ELECTRONIC GAMES - 10 OF THE BEST

Hobby Electronics

January '81
ISSN 0142-6192
55p

For A Down-To-Earth Approach To Electronics

COMPETITION -WIN A ROWTRON PROGRAMMABLE TV GAME -SEE INSIDE

DISCO LIGHTS
Build Our *SPECIAL* Sound-into-Light Project!

Chuffer Sound Project
-bring your model trains alive

Rev-counter
-put your car engine revs on display


Ever wondered who buys electronics today? You'd be surprised!
ectronics market is rapidly expanding. Whether it's
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Even the old boys circuit is getting electronicized. With our help.

Hobby Electronics

JANUARY 1981
Vol. 3 No. 3

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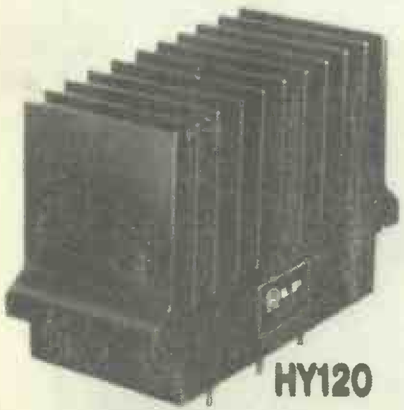
ILP

The range grows bigger... better...

New Profile Amplifiers - Two New Series



HY120

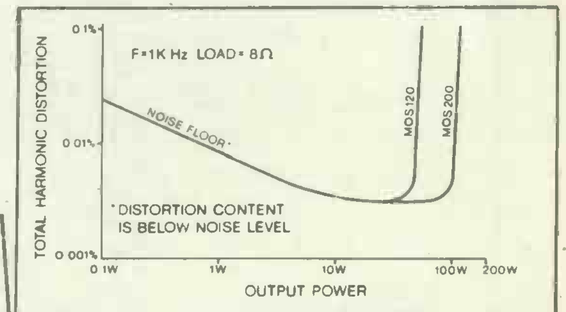
HY60

MOSFET

CHOOSE AN I.L.P MOSFET POWER AMP when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P's exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connection is via five pins on the underside. **I.L.P MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.**

Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

ILP POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE

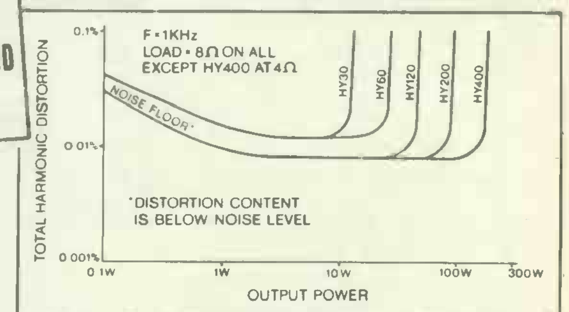


Load impedance both models 4Ω-∞ Input sensitivity both models 500mV
Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB

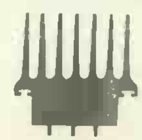
BIPOLAR

CHOOSE AN I.L.P BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

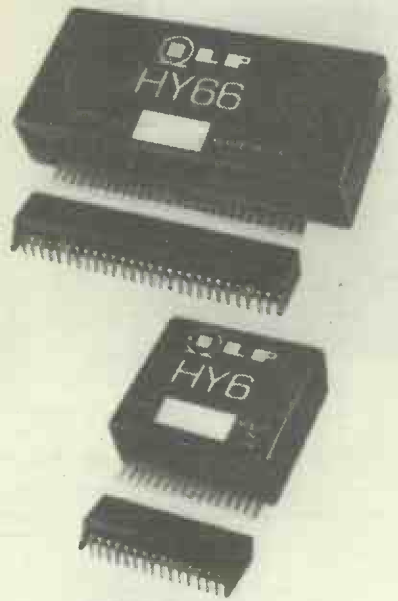
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£6.34 + 95p
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.24 + £1.09
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£15.20 + £2.28
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£18.44 + £2.77
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£27.68 + £4.15



Load impedance all models 4Ω-∞ Input sensitivity all models 500mV
Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz – 3dB



THE NEW PROFILE EXTRUSIONS
The introduction of standard heatsink extrusion for all I.L.P power amplifiers achieves many advantages:– Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for lower thermal conductivity. Extrusions vary in size according to module number.



PSU

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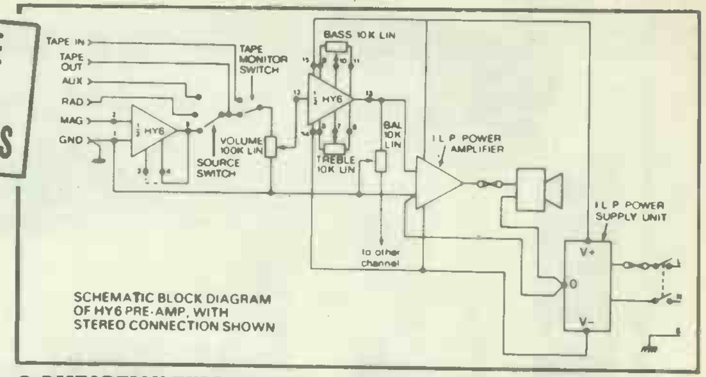
HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.
Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** – 90 x 20 x 40 mm.
Active Tone Control circuits provide ±12dB cut and boost.
Inputs Sensitivity – Mag. PU. –3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £5.60 + 84p VAT Connectors included
HY66 stereo £10.60 + £1.59 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

COMPATIBLE WITH ALL ILP MODULES



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE-AMP, WITH STEREO CONNECTION SHOWN

- **DISTORTION TYPICALLY 0.005%**
- **S/N RATIO – 90dB (Mag. P.U. – 68 dB)**
- **38 dB overload margin on Mag. P.U.**
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- **ONLY POTS, SWITCHES AND PLUGS/SOCKETS NEED ADDING**
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Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amps you choose.

