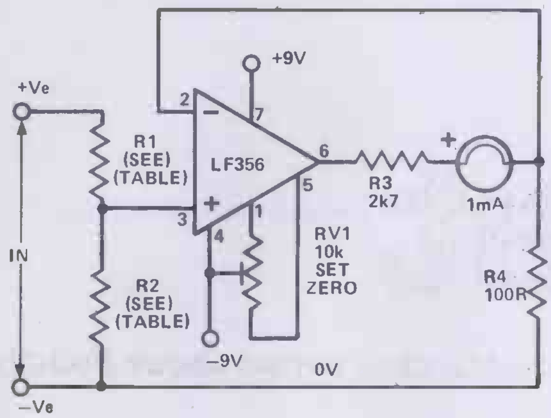
Vfsd	R1
1V	1M0
100mV	100k
10mV	10k
1mV	1k0

Fig. 1. An inexpensive DC Millivoltmeter circuit.

All of these circuits are based on a moving coil meter with a full-scale sensitivity of one milliamp. If you like, you can use any or all of these circuits in conjunction with the 1 mA DC range of an existing multi-meter, in which case you can regard Figs 1 to 6 as multi-meter 'add-on' circuits. All six circuits are designed around the LF356 FET op-amp (operational amplifier), which has a very high input impedance. If you try using a 741 instead of the LF356 you may find that the circuits won't work. Note that all circuits use split-rail supplies, necessitating the use of two 9 volt batteries.

If you want to convert an existing 1 mA meter into a fixed-range DC millivoltmeter, with a full-scale sensitivity of 1 mV, 10 mV, 100 mV, or 1 volt, you can use the circuit of Figure 1. The table shows the appropriate R1 value for different FSD (full-scale deflection) sensitivities. To set the circuit up initially, short it's input terminals together and adjust RV1 to obtain zero deflection on the meter. The circuit is then ready for use.

The Figure 2 circuit can be used to make a fixed-range DC voltmeter with any full-scale sensitivity in the range 100 mV to 1000 volts, or a fixed-range DC current meter with any full-scale sensitivity in the range 1 uA to 1 amp. The table shows alternative R1 and R2 values for



VOLTMETER

Fsd	R1	R2
1000V	10M	1k0
100V	10M	10k
10V	10M	100k
1V	900k	100k
100mV	–	100k
CURRENT METER		
1A	–	0R1
100mA	–	1R0
10mA	–	10R
1mA	–	100R
100uA	–	1k0
10uA	–	10k
1uA	–	100k

Fig. 2. A simple DC Voltage or Current meter.

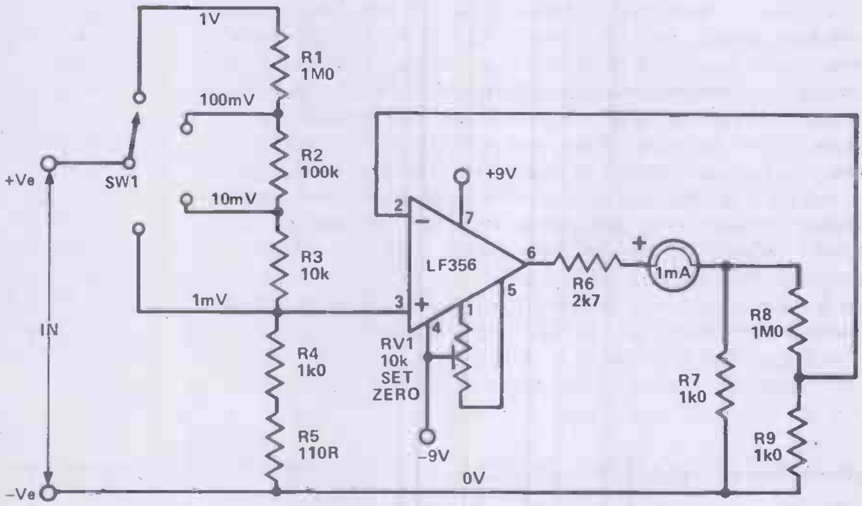


Fig. 3. A precision DC Millivoltmeter.

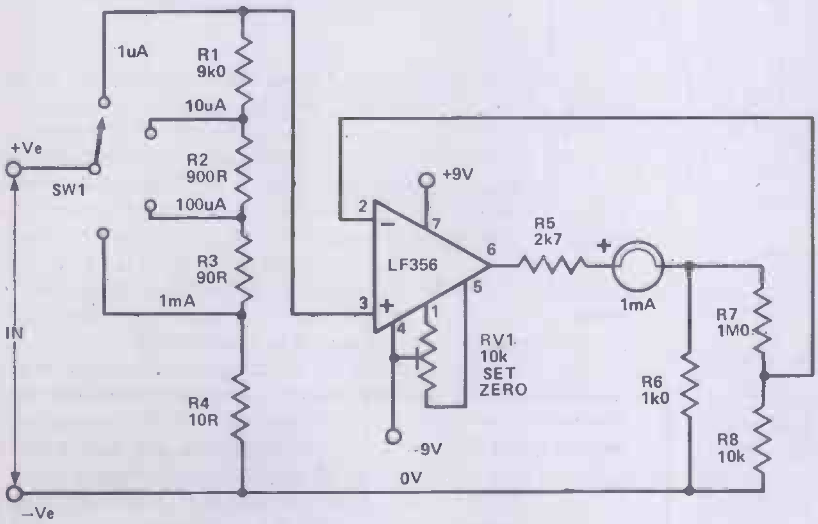
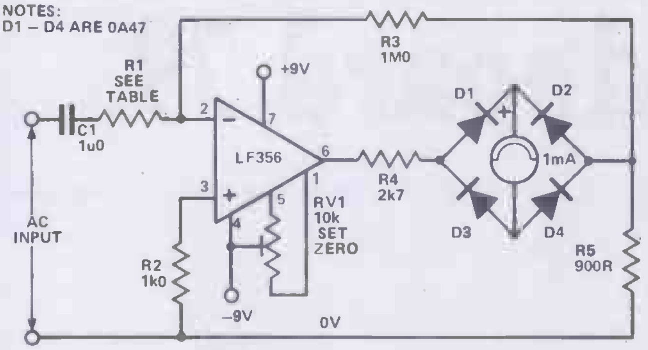


Fig. 4. A precision DC Microammeter.

different ranges. If you want to use the circuit on the 1000 volt range, make the 10M R1 value up from ten 1M0 resistors in series, so that the resistor break-down voltage ratings won't be exceeded.

Figure 3 shows how to make a 4-range DC millivoltmeter, and Fig 4 shows how to make a 4-range DC microammeter. The accuracies of these and all other circuits shown here are determined by the accuracies of the resistors that are used in the circuits. 5% components are adequate for most purposes.



Vfsd	R1 VALUE
1V	1M0
100mV	100k
10mV	10k
1mV	1k0

Fig. 5. Precision AC Millivoltmeter.

Figure 5 shows the circuit of a simple but very useful fixed-range AC millivoltmeter. The input impedance of the circuit is equal to R1, and varies from 1kO in the 1 mV FSD mode to 1MO in the 1 volt FSD mode. The circuit gives a useful performance at frequencies up to about 100 kHz when it is used in the 1 mV to 100 mV FSD modes. In the 1 volt FSD mode the frequency response extends up to a few tens of kHz. This good frequency response is ensured by the LF356 op-amp, which has a far better bandwidth than most less-expensive op-amps.

Finally, Figure 6 shows the circuit of a 5-range linear-scale ohmmeter, which has full-scale sensitivities ranging from 1kO to 10M. The accuracy of the circuit is determined by resistors R5 to R9. To initially set up and calibrate this circuit, set SW1 to the '10k' position, and short the 'Rx' terminals together. Then adjust the RV1 'set zero' control to obtain zero deflection on the meter. Next, remove the short, connect an accurate 10k resistor in the 'Rx' position, and adjust RV2 to obtain precisely full-scale deflection on the meter. The circuit is then ready for use. Once the circuit has been initially calibrated, RV1 and RV2 should require no further adjustment for several months.

The LF356 is available from Watford or Stevenson — see ads in this issue. **HE**

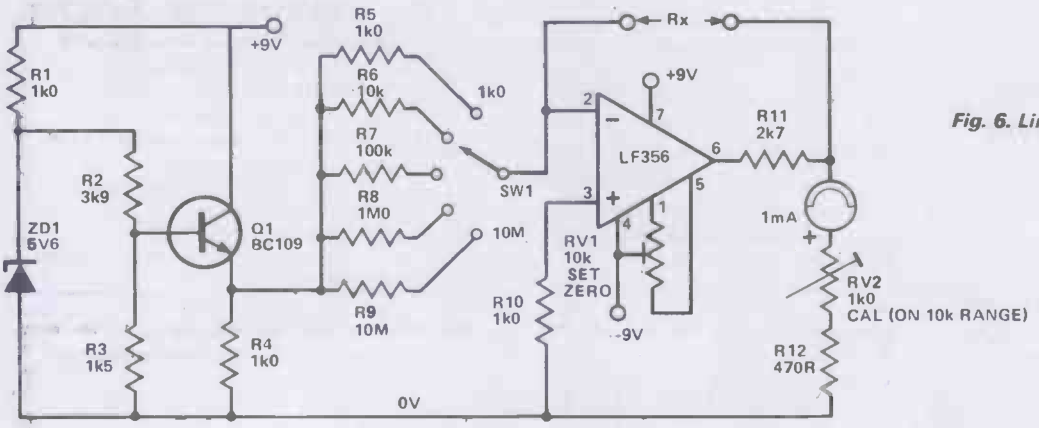
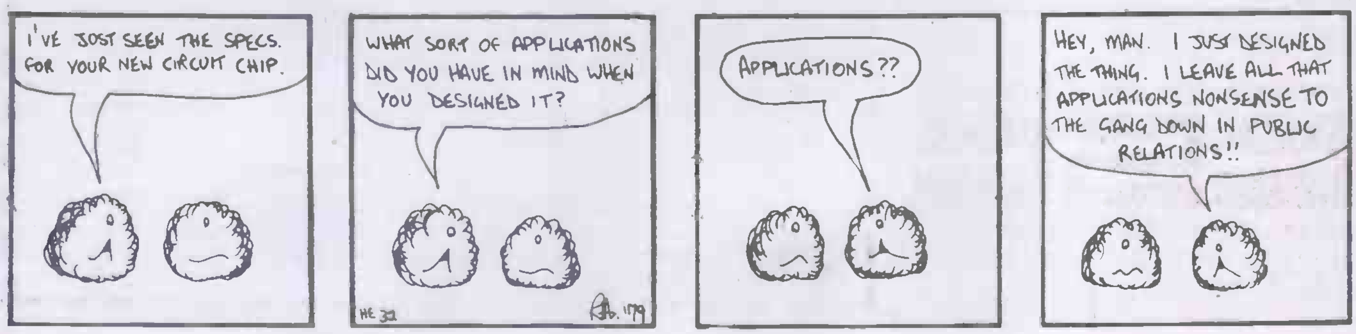


Fig. 6. Linear-Scale Ohmmeter.



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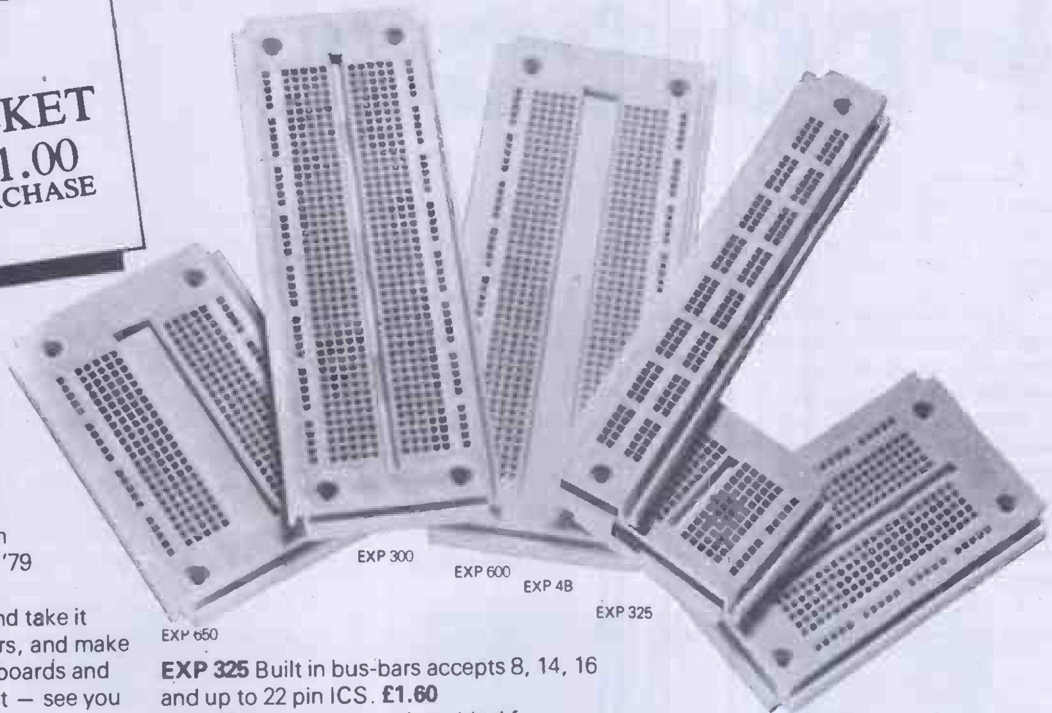

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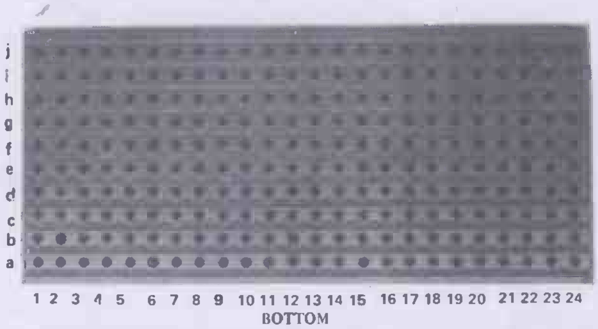
Miniboard Projects

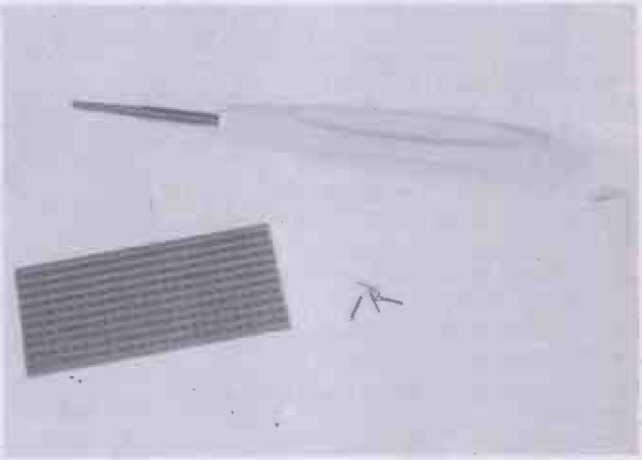
SOME TIME AGO, you may remember we said that we were considering using Vero Board in some of our projects. We tried several different methods of presentation but none seemed to work, so this month by way of an experiment we are publishing six highly original and easy-to-build projects based on a standard sized piece of Vero Board. (We did mention last month there were to be ten but space was at a premium this month.

The actual method of designating the hole co-ordinates prooved to be something of a headache for our drawing office, so in the coming months we will be attempting further Miniboard projects but using photographic techniques to indicate the track cuts and solder joints on the copper strips. This month only we will use a combination of both drawing and photograph to illustrate these projects.

So, what are you waiting for? Arm yourself with a Vero cutter, some Vero Board and get building.



The system we've adopted for numbering the holes on the board. In the coming months we will be using this photographic system for location rather than by simple diagram.



Tools of the trade. The Vero Cutter is not essential, a good sharp drill of about ¼" (or more) in diameter will suffice. We strongly recommend the use of Vero Pins when making connections to the stripboard as the adhesive used to bond the copper strip to the board does not take too kindly to repeated soldering, it also results in less physical strain on the board itself.

OPTO-THERMO SWITCH

A versatile relay-output switch that can be activated by light, dark, heat or cold.

THIS SIMPLE BUT HIGHLY VERSATILE LITTLE UNIT has a relay output that can be activated by either optical (light) or thermal (temperature) levels. The unit can be made to activate either when these levels go above or fall below pre-set values, depending on the manner in which the input sensors (an LDR or.light-dependent resistor for photo operation, or a thermistor for theirmal operation) are connected to the unit. The unit can thus function as either a 'brightness' switch, a 'darkness' switch, an over-temperature switch, or an under-temperature switch.

The unit has a multitude of practical uses. In the opto mode it can be used to automatically turn on lights when darkness falls, or to activate an alarm if a light is shone into a normally-dark area such as a cupboard or safe. In the thermo mode it can be used to turn on heating when the temperature falls below a pre-set value, or to activate a cooling system or sound an alarm when the temperature rises above a pre-set value.

CONSTRUCTION AND USE

The unit uses very few components, and can be built in about half an hour. Full constructional details are shown in Figure 3. Take care to connect D1, Q1, and IC1 in the polarity shown.

Figure 2 shows how to connect the input sensor (either an LDR or a thermistor (and RV1 to the 'x-x' and 'y-y' inputs of the unit to obtain the desired type of operation. For opto operation, the LDR must present a resistance in the range 900R to 9kO at the desired trigger level: an ORP12 is suitable for use in most cases. For thermo operation, the thermistor must be a negative-temperature coefficient (NTC) type that presents a reistance on the range 900R to 9kO at the desired trigger level: a VA1066S is suitable for use in most cases. The relay can be any 12 volt type with a coil resistance greater than 120R.

The unit must be powered from a 12 volt supply. In use RV1 is simply adjusted so that the relay just activates at the desired light or temperature level. External circuits can be controlled via the relay contacts. **HE**

How it Works

IC1 is a type 741 operational amplifier that is wired as a voltage comparator. A fixed 'half supply' reference voltage is fed to input pin 3 of the op-amp via R1 and R2, and a variable voltage is fed to input pin 2 via RV1 and the LDR or thermistor. The circuit action is such that the op-amp output is normally low and Q1 and the relay are off, but the output abruptly switches high and drives Q1 and the relay on when the pin 2 voltage falls below the pin 3 voltage. R3 introduces a small amount of hysteresis so that the circuit switches sharply and switches at slightly different ON and OFF levels, thus eliminating relay 'chatter' problems. D1 suppresses back-emf's from the relay coil, and this protects Q1 against damage from this source.

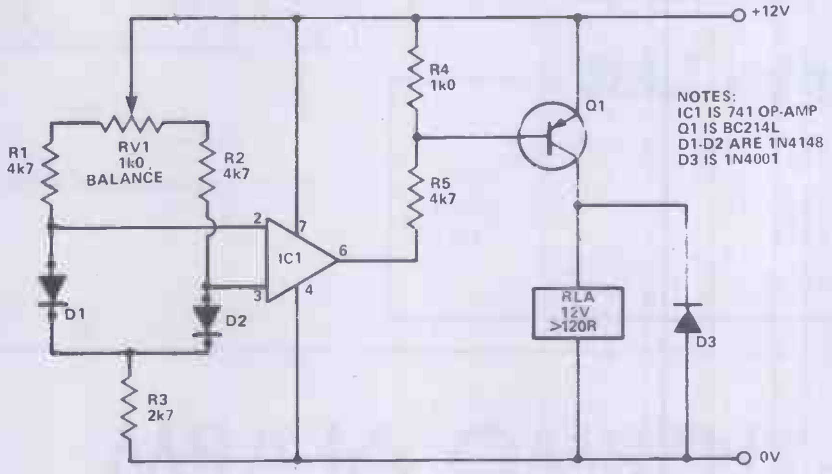


Fig. 1. Basic circuit of the opto-thermo alarm.

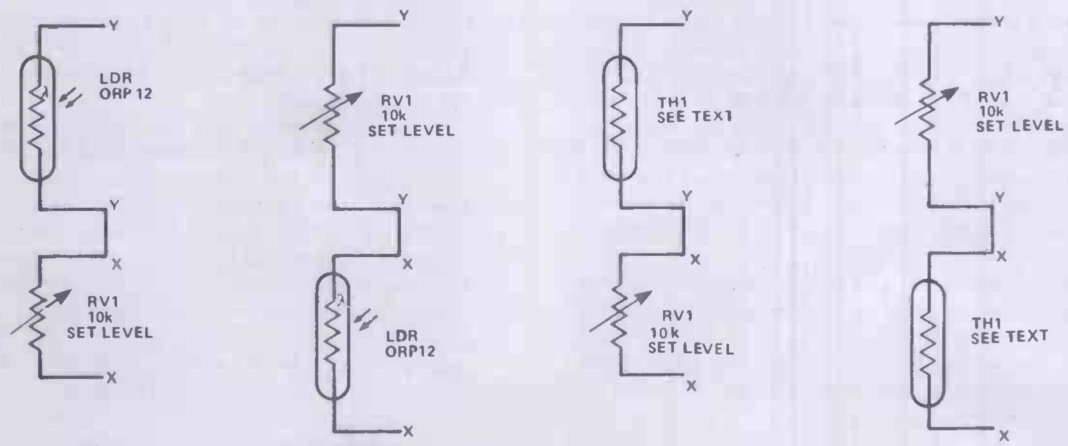
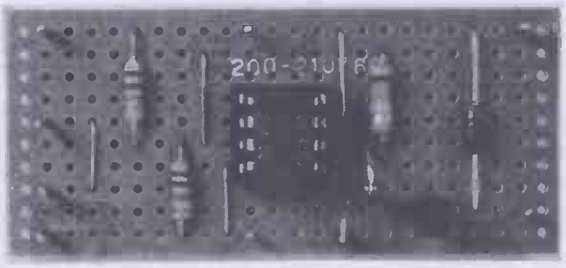
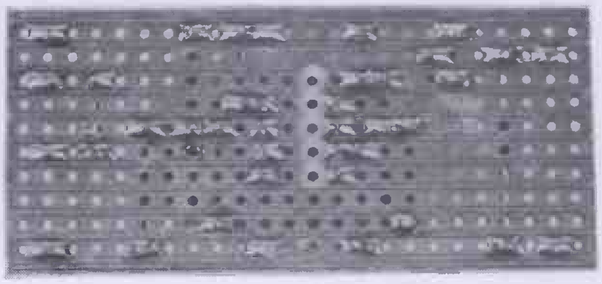


Fig.2. Connections for making the following types of alarm: a) light-operated, (b) dark-operated, (c) over-temperature, (d) under-temperature.





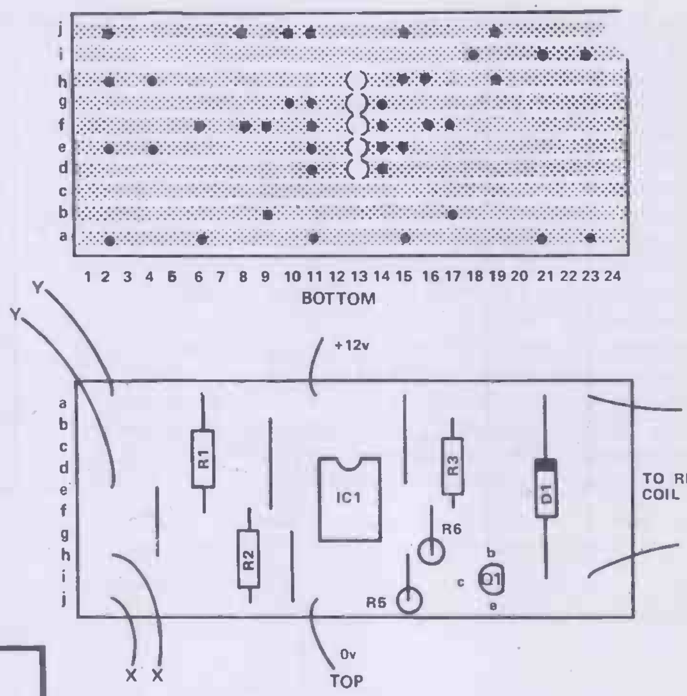


Fig. 3. Constructional details of the opto-thermo alarm.

Parts List

RESISTORS (All ¼W 5%)		SEMICONDUCTORS	
		IC1	741
R1, 2	12k	Q1	BC184L
R3	270k	D1	IN4001
R4	4k7	MISCELLANEOUS	
R5	1k0	RLA, 12V 120R	

OPTO-THERMO ALARM

A direct-output electronic alarm that can be activated by light, dark, heat, or cold.

THIS NOVEL AND USEFUL PROJECT can be powered from a 9 V to 12 V supply, and produces a pulsed-tone alarm signal in a small speaker when light or temperature levels go beyond pre-set limits. The unit can be made to activate either when these levels go above or fall below pre-set values, depending on the manner in which the input sensors (an LDR or light-dependent resistor for 'light' operation, or a thermistor for 'temperature' operation) are connected to the unit. The circuit can thus function as either a 'brightness' alarm, a 'darkness' alarm, an over-temperature alarm, or an under-temperature alarm.

The unit has a variety of uses in the house and in the car. In the car, it can be used to give a warning of road ice or of engine or gearbox overheating. In the home, it can be used to give a warning of a burnt-out night-light or a failed heating system in a child's room, or it can be used as a 'dawn' alarm.

CONSTRUCTION AND USE.

The unit is quite compact, and care must be taken in the construction. The two IC's should be mounted in suitable holders. Start construction by breaking the copper tracks in the positions shown on the underside of the board, and then fit all shorting links into the positions shown on the top of the board. The two IC holders, followed by the remaining components, can then be soldered into place.

Figure 2 shows how to connect the input sensor (either an LDR or a thermistor) and RV1 to the 'x-x' and 'y-y' inputs of the unit to obtain the desired types of operation. For light operation, the LDR must present a resistance in the range 900R to 9k0 at the desired trigger level: an ORP12 is suitable for use in most cases. For temperature operation, the thermistor must be a negative-temperature-coefficient (NTC) type that presents a resistance in the range 900R to 9k0 at the desired trigger level: a VA1066S is suitable for use in most cases. The speaker can have any impedance in the range 3R0 to 25R, the latter value being preferred.

The unit can be powered from any DC supply in the 9 V to 12 V range. In use RV1 is simply adjusted so that the alarm just activates at the desired light or temperature level. The unit produces an attractive pulsed-tone signal when it is activated. **HE**

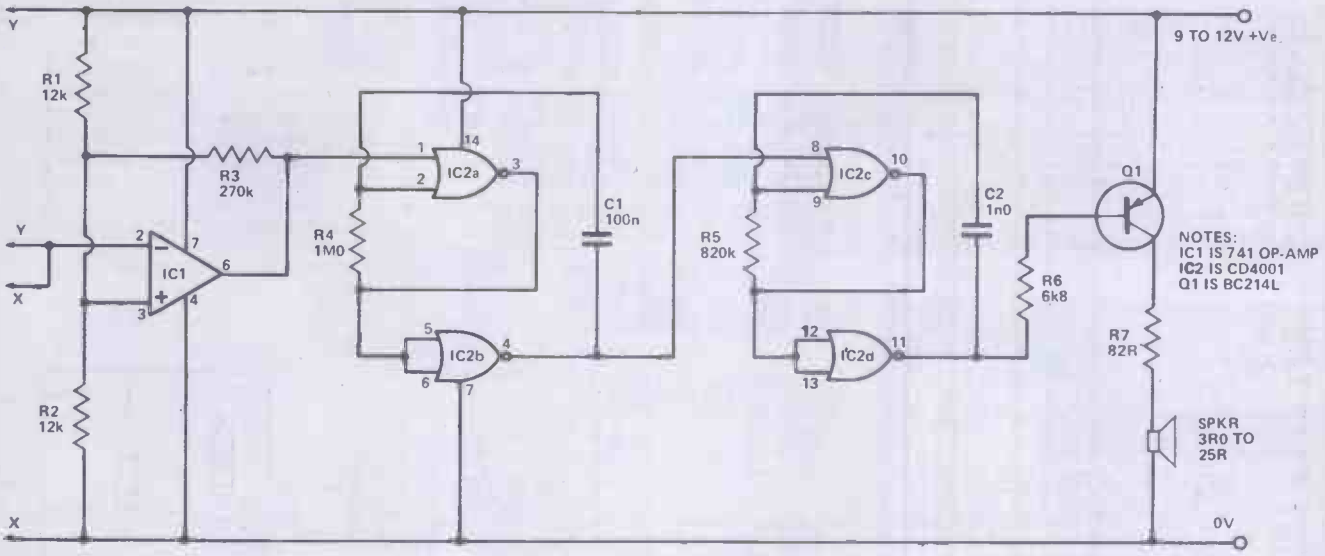


Fig. 1. Basic circuit of the Opto-thermo switch.

How it Works

IC1 is a type 741 operational amplifier that is wired as a voltage comparator with a small amount of regenerative feedback. A fixed 'half supply' reference voltage is fed to input pin 3 of the op-amp via R1 and R2, and a variable voltage is fed to pin 2 via RV1 and the LDR or thermistor. The output of IC1 is used to activate (turn on or off) a 'slow' gated astable multivibrator formed by IC2a and IC2b, and the output of IC2b is used to activate a 'fast' gated astable formed by IC2c and IC2d which has it's output fed to the speaker via Q1.

When the pin 2 voltage of IC1 is below that of pin 3, the output of IC1 is high, and the two astables are gated off and no output is produced from the unit. When the pin 2 voltage of IC1 is above that of pin 3, the output of IC1 is low, so slow astable IC2a-IC2b is gated on and it's output alternately switches the fast IC2c-IC2d astable on and off to produce a pulsed-tone in the speaker.

Since the pin 2 voltage of IC1 is determined by a potential divider RV1 and light-sensitive element LDR or temperature-sensitive element TH1, the alarm can be activated by either light or temperature levels.