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● *THE FOLLOWING WILL ALSO DRIVE I.L.P PRE-AMPS*
PSU36 for use with 1 or 2 HY30's — **£8.10 + £1.22 VAT**
● *ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS*

PSU50 for use with 1 or 2 HY60's	**£9.75 + £1.46 VAT**
PSU60 for use with 1 HY120	**£9.75 + £1.46 VAT**
PSU65 for use with 1 MOS120	**£9.75 + £1.46 VAT**
PSU70 for use with 1 or 2 HY120's	**£13.61 + £2.04 VAT**
PSU75 for use with 1 or 2 **MOS120**	**£13.61 + £2.04 VAT**
PSU90 for use with 1 HY200	**£13.61 + £2.04 VAT**
PSU95 for use with 1 **MOS200**	**£14.75 + £2.21 VAT**
PSU180 for use with 1 HY400 or 2 HY200	**£23.02 + £3.45 VAT**
PSU185 for use with 1 or 2 **MOS200**	**£24.20 + £3.63 VAT**

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EDITORIAL

STEALTHILY, over the last three months, changes have been taking place in Hobby Electronics. Some of these have been in response to comments from the many readers who took the trouble to fill in and return our Survey form (HE August 1980).

You will have noticed, no doubt, that the cover and Contents page haven't been spared: what about the magazine itself?

Judging by the response to our Survey — and the constant flow of letters that we receive — HE is meeting most of our readers' needs. But there's room for a few improvements and we've already started on these.

First the projects: we're aiming to make them more interesting and useful without at the same time making them *too* clever or *too* expensive. We'll try and keep the balance between simple projects for those starting from scratch to more expensive ones for our more experienced (or ambitious) readers. Whatever the project, we'll help you understand how it works and guide you on how to build it without getting submerged in technicalities.

Second the features: we'll try and dish up some interesting general articles for you and polish up some of the regular ones.

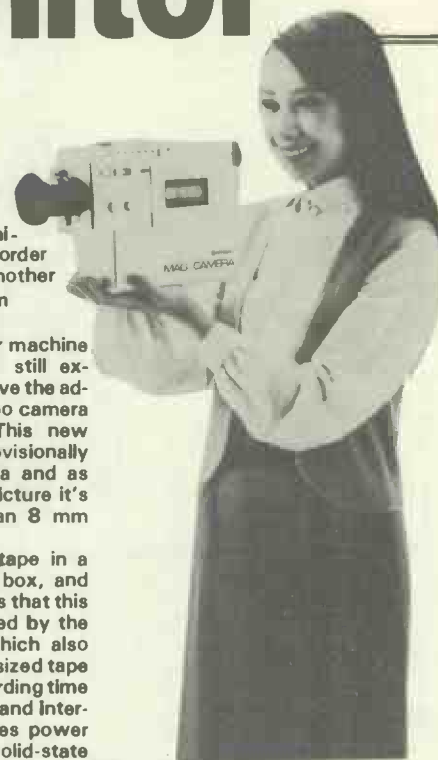
On some magazines the editorial staff sit in an ivory tower detached from their readers, apart from the odd letter of complaint. In the Modmags plastic tower in Charing Cross Road we're right in the middle of things and get plenty of support (and criticism) from our readers. The subject of electronics is exciting and an exciting part of an uncertain future. We aim to present this subject in a digestible form and make it an interesting and absorbing hobby for you.

As one of our readers in South Africa rounded off his letter to us recently, so I will end this Editorial:

Yours — in electronics
Hugh Davies
EDITOR

Monitor

Tiny Tape 11



Following our exclusive report last month on the amazing Technicolor miniature video cassette recorder we have news of yet another mini VCR, this time from Hitachi.

Unlike the Technicolor machine the Hitachi recorder is still experimental but it does have the advantage of having a video camera built-in to the case. This new machine has been provisionally called the MAG Camera and as you can see from the picture it's not much larger than an 8 mm camera.

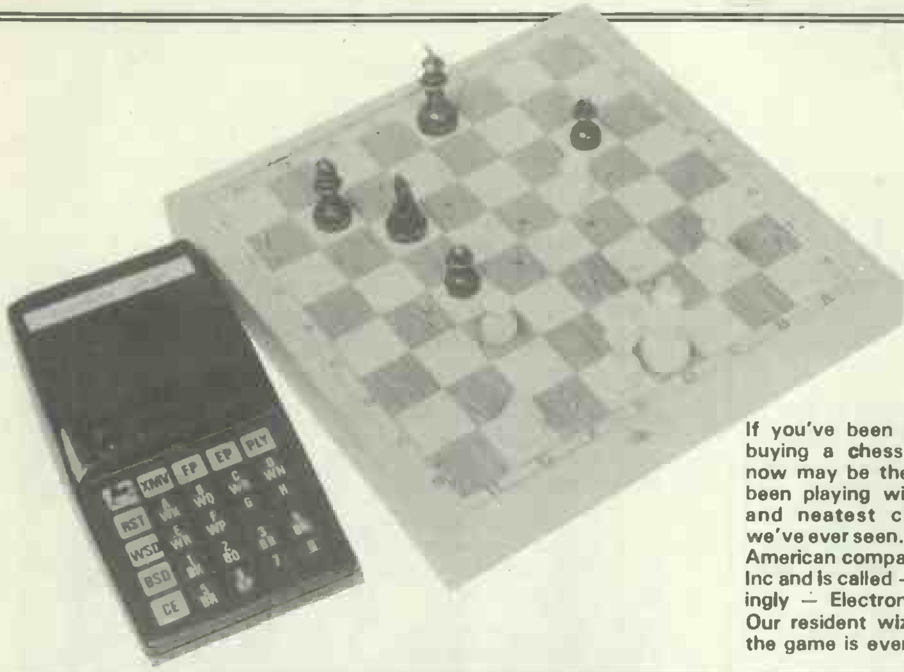
The MAG uses ¼" tape in a compact cassette-type box, and we would hazard a guess that this is the same tape as used by the Technicolor machine which also uses compact cassette-sized tape units. Up to 2 hours recording time is available on this unit, and internal rechargeable batteries power both the recorder and solid-state camera. All-up weight of the unit is just 2.6 kg (5.7 lbs) which should prevent too much muscle strain.