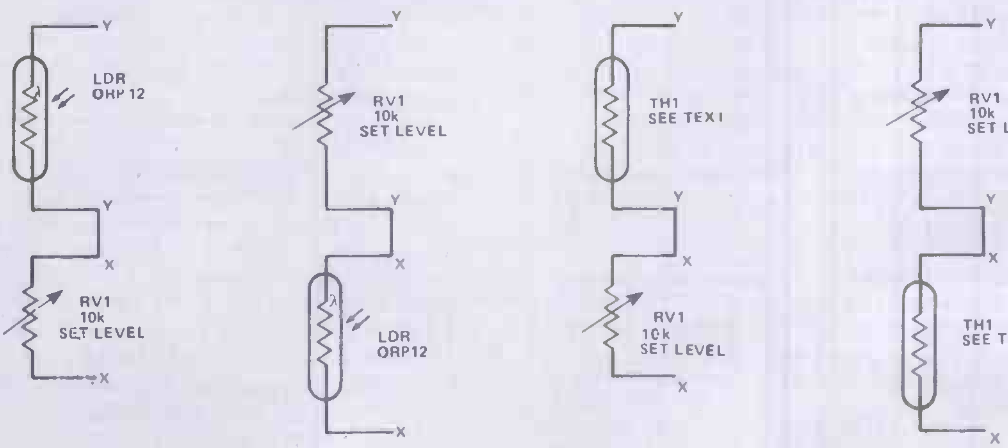
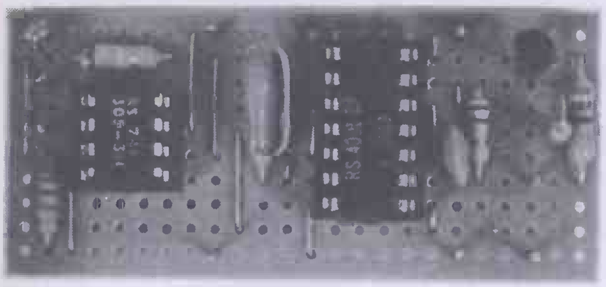
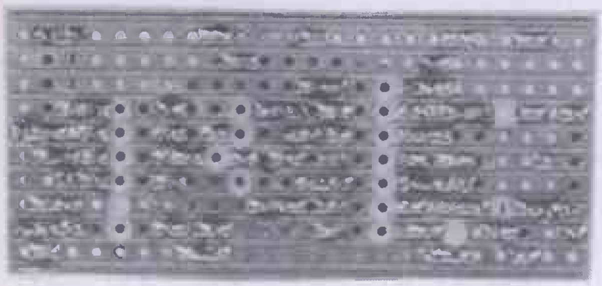


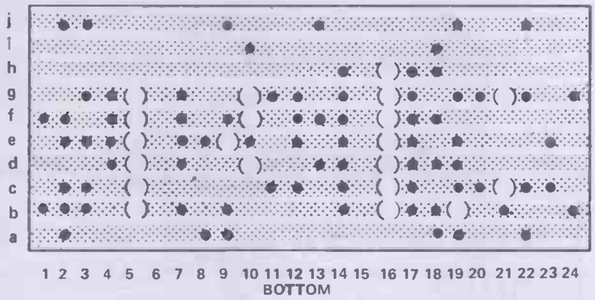
Fig. 2. Connections for making the following types of switch (a) dark-operated, (b) light-operated, (c) under-temperature, (d) over-temperature.

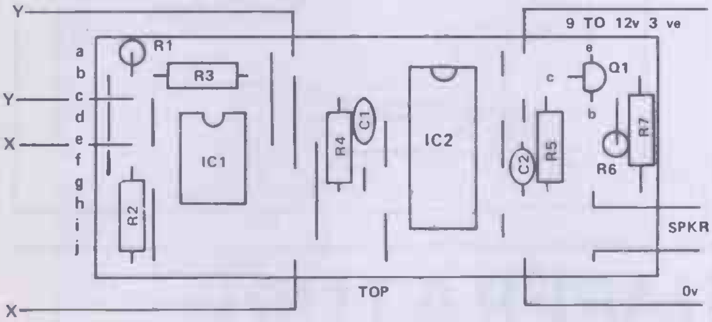
LED FLASHER

A variable-rate LED flasher that can drive either a single LED or a pair of LEDs operating in anti-phase.









THIS CIRCUIT CAN BE USED to either pulse a single LED (light-emitting diode) on and off repetitively or to similarly drive a pair of LEDs in anti-phase, so that one LED turns off when the other turns on, and vice versa. In either case, the flashing rate of each LED is variable from about 15 flashes per minute to 2,000 flashes per minute via a small pre-set pot.

The circuit can be used to add visual interest to a variety of toys, gadgets, and instruments. Model railway enthusiasts can use the unit to simulate flashing lights on miniature police cars and ambulances, etc, or to simulate warning beacons on Zebra crossings.

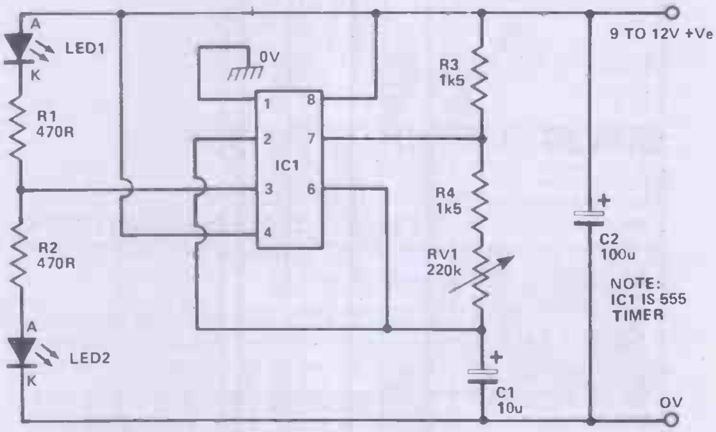


Fig 1. LED Flasher. The flash rate can be varied from 15 per minute to 2,000 per minute via RV1.

How it Works

IC1 is a type 555 'timer' IC, and is connected as a free-running or astable multivibrator that produces a square-wave output signal at pin 3. When this output signal is high it cuts LED 1 off and drives LED 2 on, and when it is low it pulls LED 1 on and cuts LED 2 off: the two LEDs thus turn on and off in anti-phase.

The operating frequency of IC1, and thus the flashing rate of the LEDs, is determined by the values of C1 and R4-RV1: the flashing rate is variable between roughly 15 and 2,000 flashes or cycles per minute via RV1. The ON currents of the LEDs are limited to safe values by the R1 and R2 470R limiting resistors.

Parts List

RESISTORS
(All 2W, 5%)

R1, 2	12k
R3	270k
R4	1M0
R5	820k
R6	6k8
R7	82R

CAPACITORS

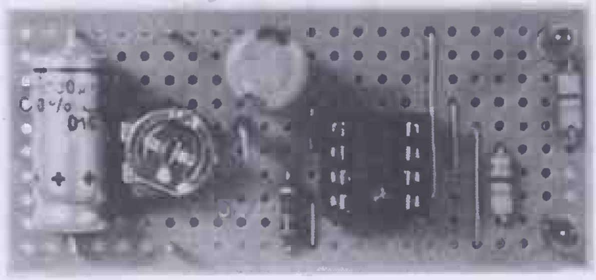
C1	100n polyester
C2	1n0 Ceramic

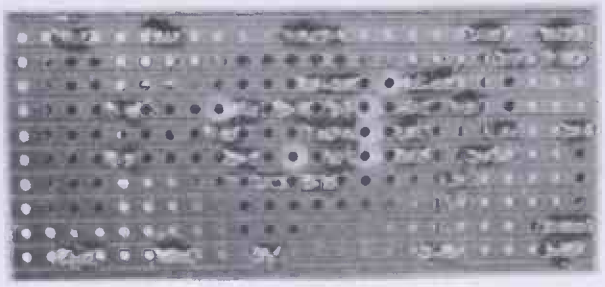
SEMICONDUCTORS

IC1	741
IC2	CD4001
Q1	BC214L

MISCELLANEOUS

LS1	3R0-25R





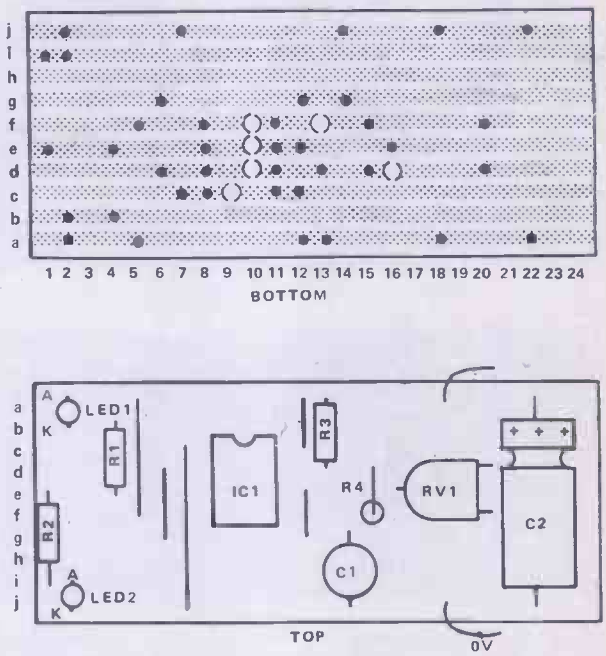


Fig 2. Constructional details of the LED flasher.

CONSTRUCTION AND USE

The unit uses only ten components, and can be built in about half an hour. Full constructional details are shown in Figure 2. Take care to fit IC1 and the two electrolytic capacitors in the polarity shown.

When construction is complete, connect the unit to a 9 volt or 12 volt supply, and check that the LEDs flash on and off repetitively. The flashing rate can be caried via RV1. If you want the circuit to operate with only one flashing LED, you can either short out the unwanted LED or can remove it and it's associated 470R resistor from the circuit. **HE**

Parts List

RESISTORS (All ¼W, 5%)	
R1, 2	470R
R3, 4	1k5
POTENTIOMETERS	
RV1	220k 1in preset
CAPACITORS	
C1	10u 16 V Tantalum
C2	100u 16 V Tantalum
SEMICONDUCTORS	
IC1	NE555
LED 1, 2	TIL209

DIFFERENTIAL TEMPERATURE SWITCH

A relay switch that turns on only when temperature 'A' is higher than temperature 'B,' irrespective of the absolute value of either temperature.

THIS INEXPENSIVE AND UNUSUAL unit can form the basis of a number of sophisticated household-control systems. The circuit uses a couple of ordinary silicon diodes as temperature-sensing elements, and uses a relay as an output 'switch.' The circuit action is such that the relay turns on only when temperature 'A' (sensed by D1) is higher than temperature 'B' (sensed by D2), and this action occurs irrespective of the absolute value of either temperature. The circuit action can be effectively reversed, so that the relay turns on only when temperature 'A' is below that of temperature 'B,' by simple transposting the measurement designations of D1 and D2.

The enterprising experimenter should be able to find a number of practical uses for this switch. It can, for example, be used to activate a blower motor to ensure that a cellar or basement is automatically warmed by the outside air if the external air temperature is above that of the cellar or basement. Alternatively, it can be used to activate a solenoid valve to ensure that a storage tank is automatically filled only from the hotter of two alternative water sources, etc.

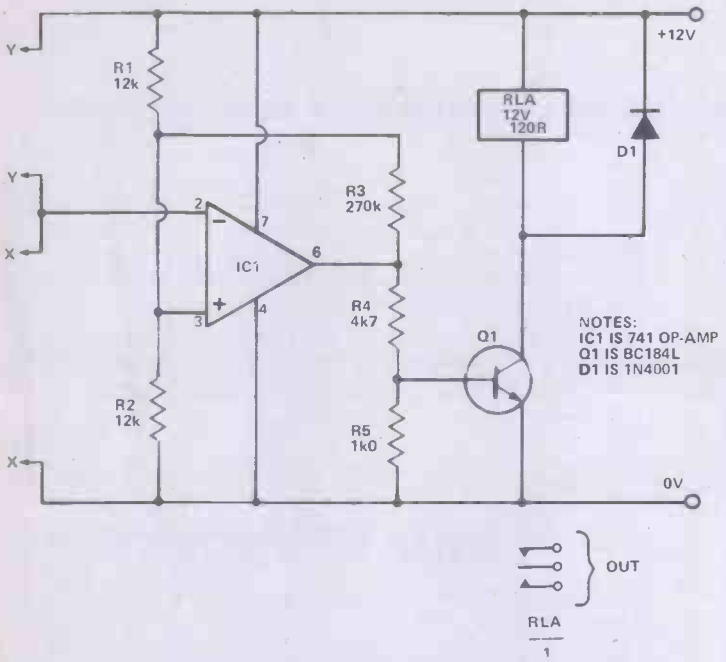
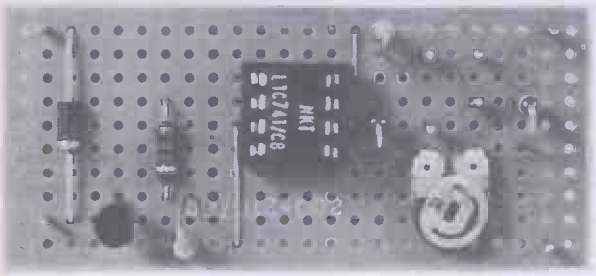
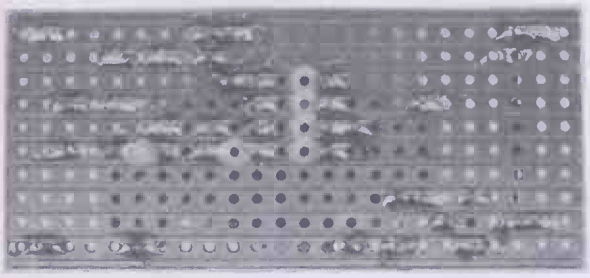


Fig. 1. Differential Temperature Switch: The relay switches on when the D1 temperature is greater than that of D2.





CONSTRUCTION AND USE

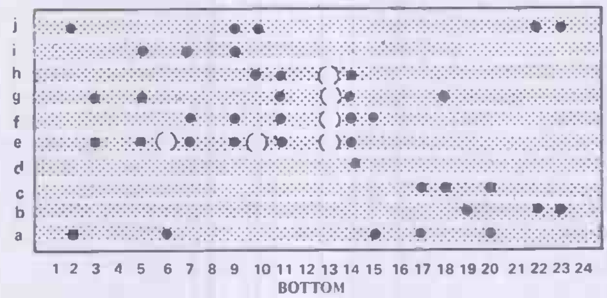
The unit uses very few components, and can be built in about half an hour. Full constructional details are shown in Figure 2. Take care to connect the three diodes, the transistor, and IC1 in the polarity shown. The relay can be any 12 volt type with a coil resistance greater than 120R.

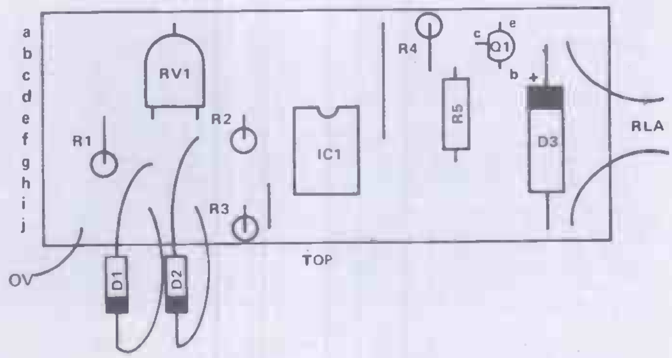
The unit must be powered from a 12 volt supply. In use, RV1 is simply adjusted so that the relay is just off when both sensing diodes (D1 and D2) are at the same temperature. The relay should then turn on if the temperature of D1 is raised a small amount above that of D2: note that at normal room temperature this action can be checked by simply touching D1, so that body heat produces the required differential. External circuits can be controlled via the relay contacts. **HE**

How it Works

Ordinary silicon diodes can develop forward voltages of several hundred millivolts at current levels of the order of 1 mA, the precise voltage value depending on the value of current and the characteristics of the individual diode that is used. All silicon diodes, however, have a virtually identical temperature coefficient of about — —V/*C, and can thus be used as accurate temperature-indicating devices.

In the Figure 1 circuit the two temperature-sensing diodes (D1 and D2) have currents passed through them via the RV1-R1-R2-R3 network; RV1 allows the relative values of the two currents to be adjusted over a limited range so that the diodes produce almost identical forward voltages when they are both at the same temperature. Consequently, the differential or 'difference' voltage between the two diodes is directly proportional to the difference in their temperatures, and equals —2mV/°C. This difference voltage is fed to the input terminals of the IC1 operational amplifier, which is connected as a voltage comparator or differential voltage switch, and the output of the op-amp is fed to the relay via Q1. This action is such that the relay turns on when the temperature of D1 rises above that of D2.





Parts List

RESISTORS
(All ¼W, 5%)
R1, 2, 5 4k7
R3 2k7
R4 1k0

POTENTIOMETERS
RV1 1k0 preset

SEMICONDUCTORS
IC1 741
Q1 BC214L
D1, 2 IN4148
D3 IN4001

MISCELLANEOUS
RLA 12 V 120R

OPTO-TONE

An unusual 'musical instrument' that can be played with a torch or with shadows.

THIS CIRCUIT IS, IN ESSENCE, a variable-frequency high-power oscillator that alters it's tone in response to the light intensity falling on the face of an LDR. The output tone is fed directly to a loud speaker, and is light-variable over a three decade range. The tone is high at high levels of illumination, and low at low levels of illumination.

The circuit is inexpensive and easy to build, and can be used as a simple musical instrument that can be 'played' with a torch or with shadows. It makes an excellent toy, and can provide lots of amusement at children's parties.

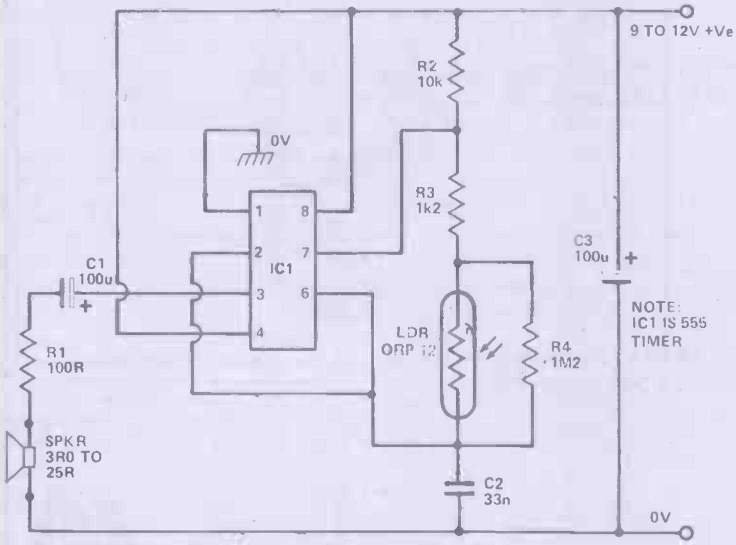
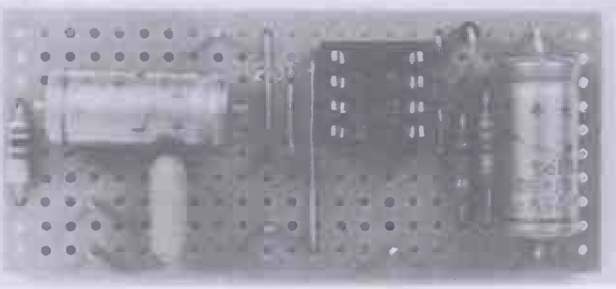
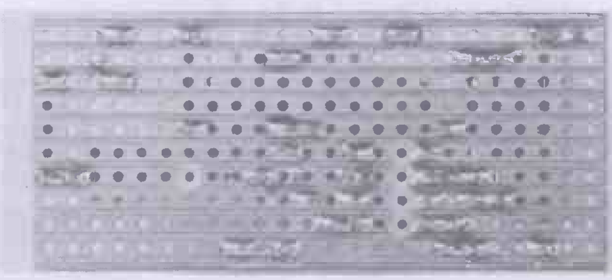


Fig. 1. Opto-tone. The output tone can be varied over three decades by altering the light level on the face of the LDR.

How it Works

IC1 is a type 555 'timer' IC, and is connected as a free-running or astable multivibrator that produces a square-wave output signal in the speaker. The oscillation frequency is determined by C2 and by the total value of resistance appearing between pins 6 and 7 of the IC. The minimum value of this resistance is determined by R3 when the LDR is short-circuited, and the maximum value is determined by R4 when the LDR is open-circuited: the intermediate values are determined by the resistance of the LDR itself, and this is determined by the level of illumination falling on the face of the LDR.





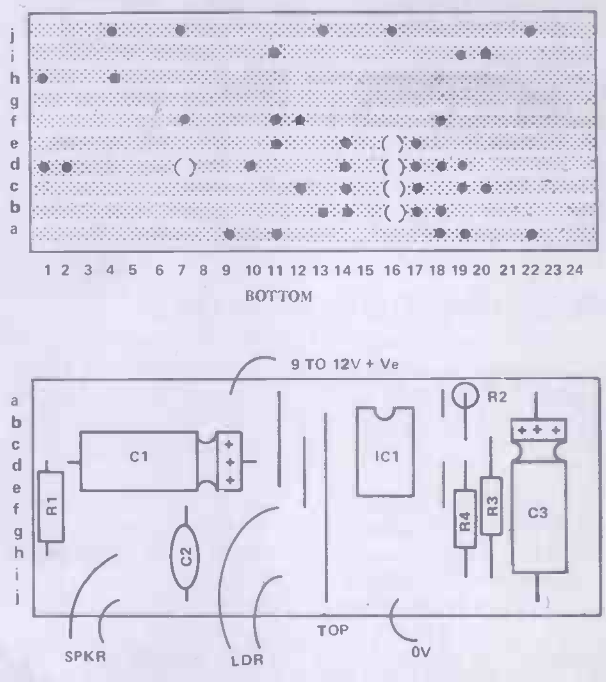


Fig. 2. Construction details of the opto-tone.

CONSTRUCTION AND USE.

The circuit uses only ten components, including the speaker, and can be built in about half an hour. Full constructional details are shown in Figure 2. Take care to connect IC1 and the two electrolytic capacitors in the correct polarity. The speaker used in the circuit can have any impedance in the range 3R0 to 25R, the latter value giving the highest output sound level.

When construction is complete, connect the speaker and the LDR in place, and connect the unit to a 9 volt or 12 volt supply. A reasonably loud tone should be heard in the speaker under normal illumination levels. The tone should fall when a hand is used to cast a shadow on the face of the LDR. Crude 'tunes' can be played by moving the hand to alter the shadowing of the LDR face.

Parts List

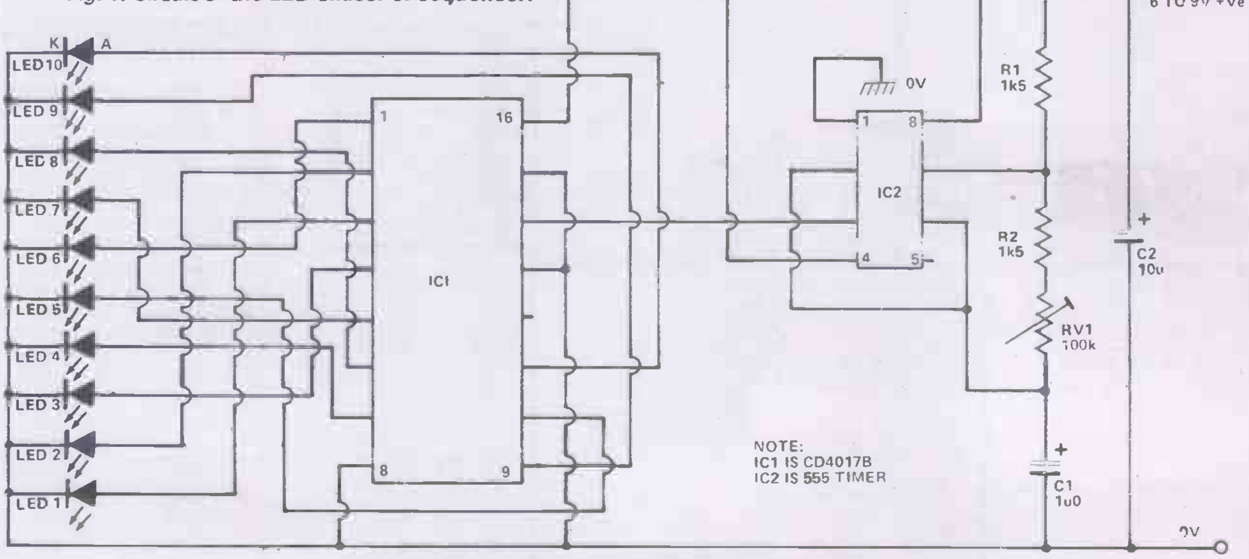
RESISTORS (All ¼W, 5%)	
R1	100R
R2	10k
R3	1k2
R4	1M2
LDR	ORP12
CAPACITORS	
C1	100u 16V Electrolytic
C2	33n polyester
C3	100u 16V Electrolytic
SEMICONDUCTORS	
IC1	NE555
MISCELLANEOUS	
SP1	3R0 to 25R

LED CHASER OR SEQUENCER

A visual display unit that produces a continuously moving 'dot' on a column of ten LEDS.

THIS UNIT HAS LITTLE practical use, but produces a very attractive visual display in the form of a moving 'dot' on a column of ten LEDs. It the unit is wired up exactly as described in following paragraphs, the display will be such that an illuminated dot will appear to move sequentially and smoothly along the line of LEDs, from the bottom of the column to the top, until the top-most LED is reached, at which point the display will seem to

Fig. 1. Circuit of the LED chaser or sequencer.



How it Works

ICI is a CD4017B decade counter with ten decoded outputs, and is 'clocked' by an astable multivibrator formed by IC2 and it's associated components. The action of the circuit is such that nine out of the ten decoded outputs of IC1 are low at any given moment of time, the remaining output being high. Each time that a clock pulse arrives a different output switches high, but all outputs go high in a fixed sequence. Each output is fed directly to it's own LED, so that the LEDs also switch in a fixed sequence. Since there are only ten outputs, the sequence repeats once in every ten clock cycles. The clock rate is variable over a wide range via RV1.

reset and the display sequence will start to repeat again. Only one LED out of the ten will be illuminated at any given moment of time.

The display can, if preferred, be wired up in a random fashion, so that the dot appears to jump about on a column of ten LEDs, but does so in a continuously repeating pattern. In either case, an attractive display will be produced. The unit can be used to simulate miniature shop display signs on model railway layouts, etc.

CONSTRUCTION AND USE

Although this circuit uses only seventeen components it calls for some care and skill in actual construction, since a total of 39 breaks must be made in the copper strips on the rear of the Veroboard panel and some 115 solder joints must be made. Constructional details are shown in Figure 2.

Start the construction by making the 39 breaks on the rear of the board, and then fit all shorting links into place: do not forget the link between holes j2 and j9, which connect the 0 volt supply line to the cathodes (K) of the ten LEDs. Next, solder the two IC holders and all resistors and capacitors into place.

Check the polarity and functioning of each individual LED before you solder it into place. You can do this by connecting a 470R resistor in series with the LED and then connecting the combination across the supply so that the LED illuminates, under which condition the anode will be the most positive terminal. Note that the LEDs should be 0.1 or 0.125 inch types: in the latter case, the ten LEDs will have to be splayed slightly so that they all fit into the board.

The most difficult part of the construction concerns the wiring of the LED anodes to the appropriate output terminals of ICI. When doing this part of the wiring, carefully check the connections against both the constructional diagram and the circuit diagram. If you want a 'random' display, however, you can make these connections in any way that you like.

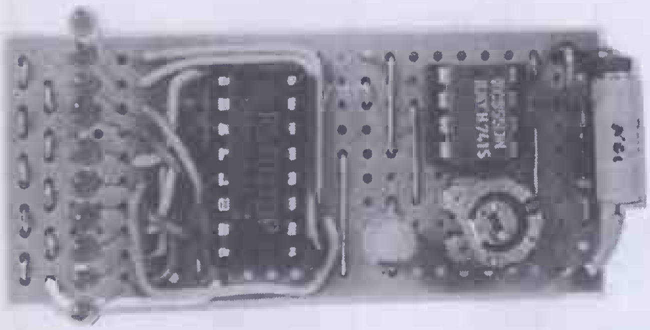
When the wiring-up is complete, fit the two IC's into their holders and connect the unit to a 6 volt or 9 volt battery. If you have wired the unit up correctly, the unit will operate as already described, with the illuminated 'dot' appearing to move along the column of LEDs: the rate is variable over a wide range via RV1. If the unit does not operate exactly as described, look for a wiring fault.

HE

Parts List

RESISTORS (All ¼W, 5%)

R1	1k5
R2	1k5
POTENTIOMETERS	
RV1	100k lin preset
CAPACITORS	
C1	1u0 16V Tantalum
C2	10u 16V Tantalum
SEMICONDUCTORS	
IC1	CD4017B
IC2	NE555
LED 1-10	TIL209



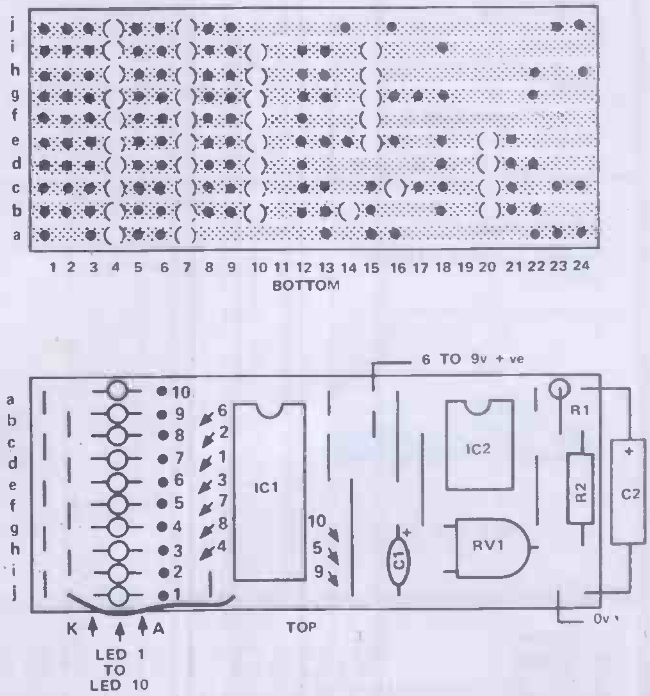


Fig. 2. Constructional details of the LED Chaser or Sequencer.