As yet Hitachi haven't announced price or probable launch date: this they claim will not be until there have been some international agreements on standardisation. It would seem to us that the battle of the new formats is going to be as bloody as the one currently being waged over VHS and Betamax. In the end no-one will win — it'll be the poor old consumer that has to make the unenviable choice of risking money on a system that might or might not become redundant. We just wish these companies would agree on standards before they launch their products and not wait until poor old Joe Public has spent his hard earned cash.

And again . . .

This is getting monotonous. Here we have yet another tiny stereo cassette player, this time from Hanimex. You all know the score by now so we'll just content ourselves with the price, which is £39.95 and the name, which is HC 300S. At the moment there are around six or seven of these little units on the market (or there will be in the very near future — in time for Christmas no doubt). We have yet to see one that rivals the Sony Stowaway, and certainly none sound as good. Watch this space: we'll tell you when we see one!

For more information contact Hanimex UK Ltd. Faraday Road, Dorcan, Swindon.



CHEAP CHESS

If you've been holding back on buying a chess computer then now may be the time. We have been playing with the cheapest and neatest chess computer we've ever seen. It comes from an American company called Tryrom Inc and is called — rather uninspiringly — Electronic Chess Game. Our resident wizard reports that the game is every bit as good as the current crop of chess machines costing up to £100.

The machine has eight levels of difficulty ranging from beginner to expert. Facilities include position verification, automatic castling, change sides and piece selection. All of this is contained in a calculator-sized box with a small travelling set of magnetic chess pieces and a wooden chess board. Each game can commence with a number of classic openings or alternatively a random opening once your strategy has been decided.

Taken overall this is an excellent little machine and the incredibly low price of just £29.95 including board and pieces represents just about the best possible value for a chess computer. For more details of this machine and a fine selection of other games contact Kramer & Co., 9 October Place, Holders Hill Road, London NW4.

Staggering Statistic

Have you ever wondered how many colour TV transmitters the BBC operate? No? Well, we'll tell you anyway, on the 7th of November the BBC opened their one-thousandth transmitter at Hedlyhope in County Durham. Makes you think about the £34 licence, almost seems cheap doesn't it?

Tune Your Guitar By Cassette

Our Guitar Tuner Project (HE November 1979, pp 61 to 62) inspired one company — Tutchings Electronics — to come up with what it claims to be the first guitar tuner *on cassette tape* in the world.

While our tuner produces six preset tones, each corresponding to the pitch of one of the guitar strings, this cassette, called simply 'Guitar Tuner', contains recordings of tones and string sounds for classical, acoustic, electric and 12-string instruments. According to Tutchings, most pupils find it difficult to tune up their guitars by simple tones, and prefer to hear the actual strings. The recordings are backed up by a string-by-string commentary.

Side one of the tape contains classical and acoustic sections, interspaced by what is described as: '. . . the frequency tone of the tuning A — 440 Hz — which lasts for 3½ minutes. The main purpose of this is to assist in finding the acoustic guitar section. It can, of course, also be used for tuning other instruments.'

For classical, acoustic and electric guitars you get a 10 second tone of each note, starting with the high E, followed by: '. . . the striking of each string four times on an accurately tuned guitar'. Each section is repeated. Tuning for the 12-string guitar is more complicated, starting with 'first pair: D in unison' down to 'sixth pair: D covered . . . now D covered, octave up'. A chord played on all strings is included at the end of each section.

We tested this cassette on a Phillips N2534 machine, and used the recordings to tune-up a classical guitar and an acoustic guitar. After the tune-up, both were checked against harmonic (open string) tuning, aided with an A (440 Hz) tuning fork. The check showed the tape method to be *reasonably* accurate, but it must be borne in mind that very few cassette players are capable of running *precisely* the same speed without some, however slight, 'wow' and 'flutter'. Such irregularities are usually imposed by the transport mechanism. (By the way, the continuous 440 Hz recorded tone was found useful for checking for such irregularities!)

Although not necessarily of hi-fi quality, the tape worked well as a tuning aid. We thought it ideal for the beginner, because most have difficulties with tuning-up (especially after fitting a new set of strings). Guitar Tuner costs £2.50 including post and packing, and is available from: Tutchings Electronics Ltd., 3 Grange Road, Bournemouth BH6 3NY

TV Game In Court

An interesting story has been drifting across the Atlantic for the past few weeks. It concerns a number of disgruntled software engineers working for Atari. Apparently the gentlemen who used to write the games programs for Atari left the company some months ago to start a company of their own. They formed a small outfit called Activision, specifically to manufacture cartridges for the Atari TV game. Naturally Atari was a little bit unhappy about all this, after all it invented the Video Computer System and saw no reason why somebody else should move in on its territory, particularly ex-employees. Atari proceeded to slap a 20 million dollar lawsuit on Activision. Much of the legal wrangling centred on the name used for one of the cartridges which had been registered by Atari. The fuss caused by the lawsuit has given Activision an immense amount of free publicity which helped its sales no end. Now it appears the Activision cartridges are soon to be sold on this side of the big pond. Already we have had a couple of samples in the HE offices. We can safely say that they are every bit as good as the original Atari cartridges. The fact they will cost about 20% less than comparable Atari cartridges will no doubt assure their popularity over here too. Currently there are four games available: Fishing Derby, Checkers, Boxing and Dragster. In the spring we can expect another two cartridges called Skiing and Bridge. Recommended retail price is likely to be around £16.95 each. It will no doubt comfort owners of Atari machines to know that the quality of these cartridges is such that Atari hasn't actually claimed that these new games will damage its machines. We wonder what will happen when they go on sale over here.