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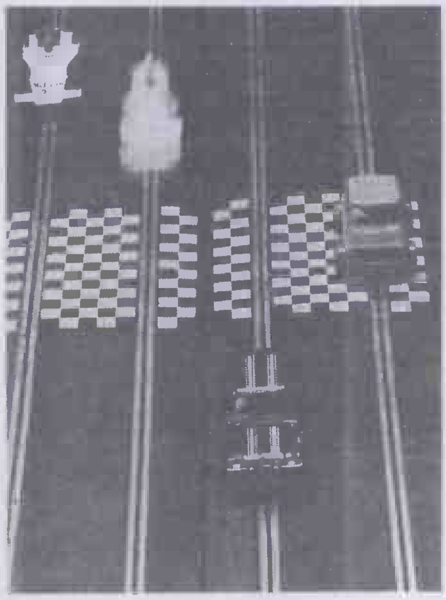
Next Month

Hobby Electronics

Have we got an issue for you next month? Yes of course we have, just cast your tired eyes over this little lot. (Tired eyes can be avoided by refraining from reading lesser electronic magazines)

SCALEXTRIC SPECIAL

Yes folks, HE's done it again. Just in time for Christmas. The HE workshop staff have been really getting their noses to the grindstones and have tirelessly, without any regard for personal health, been playing with their Scalextric set. Whilst they were doing so one of them had a bright idea, 'how about doing some projects on this lads?' He was quickly silenced and play recommenced. A little while later, after this momentous statement sunk in, they thought about it and actually all agreed, it was a good idea. So now we proudly present the last word in electronic Lap Counters, Precision Hand Controllers and other amazing things to grace your layout. Miss it at your peril.



RING MODULATOR

Where do we get them from? Now you can really sound like a Dalek. This neat little unit, designed for use on stage, at home, or just for good old fashioned fun will faithfully reproduce the dulcet tones of those amiable creatures from the planet Skaro. If you don't want to be a Dalek then it will create an interesting range of other effects too. Maybe we'll hang one on HEBOT. You never Know . . . .

UNIJUNCTION TRANSISTOR

Our brainy chief designer Ray Marston takes time off from his train controller to look at those oft maligned, collectorless transistors that are known to all and sundry as Unijunctions. So pay attention because we might be coming round your house to ask you questions about them.

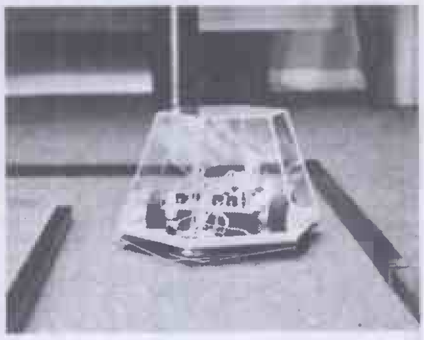
TV-THE CONTINUING STORY

This month Rick Maybury looks at the other end of the TV system, the box that sits in the corner of your living room. Find out just what happens when the on off switch is twiddled, the educated electron strikes again.

PROJECT FAULT FINDING

Gasp . . . your project didn't work, if it wasn't our fault (is it ever?) then it must be your fault. Keith Brindley, who has had to deal with one or two faulty projects in his time discusses the heart wrenching subject of dead projects.

HEBOT GROWS UP



We are expecting HEBOT to start a craze, (seriously) the combination of a really well designed, sturdy chassis at a very reasonable price, coupled with our unique electronic circuitry, brings the world of advanced robotics to within everyones grasp. This month after completing the basic drive circuitry we go on to explore tactile senses, optical stimuli and self survival instincts. HEBOT is the first serious attempt in this country to bring the world of Robotics into the seventies, others have tried and failed, we know we are going to succeed. Frighten the cat, amaze the neighbours but above all DO NOT MISS IT.

The December issue will be on sale November 9th

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

HE READER OFFERS

Beltime

Microprocessor Picoquartz Watch

HE OFFER PRICE

£37.95

(Inclusive of VAT and Postage)

This is one of the meanest offers we've arranged — your friends will hate you. Why? Because the Beltime is to your regular LCDwatches what a decent scientific calculator is to your three quid throwaway. You'll bore your friends in showing it off.

Function definition has got a bit out of hand but the Beltime Microprocessor Picoquartz has been defined as 50 — there are certainly a lot of them. The modern watches all have excellent accuracy — see, we're not knocking the competition — so we'll just say this one is in the upper league. The display is much more detailed than normal with day of the week, date, house, minutes and seconds. AM/PM Time zone and alarm on-off all on the basic display. What'll really cause a groan though is displaying the day of the week in English, Frog, Kraut, Eytie or Dago!

FEATURES

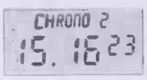
Local time, Alarm set

Time zone, different day and date

Regular alarm 1 for local time

Alarm 2 for time zone (can be second alarm for local time).

Chronograph to 1/100 of sec. with Lap feature.



Chrono 2 countdown from up to 24 hours. Different alarm. Goes over to chrono after zero

Multilanguage day of the week: English, French, German, Italian or Spanish.

Not shown. Optional 12/24 hour display, backlight, any-button alarm cancel, easy time correction and unusually attractive case and adjustable strap

To:
Beltime Watch Offer
Hobby Electronics,
145 Charing Cross Road,
London WC2H 0EE
Please find enclosed my cheque/PO for £37.95 (payable to Hobby Electronics) for my Beltime Watch

Name . . . .

Address . . . .

Please allow 28 days for delivery.

TREASURE TRACER Mk III Metal Locator Kit

HE OFFER PRICE:

£9.95

(Inclusive of VAT and Postage)

The Treasure Tracer MkIII is probably the most successful metal locator kit ever in Britain — over 8,000 have already been sold. The kit available through the HE Reader Offer is identical to those already sold except that the search head is supplied as a kit.

The Treasure Tracer is a 5-transistor BFO design using varicap tuning for extra stability — it operates into a speaker or an earphone (both are supplied). The PCB is fibreglass with component siting printed on the reverse. For anyone who can solder, the Treasure Tracer is an easily built kit taking about 3 hours to complete into a really attractive unit; comprehensive building instructions are of course supplied.

The search head is supplied as a set of component parts and incorporates a Faraday screen to reduce ground capacity effects.

This is a once-only offer and the numbers are limited so send off today.

FEATURES

- Solid state tuning: uses varicap diode for extra stability
- Lightweight construction — weighs less than 22oz.
- Uses PP3 battery (available anywhere).
- Knocks down to 17in — reassembled in seconds
- Highly sensitive and ultra-stable circuit
- Approved by Ministry of Posts and Telecommunications
- Built-in loudspeaker fitted as a standard with alternative of earphone operation (earphone supplied)
- Audio output in pulse form — enables even small frequency changes to be noticed
- Handle and control box made from tough p.v.c. for lightness and corrosion resistance
- Fitted with Faraday shield to reduce ground capacity effects to a minimum
- Three controls: Coarse Tuning, Varicap Tuning and On/Off Volume
- Predrilled, roller-tinned, fibreglass p.c. board with component siting printed on reverse
- Kit complete in every way down to last nut and bolt
- Clear instruction which assume no technical knowledge

To:
Treasure Tracer Offer
Hobby Electronics,
145 Charing Cross Road,
London WC2H 0EE
Please find enclosed my cheque/PO for £9.95 (payable to Hobby Electronics) for my Treasure Tracer Mk III kit.

Name . . . .

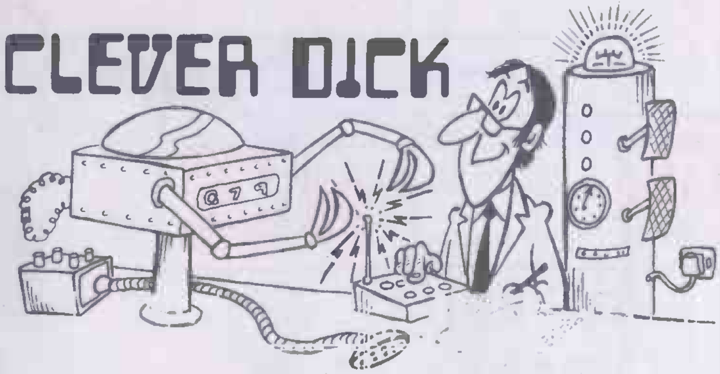
Address . . . .

. . . .

. . . .

Please allow 28 days for delivery.

CLEVER DICK



Something of a mixed postbag again this month. Everything from fish to electromagnets. Why doesn't anyone ask simple questions anymore?

Mr Leonard Taylor sets the ball rolling this month with a peculiar request concerning electromagnets and grants. Confused? So were we.

Dear Dick

Please can you help me? I need some information on Electromagnets. For instance, what is the maximum weight a modern design can lift and where can I obtain one?

Secondly. How does one go about obtaining a grant from the government in order to develop and perfect a design or theory.

Yours Sincerely
L. F. Taylor
Basildon

Judging from the devices we have seen adorning our local breakers yard — several tons. Perhaps if you had been a little more specific we may have been able to help you. May we suggest a trip to your local library. Someone's bound to have written a book on the subject although a quick look through our 'local' was rather fruitless — sorry.

Concerning your question on Government grants. Again we must admit defeat. As far as we know the Government do not have any specific department for financing individuals. Why not try the National Enterprise Board or a local business connected with your line of research? If your idea is particularly outstanding you may consider taking out a patent first to protect your interests. Your solicitor should be able to help.

Our next enquiry comes from H. M. Scott. He writes:

Dear Dick,

Greetings. I am at present building a three-octave organ and I am in need of a circuit. Can you help me? A simple circuit if you can please.

H. M. Scott
Leeds

If you can remember back to last month's HE you will have seen the wonderful Hobbytune. Of course we wouldn't claim that the Hobbytune is giving the Wurlitzer company any sleepless nights but then again have you ever tried to get a Wurlitzer in your pocket. To be serious, our design for the Hobbytune is easily modified to cover more octaves — simply by adding extra tuning resistors. Unfortunately the Hobbytune is of necessity a monophonic device, in that it can only play one note at a time. For a fully polyphonic design, why not take a look at the 'String Thing' published in our sister magazine ETI. Be warned though, it is basically simple, but it will cost a few bob.

Now to a quite different subject — fish. Mr Kingston of Seaford (how apt) writes:

Dear Dick,

I am writing to you out of sheer desperation. I am a student and I am doing research into the way fish respond to frequencies in the 10-20 000 Hz range.

I have searched your magazine for the past year for the equipment I require but to no avail. Perhaps you or one of your readers may be able to help.

I need:

(1) A speaker or transducer covering this range.
(2) A 20-watt amplifier operating from a 12-volt supply.
(3) A signal generator, same frequencies, same power supply.

As you will appreciate, being a student my cash is limited; tailor-made equipment would probably be out of the question.

Hoping you can be of some assistance.

Yours sincerely
David W. Kingston
Seaford, Sussex

We have no wish to carp but we wonder; is it really our plaice to know about such matters. (From the HE book of terrible puns, price 2s 6d from the book service).

Seriously though, we can't really help you on the transducer (assuming it's waterproof) — any suggestions?

The amplifier shouldn't be too much trouble. There are a couple of suitable devices on the market used as 'boosters' for car stereo systems. Try looking in the Exchange & Mart (they're probably COD). The signal generator is easy. How about Sine/Square Generator featured in the February HE. Any suggestions from our readers?

Times-up for another month, we're getting so many letters for Clever Dick that we're thinking about doing a special. In the meantime try to keep your letters short as we're having terrible trouble getting as many as possible into only one page.

Finally, we must stress to everyone writing into Clever Dick that they must include an SAE if they want a reply, otherwise for normal technical enquiries please only ring us on Tuesday between 3.15pm and 5.00pm.

DATA SUPPLEMENT PART 1

PRESENTED FREE WITH NOVEMBER HOBBY ELECTRONICS

Last month you may remember we promised to include an eight page pull-out data supplement, well, here it is. What we omitted to tell you, was, that whilst we were compiling the supplement we discovered that there was so much material we couldn't get it all in only eight pages. So this month we present part one, and next month we will include another eight pages called (you guessed it) part two. This months offering contains all of the commonly used colour codes, pin out diagrams for transistors and CMOS ICs (TTL next month) and a comprehensive list of commonly used abbreviations. Pull it out and keep it handy.

COMMON ABBREVIATIONS

INDEX

A	Ampere or Anode
AC	Alternating Current
ACC	Automatic Chroma Control
Ae	Aerial
AF	Audio Frequency
AFC	Automatic Frequency Control
ALC	Automatic Level Control
AM	Amplitude Modulation
ANL	Automatic Noise Limiter
ATU	Aerial Tuning Unit
AVC	Automatic Volume Control
b	Base of transistor
B&S	Wire Guage (US)
BCD	Binary Coded Decimal
C	Capacitor
c	Collector
CCD	Charge Coupled Device
CCTV	Closed Circuit Television
cgs	Centimetre-Gramme-Second
Ck	Clock
CMOS	Complementary Metal Oxide Semiconductor
CPU	Central Processing Unit
CW	Continuous Wave
D	Diode
d	Drain of FET
dB	Decibel
DC	Direct Current
DF	Direction Finding
DIL	Dual In Line
DIN	German Standards Institute
DNL	Dynamic Noise Limiter
DPDT	Double Pole Double Throw
DPST	Double Pole Single Throw
DTL	Diode Transistor Logic
DX	Long Distance
E	Voltage
ECL	Emitter Coupled Logic
EHT	Extra High Tension
EMF	Electro-Motive Force
ERP	Effective Radiated Power
F	Farad or Farenheit
f	Frequency
FET	Field Effect Transistor
FM	Frequency Modulation
G	Giga (10^9)
g	Grid or Gate
Gnd	Ground
h	Henry
HF	High Frequency

hfe	Transistor gain
HT	High Tension
Hz	Hertz
I	Current
Ib	Base Current (Transistor)
Ic	Collector current
IC	Integrated Circuit
IF	Intermediate Frequency
I^2L	Integrated Injection Logic
i/p	Input
ips	Inches per Second
K	Kilo (10^3) or Cathode
Kg	Kilogramme
L	Inductance
LCD	Liquid Crystal Display
LDR	Light Dependent Resistor
LED	Light Emitting Diode
LF	Low Frequency
Lin	Linear
Log	Logarithmic
mA	Milliamp
mH	Millihenry
MHz	Megahertz
MOSFET	Metal Oxide Semiconductor FET
MPU	Microprocessing Unit
MSI	Medium Scale Integration
MOST	Metal Oxide Semiconductor Transistor
LS	Loudspeaker
LSI	Large Scale Integration
M	Mega (10^6)
m	Milli (10^{-3})
MPX	Multiplex
mV	Millivolt
mW	Milliwatt
n	Nano (10^{-9})
Ni-Cad	Nickle Cadmium
NR	Noise Reduction
NTSC	National Television Standards Committee
o/c	Open Circuit
o/p	Output
Op-Amp	Operational Amplifier
p	Pico (10^{-12})
PA	Power Amplifier or Public Address
PAL	Phase Alternate Line
PCB	Printed Circuit Board
pd	Potential Difference
PIL	Precision In Line

PIV	Peak Inverse Voltage
PLL	Phase Locked Loop
PROM	Programmable Read Only Memory
Ptot	Total Power Dissipation
PU	Pick Up
PUJT	Programmable Unijunction Transistor
Q	Factor of Tuned Circuit
R	Resistance
RAM	Random Access Memory
ROM	Read Only Memory
RF	Radio Frequency
RFC	Radio Frequency Choke
RMS	Root Means Squared
RTL	Resistor Transistor Logic
RX	Receiver
s	Scource (FET)
s/c	Short Circuit
SCR	Silicon Controlled Rectifier
SHF	Super High Frequency
SPDT	Single Pole Double Throw
SPST	Single Pole Single Throw
SSB	Single Side Band
SSI	Small Scale Integration
SWG	Standard Wire Gauge
SWL	Short Wave Listener
SWR	Standing Wave Ratio
TRF	Tuned Radio Frequency
TTL	Transistor Transistor Logic
TVI	Television Interference
Tx	Transmitter
uF	Micro Farad
UHF	Ultra High Frequency
UJT	Unijunction Transistor
V	Volt
VA	Volt Amperes
Vcc	Supply Voltage (TTL)
VCO	Voltage Controlled Oscillator
Vdd	Supply Voltage (CMOS)
VDR	Voltage Dependent Resistor
VDU	Video Display Unit
VHF	Very High Frequency
VLF	Very Low Frequency
VMOS	Vertical Metal Oxide Semiconductor
W	Watts
X	Reactance
Xtal	Crystal
Z	Impedance

RESISTOR AND CAPACITOR LETTER AND DIGIT CODE

Resistor values are indicated as follows:

0.47 Ω marked	R47	100 Ω marked	100R
1 Ω	1R0	1 kΩ	1K0
4.7 Ω	4R7	10 kΩ	10K
47 Ω	47R	10 MΩ	10M

A letter following the value shows the tolerance.
F = ±1%; G = ±2%; J = ±5%; K = ±10%;
M = ±20%;
R33M = 0.33Ω ±20%;
6K8F = 6.8 kΩ ± 1%.

Capacitor values are indicated as.

0.68 pF marked	p68	6.8 nf marked	6n8
6.8 pf	6p8	1000 nF	1u0
1000 pF	1n0	6.8 uF	6u8

Tolerance is indicated by letters as for resistors. Values up to 999 pF are marked in pF, from 1000 pf to 999 000 pF (= 999 nF) as nF (1000 pF = 1 nF) and from 1000 nF (= 1 uF) upwards as uF.

Some capacitors are marked with a code denoting the value in pF (first two figures) followed by a multiplier as a power of ten ($3 = 10^3$). Letters denote tolerance as for resistors but C = ±0.25 pf. E.g. 123 J = 12 pF × 10^3 ±5% = 12 000 pF (or 12nF).

Tantalum Capacitors

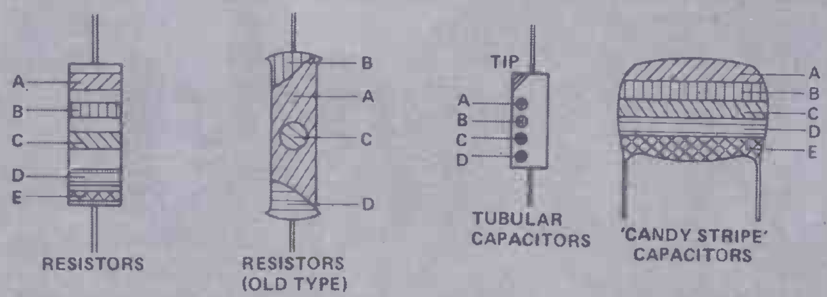
	1	2	3	4
Black	—	0	×1	10 V
Brown	1	1	×10	
Red	2	2	×100	
Orange	3	3	—	
Yellow	4	4	—	6.3 V
Green	5	5	—	16 V
Blue	6	6	—	20 V
Violet	7	7	—	
Grey	8	8	×0.01	25 V
White	9	9	×0.1	3 V

(Pink 35 V)

RESISTOR AND CAPACITOR COLOUR CODING

Colour	Band A	Band B	Band C (Multiplier) Resistors	Band C (Multiplier) Capacitors	B and D (Tolerance) Resistors	B and D (Tolerance) Capacitors Up to 10 pF	B and D (Tolerance) Capacitors Over 10 pF	Band e Resistors	Polyester Capacitors
Black	—	0	1	1	—	2 p0	±20%		—
Brown	1	1	10	10	±1%	0 p1	±1%	—	—
Red	2	2	100	100	±2%	—	±2%	—	250 v.w.
Orange	3	3	1 000	1 000	—	—	±2.5%		—
Yellow	4	4	10 000	10 000	—	—	—	—	—
Green	5	5	100 000	—	—	0 p5	±5%	—	—
Blue	6	6	1 000 000	—	—	—	—	—	—
Violet	7	7	10 000 000	—	—	—	—	—	—
Grey	8	8	10^8	10 n	—	p25	—	—	—
White	9	9	10^9	100 n	—	1p0	±10%		—
Silver	—	—	0.01	—	±10%	—	—	—	—
Gold	—	—	0.1	—	±5%	—	—	—	—
Pink	—	—	—	—	—	—	—	Hi-Stab	—

Note that adjacent bands may be of the same colour unseparated.



Preferred Values

E12 Series (10%)
1.0 1.2 1.5 1.8 2.2 2.7
3.3 3.9 4.7 5.6 6.8 8.2
and their decades

E24 Series (5%)
1.0 1.1 1.2 1.3 1.5 1.6 1.8 2.0 2.2
2.4 2.7 3.0 3.3 3.6 3.9 4.3 4.7 5.1
5.6 6.2 6.8 7.5 8.2 9.1 and their decades

8		7		6		5		4		3		2		1	
Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	268,435,456	1	16,777,216	1	1,048,576	1	65,536	1	4,096	1	256	1	16	1	1
2	536,870,912	2	33,554,432	2	2,097,152	2	131,072	2	8,192	2	512	2	32	2	2
3	805,306,368	3	50,331,648	3	3,145,728	3	196,608	3	12,288	3	768	3	48	3	3
4	1,073,741,824	4	67,108,864	4	4,194,304	4	262,144	4	16,384	4	1,024	4	64	4	4
5	1,342,177,280	5	83,886,080	5	5,242,880	5	327,680	5	20,480	5	1,280	5	80	5	5
6	1,610,612,736	6	100,663,296	6	6,291,456	6	393,216	6	24,576	6	1,536	6	96	6	6
7	1,879,048,192	7	117,440,512	7	7,340,032	7	458,752	7	28,672	7	1,792	7	112	7	7
8	2,147,483,648	8	134,217,728	8	8,388,608	8	524,288	8	32,768	8	2,048	8	128	8	8
9	2,415,919,104	9	150,994,944	9	9,437,184	9	589,824	9	36,864	9	2,304	9	144	9	9
A	2,684,354,560	A	167,772,160	A	10,485,760	A	655,360	A	40,960	A	2,560	A	160	A	10
B	2,952,790,016	B	184,549,376	B	11,534,336	B	720,896	B	45,056	B	2,816	B	176	B	11
C	3,221,225,472	C	201,326,592	C	12,582,912	C	786,432	C	49,152	C	3,072	C	192	C	12
D	3,489,660,928	D	218,103,808	D	13,631,488	D	851,968	D	53,248	D	3,328	D	208	D	13
E	3,758,096,384	E	234,881,024	E	14,680,064	E	917,504	E	57,344	E	3,584	E	224	E	14
F	4,026,531,840	F	251,658,240	F	15,728,640	F	983,040	F	61,440	F	3,840	F	240	F	15
8		7		6		5		4		3		2		1	

TO CONVERT HEXADECIMAL TO DECIMAL

1 Locate column of decimal numbers corresponding to left-most digit or letter of hexadecimal select from this column and record number that corresponds to position of hexadecimal digit or letter.
2 Repeat step 1 for next (second from left) position.
3 Repeat step 1 for units (third from left) position.
4 Add numbers selected from table to form decimal number.

TO CONVERT DECIMAL TO HEXADECIMAL

1 (A) select from table highest decimal number that is equal to or less than number to be converted.
(B) Record hexadecimal of column containing selected number.
(C) Subtract selected decimal from number to be converted.
2 Using remainder from step 1 (C) repeat all of step 1 to develop second position of hexadecimal (and remainder).
3 Using remainder from step 2 repeat all of step 1 to develop units position of hexadecimal.
4 Combine terms to form hexadecimal number

CMOS FUNCTIONS

Device	Description
CD4000	Dual 3-Input NOR gate plus Inverter
CD4001	Quad 2-Input NOR Gate
CD4002	Dual 4-Input NOR Gate
CD4006	18-Stage Static Shift Register
CD4007	Dual Complementary Pair Plus Inverter
CD4008	4-Bit full Adder with Parallel Carry
CD4009	Hex Buffer/Converter (Inverting)
CD4010	Hex Buffer/Converter (Non-Inverting)
CD4011	Quad 2-Input NAND Gate
CD4012	Dual 4-Input NAND Gate
CD4013	Dual "D" Flip-Flop with Set/Reset
CD4014	8-Stage Static Shift Register
CD4015	Dual 4-Stage Static Shift Register
CD4016	Quad Bilateral Switch
CD4017	Decade Counter/Divider
CD4018	Presettable Divide-By-"N" Counter
CD4019	Quad AND-OR Select Gate
CD4020	14-Stage Binary Ripple Counter
CD4021	8-Stage Static Shift Register
CD4022	Divide-by-8 Counter/Divider
CD4023	Triple 3-Input NAND Gate
CD4024	7-Stage Binary Counter
CD4025	Triple 3-Input NOR Gate
CD4026	Decade Counter/Divider
CD4027	Dual J K Master Slave Flip-Flop
CD4028	BCD TO-Decimal Decoder
CD4029	Presettable Up/Down Counter
CD4030	Quad Exclusive-OR Gate
CD4035	4-Stage Parallel IN/OUT Shift Register
CD4040	12-Stage Binary Ripple Counter
CD4042	Quad Clocked "D" Latch
CD4046	Micropower Phase-Locked Loop
CD4049	Hex Buffer/Converter (Inverting)
CD4050	Hex Buffer/Converter (Non-Inverting)
CD4051	Single 8-Channel Multiplexer
CD4052	Differential 4-Channel Multiplexer
CD4054	4-Line Liquid Crystal Display Driver
CD4056	BCD-7-Segment Decoder/Driver
CD4059	Programmable Divide-by-N Counter
CD4060	14-Stage Counter and Oscillator
CD4061	256-Word X 1-Bit Static Ram
CD4066	Quad Bilateral Switch
CD4068	8-Input NAND Gate
CD4069	Hex Inverter
CD4070	Quad Exclusive OR Gate
CD4071	Quad 2-Input OR Gate
CD4077	Quad Exclusive NOR Gate
CD4081	Quad 2-Input AND Gate
CD4082	Dual 4-Input AND Gate
CD4085	Dual 2-Wide 2-Input AOI Gate
CD4086	Expendable 4-Wide 2-Input AOI Gate
CD4093	Quad 2-Input NAND Schmitt Trigger
CD4099	8-Bit Addressable Latch
CD4510	BCD UP/DOWN Counter
CD4511	BCD TO7-Segment Decoder/Driver
CD4514	1 to 16 Decoder (Output High)
CD4515	1 to 16 Decoder (Output Low)
CD4516	Binary UP/DOWN Counter
CD4518	Dual BCD UP Counter
CD4528	Dual Retriggerable Monostable
MC14502	Strobed Hex Inverter/Buffer
MC14517	Dual 64-bit Static Shift Register
MC14521	24 State Frequency Divider
MC14522	Programmable divide by N-4 bit Counter (BCD)
MC14526	Programmable divide by N-4 bit Counter (binary)
MC14534	Real Time 5-Decade Counter
MC14536	Programmable Timer
MC14543	BCD-to-Seven Segment Latch/Decoder/Driver
MC14553	Three-Digit BCD Counter
MC14566	Industrial time base Generator

CMOS/TTL COMPARISON

Logic family	Noise Immunity Volts	Prop. delay nS	Fan Out	Max. Toggle Speed MHZ	Supply Voltage Nominal V	Min. V	Max. V	Power Diss. per package mW (typ)	Decoupling and other requirements
74 Series	0.4	9	10	15	5.0	4.75	5.25	40	0.1 uF Ceramic
74H Series	0.4	6	10	40	5.0	4.75	5.25	60	capacitor for every 8
74S Series	0.3	3	10	125	5.0	4.75	5.25	40	packages to eliminate
74LS Series	0.3	9	10	25	5.0	4.75	5.25	8	switchingcurrentspike
CMOS	4.5	30	>50	10	–	3.0	18.0	0.01	No special precautions

TTL BIPOLAR LOGIC

The 74 Series of transistor-transistor logic is a medium speed family of saturating integrated circuit logic designed for general digital logic application requiring clock frequencies to 30MHz and switching speeds in the 7-11 nS range under moderate capacitive loading.

The circuits are identified by a multiple emitter input transistor and an active "pull up" in the upper output network. Clamp diodes are provided at each input to limit the undershoot that occurs in typical system applications such as driving long interconnect wiring. The active pull-up output configuration provides low output impedance in the high output state. The resulting low impedances in both output states ensures excellent a.c. noise immunity and allows a high-speed operation with capacitive loads.

COMPLEMENTARY MOS (CMOS)

Complementary MOS is the newest of the general-purpose logic families.

The following are primary design features of the whole of the COS/MOS and McMOS ranges.

— Double diode protection on all inputs.
— Noise immunity typically 45% of VDD, 30% of VDD minimum.
— Buffered output compatible with MHTL and Low Power TTL.
— Low quiescent power dissipation: 25nW typ. per package.
— Wide power supply voltage: 3-18 Volt dependent on type.
— Single supply operation.
— High fanout: greater than 50
— High input impedance: 10' ohms typ.
— Low input capacitance: 5pf typ.

BIPOLAR TRANSISTORS

TYPE	CASE	POL MAT.	Vce	Vcb	IC mA	Vces	@ IC mA	Hfe	@ IC mA	Ft MHz	@ IC mA	Ptot mW	Use	Comparable Types
AC107	GT3	NG	15	15	10			30-160	.3	2	.3	80	Low Noise Audio	AC125—2N406
AC125	TO-1	PG	12	32	100			100	2	1.3	10	216	Audio Driver	2N406
AC126	TO-1	PG	12	32	100			140	2	1.7	10	216	Audio Driver	2N406
AC127	TO-1	NG	12	32	500			105	50	1.5	10	340	Audio O/P	AC187
AC128	TO-1	PG	16	32	1000	.6	1A	60-175	300	1	10	260	Audio O/P	AC188
AC132	TO-1	PG	12	32	200	.35	200	115	50	1.3	10	216	Audio O/P	AC188
AC187	TO-1	NG	15	25	2000	.8	1A	100-500	300	1	10	800	Audio O/P	AC127
AC188	TO-1	PG	15	25	2000	.6	1A	100-500	300	1	10	220	Audio O/P	AC128
AD149	TO 3	PG	30	50	3500	.7	3A	30-100	1A	.3	500	32W	G.P. O/P	OC26,AU106
AD161	PT1	NG	20	32	3000	.6	1A	80-320	500	.02	300	4W	Audio Amp.	AD165,2N1218,2N1292
AD162	PT1	PG	20	32	3000	.4	1A	80-320	500	.015	300	6W	Audio Amp.	AD143,AD152,AD427
AF114	TO-7	PG	15	32	10			150	1	75	1	75	H.F. Amp.	AF144,AF194,2N3127
AF115	TO-7	PG	15	32	10			150	1	75	1	75	H.F. Amp.	AF146,AF185,2N2273
AF116	TO-7	PG	15	32	10			150	1	75	1	75	H.F.Amp.	AF135,AF136,2N3127
AF117	TO-7	PG	15	32	10			150	1	75	1	75	H.F. Amp.	AF136,AF197,2N5354
AF118	TO-7	PG	20	70	30	5	30	35	10	175	10	375	V.H.F. Amp.	BFW20
ASZ15	TO-3	PG	60	100	10A	.4	10A	20-55	1A	.2	1A	30W	H.C. Sw.	OC28
ASZ16	TO-3	PG	32	60	10A	.4	10A	45-130	1A	.25	1A	30W	H.C. Sw.	OC29,AD138,AD723
ASZ17	TO-3	PG	32	60	10A	.4	10A	25-75	1A	.22	1A	30W	H.C. Sw.	OC35,AD424
ASZ18	TO-3	PG	32	100	10A	.4	10A	30-110	1A	.22	1A	30W	H.C. Sw.	OC36
BC107	TO-18	NS	45	50	100	.2	100	110-450	2	300	10	300	S.S. Amp.	BC207,BC147,BC182
BC108	TO-18	NS	20	30	100	.2	100	110-800	2	300	10	300	S.S. Amp.	BC208,BC148,BC183
BC109	TO-18	NS	20	30	100	.2	100	200-800	2	300	10	300	Low Noise S.S. Amp.	BC209,BC149,BC184
BC109C	TO-18	NS	20	30	100	.2	100	420-800	2	300	10	300	Low Noise High Gain	BC209C,BC184C,BC149C
BC157	SOT-25	PS	45	50	100	.25	100	75-260	2	150	10	300	S.S. Amp.	BC177,BC307,BC212
BC158	SOT-25	PS	25	30	100	.25	100	75-500	2	150	10	300	S.S. Amp.	BC178,BC308,BC213
BC159	SOT-25	PS	20	25	100	.25	100	125-500	2	150	10	300	S.S. Amp.	BC179,BC309,BC214
BC177	TO-18	PS	45	50	100	.25	100	75-260	2	150	10	300	S.S. Amp.	BC157,BC307,BC212
BC178	TO-18	PS	25	30	100	.25	100	75-500	2	150	10	300	S.S. Amp.	BC158,BC308,BC213
BC179	TO-18	PS	20	25	100	.25	100	125-500	2	150	10	300	S.S. Amp.	BC159,BC309,BC214
BC182(L)	SOT-30 (TO-92/74)	NS	50	10	200	.25	10	100-480	2	150	10	300	S.S. Amp.	BC107,BC207,BC147
BC183(L)	SOT-30 (TO-92/74)	NS	30	45	200	.25	10	100-850	2	150	10	300	S.S. Amp.	BC108,BC208,BC148
BC184(L)	SOT-30 (TO-92/74)	NS	30	45	200	.25	10	250-850	2	150	10	300	Low Noise, High Gain	BC109,BC209,BC149
BC186	TO-18	PS	25	40	200	.5	50	40-200	2	50	50	300	G.P. Amp.	BC213,BC177,BC158
BC207	TO-106	NS	45	50	200	.25	10	110-220	2	150	10	300	S.S. Amp.	BC107,BC182,BC147
BC208	TO-106	NS	20	25	200	.25	10	110-800	2	150	10	300	S.S. Amp.	BC108,BC183,BC148
BC209	TO-106	NS	20	25	200	.25	10	200-800	2	150	10	300	Low Noise, High Gain	BC109,BC184,BC149
BC212(L)	SOT-30 (TO-92/74)	PS	50	60	200	.25	10	60-300	2	200	10	300	S.S. Amp.	BC307,BC157,BC177
BC213(L)	SOT-30 (TO-92/74)	PS	30	45	200	.25	10	80-400	2	200	10	300	S.S Amp.	BC308,BC158,BC178
BC214(L)	SOT-30 (TO-92/74)	PS	30	45	200	25	10	80-400	2	200	10	300	S.S. Amp.	
BC327	TO-92	PS	45	–	1000	0.7	500	100-600	100	100	10	800	O/P	2N3638
BC337	TO-92	NS	45	–	1000	0 7	500	100-600	100	200	10	800	O/P	2N3642
BC547	SO7-30	NS	45	50	100	.6	100	110-800	2	300	10	500	S.S. Amp.	8C107,BC207,BC147
BC548	SO7-30	NS	30	30	100	6	100	110-800	2	300	10	500	S.S. Amp.	BC108,BC208,BC148
BC549	SO7-30	NS	30	30	100	6	100	200-800	2	300	10	500	Low Noise S. Sig.	BC109,BC209,BC149
BC549C	SO7-30	NS	30	30	100	6	100	420-800	2	300	10	500	Low Noise, High Gain	BC109C,BC149C
BC635	TO-92(74)	NS	45	45	1A	.5	500	40-250	150	130	500	1W	Audio O/P	BC639
BC636	TO-92(74)	PS	45	45	1A	.5	500	40-250	150	130	500	1W	Audio O/P	BC640
BC639	TO-92(74)	NS	80	100	1A	.5	500	40-160	150	130		1W	Audio O/P	MU9610,TT801
BC640	TO-92(74)	PS	80	100	1A	5	500	40-160	150	130		1W	Audio O/P	MU9660,TT800
BCY70	TO-18	PS	40	50	200	.5	50	50	10	250	50	350	G. P.	8C212
BCY71	TO-18	PS	45	45	200	.5	50	100 600	10	200	50	350	G.P.	BC212
BCY72	TO-18	PS	25	25	200	.5	50	50	10	200	50	350	G.P.	BC213
BD137	TO-12G	NS	60	60	1A	.5	500	40-160	150	250	500	8W	G.P. O/P	BD139
BD138	TO-126	PS	60	60	1A	.5	500	40-160	150	75	500	8W	G.P. O/P	BD140
BD139	TO-126	NS	60	100	1A	.5	500	40-160	150	250	500	8W	G.P. O/P	40409
BD140	TO-126	PS	80	100	1A	.5	500	40-160	150	75	500	8W	G.P. O/P	40410
BD262	TO-126	PS	60	60	4A	2.5	1.5A	750	1.5A	7	1.5A	36W	High Gain Darl. O/P	BD266
BD263	TO-126	NS	60	80	4A	2.5	1.5A	750	1.5A	7	1.5A	36W	High Gain Darl. O/P	BD267
BD266A	TO-220	PS	80	80	8A	2	3A	750	3A	7		60W	High Gain Darl. O/P	
BD267A	TO-220	NS	80	100	8A	2	3A	750	3A	7		60W	High Gain Darl. O/P	
BDX64A	TO-3	PS	80	80	12A	2.5	5A	1000	SA	7	5A	117W	Darl. O/P	
BDX65A	TO-3	NS	80	80	12A	2.5	5A	1000	SA	7	5A	117W	Darl. O/P	
BDY20	TO-3	NS	60	100	15A	1.1	4A	20 70	4A	1	4A	115	Power O/P	2N3055
BF115	TO-72(28)	NS	30	50	30			45-165	1	230	1	145	V.H.F. Amp.	
BF167	TO-72(28)	NS	30	40	25			26	4	350	4	130	T.V. I.F. Amp.	
BF173	TO-72(28)	NS	25	40	25			37	7	550	5	230	T.V. I.F. Amp.	
BF177	TO-39	NS	60	100	50			20	15	120	10	795	T.V. Video Amp.	BF336
BF178	TO 39	NS	115	185	50			20	30	120	10	1.7W	T.V. Video Amp.	BF336
BF179	TO-39	NS	115	250	50			20	20	120	10	1.7W	T.V. Video Amp	BF338
BF180	TO 72(25)	NS	20	30	20			13	2	675	2	150	U.H F Amp	BF200
BF184	TO 72(28)	NS	20	30	30			75-750	1	300	1	145	H.F Amp	
BF185	TO 72(28)	NS	20	30	30			34-140	1	220	1	145	H F Amp	BF195
BF194	SOT-25/1	NS	20	30	30			65-220	1	260	1	250	H.F Amp	
BF195	SOT-25/1	NS	20	30	30			35-125	1	200	1	250	H F. Amp.	BF185
BF200	TO-72(25)	NS	20	30	20			15	3	650	3	150	V H F Amp.	BF180
BF336	TO-39	NS	180	185	100			20-60	30	130		3W	Video Amp	
BF337	TO-39	NS	200	300	100			20-60	30	130		3W	Video Amp	
BF338	TO-39	NS	225	250	100			20 60	30	130		3W	Video Amp	
BFY50	TO-39	NS	35	80	1A	.2	150	30	150	60	50	2 86W	G P.	
BFY51	TO 39	NS	30	60	1A	.35	150	40	150	50	50	2 86W	G P	
BFY52	TO-39	NS	20	40	1A	.35	150	60	150	50	50	2.86W	G P	
MJ2501	TQ 3	PS	80	80	10A	2	5A	1000	5A			150W	Darl O/P	
MJ2955	TO 3	PS	[illegible]	70	15A	1 1	4A	20 70	4A	4	500	115W	High Power O/P	2N4908,2N4909,2N5871
MJ3001	TO-3	NS	80	80	10A	2	5A	1000	5A			150W	Darl O/P	

TYPE	CASE	POL MAT	Vce	Vcb	IC mA	Vces	@ IC mA	Hfe	@ IC mA	Ft MHz	@ IC mA	Ptot mW	Use	Comparable Types
MJE2955	90-05	PS	[illegible]	70	10A	1 1	4A	20 70	4A	2	500	[illegible]	[illegible] O/P	TIP2955
MJE3055	90 05	NS	[illegible]	70	10A	1 1	4A	20 70	4A	2	500	[illegible]	[illegible]	TIP3055
MU9610	152	NS	30	40	2A	0.4	1.5A	80 400	350	70	250	1W	[illegible]	TT801
MU9611	152-01	NS	30	40	2A	0.4	1.5A	80 400	350	70	250	1W	[illegible]	TT801
MU9660	152	PS	30	40	2A	0.4	1.5A	80 400	350	70	250	1W	O/P	TT800
MU9661	152-01	PS	30	40	2A	0.4	1.5A	80 400	350	70	250	1W	[illegible]	TT800
NSD106	TO-202(35	NS	100	140		2-9	100	[illegible]	100	80	50		[illegible] O/P	
NSD206	TO-202(35,	PS	100	100		2–1	100	[illegible]	100	150	50		[illegible] O/P	
OC26	TO-3	PG	[illegible]	50	3.5A	7	3A	30 120	1A	.5	500	[illegible]	[illegible]	AD149
OC28	TO-3	PG	[illegible]	100	10A	4	10A	20 55	1A	.2	1A	[illegible]	[illegible]	AS215
OC44N	TO-1	PG	5	15	10			45 225	1	7.5	1	[illegible]	R.F. Amp	AF125,AF135,AF172
OC45	GT-3	PG	5	15	10			25 125	1	3	3	[illegible]	R.F. Amp	AF1[illegible] AF185 AF196
OC70	GT-3	PG	10	30	50			30	5	.5		[illegible]	[illegible]	[illegible] 2N1190
OC71	GT 3	PG	10	30	50			35 75	3	6		[illegible]	[illegible]	[illegible]
OC72	GT 6	PG	16	32	250			[illegible]	10	35		[illegible]	Audio O/P	AC[illegible] AC128 AC162
OC74N	TO 1	PG	10	20	300	6	300	[illegible]	50	1		[illegible]	Audio O/P	AC1[illegible] AC192
OC75	GT 3	PG	10	30	50			[illegible]	3	1		[illegible]	[illegible]	AC173 AC192
TIP31B	TOP 66	NS	80	80	3A	1 2	3A	20	500	3	500	40W	[illegible]	
TIP32B	TOP 66	PS	80	80	3A	1 2	3A	20	500	3	500	40W	[illegible]	
TIP2955	TOP 3	PS	70	100	15A	1 1	4A	25	4A	8		[illegible]	[illegible]	[illegible]
TIP3055	TOP 3	NS	70	100	15A	1 1	4A	25	4A	8		[illegible]	[illegible]	[illegible]
TT797	TO 39	PS	60	60	1A			40 120	100	100		[illegible]	Audio Driver ... Sw	TT800 [illegible]
TT798	TO-39	NS	[illegible]	80	1A			40 120	150	80		[illegible]	Audio Driver ... Sw	TT801 [illegible]
TT800	TO 39	PS	60	60	1A			40 120	100	100		[illegible]	Audio Driver ... Sw	[illegible]
TT801	TO 39	NS	[illegible]	80	1A			40 120	150	80		[illegible]	Audio Driver ... Sw	TT[illegible] 106
2N301	TO 3	PG	32	40	3A			50	1A	[illegible]	1A	[illegible]	Audio O/P	AT[illegible] OC26
2N706A	TO 18	NS	15	[illegible]	200			20	10	200		[illegible]	High Speed Sw	
2N2926	TO [illegible]	NS	[illegible]	[illegible]	100			15	2	[illegible]		[illegible]	[illegible]	BC[illegible]
2N3053	TO 39	NS	40	[illegible]	[illegible]	1 4	150	50 250	150	100	50	[illegible]	[illegible]	[illegible]
2N3054	TO 66	NS	[illegible]	[illegible]	[illegible]	1	200	25	500	8	200	[illegible]	[illegible]	TIP[illegible]
2N3055	TO 3	NS	60	[illegible]	15A	1 1	4A	20	4A	[illegible]	1A	[illegible]	[illegible]	[illegible]
2N3563	TO 106	NS	12	30	50			20 200	8	[illegible]	8	[illegible]	R.F. ... I.F. Amp	[illegible]
2N3564	TO 106	NS	15	30	100	3	20	20 500	15	[illegible]	15	[illegible]	R.F. ... I.F. Amp	[illegible]
2N3565	TO 106	NS	25	30	[illegible]	.35	1	150 600	1	40	1	[illegible]	Low Level [illegible]	[illegible] BC108
2N3566	TO 105	NS	30	40	200	1	100	[illegible]	10	40	[illegible]	[illegible]	[illegible]	BC[illegible]
2N3567	TO 105	NS	40	80	500	.25	150	40 120	1	[illegible]	[illegible]	[illegible]	G.P. Amp & Sw	BC337
2N3568	TO 105	NS	60	80	500	.25	150	40 120	1	60	50	[illegible]	G.P. Amp & Sw	
2N3569	TO 105	NS	40	80	500	.25	150	100 300	1	60	50	[illegible]	G.P. Amp & Sw	
2N3638	TO 105	PS	25	25	500	.25	50	30	50	100	50	[illegible]	G.P. Amp & Sw	BC327
2N3638A	TO 105	PS	25	25	500	.25	50	100	50	150	50	[illegible]	G.P. Amp & Sw	BC[illegible]
2N3640	TO 106	PS	12	12	80	[illegible]	10	30 120	10	[illegible]	10	[illegible]	[illegible]	
2N3641	TO 105	NS	30	60	500	.22	150	40 120		[illegible]	50	[illegible]	G.P. Amp & Sw	BC[illegible]
2N3642	TO 105	NS	45	60	500	.22	150	40 120	150	[illegible]	50	[illegible]	G.P. Amp & Sw	BC[illegible]
2N3643	TO 105	NS	30	60	500	.22	150	100 300	150	[illegible]	50	[illegible]	G.P. Amp & Sw	BC[illegible]
2N3644	TO 105	PS	45	45	600	1	300	100 300	50	[illegible]	20	[illegible]	G.P. Amp & Sw	BC327
2N3645	TO 105	PS	60	60	500	1	300	100 300	[illegible]	[illegible]	20	[illegible]	G.P. Amp & Sw	
2N3702	TO 92 [illegible]	PS	25	[illegible]	200	.25	50	60 300	50	100	50	[illegible]	G.P. Amp & Sw	BC[illegible]
2N3904	TO 92	NS	40	60	200			100 300	10mA			[illegible]	[illegible]	BC[illegible] BF194
2N4250	TO 106	PS	40	40	100	.25	10	250 [illegible]	1	50		[illegible]	[illegible]	BC[illegible]
2N4258	TO 106	PS	12	12	50	.5	50	30 120	10	[illegible]	10	[illegible]	[illegible]	
2N4292	TO 92	NS	15	30	50	.6	10	20	3	600	4	[illegible]	[illegible]	
2N4403	TO 92	PS	40	40	600			100 300	10			[illegible]	G.P.	BC307A 2N2904
2N5589	MT 71C	NS	18	[illegible]	600			5	100	175+	[illegible]	[illegible]	[illegible]	
2N5590	MT 72C	NS	18	[illegible]	2A			5	250	175+	[illegible]	[illegible]	[illegible]	
2N5591	MT 72C	NS	18	[illegible]	[illegible]			5	[illegible]	175+	[illegible]	[illegible]	[illegible]	
2N5871	TO 3	PS	[illegible]	[illegible]	[illegible]	1	4A	20 100	2.5A	4	250	[illegible]	[illegible]	[illegible] 2N4908,MJ2955
40250	TO 66	NS	50	50	[illegible]	1.5	1.5A	[illegible]	100	1		[illegible]	[illegible]	[illegible]
40408	TO 5	NS	[illegible]		[illegible]	1.4	[illegible]	40 200	200	100		[illegible]	[illegible]	[illegible]
40409	TO 39(H)	NS	80		700	1.4	[illegible]	50 250	150	100		[illegible]	[illegible]	[illegible]
40410	TO 39(H)	PS	80		700	1.4	[illegible]	50 250	150	100		[illegible]	[illegible]	[illegible]

FETS

TYPE	CASE	BVGSS V	@ IG (uA)	VGS (OFF) Min	Max	@ VDS	ID (nA)	IDSS (mA) Min	Max	@ VDS	VGS	Y fs (umhos) Min	Max	@ VDS	Ptot MW	Use/Comments
MPF102	TO [illegible]	25	10	.5	8	15	2	2	20	15	0	[illegible]	[illegible]	[illegible]	[illegible]	N-CH Junction – VHF
MPF103	[illegible]	25	1		6	15	1	1	5	15	0	[illegible]	[illegible]	[illegible]	[illegible]	N-CH Junction – Audio Sw
MPF104	[illegible]	25	1		7	15	1	2	9	15	0	[illegible]	[illegible]	[illegible]	[illegible]	N-CH Junction – Audio Sw
MPF105	[illegible]	25	1		8	15	10	4	16	15	0	[illegible]	[illegible]	[illegible]	[illegible]	N-CH Junction – Audio Sw
MPF106	[illegible]	25	1	.5	4	15	10	4	10	15	0	[illegible]	[illegible]	[illegible]	310	N-CH Junction – RF
[illegible]	[illegible]	25	1	.5	6	15	10	1	5	15	0	[illegible]	[illegible]	[illegible]	310	N-CH Junction – Audio Sw
[illegible]	[illegible]	25	1	1	7	15	10	2	6	15	0	[illegible]	[illegible]	[illegible]	[illegible]	N-CH Junction – Audio Sw
[illegible]	[illegible]	25	1	2	8	15	10	4	9	15	0	[illegible]	[illegible]	[illegible]	[illegible]	N-CH Junction – Audio Sw
[illegible]	[illegible]	25	1	.3	3	15	10	1	5	15	0	[illegible]	[illegible]	[illegible]	[illegible]	N-CH Junction – VHF
[illegible]	[illegible]	25	1	.5	4	15	10	4	10	15	0	[illegible]	[illegible]	15	[illegible]	N-CH Junction VHF
[illegible]	[illegible]	[illegible]						8	20	15	0		[illegible]		300	N-CH Junction Audio to H.F.
[illegible]	[illegible]	[illegible]						4	10	15	0		[illegible]		300	N-CH Junction Audio to H.F.
[illegible]	[illegible]	[illegible]						2	20	15	0		[illegible]		[illegible]	N-CH Junction Audio to H.F.
[illegible]	[illegible]	7 20			4	15		5	[illegible]	15	0	1000	[illegible]	[illegible]	[illegible]	[illegible] Amp
[illegible]	[illegible]	20			5	10		1	30	15	0		[illegible]		[illegible]	[illegible] Audio Sw

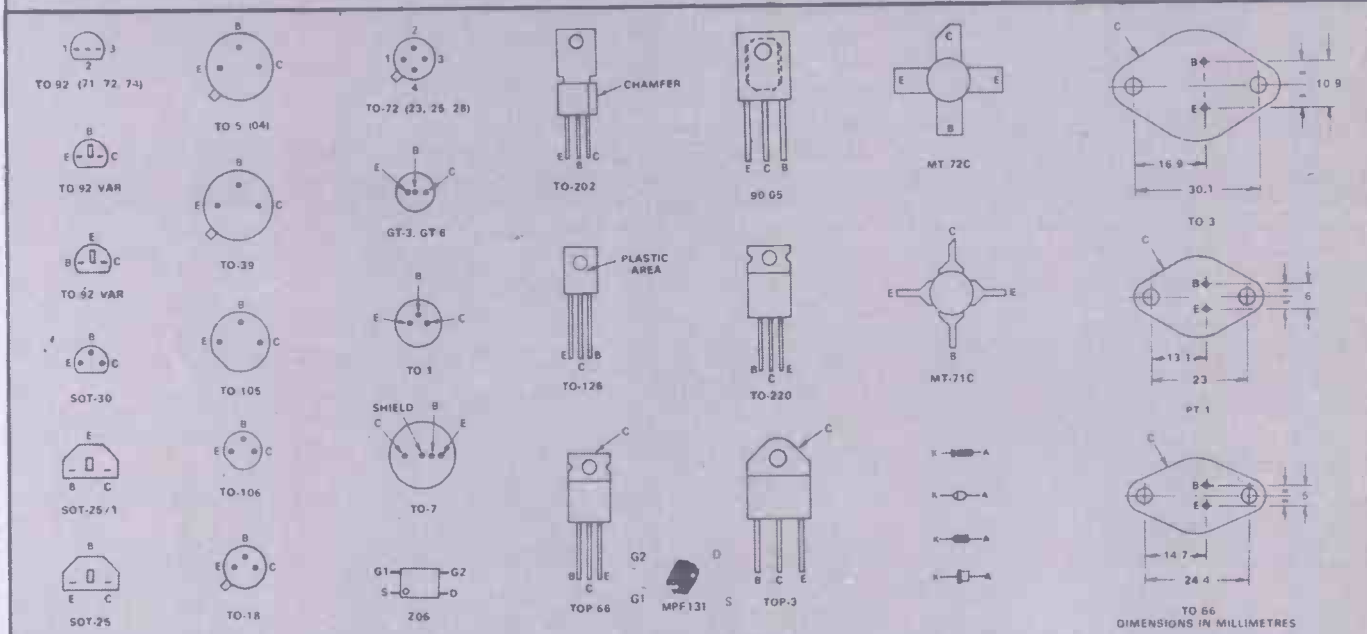
DIODES

TYPE	MAT	V_R	I_F (A)	V_F	@ I_F (A)	I_R (μA)	@ V_R	USE
A 14 P	S	[illegible]	[illegible]	1.5	[illegible]	[illegible]	[illegible]	[illegible]
A 15 A	S	[illegible]	5	1.1	[illegible]	5	[illegible]	[illegible]
BYX21L/200R	S	[illegible]	[illegible]	1.2	[illegible]	1.1	[illegible]	[illegible]
EM 4005	S	50	1	1.1	1	[illegible]	[illegible]	[illegible]
EM 401	S	100	1	1.1	1	[illegible]	[illegible]	
EM 404	S	400	1	1.1	1	[illegible]	[illegible]	
EM 410	S	1000	1	1.1	1	[illegible]	[illegible]	
[illegible]	S	[illegible]	1	1.1	1	[illegible]	[illegible]	
[illegible]	S	100	1	1.1	1	[illegible]	[illegible]	
[illegible]	S	[illegible]	1	1.1	1	[illegible]	[illegible]	
[illegible]	S	[illegible]	1	1.1	1	[illegible]	[illegible]	
[illegible]	S	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

TYPE	MAT	V_R	I_F (A)	V_F	@ I_F (A)	I_R (μA)	@ V_R	USE
IN 5059(A14B)	S	200	2.5	1.25	2.5	0.2	200	Transient Protected (Controlled Avalanche)
IN 5060(A14D)	S	400	2.5	1.25	2.5	0.2	400	" "
IN 5061(A14M)	S	600	2.5	1.25	2.5	0.2	600	" "
IN 5062(A14N)	S	800	2.5	1.25	2.5	0.5	800	" "
MR 110	S	100	10					G.P. Stud Mount
MR 410	S	400	10					"

DIODES

DIODES	CASE	V_R	I_F (mA)	C_d (pF)	V_F	@ I_F (mA)	I_R (μA)	@ V_R	T_{rr} (nS)	USE	COMPARABLE TYPES
Germanium											
AA 119	DO-7	30	100	1.2	2.2	10	150	30		AM/FM Detection Point Contact	
OA 90	DO-7	20	45		1.5	10	450	20		G.P.–Point Contact	OA70, OA80
OA 91	DO-7	90	150		1.9	10	180	75		"	OA71, OA79, OA81
OA 95	DO-7	90	150		1.5	10	110	75		"	
Silicon											
BA 100	DO-7	60	90	25	.96	10	10	60		G.P. – Alloyed	
BA 102	DO-7	20		20 45	C_d ratio 1.4 @ 4/10 V/VV					Variable Capacitance	
BA 114	DO-7		20		7	1				Bias Stabilizer	
OA200	DO-7	50	160	25	.96	10	1	50		Small Signal–Alloyed	
OA202	DO-7	150	160	25	.96	10	1	150		"	
IN 914A	DO-35	75	75	4	1	10	5	75	4	Small Signal–Switching	IN 4148
IN 4148	SD-5	75	75	4	1	10	.025	20	4	"	IN 914A
5082 2800	DO-7	70	15	2	.41	1	0.2	50	0.1	Schottky (Hot Carrier) UHF Detector, Mixer, Switch	



PIN	72 (STD) T	72 (STD) FET
1	C	G
2	B	S
3	E	D

PIN	71 T	71 FET
1	C	G
2	E	D
3	B	S

PIN	74 T	74 FET
1	B	S
2	C	G
3	E	D

PIN	T (25)	FET N (25)
1	E	S
2	B	D
3	C	G
4	GND	CASE

PIN	T (28)	FET P (23)
1	B	S
2	E	G
3	C	D
4	GND	CASE

BIPOLARS
E EMITTER
B BASE
C COLLECTOR
NG NPN GERMANIUM
PG PNP GERMANIUM
NS NPN SILICON
PS PNP SILICON

FETS
S SOURCE
G GATE
D DRAIN
N/CH N CHANNEL
P/CH P CHANNEL

DIODES
A: ANODE
K: CATHODE

G.P. GENERAL PURPOSE
S.S. SMALL SIGNAL
SW SWITCH
O/P OUTPUT
R.F. RADIO FREQUENCY
H.F. HIGH FREQUENCY
V.H.F. VERY HIGH FREQUENCY

PROBLEMS?

SUFFIXES 'k', 'm', 'M' etc after component values indicate a numerical multiplier or divider – thus

Multipliers

k = X 1000
M = X 1000 000
G = X 1000 000 000

Dividers

u = ÷ 1000 000
n = ÷ 1000 000 000
p = ÷ 1000 000 000 000

Where the numerical value includes a decimal point the traditional way of showing it was, for example, 4.7k. Experience showed that printing errors occurred due to accidental marks being mistaken for decimal points. The Standard now calls for the ex-suffix to be used in place of the decimal point. Thus a 4.7 k resistor is now shown as 4k7. A 2.2 uF capacitor is now shown as 2u2 etc.

Some confusion still exists with capacitor markings. Capacitors used to be marked with multiples or sub-multiples of microfarads – thus 0.001 uF, 470 uF etc. Markings are now generally in sub-multiples of a Farad. Thus

1 microfarad (1u) = 1×10^{-6} F
1 nanofarad (1n) = 1×10^{-9} F
1 picofarad (1p) = 1×10^{-12} F

OV on our circuits in this series means the same as –ve (an abbreviation for 'negative'.

Unless otherwise specified all components in our drawings are shown as seen from above – note however that component manufacturers often show them as seen looking *into* the pins.

Pin numbering of ICs – with the IC held so that the pins are facing away from you and with the small cut-out downwards pins are numbered anti-clockwise starting with pin number 1 at bottom right.

The thin line on a battery schematic drawing is positive (+ve or just +).

If a circuit won't work the most probable causes of trouble in the most probable order of occurrence are:–

(a) Components inserted the wrong way round or in the wrong places.
(b) Faulty soldering.
(c) Bridges of solder between tracks (particularly with Veroboard) – breaks in Veroboard omitted – and/or whiskers of material bridging across Veroboard breaks.
(d) Faulty components.

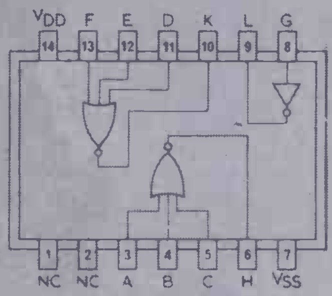
CMOS IC PIN-OUTS

As you will probably realise there are several hundred different types of CMOS IC. To publish the Pin-Out diagrams of them all would require a book larger than HE itself, let alone an eight page Data Supplement.