EXT MONTH. NEXT MONTH. NEXT MONTH. NEXT MONTH. NEXT MO

Hobby Electronics

ON SALE JANUARY 16th

First Report

Just hours before we went to press on this issue of Hobby Electronics the 1980 Breadboard Show opened its doors. We couldn't resist showing you a couple of pictures of the proceedings. Within minutes of the show opening hundreds of eager enthusiasts were milling around the dozens of stands crammed with electronic goodies. Look out for a full picture report next month, right here in Hobby Electronics.

Yes, that is Brian Rix (third from right) with Ron Harris (right) Editor ETI, Geoff Arnold (Editor PW), Mike Kennard (Editor EE) and Jim Connell (Managing Director Modmags)

You can't actually see it but there are some Space Invader machines on our stand drawing the crowds

Doppler Burglar Alarm

No, it's not a special alarm system for doppler thieves but a highly-sensitive ultrasonic project which uses the doppler principle to detect moving objects entering a field of inaudible sound. It provides a low-cost method of home protection and has other interesting uses.

High-impedance Voltmeter

Standard multimeters have a nasty habit of 'damping' high-impedance electronic circuits when you try to measure component voltages: the meter impedance is just too low. The meter in this project has an impedance in excess of 11 *million* ohms and will give a true reading of DC voltages in most high-impedance circuits.

Signal Generator

Ever wanted an audio-frequency tone to test your amplifier or other audio project? This generator will enable you to select signals over the audio spectrum.

Train Sound Generator

Yes — a follow-up to the Chuffer in the January issue. But we're not prepared to say what the sound is this time. So, all you model train enthusiasts, wait until the February issue for the secret to be revealed!

Miniature MW Radio

This is the set you can tuck away in your top pocket (or wherever) and tune into . . . whatever's your fancy. Definitely personal pleasure at low cost.

Background Noise Source

Background *what*? This is an HE special, a project to soothe your nerves, help you cope with the frantic pace of life in the 80's and relax as you read HE. More details next month.

Oscilloscopes

The oscilloscope is probably the most versatile piece of test equipment available to the amateur constructor. That much we all know, but how many of us know exactly how they work? Well, we're going to put that right next month with possibly the most comprehensive feature on oscilloscopes ever published. If there are any questions you ever wanted answered about 'scopes then you'll find everything you want to know, right here next month — don't miss it!

Items mentioned here are those planned, but unforeseen circumstances may affect the actual contents.

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160V: 39µF, 100n, 150n, 220n 11p; 330n, 470n 19p; 680n, 1µF 22p; 1µ5, 2µ2 32p; 4µ7F 36p.
1000V: 10nF, 15n 20p; 22n 22p; 47n 26p; 100n 38p; 470n 80p; 1µF 175p.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10nF, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n 10p; 220n, 330n 13p; 470n 17p; 680n 19p; 1µF 22p; 1µ5 30p; 2µ2 34p; 4µ7 60p.

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TAG-END TYPE: 450V: 100µF 180p; 70V: 4700, 165p; 64V: 3300 150p; 2500 110p; 50V: 3300 135p; 2200 99p; 40V: 4700 130p; 4000 92p; 3300 93p; 2500, 2200 90p; 2000+2000 120p; 30V: 4700 110p; 25V: 15,000 195p; 6400 120p; 4700 100p; 3300 85p; 2200 60p.

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35V: 0.1µ; 0.22, 0.33; 0.47; 0.68, 1.0µ; 2.2µ; 3.3µ; 4.7; 25V: 10.
20V: 6µ8; 16V: 2µ2; 4µ7; 10. 20p.
16V: 22µ; 30p; 47, 100 58p; 220 80p.
10V: 15µ, 22µ, 33, 28p; 100 40p; 6V: 47µ; 68; 100 32p; 3V: 100 23p.

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01µF 6p
0·015, 0·02, 0·04, 0·05, 0·056µF 7p
0 1µF 8p. 50V: 0 47µF 12p

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POTENTIOMETERS: Rotary, Carbon, Track. 0.25W Log & 0.5W Lin.
500Ω, 1KΩ & 2KΩ (Linear only) Single Gang 29p
5KΩ-2MΩ Single Gang 29p
5KΩ-2MΩ Single Gang D/P Switch 65p
5KΩ-2MΩ Double Gang 88p

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm
5KΩ-500KΩ single gang 70p
10KΩ-500KΩ dual gang 80p
Self Stick Graduated Bews 36p

PRESET POTENTIOMETERS
Vertical & Horizontal
0.1W 50Ω—5MΩ Miniature 7p
0·25W 100Ω—3.3MΩ horiz. 10p
0·25W 200Ω—4.7MΩ vert. 10p

RESISTORS -- Carbon Film, High Stability, Low Noise, Miniature Tolerance 5%.

	RANGE	VAL	1-99	100+
¼W	2Ω2—4M7	E24	2p	1p
½W	2Ω2—4M7	E12	2p	1p
1W	2Ω2—10M	E12	5p	4p
2%Metal Film 10Ω-1M			6p	4p
1%Metal Film 51Ω-1M			8p	6p

100+ price applies to Resistors of each value not mixed.

S-Dec 350p U-Dec 'B' 699p
U-Dec 'A' 465p Euro Breadboard 530p

OPTO ELECTRONICS
LEDs plus clips

TIL209 Red	13
TIL211 Grn.	18
TIL212 Yel.	18
2" Red	15
2" Yel. Grn.	18
Square LEDs	30
ORP12	63
2N5777	45
LD271	40
SFH205	98
TIL32	58
TIL78	70

7 Segment Displays

TIL321 C A 5"	115
TIL322 C C 5"	115
DL704 C Cth 3"	99
DL707 C A 3"	99
3 Green CA	150
DL747 C.A .6"	180
FND357	120
MAN3640	175
10 Seg Bargraph	225
LCD 3½ Digit	775

SWITCHES
MEC, Black body, Red, Grn, Blue,

SRL Latching	125
SRM Momentary	125

TOGGLE, 2A 250V

SPST	33
DPDT	44
4 Pole on/off	54

SUB-MIN TOGGLE

SP changeover	60
SPST on/off	54
DPDT 6 tags	75
DPDT c/of	88
DPDT Biased	145

SLIDE 250V:

1A DPDT	14
1A DP c/off	15
½A DPDT	13
4 pole c/over	24

VOLTAGE REGULATORS

1A	TO3	+ ve		−ve	
5V	7805	145p		7905	220p
12V	7812	145p		7912	220p
15V	7815	145p			—
18V	7818	145p			—

1A	TO220	Plastic Casing		
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	65p
18V	7818	60p	7918	65p
24V	7824	60p	7924	65p

100mA	TO92 Plastic Casing			
5V	78L05	30p	79L05	65p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	65p
15V	78L15	30p	79L15	65p

CA3085	95p	LM323K	625p	TAA550	50p
LM300H	170p	LM325N	240p	TBA625B	95p
LM305H	140p	LM326N	240p	TDA1412	150p
LM309K	135p	LM327	270p	78HO5	595p
LM317K	350p	LM723	39p	78HG5	650p

We stock parts for most of the projects in this magazine.

ACCESS
Just phone your order through. We deal with the rest (but min. £10 please).

SWITCHES Miniature Non-Locking
Push to Make 15 Push Break 20
ROCKER: SPST on/off 10A/250V 28
ROCKER: Illuminated (black) chrome bezel, lights when on; DPST 3A 240V 85
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way, 2p/2-6 way, 3p/2-4 way, 4p/2-3 way 45
ROTARY: Mains 250V AC. 4 Amp 52

DIL SOCKETS (Low Profile — Texas) 8 pin 10p; 14 pin 12p; 16 pin 13p; 18 pin 16p; 20 pin 22p; 24 pin 30p; 28 pin 35p; 40 pin 40p.

JACKSONS VARIABLE CAPACITORS

Dielectric		0 2 365pF with slow motion Drive	450p
100/300pF	205p	00 208/176	395p
500pF	250p	00 208/176 with slow motion drive	410p
6 1 Ball Drive 4511/DAF	145p	C804-5pF: 10: 15: 25: 50pF	250p
Dial Drive 4103 6·1/36:1	775p	100, 150pF	335p
Drum 54mm	59p	'L' 3x310pF	725p
0-1.365pF	325p	00.3x25pF	550p
00-2.365pF	395p		

DENCO COILS

'DP' VALVE TYPE Range 1 to 5 Bl., Rd, Tl., Wht.	106p	RFC 5 chokes	120p
6-7 BYR	95p	RFC 7 (19mH)	133p
1 5 Green	130p	13; 14; 15; 16; 17	110p
'T' type 1 to 5, Bl, Rd, Wht. Yl	130p	18/1.6	116p
		18/465	132p
B9A Valve Holder	35p	TOC 1	110p
		MW5FR	112p
RDT2	120p	MW/LW SFR	134p

VEROBOARD

	0 1 (copper clad)	0.15 (copper clad)	0 15 (plain)
2½ x 3¼	66p	59p	34p
2½ x 5	75p	69p	39p
3¾ x 3¾	75p	75p	—
3¾ x 5	86p	92p	65p
2½ x 17	202p	199p	—
3¾ x 17	296p	260p	178p
4¾ x 17	387p	—	280p

Pkt of 36pins	20p	'DIP' Board	326p
Spot face cutter	107p	'VQ' Board	144p
Pin insertion tool	147p	Veroblock	350p

DIODES

BA100	16
BY126	12
BY127	12
CR033	158
OA9	45
OA47	18
OA70	12
OA79	15
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	9
OA202	9
IN914	4
IN916	6
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IN5401/2	15
IN5403/4	20
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

We stock a wide selection of Electronic Books and Magazines

ZENERS
Range: 2V7 to 39V 400mW 8p each
Range. 3V3 to 33V, 1.3W 15p each

NOISE
Z5J 180p

BRIDGE RECTIFIERS

(plastic case)	p
1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

DIAC
ST2 25

SCRs Thyristors

0.6A/200V	30
0 8A100V	30
0 8A200A	35
1A100V	42
1A200V	47
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A500V	58
8A600V	85
12A300V	59
12A500V	92
15A700V	195
2N4444	140
BT106	150
C106D	38
TIC44	25
TIC45	45

TRIACS

3A100V	48
3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
12A800V	130
16A100V	95
16A500V	150
25A800V	295
25A1000V	480
T280000	120