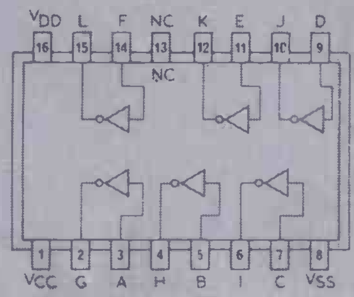
So with the help of our learned friends from the HE workshop we've got together all of the most commonly used CMOS IC Pin-outs and tried to cram them into the following two pages.

Several of these ICs may be new to you but don't worry, if we haven't used them already you can be sure we will be doing so in the near future. Next month we will be giving the same treatment to the multitude of ICs that belong to the TTL family.

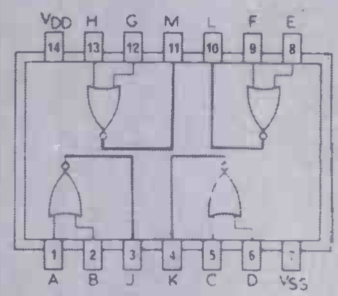
CD 4000A DUAL 3-INPUT NOR GATE PLUS INVERTER



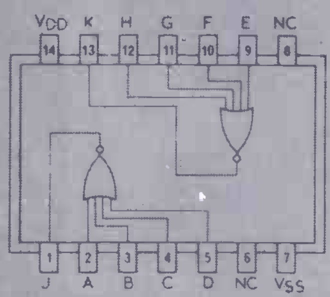
CD4009A, 4049A HEX BUFFER CONVERTER – INVERTING



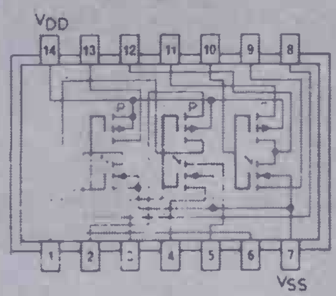
CD4001A QUAD 2-INPUT NOR GATE



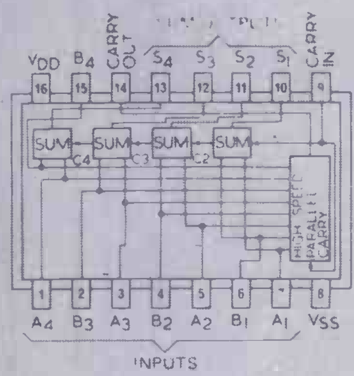
CD4002A DUAL 4-INPUT NOR GATE



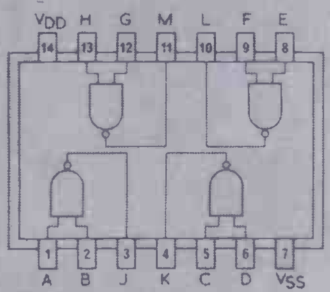
CD4007A DUAL COMPLEMENTARY PAIR WITH INVERTER



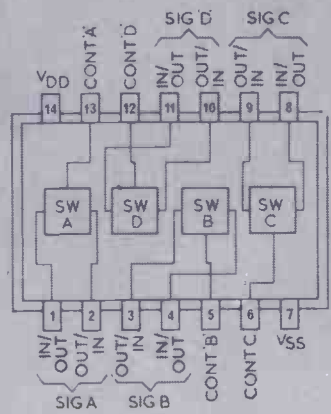
CD4008A 4-BIT ADDER WITH PARALLEL CARRY



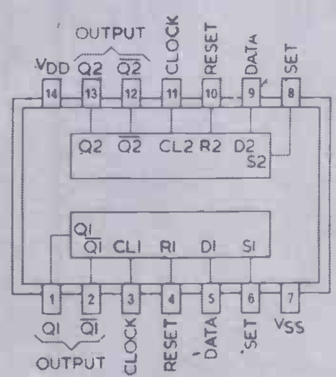
CD4011A QUAD 2-INPUT NAND GATE



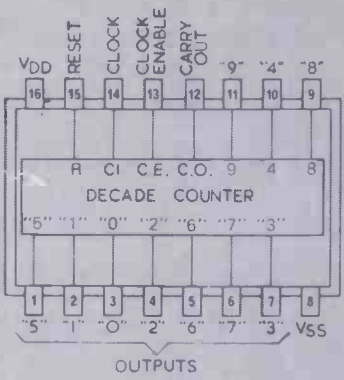
CD4016A, 4066A QUAD SWITCH



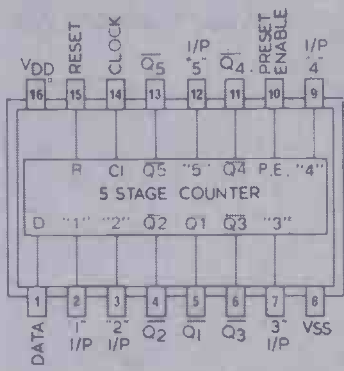
CD4013A DUAL D-TYPE FLIP-FLOP WITH RESET



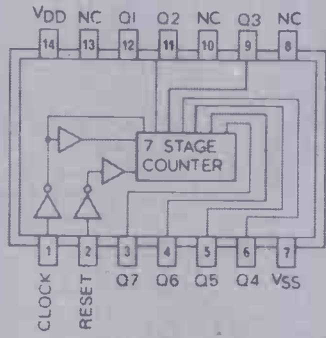
CD4017A DECADE COUNTER



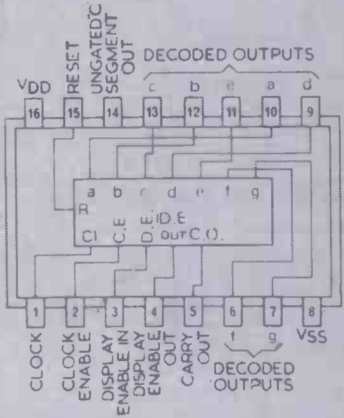
CD4018A PRESETTABLE DIVIDE-BY-N COUNTER



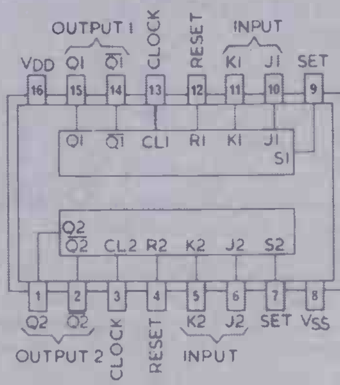
CD4024A 7-STAGE BINARY COUNTER



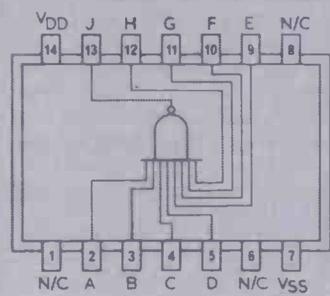
CD4026A DECADE COUNTER-DIVIDER



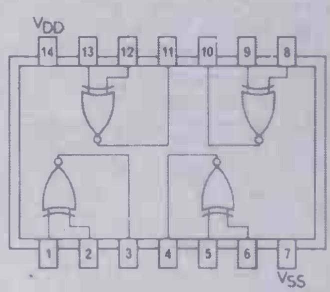
CD4027A DUAL J-K FLIP-FLOP



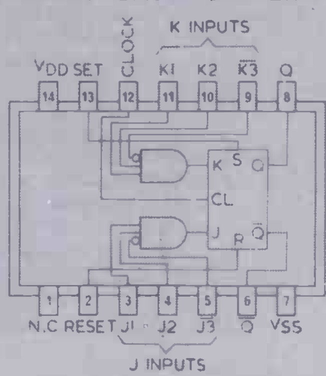
CD4068B 8-INPUT NAND GATE



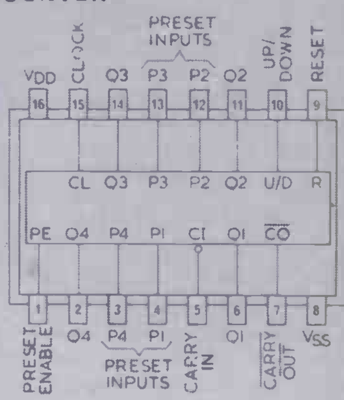
CD4077B QUAD EX NOR GATES



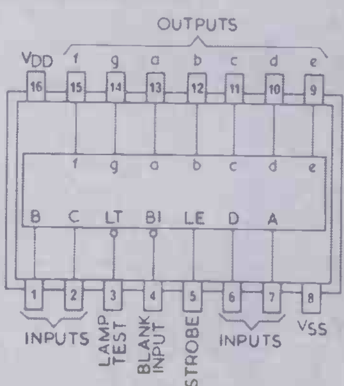
CD4096B GATED J-K FLIP-FLOP



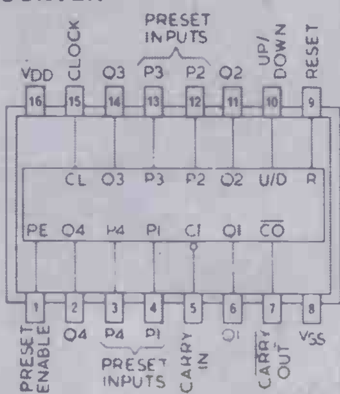
CD4510B BCD UP-DOWN COUNTER



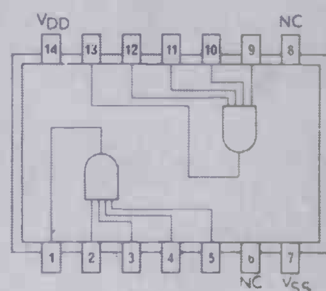
CD4511B BCD-TO-7-SEGMENT DECODER/DRIVER



CD4516B BINARY UP-DOWN COUNTER



CD4082B DUAL 4-INPUT AND GATE



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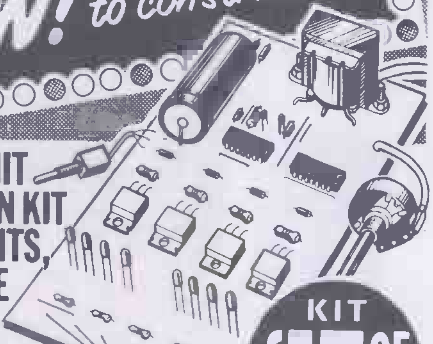

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TANTALUM BEAD	
.1 35V	.12
.15 35V	.12
.22 35V	.12
.33 35V	.12
.47 35V	.12
.68 35V	.12
1 35V	.10
1.5 35V	.12
2.2 16V	.12
2.2 35V	.14
3.3 16V	.12
3.3 35V	.15
4.7 10V	.13
4.7 25V	.15
4.7 35V	.16
6.8 35V	.20
10 6.3V	.14
10 16V	.16
10 25V	.20
10 35V	.22
15 16V	.20
15 25V	.25
22 10V	.20
22 16V	.23
22 2.5V	.30
33 10V	.23
33 16V	.30
47 6.3V	.23
47 10V	.25
47 16V	.36
68 3V	.22
100 3V	.20
100 6.3V	.30
100 10V	.30

RADIAL ELECTROLYTICS	
.47 50V	.06
1 50V	.06
2.2 50/63V	.06
3.3 50V	.08
4.7 35V	.06
4.7 50V	.07
10 16V	.06
10 25V	.06
10 63V	.08
22 10V	.05
22 16V	.06
22 35V	.07
22 50V	.08
33 16V	.06
33 25V	.07
47 16V	.07
47 25V	.08
47 63/50	.15
100 10V	.06
100 16V	.08
100 25V	.09
100 63V	.22
220 10V	.08
220 16V	.10
220 35V	.19
330 10V	.15
330 25V	.19
470 6.3	.09
470 16V	.15
470 25V	.21
470 50V	.35
1000 16V	.18
1000 25V	.35
2200 6.3	.24
2200 16V	.38
2200 40V	.64
4700 6.3	.38
TAG 2200 63V	1.72
TAG 4700 63V	1.99

AXIAL ELECTROLYTICS	
.47 63V	.08
1 63V	.08
2.2 63V	.08
4.7 25V	.06
4.7 63V	.08
4.7 450V	.19
10 25V	.08
10 63V	.10
10 450V	.27
22 25V	.08
22 450V	.47
33 25V	.08
47 10V	.07
47 25V	.08
47 63V	.12
47 450V	.60
100 16V	.10
100 25V	.10
100 63V	.19
220 16V	.12
220 25V	.13
220 63V	.30
470 25V	.20
680 16V	.35
1000 25V	.33
2200 25V	.70
2200 40V	.75
4700 25V	.85

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.01	.025 ea.
.1	.035 ea.
.47	.06 ea.
.68	.08 ea.
.1 25V ceramic	.05 ea.

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.001	.06
.0015	.06
.0022	.06
.0047	.06
.0068	.06
.01	.06
.015	.06
.022	.07
.033	.07
.047	.07
.068	.08
.1	.10
.22 (100V)	.13
.47 (100V)	.22
.68 (100V)	.25
1mfd (100V)	.28

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1000-2200pf	.035
2700-10,000pf	.04
.1	.09

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1-47pf 2% (Low K)	.03
56-100pf 2% (Low K)	.035
100-150pf 2% (Low K)	.055
180-820pf 10% (Med. K)	.03
1000-2200pf 10% (Med. K)	.04
3300-4700pf 10% (Med. K)	.05
10,000-20 + 80 40V	.035
22,000 .20 + 80 40V	.06

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0.022	.13	0.1		.18
0.033	.14	0.15		.24
0.047	.15	0.22		.32

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HE MARKET

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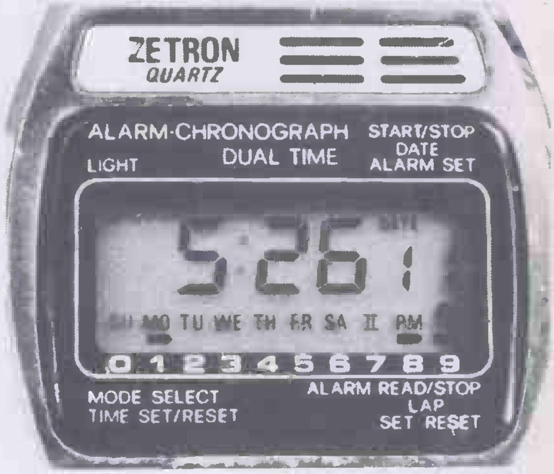

This new addition to our unbeatable selection of bargains is no ordinary LCD watch. It's a slim, multi-function, dual time chronograph alarm watch, no less.

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

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PLACE

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

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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.

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

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TV Broadcasting

The Inquisitive Rick Maybury was let loose at the BBC earlier this month, apart from sitting in Angela Rippon's chair he managed to find out about one or two things on how TV programmes are made.

WHEN WE BEGAN our research into TV Broadcasting we had no idea just how much unseen technology went into the making of even the most basic TV programme. Our 'education' began with a visit to the BBC Television Centre in Shepherd's Bush, London. On its own this Fifties designed and built building is enough to set the imagination going. After only half an hour one is left with the nagging question, do even they know where all the wires go? If there is a circuit diagram somewhere for Television Centre it must bear more than a passing resemblance to the proverbial explosion in a spaghetti factory. Perhaps that's a little unfair though, everybody and everything 'moves' with a quiet efficiency that belies the incredible amount of thought, technology and organisation behind the scenes.

We could never hope to deal with the electronics of even the most humble monochrome monitor in such a short space so we'll try to outline some of the philosophy behind what must rank as the world's foremost TV service.

TELETEXT TO TELECINE

Basically there are three ways an image can end up on the screen of a domestic telly. The first and most obvious method is the directly processed 'live' or electronically recorded (Videotape) TV picture. The second method is essentially the same except that the pre-recorded image is held on photographic film and converted into a TV picture with a device called a Telecine. The third, and most recent arrival on the scene is the 'Electronic' image, the most familiar example being the British developed Teletext system or to give it its more familiar BBC name CEEFAX. (The IBA operate an almost identical service called ORACLE). This system is purely electronic in that at no point are photographic techniques used to generate the final picture, instead it is done digitally by computer. (Actually CEEFAX does have the facility to 'Digitise' a picture but as it doesn't move it still doesn't count).

Looking around the CEEFAX department confirmed an already growing suspicion that the subject of Teletext was worthy of a feature all of its own, look out for that, hopefully in the coming months.

PICTURE GALLERY

Taking the simplest case of a live TV programme, the Weather-say, there may be up to 30 or 40 people directly concerned with getting that picture of Bert Foord to your screen and that doesn't include the small army of back-up personnel involved in scenery, make-up and maintenance etc.

Three main departments are responsible for getting that programme on the air. During the transmission (in the case of a live programme) or recording of a programme the three departments all come together in a large glass fronted sound-proofed room overlooking the studio called the 'Gallery.' The Gallery is partioned off into three rooms for each of the departments.

The first and doubtless the most busy is the production control room. This is where everything gets co-ordinated, all of the camera direction, picture direction, special effects (wiping, fading etc) are controlled, as well as the million and one other things that the producer and director are responsible for artistically, rather than electronically. The second, and probably most impressive from the button pusher and knob twiddler's point of view is the Lighting Control Room. Apart from controlling anything up to 200 separate lights or 'Lumieres' the lighting controller also has the final say in the colour setting of the transmitted picture, able to make quite drastic adjustments to the colour balance. Modern lighting desks now feature computer control whereby, rather than setting the lights for each scene over and over it can be optimised during rehearsal and then stored in the computer's memory and recalled again later during recording or transmission.

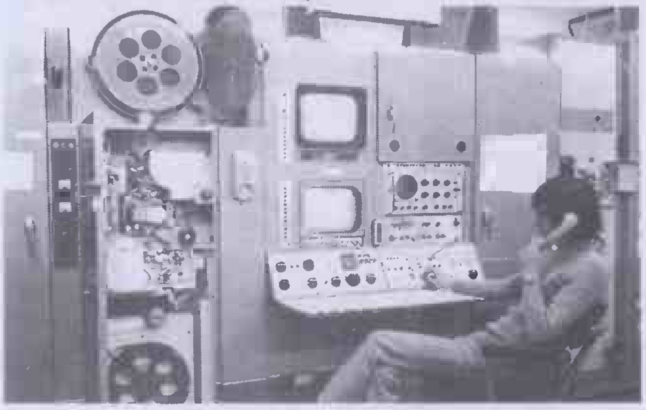
The third department is the Sound Control. Banks of faders and knobs, rows of tape recorders, speakers and some rather venerable (but we're assured yet to be equalled) 'gramophones' are crammed into the smallest room of the Gallery. Here all of the incoming sound signals are duly dealt with, balanced, compressed, expanded and generally fiddled about with until it matches the Beebs stringent requirements. As well as dealing with the studio sound the Sound Control is also responsible for adding any sound effects or incidental music that may be required.

The shape of things to come. As the news services become more mobile the need for smaller and ligher colour cameras offering 'studio' quality increases. This is a 'Minicam' (to use the American terminology) from Phillips. The Vidicons can be seen at the top and inside the camera body.

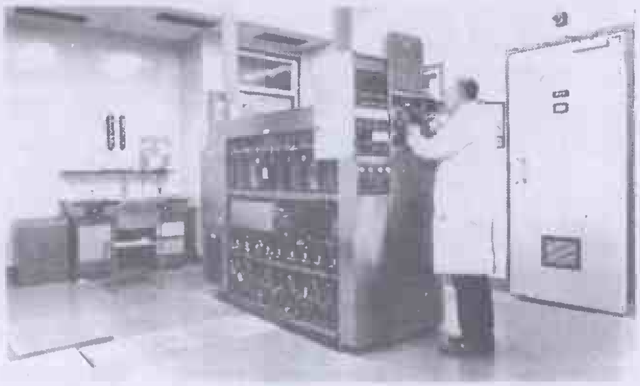
Shown here is the BBC's Research Department's new digital audio tape recorder and mixer desk soon to become a standard feature of sound processing studios.

The Sound Desk, this one is a condensed version used in Outside Broadcast Vans for mobile work.

A Philips 'Minicam' attached to a cameraman. The collection of straps and links ensures the maximum manoeuvrability with the minimum of strain on the operator.



Close up of a Telecine camera and projector, the projection equipment can be seen inside the open cabinet, the camera is contained inside the locker on the left.



The colour film processing equipment at the BBC, essential for fast turn around of material.

Each studio has a camera control department ensuring that all the studio cameras are correctly aligned prior to transmission or recording. Whatever you may say about the content of the programmes on the telly, the BBC go to incredible lengths to ensure the quality of the transmitted picture is second-to-none.

ADDITIONAL MATERIAL

Of course this is the simplest case, in reality most programmes are recorded and programmes like the news may use material from a variety of sources including 'live' action, film and Videotape. The coordination of all these elements must be a major headache to all concerned, it is to their credit that 'mistakes are so few and far between, perhaps we take it all too much for granted.

In general though, most 'home grown' material is pre-recorded on video tape or film. Material shot in the studio is usually commited to video tape and it is the BBCs proud boast that they are able to 'set up' a complete studio, take all of their shots (even allowing for foul-ups) and clear it all away all in a working day. Take it from us that after seeing a set for a production of the space serial 'Blakes Seven' that takes some organisation!

Obviously regular programmes like the News have their own 'dedicated' studios. The BBC News studio is almost completely remotely controlled, apart from the Floor Manager and a couple of others operating 'Auto

This rather unwieldly looking piece of apparatus is called a 'Steadicam' camera steadying device with a lightweight electronic camera attached.

Cue' cameras and caption boards the studio is deserted. Likewise in the Gallery an abbreviated version of a full size studio controls the programme, everything is in miniature, running like clockwork under the watchful eyes of the producer and director.

GETTING IT ALL TOGETHER

All of the signal sources come together in the Central Control Room, because several different methods of signal generation are used as well as up to ten different cameras for studio work incredible problems arise in keeping everything synchronised. Inside the control room lurks the central Sync generator based on a Rubidium oscillator. Using equipment with this kind of accuracy leads to all kinds of other problems. Because the various studios are spread about the site they are all different distances away from the Central Control Room, sometimes only a matter of feet but this is enough to cause a slight jitter when switching from studio to studio. To counteract this problem the BBC engineers have adopted the crude but effective method of connecting each studio to the central control room with cables of the same length. This means that studios close to the control room have an excess of cable which is neatly coiled up in racks in the control room itself.

Apart from acting as a switching centre for all of the local signal sources the Central Control Room co-ordinates all of the regional inputs to the network and outside broadcasts from remote locations via land line

Telecine equipment used to convert movie film into an electronic image, it is nothing more than a conventional movie projector coupled up to a colour camera.

The BBC Regional News Room, in front of the presenter are banked monitors and Auto Cue displays.

Close up of part of the Production Control Desk in the Gallery.

An outside broadcast camera on a riser. By using a clever system of levers and counterbalances the camera and operator can be effortlessly raised and lowered.

ENG or Electronic News Gathering OB vehicle being set up for a microwave link with the studio. The BBC are currently experimenting with this method of news presentation.

Cameraman's eye view on a riser, his hand rests on the main focus/pan/tilt/and zoom control.

The riser fully extended, the hydraulic rams can be seen under the upper arm, a scene from this year's Chelsea Flower Show.

and microwave link. Large display boards monitor the network indicating any faults that may have occurred in the system. Behind the control room lurks the new CEEFAX computer an impressive looking machine which we hope to look at in more detail in a future issue. Also to be found in this are two interesting devices used by the BBC to carry information and control remote equipment. Like the teletext system it uses unused portions of the TV signal to carry coded signals. The first is called PRESSFAX and works in a very similar way to CEEFAX. It contains all of the up-to-date information on programme running times, alterations, cancellations etc, purely on an internal basis. The second system is called ICE and this is a control signal that can be used to activate VTRs or transmitters on cue.

Well, that's about as far as the TV signal goes within the studio complex from here it is transmitted as a standard one volt video signal via land line to the transmitter site.

TRANSMITTER TO TELLY

This is the easy bit, once the processed video signal leaves the control room it has had all of the synchronisation pulses inserted along with the colour information and Teletext signal so very little signal manipulation is carried out from now on.

Upon arrival at the transmitter site the composite video signal is modulated onto the UHF carrier (most of which is suppresed at the output) and fed to a suitably sited aerial, many are not un-manned (or un-womanned ????) and operate under instruction from the ICE equipment.

From then on its through the air, down the aerial and on to your screen but that's a different story and if the last three paragraphs seem a bit brief you'll have to wait until next month to find out exactly what happens between the transmitter and receiver. **HE**

The author would like to thank Gwyn Morgan and the staff of the BBC for their kind help in preparing this article.

Kit Review

CAR ANTI-THEFT ALARM

No need to become a statistic, this month's car alarm kit should protect your car against even the most determined car thief or casual 'joy rider'.

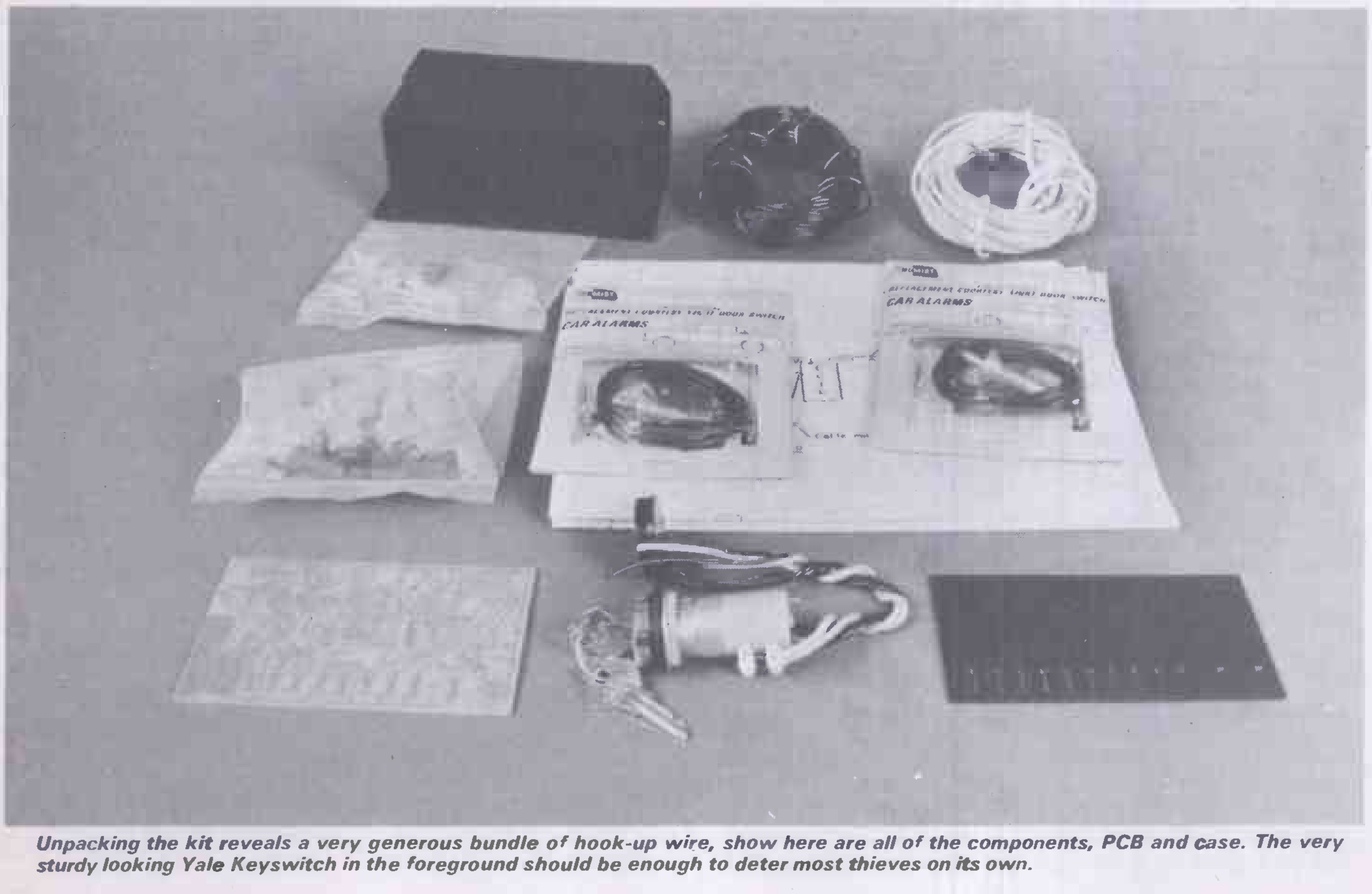
HOPEFULLY, THIS IS ONE KIT that will never have to work. Official sources now reckon that a car is stolen in Britain at the rate of about one a minute. So it would seem sensible to take at least some precautions to protect your vehicle. It's probably quite true to say that there's not much you can do about a really determined, professional car thief but a well designed (and installed) burglar alarm should at least offer some protection, and will certainly prevent the casual ''joy rider'' from stealing your car.

At first glance it would seem relatively easy task to design a car alarm, a few micro-switches here and there and 'Bob's your uncle'. Such a system is fine but it still won't guard against anyone pinching your expensive car, radios and stereos etc. (Shame on the man who said CB rig, you shouldn't have one of those anyway).

SENSORS

Our kit this month is a particularly well-designed and thought out car alarm. It can operate in three modes, open-circuit loop, closed-circuit loop and voltage sensing. Just in case an enterprising thief should try to disconnect the car battery, it also has a provision for an internal 'back-up' battery. The open circuit loop is ideal for connection to courtesy light switches on doors, bonnet and boot, extra switches are supplied with the kit. The closed circuit loop is intended for use with inertia type switches or any loop or wire that may be cut or broken. The voltage sensing circuit will activate the alarm, if for instance, it is connected to the ignition coil and the ignition is switched on.

With all these options it would be very difficult for any



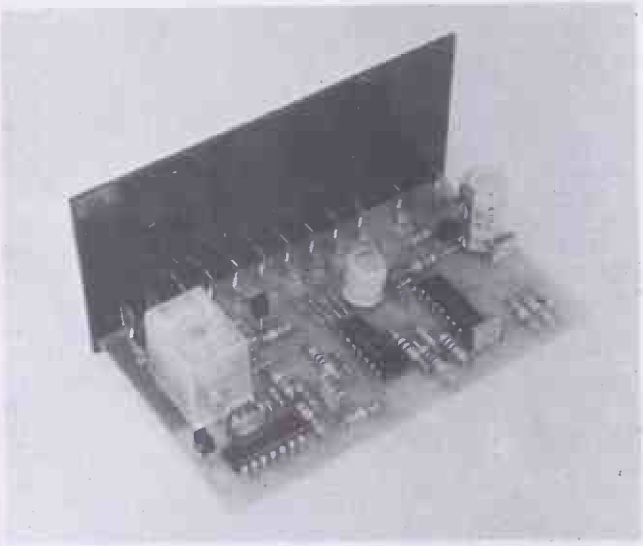
Unpacking the kit reveals a very generous bundle of hook-up wire, show here are all of the components, PCB and case. The very sturdy looking Yale Keyswitch in the foreground should be enough to deter most thieves on its own.

kind of thief to penetrate all those defences, so enough of theory and on to the kit in question.

AN ALARMING EXPERIENCE

It comes from a company called CEH Audio Visual, new to us we must admit. Our review kit was a pre-production prototype so if we're a little unkind about the paperwork, please bear in mind that ours was a preview model and we're assured that the actual finished product will be complete.

Unpacking the kit, we were confronted by a large assortment of connectors, wires and switches, after a fair amount of searching we finally discovered the electronic components and glass-fibre roller tinned PCB. Without waiting to be asked all this was rapidly assembled (patience is not a virtue in great abundance amongst members of the HE staff).



The completed Car Alarm prior to being cased. The use of spade type connectors enables the alarm to be swiftly and reliably installed. The production version will use sockets for the ICs and the PCB will have the components position clearly marked.

The electronics are quite 'extensive', especially considering the basic simplicity of the circuitry, no less than three ICs, thirteen diodes, a handful of resistors and capacitors, a relay and three transistors. Building time for the electronics should be no more than one hour. Once completed the PCB fits into a tough looking, water tight, plastic box. Only the 12 spade connectors protrude through slots cut in the front panel of the case.

Once you have got this far the rest is up to you, the basic kit is more than adequate to protect most cars. Traditionally the weakest link in any alarm is the on-off switch, this is taken care of by a very strong looking Yale keyswitch. The extra switches supplied would probably be best sited on the boot and bonnet. Another welcome touch was the addition of those 'in circuit' connectors that can make connections to leads without breaking the circuit. The wire to be connected is simply pushed into one side of the connector and the wire to be joined into the other side, then the two halves are simply squeezed together, neat and simple.

IF IT WORKS

Of course it works but without any technical information it's a bit difficult to explain exactly how. From looking at the circuit board it would seem the logic is fairly straightforward, based as it is, on three 4001 quad NOR ICs. Part of the circuit forms a timer with a two minute period, this determines how long the horn (or warning device of your choice) will sound after the alarm has been triggered, provided of course that the cause of this alarm has been rest. Again we're assured by the distributors that the production version of the alarm will be complete with circuit diagram and a very comprehensive technical back-up.

Installation in any burglar system represents the majority of work, the more care that is taken with installation the more reliable the system as a whole should be. Pay particular attention to concealing the cables, CEH thoughtfully provide plenty of hook-up wire so unless you're fitting a London bus you shouldn't need to buy anything else, apart from any additional sensors that may take your fancy (or suit your pocket.)

One of the most irritating aspects of any alarm set-up is the possibility of false alarms, they usually occur at the most embarrassing moment (four o'clock in the morning is a favourite time), as it stands we cannot see this system being any trouble whatsoever, provided reasonable care is taken during building and installation. So before you tackle a project like this sit down and plan exactly what type of protection you will need.

GRIPES

Our only real moan arose from the omission of technical information, this we realise is only because of our particular model being a prototype. The installation notes are very comprehensive and leave nothing to chance. All in all a very good kit.

Just in case you're a little more ambitious CEH will 'customise' alarms to your requirements, or if you want to go it alone they can supply a variety of additional extras, switches, inertia, reed etc, electronic sirens and advice on individual installations.

The mass of connectors supplied with the kit. The connectors at the top of the photograph are the type that can 'patch' into a wire without actually breaking the inner conductor, very useful in this kind of installation.

As a postscript we have heard from the manufacturers that the alarm could easily be adapted for use in boats, caravans or even houses, they will be glad to offer any advice concerning a particular requirement.

The CEH Alarm is available exclusively from NIC Electronics, 27 Sidney Road, London N22 4LT for a very reasonable £18.90, all inclusive of VAT, post and packing. **HE**

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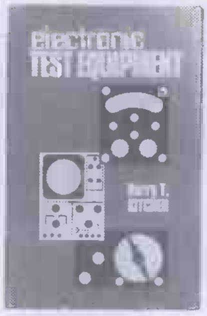

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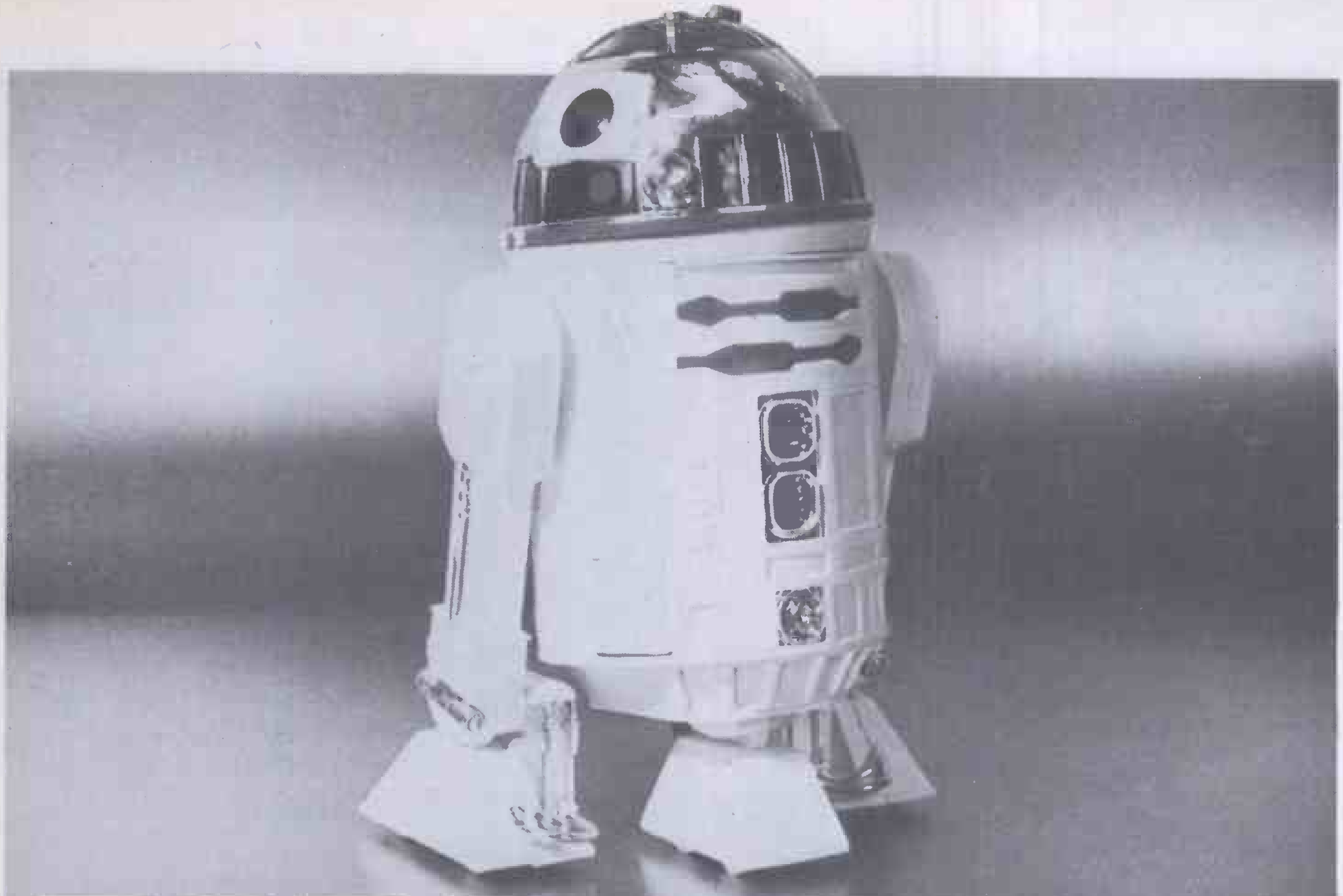


R2D2 Radio

Tired of tobacco tins? Realise that revolutionary sound with the R2D2 robot radio.

PSSST . . . had your ear to the ground for a really good project? Well now is the time to put it to the HE robot radio and get an earful of entertainment. Yes! Thrill to the Jimmy Young show while feasting your eyes on your favourite 'Star Wars' character.

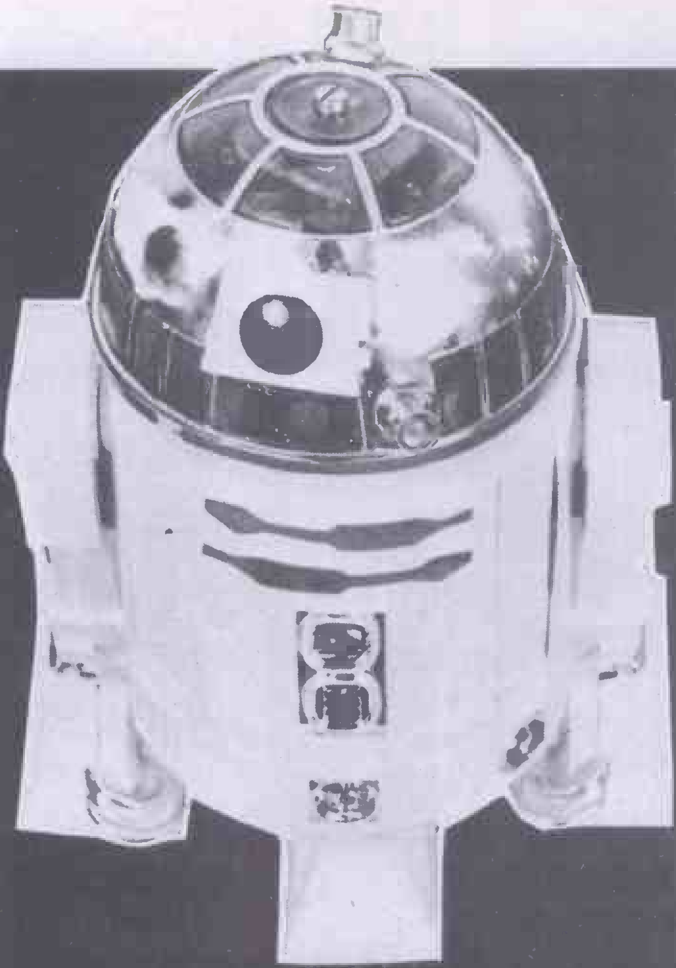
Featuring complete coverage of the medium wave band with only two simple-to-operate controls; excellent reproduction from the internal loudspeaker should be enjoyed almost everywhere throughout the country. An integrated circuit is employed in the unit giving high quality and efficiency with small size and low battery drain.

REFLEX REJECTS

In the bad old days of transistorised radio (when a man with a red flag ran in front of every transmission) it was customary to design receiver circuits to get the maximum use from costly expensive and inefficient component. This resulted in a cross-breed of radio and audio amplifiers called reflex sets where one component did the work of two. We remember one circuit where the signal went down the tubes three times before it found its way out, though we cannot imagine how they did it!

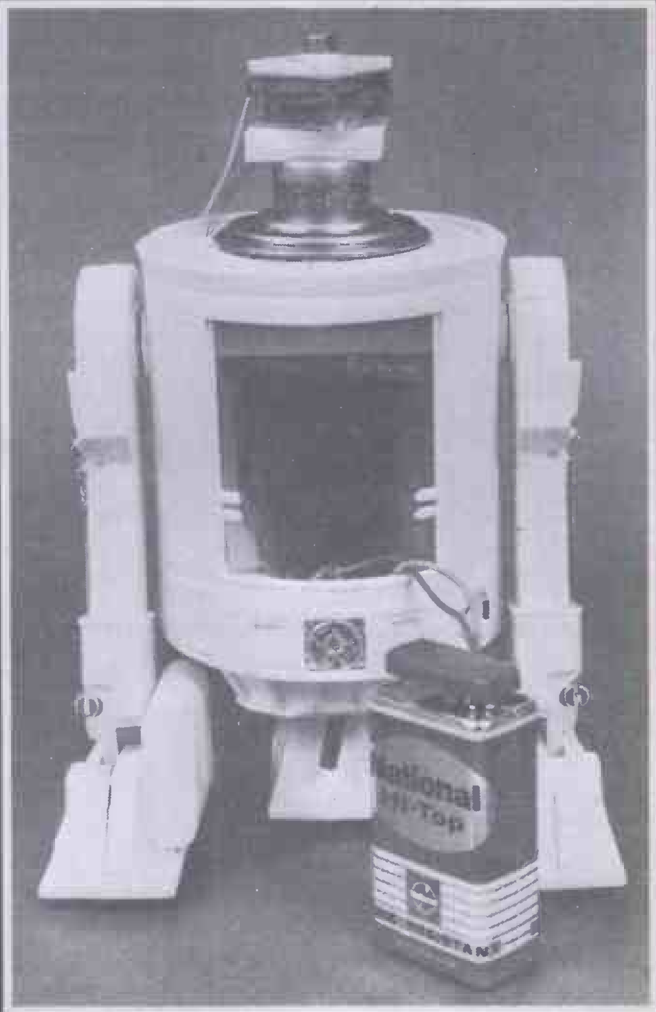
Modern technology and Asian industry have brought us super-cheap superhets and high gain and frequency transistors. It is now possible to build quite sensitive receivers without resorting to the devious circuit techniques described above. A few years ago, Ferranti introduced the ZN414; a ten transistor TRF circuit. This is a very good chip and was considered for this project. However, its major drawback is the requirement for a low voltage supply and in some circuits this results in the use of more components in the regulator than in the rest of the receiver.

We finally decided to design our own circuit and the outcome is a sensitive and very stable tuner with low current consumption and using only a handful of ordinary, easy to obtain components. It was felt that a loudspeaker output was essential. After all, if you walk round with an earphone in your ear all day, your ear might atrophy and drop off. The audio amplifier is very simple and straightforward and will drive any size of loudspeaker with impedance ranging from eight to eighty ohms. Higher impedance loudspeakers give lower available output power though you do get the bonus of lower distortion. The prototype gave more than adequate volume and even provided reception of a few stronger stations inside a steel-frame building.



wires can be brought out to a case mounted component. The ferrite rod aerial should be mounted horizontally (it won't work the other way!) and the tuning capacitor should be mounted as close as possible, keeping the connecting leads short. A wire should be taken from the 0 V line to the rotating vanes of the tuning capacitor, usually the centre contact.

However it is constructed, the robot radio is fun to build and will give endless hours of entertainment when completed.



Open for inspection. Note the tuning capacitor mounted above the loudspeaker and the power switch mounted on the base.

CONSTRUCTION

Construction should not present any difficulties. Of course, if you want to build your radio in a robot you will have to solve the problems of exactly where to put the components yourself, though you can pick up some pointers from our design.

The circuit is very tolerant of constructional technique and special care was taken in its design and PCB layout to make it as stable as possible. Any high gain circuit is prone to instability and RF circuits can suffer from all kinds of gremlins. A useful tip if you have any trouble is to try reversing the connections to L2 or to the loudspeaker. This will reverse the feedback of the unwanted signal and should result in its suppression. In view of the pitfalls mentioned, use of our PCB is strongly recommended.

Any size of ferrite rod may be used; the larger the rod the greater the signal pick-up. In fact spare the rod and spoil the signal! You may want to buy a ready-wound ferrite rod, 'borrow' one from an old transistor radio or wind your own.

If you wind you own, L1 should be about eighty turns of thin wire. By winding more turns you can cover the long waveband and receive the elusive radio four. L2 should consist of about five turns in either case . . . experiment to get the coverage you require. It is a wise move to protect the wire by first wrapping a thin layer of paper around the rod. You can secure the turns with sellotape. The best wire to use is enamelled copper wire of about 30 swg.

Loudspeaker size is a matter of personal choice. Choose one to fit the case you want to use. Provision is made on the board for a preset volume control though

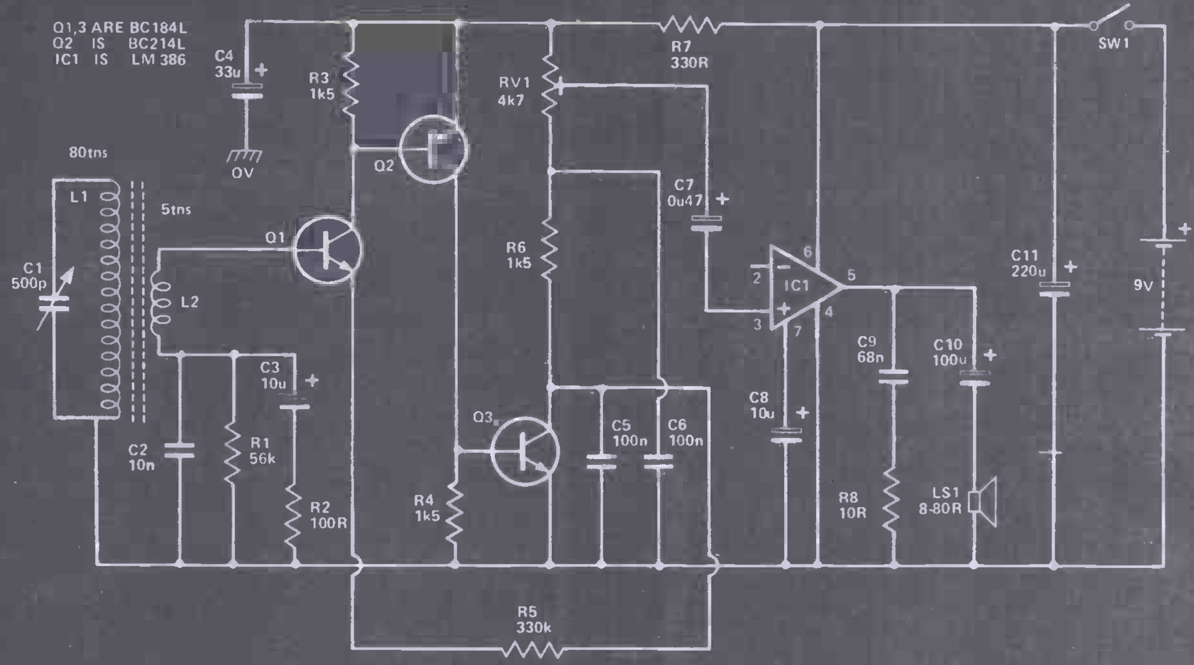


Fig 1. Circuit diagram of R2D2 radio

How it Works

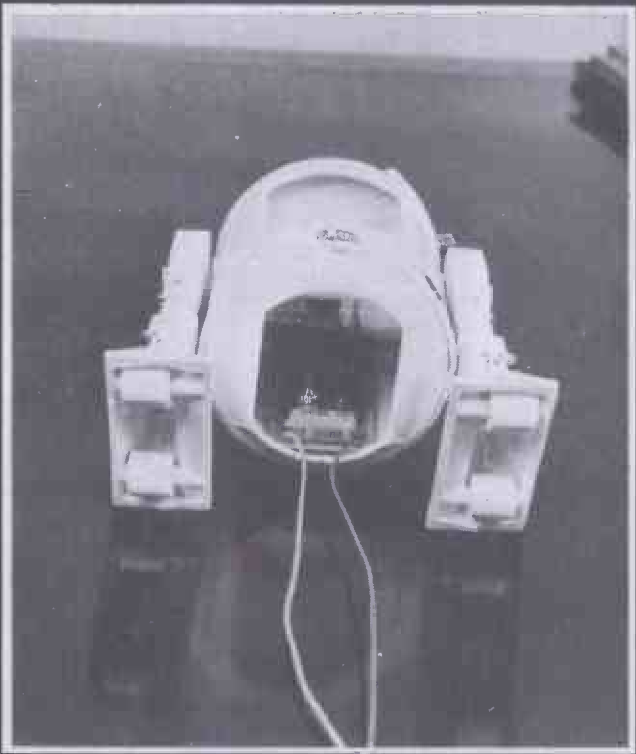
The robot radio is a MW AM receiver. This means it is designed to receive amplitude modulated transmissions between about 500kHz and 1.6MHz, the medium waveband. Amplitude modulation describes a mode of transmission where a carrier wave at a certain frequency is varied in strength by the audio signal to be transmitted. No change in the carrier frequency should take place and great care is taken to ensure that a 'clean' signal is transmitted to avoid interference with other transmissions on nearby frequencies.

The signal is picked up by the ferrite rod aerial and L1, C1 comprise a parallel-resonance tuned circuit to select the desired station. At most frequencies, L1, C1 looks like a piece of wire to earth. However, at one particular frequency, (variable by adjustment of C1,) the tuned circuit exhibits a very high impedance and a voltage is developed across it. A portion of this signal is inductively coupled to L2 where it is available for amplification and detection. Direct coupling to L1 is avoided as this would 'damp' the tuned circuit causing loss of selectivity.

Transistors Q1, 2, 3, are configured as a direct coupled amplifier with overall DC bias set by resistors R5, R1. AC decoupling is provided by C3, R2 and capacitors C2, 5, 6 provide RF decoupling. The radio frequency signal from L2 is amplified by Q1 and Q2. The third transistor Q3 acts as a detector and audio amplifier and the audio signal is developed across RV1 and R6.

A portion of this signal is tapped off from RV1 by potential divider action and coupled to the audio amplifier IC1 by C7. Bias and gain are set automatically inside IC1 and the amplified output signal is coupled to the loudspeaker by C10. At first glance R8, C9 appear to have no function. In fact they are essential. If omitted, IC1 would be prone to spurious RF oscillation causing distortion. These components should be mounted as close to the chip as possible. C4, 8, 11 are all supply decoupling components at various points in the circuit.

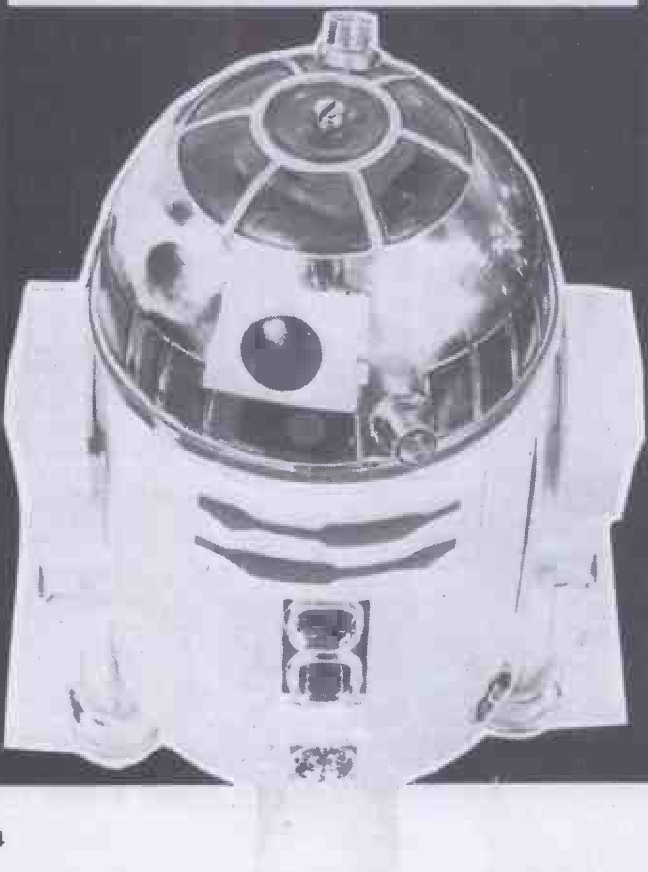
A point worth note is the availability of an amplified 'in-phase' RF signal at the collector of Q2. By coupling a small portion of this signal to the base of Q1, positive feedback can be produced giving increased sensitivity. This can be achieved by connecting short (about one inch) pieces of insulated wire to the collector of Q2 and the base of Q1 and gently twisting them together ensuring they remain insulated from each other and the rest of the circuit. This is the same as connecting a small capacitor of a few pF between these two points and the technique is called regeneration. Too much feedback will result in the circuit oscillating and producing squeaks and whistles. This condition should be avoided as it causes interference to other radio listeners. The right amount of feedback is when the circuit is just on the point of oscillating. You will find this gives an increase in both sensitivity and selectivity. However, this technique will probably not be required as the prototype was found to be quite sensitive when built as described.



The main PCB mounted inside R2D2's body

Buylines

All the components should be readily available apart from the LM386 which can be obtained from Marshalls.



Parts List

RESISTORS (All ¼W, 5%)

R1	56k
R2	100R
R3, 4, 6	1k5
R5	330k
R7	330R
R8	10R

POTENTIOMETER

RV1	4k7 (see text)

CAPACITORS

C1	500pF variable
C2	10n polyester
C3, 8	10µ tantalum
C4	33µ tantalum
C5, 6	100n polyester
C7	0µ47 tantalum
C9	68n polyester
C10	100µ tantalum
C11	220µ electrolytic

SEMICONDUCTORS

Q1, 3	BC184L
Q2	BC214L
IC1	LM386

MISCELLANEOUS

L1, L2, ferrite rod aerial (see text) loudspeaker 8 to 80 ohms any size.

S1	SPST switch
9v battery	(PP3 etc.)

Approximate cost £4.50

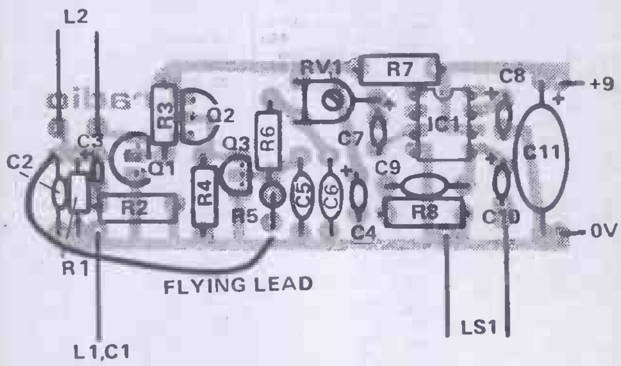


Fig 2. Overlay for R2D2 radio

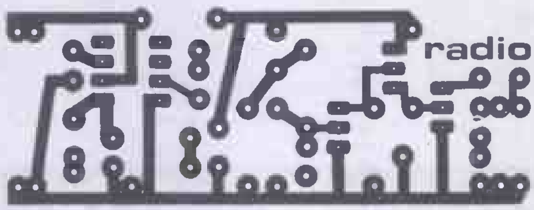


Fig 3. PCB for R2D2 radio

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Breaker One-Four

Send any news, comments, or information you may have to. Breaker One Four, Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE.

Following the disclosure last month in Breaker-One-Four we've had many phone calls telling similar stories — meanwhile do not sit back — write that letter to your MP — it's still not too late.

CHANNEL 35

It's very easy to bury your head in the sand when it comes to talking about the illegal side of CB. No matter how much you may condemn this aspect of CB it still exists, and current estimates reckon there are about 150 000 to 200 000 CB rigs in the country at the moment. Now don't get us wrong, we still will not condone any CB system that interferes with other people, but if it were legalised tomorrow there would still be many thousands of people out there who are unwilling to dump their rigs, often costing over £100, and you may be sure that if and when CB is legalised it will not be on 27 MHz.

So what can we do about all those people? The answer came a few days ago during a conversation with Keith Townsend of the Midlands CB Club. Most if not all of the criticism of 27 MHz CB comes from the radio modellers (and rightly so) for they legitimately occupy the first 27 channels of the 40-channel set-up. The Breaker Channel 14 is slap bang in the middle of their allotted band but above channel 30 (say) there is nothing as far as we know (please let us know if there is anyone already there). If we were to suggest moving the Breaker Channel away from 14 to 35 during daylight hours and stick as far as possible to the channels 30-40 how would that sound?

Again we must stress we're not encouraging the illegal use of CB but rather trying to alleviate a growing problem, it's still breaking the law but maybe someone's life may be saved from an out-of-control model aircraft. Of course for it to be of any use whatsoever it must be adopted nationally and simultaneously. So we would like to suggest a national changeover to this system on the 1st of November.

We would be glad to hear of any reaction to this suggestion.

TEE-SHIRTS

You may remember last month we said that the 10-4 Club were producing some Tee-Shirts, well, details of their offerings have arrived. It consists of a rather eye-catching combination of silver logo and lettering on a black cotton Tee Shirt, and very good it looks too. Price for these garments is a very reasonable £2.10 plus 50p postage and packaging (please state whether S. M. L or XL) from the clubs address given last month. (See Club Call).

This is also a good opportunity to tell you about some Tee-Shirts we're thinking of having made up, we'll let you know more about that next month.

BREAKER BRIDE

It was inevitable. A Mr 'White Prince' has informed us of the first CB wedding in this country. Mr Delta 24 met Miss Pussy Galore at an Eyeball in February earlier this year (sounds like a game of consequences), as a result of this fateful meeting they have since married (early September). Hobby Electronics would like to congratulate the happy couple and hope that their antennas may forever remain perfectly SWR' ed.

'Has anybody else got any new of 'strange' happenings directly as a result of CB? Write to us at Breaker-One-Four and tell us about it.

CB SLANG

Entries for our slang competition have at last started arriving. Unfortunately one or two are still unprintable (but very funny) so keep the clean ones coming. (And the dirty ones, we like reading them too.)

Here is our first selection, Tee Shirts are on the way to all concerned.

Lollipop .... Traffic Lights
Jam Sandwich .... Police Rover
Starduster (again?) London.

Dry Glasses .... Headlights on main beam
Head And Shoulders .... Snow
Beer Bottle .... Road Tanker
Grizzley Bear .... Magistrate
From M. A. Read, Berks.