TTL 74

7400	11
7401	11
7402	11
7403	14
7404	14
7405	18
7406	36
7407	36
7408	17
7409	20
7410	17
7411	25
7412	20
7413	32
7414	38
7416	30
7417	30
7420	19
7421	38
7422	25
7423	28
7425	28
7426	43
7427	32
7428	35
7430	19
7432	27
7433	36
7437	35
7438	32
7440	20
7441	68
7442	58
7443	120
7444	116
7445	105
7446	132
7447	72
7448	75
7450	20
7451	20
7453	20
7454	20
7460	20
7470	40
7472	30
7473	35
7474	34
7475	56
7476	40
7480	52
7481	120
7482	75
7483	90
7484	99
7485	105
7486	33
7489	205
7490	42
7491	84
7492	50
7493	57
7494	85
7495	70
7496	80
7497	176
74100	130
74104	62
74105	62
74107	34
74109	60
74110	54
74111	68
74112	170
74116	180
74118	85
74119	120
74120	75
74121	35
74122	50
74123	65
74125	50
74126	45
74128	65
74132	55
74136	65
74141	75
74142	185
74143	250
74145	90
74147	150
74148	125
74150	130
74151	70
74153	70
74154	120
74156	75
74157	70
74159	165
74160	99
74161	99
74162	99
74163	99
74164	120
74165	120
74166	130
74167	205
74170	205
74172	375
74173	110
74174	100
74175	82
74176	80
74177	85
74178	110
74180	90
74181	280
74182	85
74184	130
74185	130
74188	310
74190	130
74191	120
74192	120
74193	120
74194	102
74195	75
74196	99
74197	88
74198	160
74221	150
74246	150
74247	151
74248	189

74LS

74LS00	13
74LS01	13
74LS02	15
74LS03	15
74LS04	16
74LS05	23
74LS08	22
74LS09	23
74LS10	20
74LS11	32
74LS12	32
74LS13	40
74LS14	60
74LS15	40
74LS20	21
74LS21	32
74LS22	35
74LS26	44
74LS27	35
74LS28	35
74LS30	20
74LS32	25
74LS42	66
74LS47	85
74LS48	105
74LS55	30
74LS63	150
74LS73	45
74LS74	35
74LS75	45
74LS76	45
74LS83	105
74LS85	80
74LS86	38
74LS90	50
74LS92	75
74LS93	60
74LS95	115
74LS96	120
74LS107	45
74LS109	75
74LS112	40
74LS113	75
74LS114	40
74LS122	70
74LS123	75
74LS124	180
74LS125	45
74LS126	45
74LS132	60
74LS136	55
74LS138	70
74LS139	70
74LS145	120
74LS147	210
74LS148	170
74LS151	90
74LS153	85
74LS155	75
74LS157	70
74LS158	70
74LS160	90
74LS161	98
74LS162	110
74LS163	95
74LS164	115
74LS165	145
74LS166	175
74LS173	105
74LS174	110
74LS175	110
74LS181	295
74LS190	95
74LS191	95
74LS192	95
74LS193	99
74LS195	130
74LS196	120
74LS197	85
74LS221	120
74LS240	165
74LS241	165
74LS242	165
74LS243	165
74LS244	195
74LS245	350
74LS247	135
74LS248	135
74LS249	135
74LS251	130
74LS365	65
74LS367	65

CMOS★

4000	14
4001	14
4002	15
4006	86
4007	19
4008	76
4009	40
4010	48
4011	18
4012	24
4013	43
4014	90
4015	82
4016	35
4017	70
4018	76
4019	48
4020	85
4021	90
4022	85
4023	24
4024	60
4025	24
4026	180
4027	45
4028	92
4029	98
4030	55
4031	185
4032	125
4033	175
4034	213
4035	95
4036	275
4037	115
4038	110
4039	299
4040	85
4041	80
4042	70
4043	80
4044	80
4045	175
4046	96
4047	98
4048	65
4049	35
4050	38
4051	86
4052	86
4053	86
4054	130
4055	130
4056	135
4057	2850
4059	575
4060	110
4061	1225
4062	995
4063	120
4066	46
4067	430
4068	26
4069	22
4070	25
4071	25
4072	25
4073	25
4075	23
4076	85
4077	30
4078	28
4080	25
4081	26
4082	26
4085	90
4086	90
4089	150
4093	55
4094	210
4095	95
4096	95
4097	340
4098	115
4099	150
4160	115
4161	115
4162	115
4163	115
4174	115
4175	120
4194	115
4408	790
4409	790
4410	750
4411	950
4412F	1250
4412V	1520
4415F	480
4415V	480
4419	320
4422	570
4432	1050
4433	995
4435	850
4440	999
4450	350
4451	350
4452	—
4490F	350
4490V	350
4501	28
4502	105
4503	65
4506	75
4507	48
4508	325
4510	85
4511	98

LINEAR ICs

2102-2	225
2114	225
2708	495
4116	299
6502	650
6800	700
709C 8 pin	35
710	67
733	75
741C 8 pin	17
747C	78
748C	36
753	150
810	159
81LS95	135
81LS96	135
81LS97	140
AY-1-0212	595
AY-1-1313A	660
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6721/6	210
AY-3-8500	390
AY-3-8910	850
AY-5-1224A	235
AY-5-1230	450
CA3018	68
CA3020	186
CA3023	191
CA3028A	80
CA3035	235
CA3045	365
CA3046	70
CA3048	214
CA3059	195
CA3080E	65
CA3081	190
CA3085	95
CA3089E	215
CA3090AQ	375
CA3123E	150
CA3130	90
CA3140	48
ICL7106E	795
ICL7107	975
ICL8038CC	340
ICM7205	1150
ICM7216A	1950
ICM7217A	790
ICM7555	89
LD130	452
LF351	48
LF356	90
LM300HX	170
LM301A	26
LM308	95
LM318	200
LM324	50
LM339	68
LM348	90
LM349	115
LM379	375
LM380	80
LM381	145
LM382	125
LM386	99
LM387	120
LM1458	45
LM3900	60
LM3909N	70
LM3911	125
LM3914	240
LM3916	255
M252	625
M253AA	1150
MC1304P	260
MC1310	150
MC1458	45
MC1488	90
MC1489	90
MC1495	350
MC1496	92
MC1710	79
MC3340P	120
MC3360P	120
MC3401	52
MC3403	135
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
NE543	210
NE544	185
NE555	22
NE556	55
NE560	325
NE561	398
NE562	410
NE564	435
NE565	120
NE566	180
NE567	170
NE570	450
NE571	420
RC4136	110
S5568	275
SAB3209	425
SAB3210	275
SN76003	240
SN76013	170
SN76023	170
SN76033	195
SN76477	175
TAA621	250
TBA120	70
TBA641	250
TBA800	90
TBA810	95
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA1490	290
TDA2020	320
TL061	46
TL063	95
TL071CP	45
TL074	140
TL081	42
TL082	70
TL083	95
TL084	120
UAA170	170
UAA180	170
Z80	780
Z80A	899
Z80CTC	595
Z80P10	575
ZN1034E	200
ZN1040E	685
7N414	95
ZN424E	130
ZN425E	415

TRANSISTORS

AC125	35
AC126	25
AC127	25
AC128	25
AC141	30
AC142	30
AC176	28
AC187	28
AC188	30
ACY17	70
ACY18	70
ACY20	75
ACY21	75
ACY22	60
AD140	120
AD149	79
AD161	42
AD162	42
AF115	60
AF139	40
AF178	75
AF180	70
AF186	70
AF239	78
BC107	10
BC108	10
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC117	24
BC119	38
BC137	40
BC140	30
BC143	30
BC147	9
BC148	9
BC149	9
BC153	27
BC154	27
BC157	10
BC158	10
BC159	11
BC160	45
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171	11
BC172	11
BC177	20
BC178	20
BC179	20
BC182	10
BC182L	10
BC183	10
BC183L	10
BC184	10
BC184L	10
BC187	26
BC212	10
BC212L	10
BC213	10
BC213L	10
BC214	10
BC214L	10
BC307B	14
BC328	15
BC338	15
BC441	34
BC461	34
BC477	40
BC516	40
BC517	40
BC547	14
BC548	14
BC549	14
BC557	15
BC558	15
BC559	15
BCY70	16
BCY71	18
BCY72	20
BD131	48
BD132	48
BD133	60
BD135	45
BD136	40
BD137	40
BD138	40
BD139	40
BD140	40
BD695A	85
BD696A	85
BDY17	195
BDY60	160
BDY61	160
BF115	35
BF167	29
BF173	27
BF177	25
BF178	30
BF179	35
BF180	38
BF194	12
BF195	12
BF196	12
BF197	12
BF198	16
BF200	30
BF224A	25
BF244	28
BF256	35
BF257	32
BF258	32
BF259	35
BF594	40
BF595	39
BFR39	23
BFR40	23
BFR41	23
BFR79	23
BFR80	25
BFR81	25
BFX29	28
BFX81	45
BFX84	26
BFX85	28
BFX86	28
BFX87	28
BFX88	28
BFY50	23
BFY51	23
BFY52	23
BRY39	40
BSX20	20
BSY65	35
BSY95A	25
BU105	170
BU205	190
BU208	200
E113	45
E176	50
E421	250
MJ2955	90
MJE340	54
MJE370	100
MJE371	100
MJE520	95
MJE521	95
MJE2955	99
MJE3055	70
MPF102	66
MPF103	36
MPF104	36
MPF105	36
MPF106	40
MPSA05	25
MPSA06	25
MPSA12	30
MPSA55	30
MPSA56	30
MPSU06	55
MPSU56	60
OC28	120
OC35	125
OC36	120
OC41	120
OC42	120
OC44	120
OC45	40
OC70	40
OC71	40
OC72	40
OC76	50
OC77	50
OC81	50
OC82	50
OC83	40
OC84	40
OC140	110
OC170	85
OC171	85
TIP29	34
TIP29C	60
TIP30	48
TIP30C	58
TIP31A	45
TIP31C	55
TIP32A	46
TIP32C	60
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	160
TIP35C	185
TIP36A	170
TIP36C	199
TIP41A	55
TIP41B	60
TIP42A	60
TIP42B	75
TIP120	90
TIP121	99
TIP122	99
TIP142	120
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44	45
TIS90	30
TIS91	32
ZTX107	11
ZTX108	11
ZTX109	12
ZTX300	13
ZTX301	16
ZTX302	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX326	30
ZTX341	30
ZTX500	14
ZTX501	15
ZTX502	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N526	58
2N696	30
2N697	23
2N698	40
2N699	48
2N706	19
2N708	19
2N918	35
2N930	20
2N961	65
2N1131	24
2N1132	24
2N1302	45
2N1304	65
2N1305	60
2N1671B	120
2N2160	350
2N2219A	28
2N2220A	23
2N2222	25
N2369A	18
2N2476	50
2N2484	27
2N2483	27
2N2497	63
2N2646	45
2N2894	30
2N2904	28
2N2905A	26
2N2906	26
2N2907	26
2N2926G	10
2N3053	26
2N3054	58
2N3055	48
2N3121	30
2N3133	45
2N3135	30
2N3252	46
2N3442	140
2N3568	25
2N3663	15
2N3702	10
2N3703	10
2N3704	10
2N3705	10
2N3706	10
2N3707	10
2N3708	10
2N3709	10
2N3710	10
2N3711	10
2N3713	140
2N3771	179
2N3772	195
2N3773	270
2N3819	22
2N3820	45
2N3822	65
2N3823	65
2N3866	90
2N3903	18
2N3904	18
2N3905	15
2N3906	17
2N4037	46
2N4058	10
2N4061	10
2N4062	10
2N4069	45
2N4859	78
2N4871	55
2N5135	20
2N5136	20
2N5138	18
2N5179	45
2N5180	45
2N5191	75
2N5305	24
2N5457	36
2N5458	36
2N5459	36
2N5485	36
2N5777	45
2N6027	32
3N128	112
3N140	112
40311	60
40313	130
40316	95
40317	60
40324	100
40326	60
40327	70
40348	120
40360	40
40361	50
40362	50
40407	60
40408	70
40411	285
40412	65
40467	130
40468	85
40594	105
40595	110
40603	110
40636	175
40673	95