Four-Legged Milk Float .... Cow
From 'Songbird,' London.

Trail Blazer .... Member of the clergy??
From A. S. Foster, Bedfordshire — see also club section.

Traffic Warden .... Custard
Traffic Warden (female) .... Custard Tart
Morris Minor .... Jelly Mould
Taxi Driver .... Loony
Low Bridge .... Head Banger
Football Fans .... Scarves
From K. R. Blagg, Blackpool

R/C MODELLERS

We've just heard within the last couple of days that the proposed 'switch-over' by the Radio Control Modellers to 35MHz is now very unlikely in the time we suggested last month. In fact one source now reckons that they may even be losing part of their allocation on the 495 MHz band so it is even more crucial that something be done to alleviate the interference problem on 27 MHz.

CLUB CALL

Details of clubs are still coming in, before we get down to the new ones we would like to apologise to the 10-4 Club for getting their address wrong last month, it's 85 Essex Close, not 83 as we said last month.

CB (Christian Buddies) CB Club
Chairman Artur Scott-Foster.
103 Southwood Road,
Downside, Dunstable, Beds.

ANTENNAS AGAIN

Suddenly everyone's selling CB aerials, three companies have been in touch with us to tell us about their wares. The first is good old N.I.C. Models, see Ad. in this issue for details. The next is John Woolfe Racing Ltd, purveyors of fine Wheels and other mobile goodies. (How about a set of slot mags for review lads?) They are currently offering quite a comprehensive range of 'sticks,' Co-Phased truck devices for £39, Mag mounts for £18 and 'Disguised' for £22.95. They also tell us they've got a few Yankee books on offer, including the excellent Big American CB Book for £3.95 and Chilterns CB Book for £4.00.

Tandy (surprise, surprise) are also getting in on the act, they tell us that they will have a range of three antennas on sale at the beginning of the month (October), with more goodies, mikes etc later on in the year. The first is a Truckers antenna, retailing at £21.95 a Boot mount will cost £24.95 and finally a Mag Mount going for £26.95. Tut Tut to all concerned.

TO ALL CB CAMPAIGN ORGANISERS

Gentlemen,

Though we are all working to achieve the same end I am forced to conclude that we are going about it in the wrong way, insofar as we each represent a separate campaign.

We are all aware of the current rumours suggesting imminent legalisation but we must remember they are as yet unconfirmed and that we may yet have some way to go.

Various points of view, each having some merit have been put forward regarding the frequencies favoured by each individual group but I suggest that this problem be considered of secondary importance and that we should now be prepared to present the authorities with a united front in order to achieve our primary aim-the introduction of a legal CB facility.

I suggest that a meeting be held between officials of all interested bodies as soon as possible.

Individual groups would benefit from the pooling of information and resources and our own common cause would be greatly strengthened.

I look forward to receiving any comments and suggestions which you may have.

Keith Townsend
Secretary MCBRC

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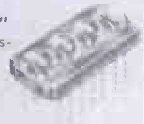

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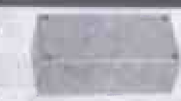

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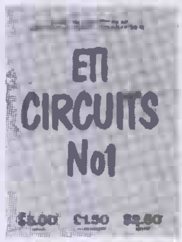

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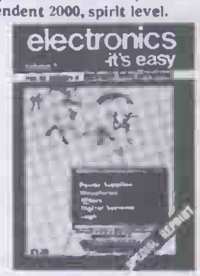

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The complete series of Ian Sinclair's series Into Electronics Plus a selection of some of the most popular and informative articles from HE. Everything from Home Computing to making your own PCBs.
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Guitar Tuner

Now, for the first time we present a readers design, a good straightforward circuit put to novel use.

UNLIKE OTHER MAGAZINES all of the projects in HE are designed and built by our very professional project team, this month by way of a change we are publishing a design sent in by a reader — Mr Steven Ibbs. We were so impressed by the originality and simplicity of the circuit and the professional way he had built his project we felt it was good enough to publish.

Apart from re-doing the circuit diagram a 'How It Works' section, and PCB layout this is all his own work, so now over to you Mr Ibbs.

Before September last, I did not know the difference between a resistor and a capacitor. However, since then and with the aid of HE, I have started to learn about electronics. I have been constantly asked by students at the college where I teach music if I could build them something to help them tune guitars. I didn't know enough to help them until I saw the recent ETI and HE articles on CMOS circuits, this set my imagination going.

The circuit uses an LM386, available from most large components retailers, the smallest loudspeaker I could find, and a small vero-case. Using such a small box enables it to be stored within a guitar carrying case.

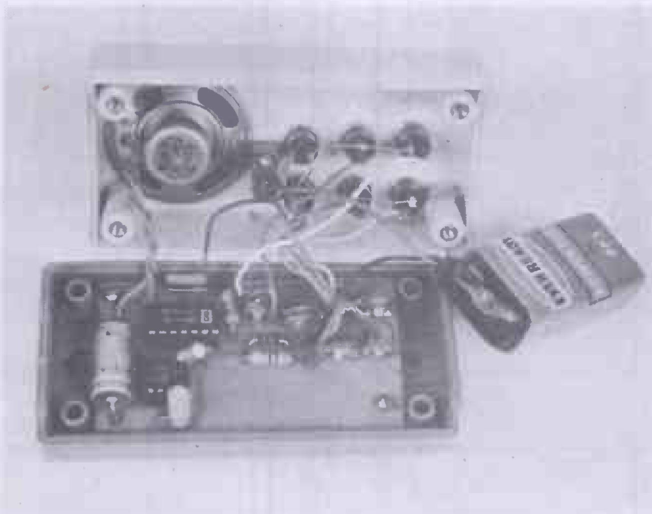
Back to us now for some constructional advice, we recommend using the same Vero-box as Mr Ibbs as everything fits in quite snugly. Our only real criticism of the original design was the siting of the on-off switch. We felt that this was just a little too close to the buttons for comfort. From our limited knowledge of music it would seem that the arrangement of the buttons is about right, they should follow the sequence EADGBE as this is the order of the strings on the guitar.

Obviously tuning the unit may prove to be something of a problem, the obvious answer is to use a guitar that is already in tune, or a alternatively a piano. Failing that may we suggest our Analogue Frequency Meter project in last month's HE.

AND FINALLY. . . .

We must stress this is a one-off as we have a very prolific design team. However, if you think you have got a really good idea and you have successfully built a prototype why not send us a picture of it along with a brief description of what it does. Please include an SAE if you wish to have your material returned. Mark your envelope Readers' Projects. **HE**

The Guitar Tuner in its Vero-Box. We took the liberty of dressing the case up a little for the photographs, otherwise it is as Mr Ibbs intended.



Inside the Guitar Tuner, note the small loudspeaker fitted snugly into the corner of the case. We would suggest that anyone using this method of construction puts the On-Off switch well away from the pushbuttons.

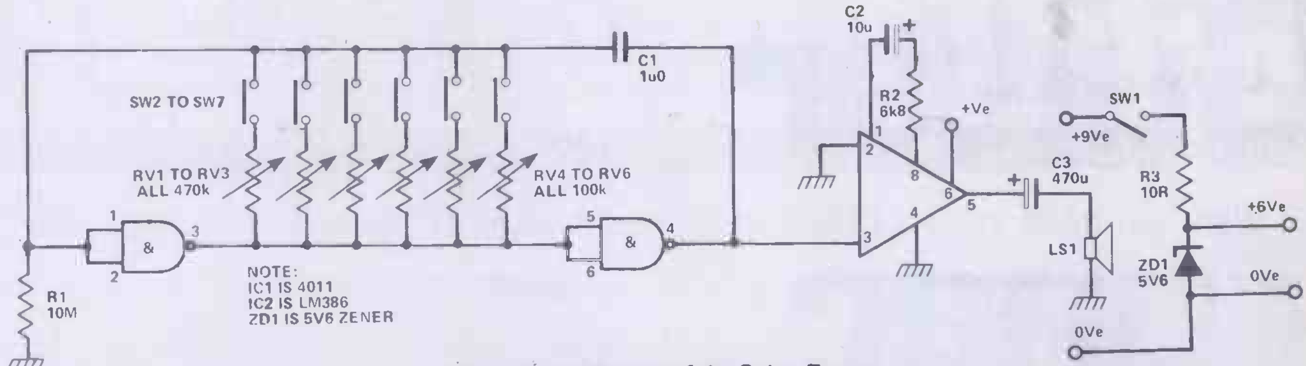


Fig. 1. Circuit diagram of the Guitar Tuner.

How it Works

The circuit is centred around a simple CMOS oscillator comprising two gates from IC 1, a quad, dual-input NAND gate. The various notes are selected by switching into circuit timing resistors RV1 to RV6 via push button switches SW2 to SW7. The setting of the presets determines the note produced. The oscillator timing is determined by the combined values of the particular resistor in circuit ie RV1 to RV6 and the capacitor C1.

The output from the oscillator is fed into the audio oscillator built around IC2. The amplifier output is taken via output capacitor C3 to the miniature loudspeaker LS1.

To ensure a degree of stability under variable voltage conditions the supply is regulated by a simple potential divider network comprising R3 and zener diode ZD1.

Parts List

RESISTORS (all ¼W 5%)

R1	10M
R2	6k8
R3	10R

POTENTIOMETERS

RV1-RV3	470k lin present
RV4-RV6	100k lin preset

CAPACITORS

C1	1µ polyester
C2	10µ electrolytic 16 V
C3	47µ electrolytic 16 V

SEMICONDUCTORS

IC1	CD4011
IC2	LM386
ZD1	5V6 zener 400 mW

MISCELLANEOUS

SW1 Miniature SPST toggle. SW2-7 Miniature push to make switches. LS1 Miniature 1½ inch 8 ohm speaker. Vero-box, battery connector PCB.

Approximate cost £4.50.

Buylines

All of the components used are readily available, the miniature loudspeaker is obtainable from Audio Electronics of Edgeware Road in cases of difficulty.

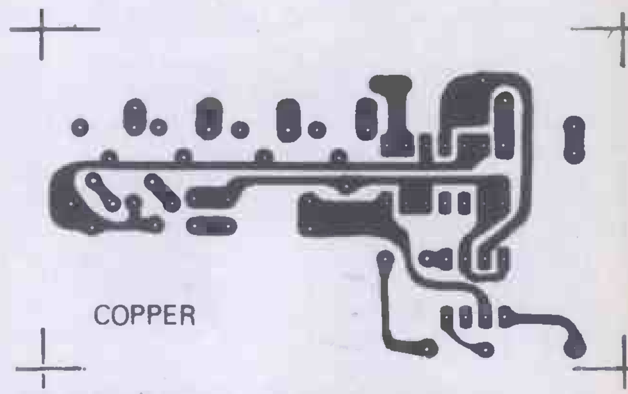


Fig. 2. PCB foil pattern for the Guitar Tuner.

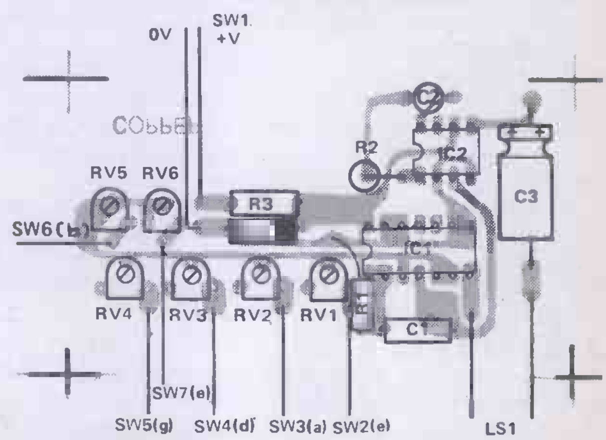
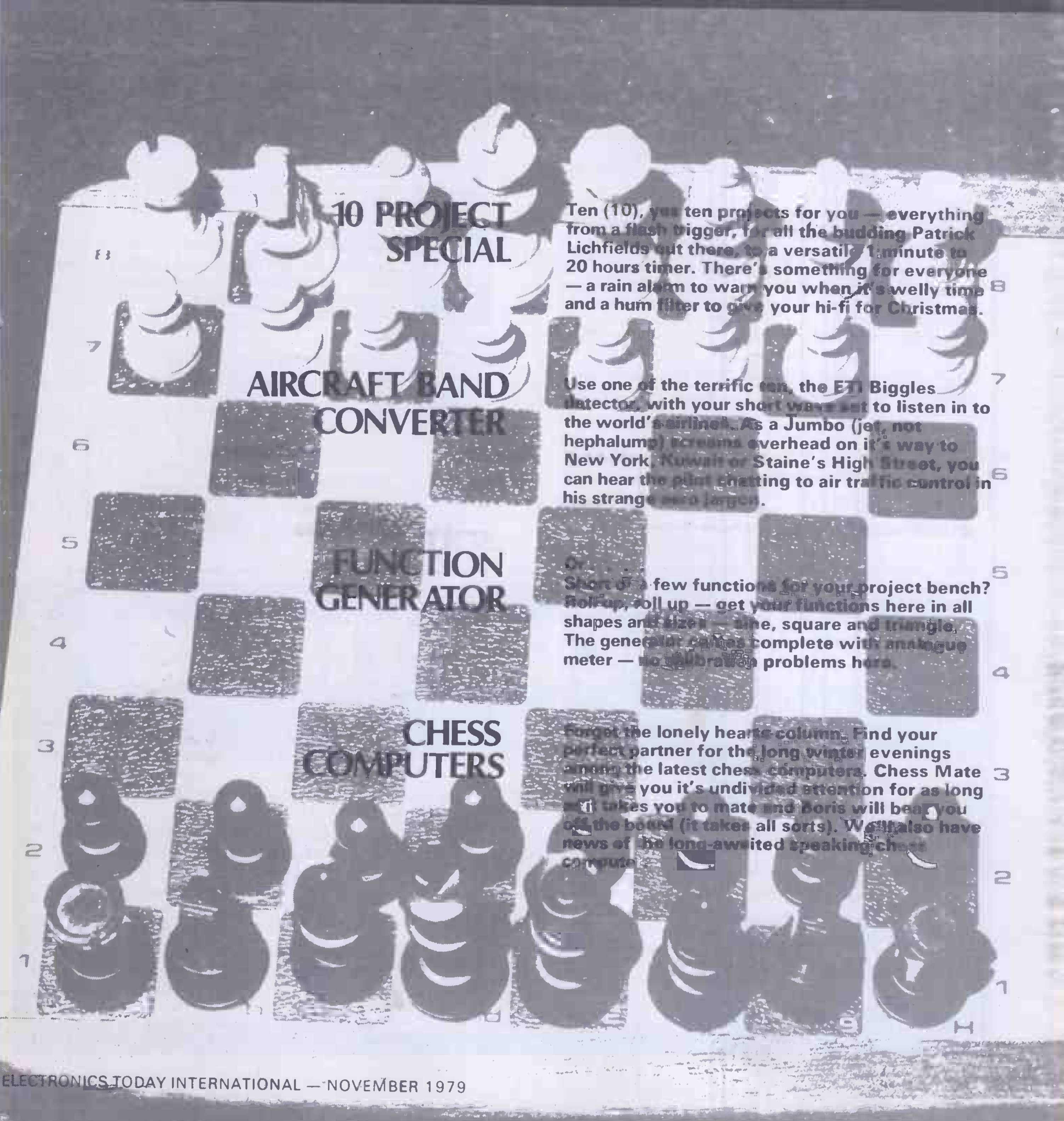


Fig. 3. Overlay diagram for the Guitar Tuner, ensure the ICs are inserted into their sockets the right way round. The connections for the pushbutton switches can be seen at the bottom of the previous page. Be sure to use vertical presets for RV1 to RV6 as horizontal types will not fit.

electronics today international

What to look for in the December Issue: On sale November 2nd



10 PROJECT SPECIAL

Ten (10), yes ten projects for you — everything from a flash trigger, for all the budding Patrick Lichfields out there, to a versatile 1 minute to 20 hours timer. There's something for everyone — a rain alarm to warn you when it's welly time and a hum filter to give your hi-fi for Christmas.

AIRCRAFT BAND CONVERTER

Use one of the terrific ten, the ETI Biggles detector, with your short wave set to listen in to the world's airlines. As a Jumbo (jet, not hephalump) screams overhead on it's way to New York, Kuwait or Staine's High Street, you can hear the pilot chatting to air traffic control in his strange aero jargon.

FUNCTION GENERATOR

Or . . .
Short of a few functions for your project bench? Roll up, roll up — get your functions here in all shapes and sizes — sine, square and triangle. The generator comes complete with analogue meter — no calibration problems here.

CHESS COMPUTERS

Forget the lonely hearts column. Find your perfect partner for the long winter evenings among the latest chess computers. Chess Mate will give you it's undivided attention for as long as it takes you to mate and Boris will beat you off the board (it takes all sorts). We'll also have news of the long-awaited speaking chess computer.

Back Numbers From HE

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

Hobby Electronics
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145 Charing Cross Road
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Shown next to each issue is the relevent code letter to use when ordering Hobbyprints. (See Hobbyprints ad. elsewhere in this issue.)

We regret to say that copies of the November, December and January issues of Hobby Electronics have sold out (we did warn you!) However Hobbyprints A B and C are still available.

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

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

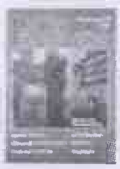
APRIL 79 (Hobbyprint F)
Projects: Model Train Controller, Cistern Alarm, Transistor Tester.
Features: The Telephone System, TV Aerials, Electronics in Warfare, Catalogue Survey etc.

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

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

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

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



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

OCTOBER 79 (Hobbyprint L)
Projects: Tantrum, Hobbytune, Analogue Frequency Meter, Multi Siren.
Features: Home Computing, Electronic Games, Micro-wave Cooking, Breaker One-Four.

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Into Linear ICs

By Ian Sinclair Part 5

Having dealt. with all of the 'ins and outs' of the 741 Ian Sinclair turns his attention to the very popular 555 timer IC.

HARKING BACK TO PART 1, do you remember all that spiel about having to make ICs in immense quantities if they're to be worth making? Our next chip is an example of just that — a very versatile IC which practically every IC manufacturer turns out in great quantities. We certainly can't ignore it, it's the 555 timer. Like the 741, this chip comes with different letter codes before the number, and in various different packages. We'll stick to the 8-pin DIL package, and, so that you can use 741 circuits at the same time, we'll place pin 1 of the 555 on line C1 of the Eurobreadboard.

The 555 timer contains a number of circuit components; two operational amplifiers which are used as comparators, one bistable (or flip-flop), one output stage and one switching transistor. You don't need to know what happens inside the 555 to be able to use the chip in the circuits which follows, but you can make much more effective use of it if you do know something about it, so here goes.

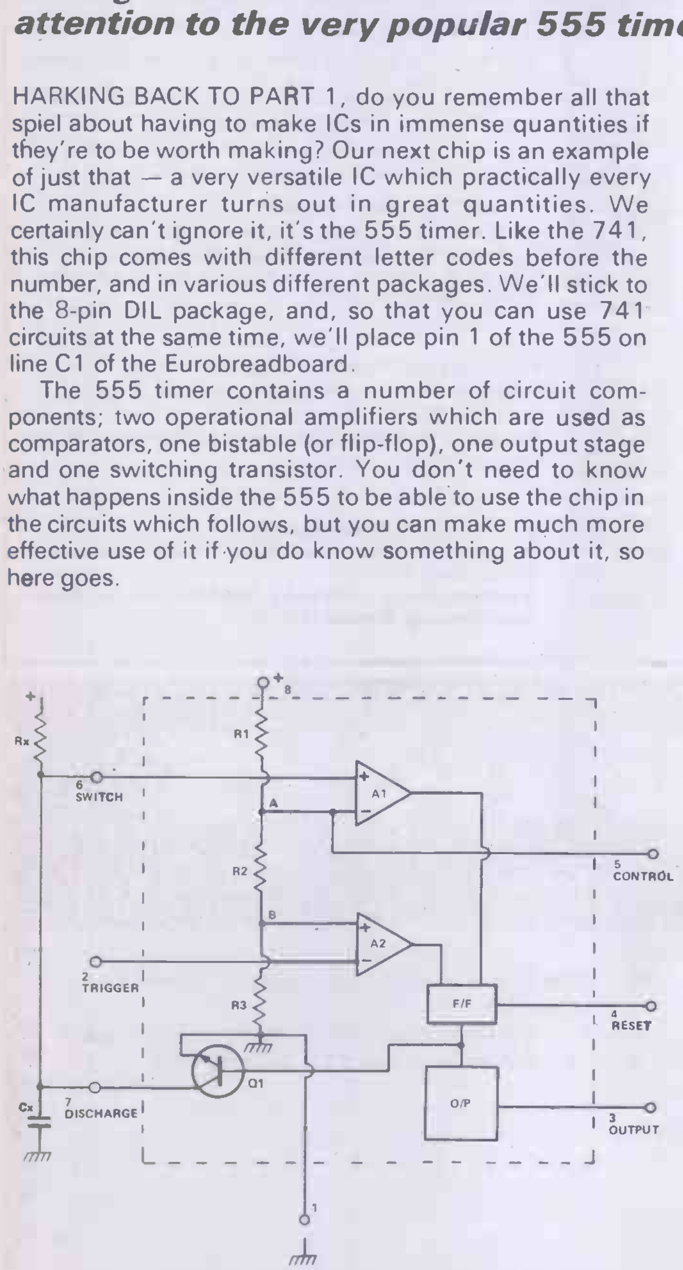

Fig. 5.1 The works — a block diagram of the circuits inside the 555 timer.

The arrangement inside the 555 is as sketched in Fig. 5.1. The resistors R1, R2 and R3 are all equal in value, so that the voltage at point B is one third of the supply voltage (V+), and the voltage at point A is two thirds of the supply voltage. At the time when the whole lot is switched on, Q1 is conducting so that any circuit which is connected to pin 7 is earthed — in many applications, this pin is connected to pin 6 and to a CR circuit which is shown dotted in the diagram. The output voltage is held low, and will stay low even is a current of up to 200 mA flows into the output pin, pin 3.

Timing is started by a negative-going trigger pulse at pin 2, and the action really begins when the voltage at pin 2 drops below the voltage at point B, which is one third of V+. When this happens, the comparator A2 switches over, its output voltage rises and so causes the flip-flop to switch over. The flip-flop is an electronic switch, turned on by a positive pulse from A2, and which can be turned off only by a positive pulse fro A1, or a reset voltage from pin 4. Ignoring the reset action, then, the flip-flop switches on with a positive pulse from A2, *off* with a positive pulse from A1.

The flip-flop controls both Q1 and the output stage — it switches Q1 off, and switches the output stage over so that the voltage on pin 3 goes high, almost to the level of V+. With the output high, up to 200 mA can be taken from pin 3 to feed any sort of load. The action now passes to the external components. In our example, with the external components shown dotted, Cx can now start to charge through Rx. As the capacitor charges, the voltage on pin 6 rises, and is compared with the voltage at point A, two thirds of V+. When the two are equal, the output voltage of comparator A1 switches high and turns off the flip-flop. This in turn causes the output at pin 3 to switch low, and Q1 to conduct again. With Q1 conducting, Cx is rapidly discharged to almost earth voltage, and the timer waits in this state for the next trigger pulse.

SKIN DEEP

Let's go back to the outside of the IC. The supply pins are No. 8 (V+) and No. 1 (negative), and a single supply of any voltage between 4.5 V and 16 V can be used. We'll run most of our circuits from a single 9 V battery. Pin 2 is the trigger input, which is normally connected through a resistor to supply positive. Connecting or pulsing this input momentarily to earth or to any voltage less than one third of V+ will cause one comparator (B) inside the 555 to switch over, causing in turn the output to go from LOW to HIGH, and pin 7 to become open circuit instead of connected to earth. This is the start of the timing action of the 555, as we have described.

The output of the 555 timer will deliver (source) or accept (sink) up to 200 mA, so that load resistances can be connected either between pin 3 and earth or between pin 2 and supply +. The timing periods which are produced by the action of the timer are not noticably affected by changes in the supply voltage, so that the timer will continue to work well even with a battery which is near the end of its useful life.

Because pins 6 and 7 can be separated, however, rather than connected together, we can stop the action by a separate circuit, and we can also control the timer by using pins 4 and 5. Pin 4 is a reset pin whose voltage is normally set high. Connecting pin 4 to a low voltage will cause the flip-flop to reset, making the output go LOW and earthing pin 7, no matter what was going on previously. Pin 5 enables us to vary the control voltages, so that both triggering (on pin 2) and automatic resetting (on pin 6) can take place at higher or lower voltages. Lowering the voltage on pin 5, for example, makes the triggering and reset voltages lower; raising the voltage on pin 5 makes the triggering and reset voltages higher. In most applications pin 5 is not used and is simply connected through a capacitor to earth. The capacitor prevents voltage pulses which are radiated from other wiring from being picked up on pin 5.

TIMELY CIRCUITS

Now for some circuits: Fig. 5.2 is a circuit of a 1 minute timer, which starts timing when the START button is pressed, and stops timing one minute later. The time can be set to exactly one minute by adjusting the value of RV1. When the circuit is first switched on, the output from pin 3 is LOW, so that th LED does not glow. When

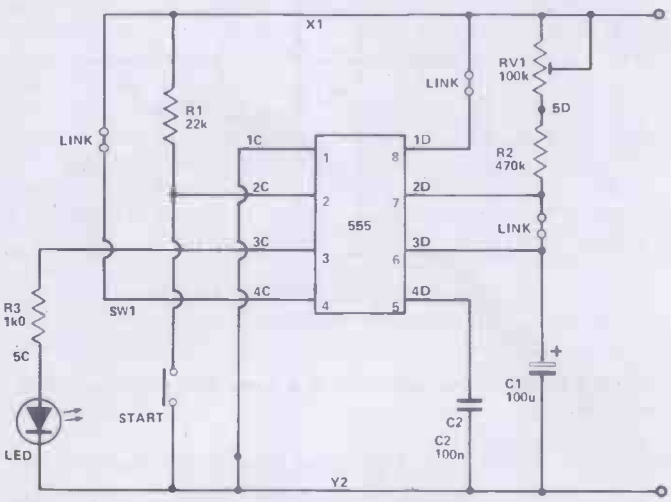

Fig. 5.2. A one-minute timer. Notice that the IC has been placed with its pin 1 on the Eurobreadboard line 1C. The Eurobreadboard references are shown nunver-first to avoid confusion with the capacitor numberings. Lines X1 and Y2 are used for supplies, and lines 4C, 1C, 1D are linked through wires.

the push-button switch is pressed momentarily, the circuit triggers, because the trigger pin, pin 2, has been earthed. The output at pin 3 goes high, so that current can now flow through R3 and the LED, causing the LED to glow. At the same time, becasue pin 7 is no longer earthed internally, C1 can start to charge through R2 and RV1. Since C1 is also connected to pin 6, the circuit will switch back when the voltage across C1 is equal to two thirds of the supply voltage. This switches the output LOW, extinguishing the LED. It's a useful little timer circuit, particularly for a photographic darkroom, because the red LED doesn't affect black/white papers (be careful with colour papers, though, you may need some shielding around the LED). To obtain different time ranges, just change the values of C1 and R2. Larger values give longer times, but don't exceed 100 µF for C1, nor 10M for R2.

Let's get a bit more ambitious now, and look at a control timer circuit. If we want to use the 555 timer IC for controlling equipment which works at higher voltages than the timer itself, the easiest and safest method is the use of a relay. Any relay which has a coil requiring low voltage (9 to 12 V) and an operating current of less than 200 mA is suitable, so that the resistance of the relay should be 60 ohms or more. The contacts of the relay should be adequate for the current which is to be controlled; that means that a circuit which needs 3 A should be controlled by a relay whose contacts are rated at 3 A or more. The insulation of the relay should be also adequate if the contacts are to be used for switching mains voltages; it's usual to have a relay tested to 1 000 V between contacts and coil when it is to be used for 240 V mains. The relay contacts may be of three types — normally closed, normally open, or changeover according to the use which is to be made of it. The word 'normally', incidentally, means 'when no current is being passed through the relay coil'. The advantages of using a relay rather than an electronic device like a thyristor are that the relay contacts are completely isolated from the coil, and that a relay can deal with a much greater range of currents and voltages. In addition, relays can be obtained which will switch several circuits at the same time.

LATCHING ON

When a relay or any other highly inductive load like a solenoid, is activated by the output of a 555 timer, protective diodes D1 and D2 must be connected as shown. D1 should be a high-voltage, high-current diode like the 1N4001, and D2 should be a 'gold-bonded' germanium diode like the 0A47. These two suppress the high voltage which is otherwise generated when a relay coil, or any other large inductor, is switched off. In addition, D2 protiect the 555 from 'latch-up', a condition which makes the output voltage stay high until the circuit is switched off. Latch-up occurs because the voltage pulse which occurs when a relay is switched off can be coupled through the wiring or by stray capacitance to the trigger input, so causing re-triggering. The trigger input is very sensitive, but a reasonably low resistance connected to pin 2, and the use of these diodes will completely prevent latch-up, which incidentally doesn't happen when the relay is connected as shown in Fig. 5(3)b.

In our circuit, Fig. 5.4, the usual timing action is used, with timing capacitors C1 and C2 selected by

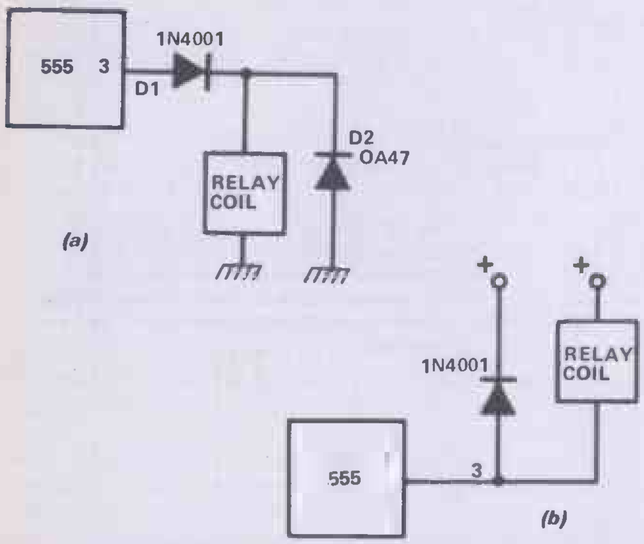

Fig. 5.3. Methods of connecting a relay to the 555. In method (a), the relay is activated when the output of the 555 goes high, latchup must be avoided by suitable choice of diode types for D1 and D2. In Method (b) there is no risk of latchup since the relay is activated when the output of the 555 goes low, but a protective diode is still needed.

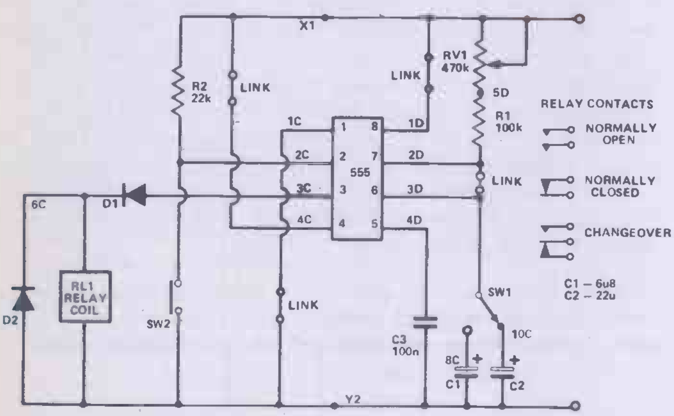

Fig. 5.4 The control timer-circuit. The relay coil and the contacts of SW1 are best connected to the Eurobreadboard by single-core wire links. Don't forget also the wire links from 4C and 1D to X1, and from 1C to Y2.

SW1 and charging through R1 and RV1. Switch SW1 acts as a coarse time selector, with RV1 providing fine adjustment. Before the START button is pressed, the output at pin 3 is LOW, so that the relay is not activated. Pressing SW2 momentarily will start the timing cycle, so that the replay is activated, and C1 and C2 starts to charge through R1 and RV1. At the end of the timing cycle, the relay is switched off and the capacitor C1 or C2 discharges through the timer. This action is ideally suited to such applications as a photographic enlarger lamp; Fig. 5.5 shows two refinements, a 'continuous-light' switch, to allow setting-up, and a 'push-to-stop' button so that the timing can be interrupted if need be.

Fig. 5.6 shows a turn-off delay. The application for this circuit is to turn on the interior light of a car when the ignition is switched off, and then to turn the light off again after about 1½ minutes, so giving the driver time

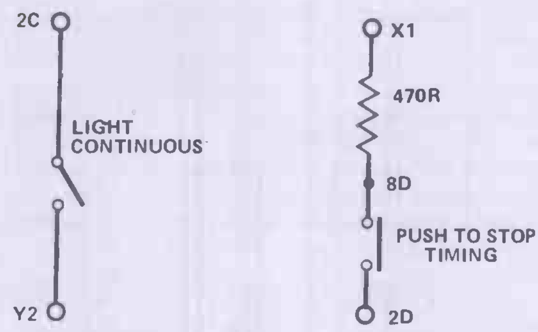

Fig. 5.5 Two modifications which are useful when the control timer is used for controlling a photographic enlarger.

to gather up his/her keys and go. A 12 V relay is used to carry out the switching, since the circuit must operate from the 12 V car battery, and several interior or exterior lamps can be controlled if necessary. It may be useful, for example, to switch on the reversing lights for this short time (if this is legal — in the UK a reversing lamp must be operated either by the reverse gear being selected, or by a switch which has a warning light; our circuit might qualify if another lamp is operated at the same time).

The main 12 V supply to the 555 circuit must be taken from a point in the wiring loom which is not switched off when the ignition switch is turned off — one obvious point is the wire which supplies the ignition switch, or the live lead to the interior light. There must also be a connection to the switched side of the ignition switch and from the relay contacts (open when the relay is not energised) across one of the door siwtches (Fig. 5.6).

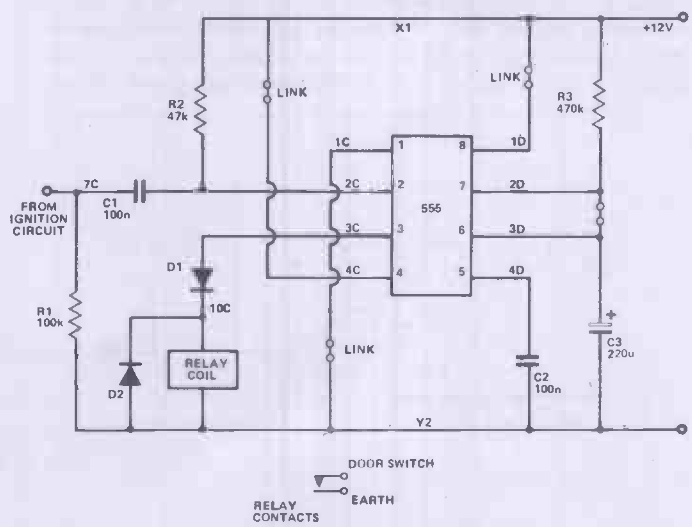

Fig. 5.6 A delay lamp circuit with a fixed delay of about 1½ minutes.

The action of the circuit is like this. When the ignition is switched off, the voltage across R1 drops to zero, and momentarily causes the voltage at pin 2 to drop to zero until C1 charges. This is enough to cause the 555 timer to trigger, so that the output on pin 3 goes high, activiating the relay and so turning on the interior light. After the timed interval, determined by the values of R3

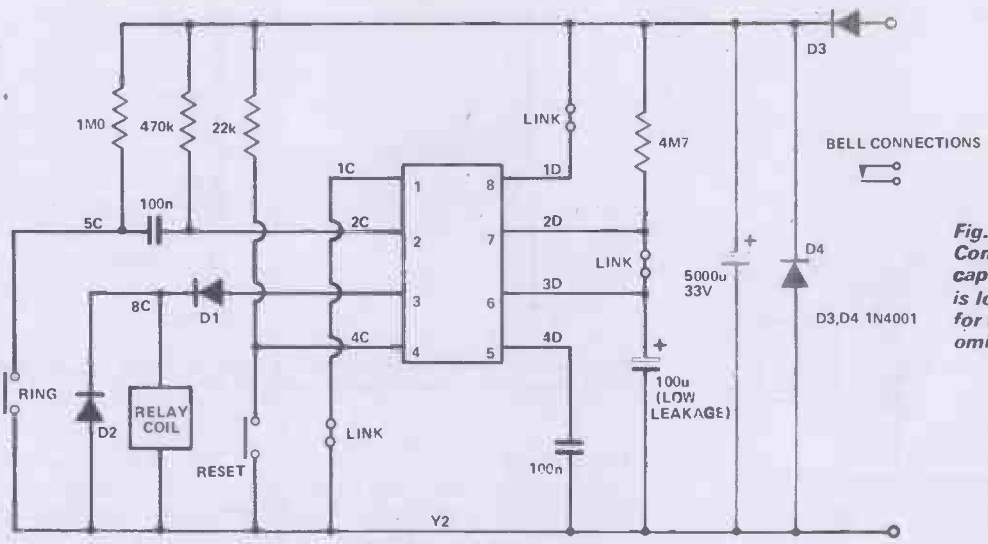

Fig. 5.7 The long-ring door-bell circuit Components D3, D4 and the 5 000 uF capacitor is needed if the bell supply is low voltage AC. If a DC supply is used for the bell, these components can be omitted.

and C3, the circuit switches back, the voltage at pin 3 goes low again, and the relay returns to open circuit, switching off the interior light.

RINGING THE CHANGES

Now for a different door-bell. This is a circuit (Fig. 5.7) which turns an ordinary door-bell into something that can't easily be ignored. When the bell-push is operated, the 555 timer is triggered, operating the relay and so ringing the bell. The bell will then ring for the time set by the timer, or until the reset switch is operated from inside the house. The circuit can be powered from the same supply as the bell if the bell is DC operated, otherwise a separate supply can be used for the timer. Once again, diodes D1 and D2 are used to protect the 555 from the effects of turning off the relay. If you're not too keen on your present doorbell, you might want to combine this circuit with one of the tone-generator circuits (later), so that the door-alarm becomes a purely electronic device.

These circuits should give you a pretty good idea of how the 555 timer can be used in timing circuits, but that is by no means all that we can do with this very versatile IC. Fig. 5.8 shows a pulse generator, a useful circuit for testing digital circuits or even for testing 555s themselves. The circuit generates pulses from any input wave whose amplitude is large enough to trigger the input. Souces such as a sinewave generator, a microphone and amplifier, or the secondary winding of a low-voltage transformer can be used.

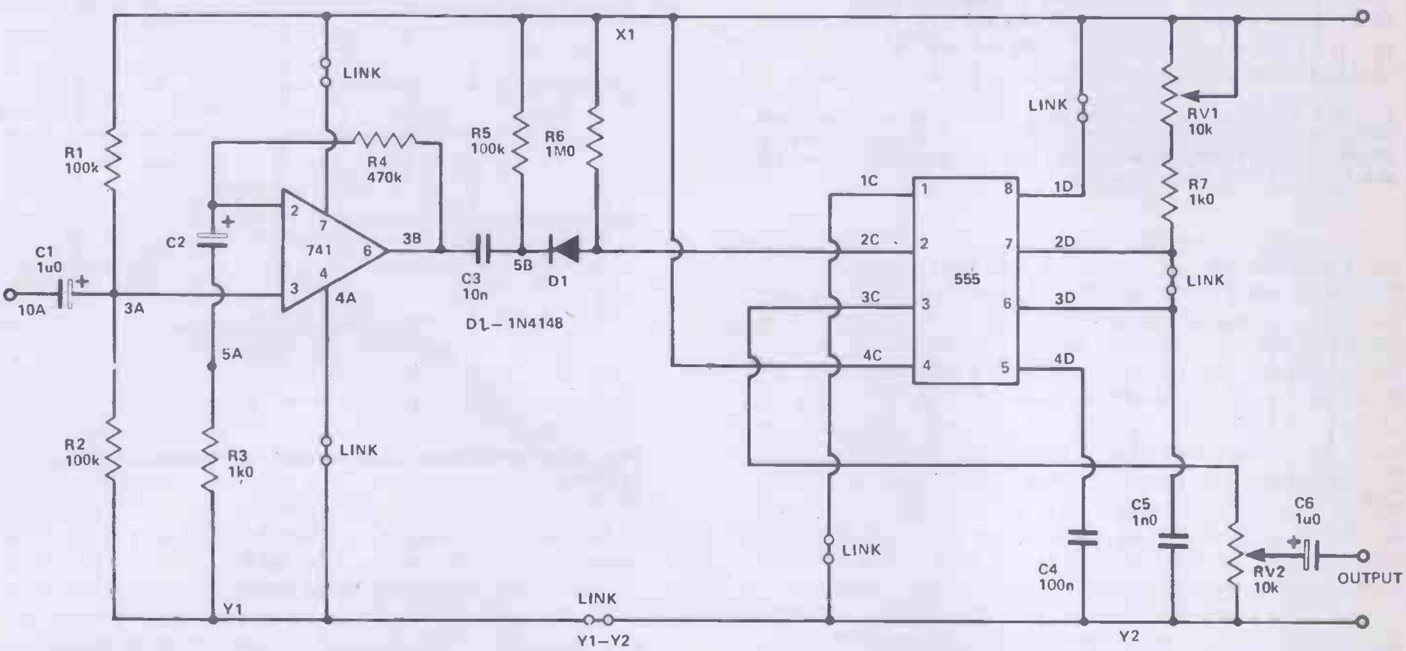

Fig. 5.8 The pulse generator. The imput is a signal which can be a sinewave or any other waveform. The output is a series of pulses at the same frequency as the input wave. RV1 controls the duration (width) of the pulse, and RV2 controls the amplitude of the output

IC1 is a 741 used as an amplifier with a very large gain. Because of the large amount of gain, the output is a squarewave with fairly steep sides even if the orignal input was a sinewave. When this squarewave is applied to capacitor C3, the combination of C3 and R5 differentiates the wave converting it into two pulses, one positive and the other negative. Diode D1 selects the negative pulse and uses it to operate the trigger circuit of the 555. The 555 is connected as a timer, generating a short pulse whose duration (pulse width) is controlled by th value of C5 and the setting of RV1. The output pulses have a good rectangular shape, ideal for test purposes. The frequency of the output pulses will be the same as the frequency of the input wave, which should be within the audio range. Try this one driven by a microphone and preamplifier, with the output connected to an amplifier — it's a good ''space-age' sound effect!

A TESTING TIME

Let's go a bit further along this 'test-instrument' line of thought. Fig. 5.9 shows a 555 circuit which generates a squarewave signal with no input needed. This is achieved by making the timer self-triggering, so that the trigger input on pin 2 has to be connected to the threshold pin, pin 6. The action goes something like this. Imagine that the unit has just been switched on, so that the voltage at pins 6 and 7 is low. Since the voltage on pin 2 must also be low, the unit will trigger, and pin 7 will be open-circuited. This now allows the voltage at pin 7 to rise, so that C2 will start to charge through R3 and RV1 — meantime the output voltage on pin 3 has gone high. When the voltage on pin 6 reaches two thirds of the supply voltage, the timer circuits switch over, so that pin 7 (and also pin 2) is earthed; but the voltage at pin 6 is still at about two thirds of the supply voltage. The output voltage at pin 3 is now low again. C2 now discharges through RV1 and R3, because pin 7 is internally earthed, until the trigger voltage of one third of V+ is reached. When this vôltage is reached, the effect on pin 2 is to start another cycle, with the output going high again an dC2 charging once more. providing that the value of RV1 + R3 is much greater than that of R2, the output wave has a good square shape. If R2 is too large in comparison, the high part of the output wave, known as the mark, lasts longer than the low part, the space.

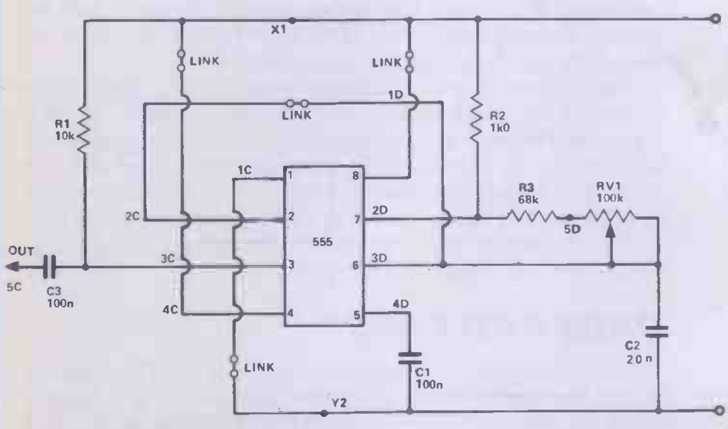

Fig. 5.9 The square-wave generator. Don't forget the wire links — there are four of them, including the 2C-3D one.

That's a basic form of circuit — let's see what we can use it for. Since the squarewave at the output can be at an audio frequency, and since the 200 mA current capability of the 555 is quite enough to drive a small loudspeaker, the 555 can be used in a number of alarm circuits. A burglar alarm basic circuit is shown in Fig. 5.10, using a loudspeaker of 4 ohms to 16 ohms resistance; Fig. 5.10(b) shows how a 60 to 80 ohm loudspeaker ca be used in a simpler circuit.

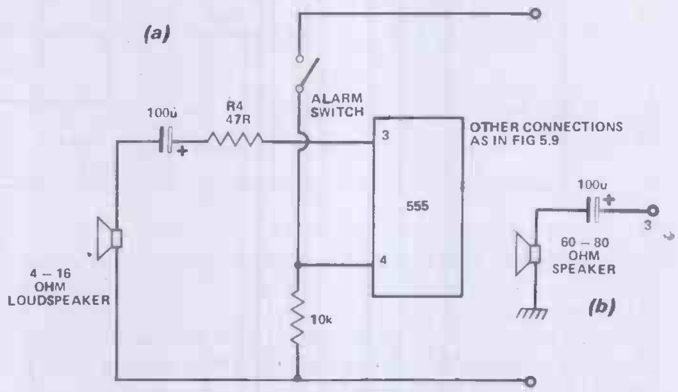

Fig. 5.10 Using the square-wave generator (a) to drive a loudspeaker when an alarm switch is pressed. The connection (b) for a high resistance speaker are also shown.

SINE WAVE

The circuit itself is simple, using the 555 connected as a square-wave oscillator with an output to the loudspeaker. R4 is used to limit theamount of current which can flow, in case the current capability of the 555 is exceeded. The alarm is sounded by SW1 being closed — this switch can be a window contact, a door-mat switch or any of the many types of swich sold for this purpose by security specialists. This circuit can be combined with the sensing circuit of Fig. 3.2 (Part 3) providing that biasing is arranged so that the 741 output goes low when the sensing wire is touched.

We're not limited to outputs from mechanical switches. Fig. 5.11 shows a freezer-alarm circuit which is a development of the circuit of Fig. 5.9 and which also uses the 555 as an oscillator driving a loudspeaker. The temperature sensing device is a thermistor which is located inside the freezer, using the special sticky tape which is sold for sealing freezer bags — ordinary tape cracks at low temperatures. The thermistor need not be near the alarm circuit, and can be connected by fine-gauge wires which can be laid over the freezer sealing rubbers without causing any damage. RV1 is used to adjust the amount of resistance which is connected in series with the thermistor, so that Q1 is just biased off. A rise in the temperature will cause Q2 to switch on. With Q2 on, the voltage at pin 4 of the 555 is raised enough to allow the 555 to start oscillating — any voltage above 0.7 V which can pass a current of 0.1 mA is enough to release the reset action. The 555 oscilates, and the alarm sounds. RV1 should be set so that the alarm will NOT sound every time the lid is raised, but will sound if the lid is kept open for more than a few minutes.

Now it's your turn! Could you use a 741 in place of the two transistors in that circuit? Try it out — you'll find

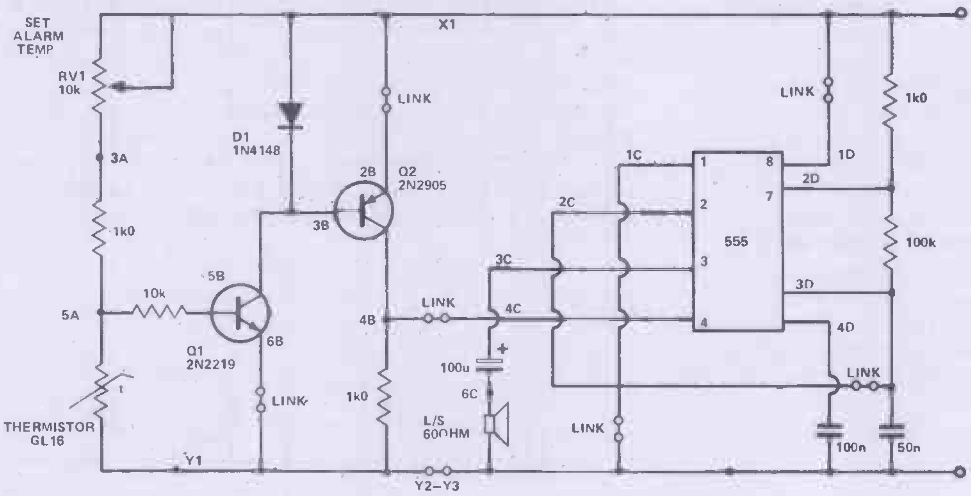

Fig. 5.11 Using a 555 as the oscillator in a freezer-alarm.

that using the Eurobreadboard allows you to hook up circuits in a fraction of the time it would take to make a soldered circuit, and also enables you to try different component values by unplugging one component and plugging in another. In addition, you can keep a record of your layout by noting the number/letter codes.

OVER TO YOU

All change again, this time to a circuit which can be used for controlling the speed of small motors (are you listening, model train and slot-car fans?). The type of control which is used is called mark-space control, and it's a great improvement over the simple variable resistor which is so often used as a speed control for small motors. In a rectangular wave (Fig. 5.12) the mark time is the time for which the voltage is high, and the space time is the time for which the voltage is low. A large mark-space ratio means that the output voltage is high for most of the time of one cycle; a small mark-space ratio means that the voltage is low for most of the time of a cycle. A 1:1 mark-space ratio means a square wave, whose average voltage is equal to half of the peak voltage. If we apply a voltage which has fixed amplitude but variable mark-space ratio to a small electric motor, the speed of the motor will depend on the mark-space ratio and very smooth control of speed can be achieved, without the loss of torque which is the problem when a variable resistance is used as a controller.

The circuit of Fig. 5.12 shows th mark-space generator. Motors which take less than 200 mA stalled (not moving) current at 12 V can be operated directed from the output of the 555 timer, but most model locomotive motors nowadays need rather more current, so that a simple add-on power booster, using a 2N3055 (as in Fig 5.13) is useful. The variation of the mark-to-space ratio is carried out by using the oscillator circuit of Fig. 5.9 with the addition of two diodes. While C2 is charging, D1 conducts so that the charging current comes through R1 and the portion of RV1 which is between point A and the top end of the potentiometer. When the circuit switches over, with pin 7 internally earthed, D1 is cut off, and C2 discharges through D2, R2 and the oter part of the potentiometer RV1 between point B and the tap. Since the total resistance of R1, R2 and RV1 is constant, the frequency of the output is steady, but the ratio of charge-to-discharge times can be varied greatly by

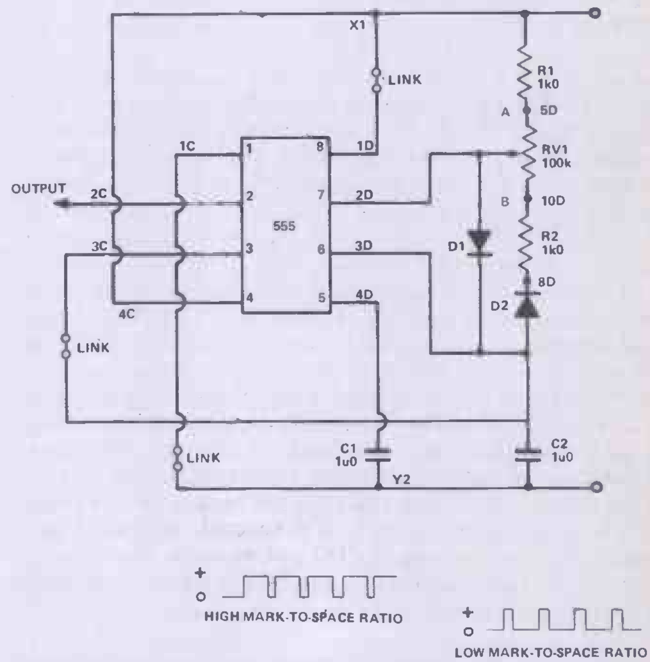

Fig. 5.12 The motor-speed controller circuit. Full speed corresponds to a large mark-to-space ratio, and currents greater than 0.2A can be provided by using a power-booster.

adjusting RV1. With the values shown, the ratio can be varied between about 1:100 and 100:1, so that an excellent control range can be obtained.

Note that this circuit is useful only if the supply to the circuit is DC, and reasonably smoothed. Most model-motor supplies are simply full-wave rectified, with no smoothing, so that a 5 000 μF capacitor, rated at 36 V should be added to make the circuit more effective — but check that this does not cause the output voltage to rise above the rated 16 V for the 555. If it does, use the modifications shown in Fig. 5. 14.

ODDS AND ENDS

Now for the odds-and-ends section. Fig. 5.15 shows a circuit for a car or motor-bike rev counter. Old fashioned mechanicalrev counters needed a mechanical drive, but the modern electronic type need only electrical connections, and can be used with any conventional ignition

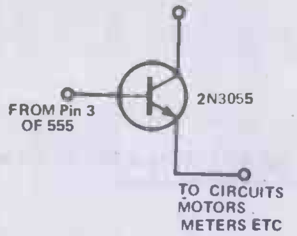

Fig. 5.13 A power-booster stage for the motor-speed controller.

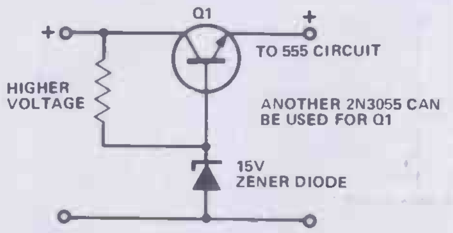

Fig. 5.14 A voltage regulator to prevent the supply to the 555 rising above 16V.

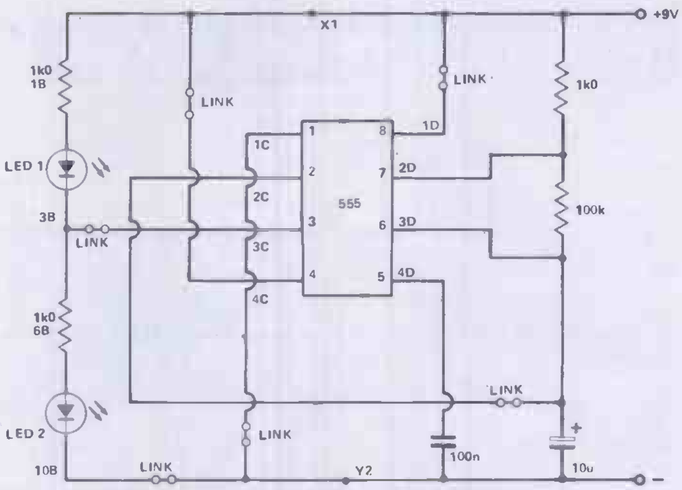

Fig. 5.16 The 555 tester circuit.

system which uses contact points. The circuit operates on the sudden rise of voltage across the points each time they open to create the spark. For a single cylinder engine, there is either one spark per revolution (two-stroke) or one spark every second revolution (four-stroke), and for multi-cylinder engines, this number is multiplied by the number of cylinders which are fired from the same contact-breaker. For a four-cylinder engine running at 3 000 rpm, for example, there will be two sparks per revolution, 6,000 sparks per minute, 100 per second. Each time the points separate. Q1 and Q2 will turn on, causing th collector of Q2 to go momentarily to a low voltage. This, in turn, triggers the 555, sincle pin 2 of the 555 is connected to the collector of Q2 through C2. Once the 555 is triggered, C4 starts to charge, and the output voltage goes high. The values of R4 and C4 are chosen so that the output will remain high for one two-hundredth of a second, so that if the rate of the input pulses is 200 per second, the output from the 555 will stay high — the 555 is being triggered again just at the end of each delay. This rate of 200 pulses per second corresponds to 6 000 RPM for a four-cylinder four-stroke, and RV1 can be adjusted so that the meter M reads full scale at this pulse rate. This calibration need not be done from an engine — incidentally, it can just as easily be carried out using a 200 Hz signal generator. Another method is to calibrate using 50 Hz from a small transformer, and adjust the meter to read 1 500 RPM with this input.

If the engine speed is less than 6 000 RPM, the 555 has time to finish its output wave before it is triggered again, so that the meter reading is rather less than at full speed. The meter reading is proportional to the average voltage at the output of the 555, and that is, in turn, proportional to the speed of the engine to which the circuit is attached.

We'll finish with a little one — you can word out for yourselves how it works. It's for testing 555s, and it makes use of the oscillator circuit. When a working 555 is inserted, the LEDs will flash alternatively. If both LEDs light or if only one lights, the 555 is faulty. If neither of the LEDs lights the battery is flat! **HE**

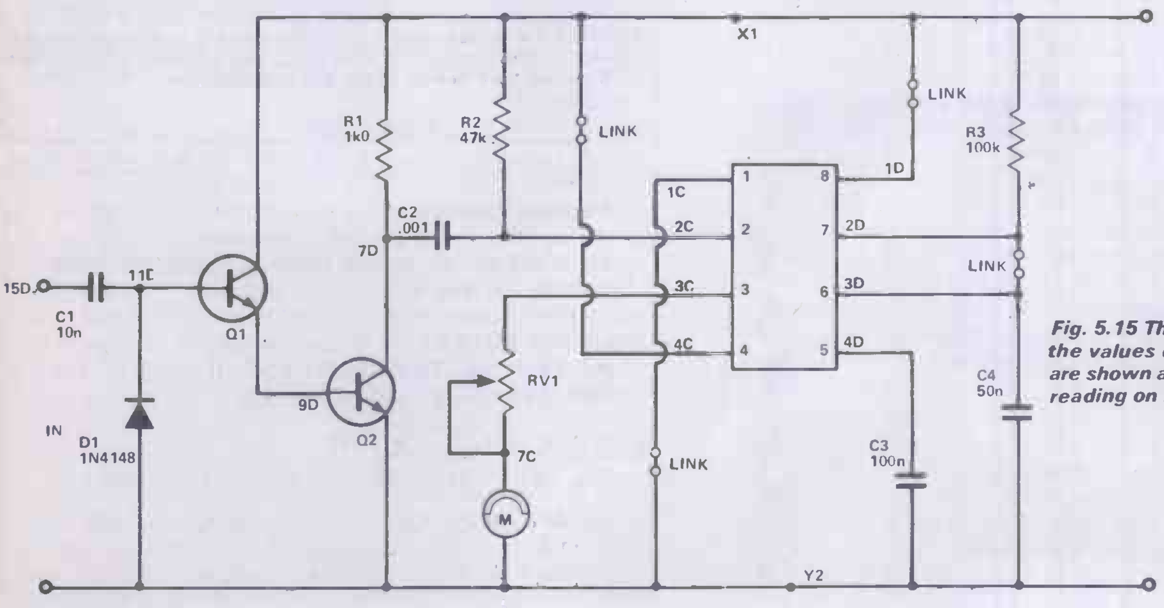

Fig. 5.15 The rev-counter circuit—the values of R3 and C4 which are shown are for full-scale reading on 200 pulses per second.

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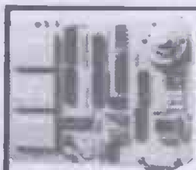

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