Sound-into-Light Module

No ordinary sound-into-light display this: by creating a pulsating, rising-and-falling light show it will transform your party or disco. Designed by Magenta Electronics

OH NO, NOT another boring old sound-into-light converter — well yes and no. Yes, it is a sound-into-light converter but no, it certainly is *not* boring, in either appearance or design. By constructing the HE Ladder-of-Light as a modular design you will be the owner of a very versatile project. The simplest module (as shown here) will drive ten 100 W bulbs either in bar mode (in a line increasing from one end) or dot mode (one bulb at a time) according to the volume of music. All that's required is to connect the Ladder-of-Light to your amplifier or speakers.

By filtering the audio signal through a low-pass, a high-pass or an all-pass filter, the converter is controlled by bass, treble or middle frequencies allowing the display to pulsate in time with music or vocal etc. An adjustable sensitivity level means that most amplifiers regardless of output power, can be used with the project.

The display of bulbs is triac-controlled with zero-cross detection and triggering to prevent radio frequency interference (RFI), and with no heatsinking ten 100 W bulbs can be used without the triacs overheating. If you wish, the triacs can be fitted with heatsinks thus taking power handling up to the triacs maximum of 1k2 W per bulb, but it is outside the scope of this article to show how this can be done. If you want to increase power handling, remember that the total current consumption of the converter and display must not exceed that available from mains (ie 13 A). Style of the display is largely a matter of personal choice and so we only give suggestions for its constructional details, but designs could be in the form of a line of bulbs, a circle, a spiral etc.

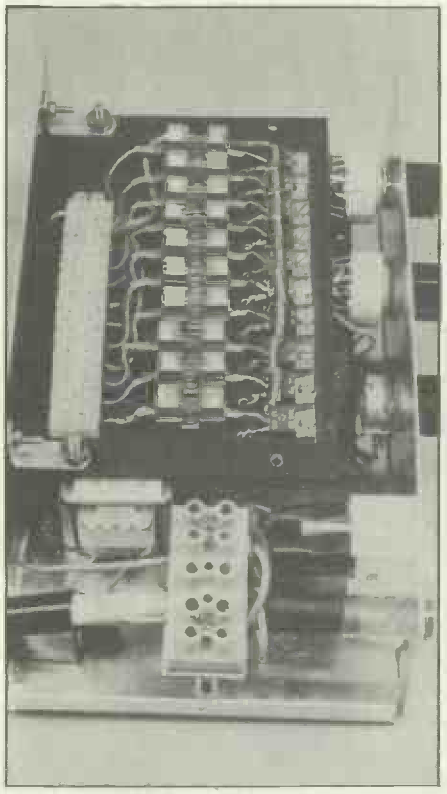
More intricate and eye dazzling displays can obviously be built if more than one module is used so that different coloured bulbs can be used, for bass and treble for example, adding a new dimension.

Construction

Unlike most mains-powered projects (especially those which control mains voltages via triacs and thyristors etc) we have not used a PCB for constructional purposes, but Veroboard. The main reason for this is that the only mains connection to the board is a *neutral* connection. However, we must stress that while we have taken every precaution in the wiring of the project, if the mains wiring of the particular application is incorrect (ie the live and neutral connections are reversed), then the mains and triac board will be *potentially live* — and prying fingers might pry no more. So take care!

Construction starts with the Veroboard — a larger-than-usual piece — 26 strip by 50 holes, 0.1" matrix. We are assuming that builders of this projects are not beginners so we need not explain *all* stages of build-up of the board, just remember to make the breaks in the track first. Use pins in the board for all external connections — in this way the board can be fixed in position into the case using *plastic* mounting brushes (for insulation) before wiring-up starts.

Drill the case for all switches, the pot, neon, cable holder, triac and main board mounting holes, transformers, connector blocks and a rectangular slot in the back panel to allow the cables from all lamps to enter the case. Grommet strips should be put around the slot to prevent chaffing of the cables. Your project can now start to go together as in the connection diagram of Fig. 5 which should provide you with details of the full project minus only the triac board. This is a piece of paxolin on which the ten triacs, 10 fuseholders and the



12-way connecting block fit as you can see in the photograph. These must all be firmly mounted on the paxolin. Solder all 10 triac MT1 terminals together, using a suitable length of single-core, tinned wire and insulate this adequately with sleeving. Each MT2 terminal of the triacs goes to the corresponding fuseholder (again insulated). The final triac connections — the 10 gate terminals — should be taken to the corresponding output of the LM3914 on the main board. **Figure 1** connection diagram shows their order.

The other sides of the fuseholders go to the first 10 terminals on the connecting block. The final two terminals of the block are neutral connections, one to the mains input connecting block and one to the main board. These two terminals are joined and then taken to the ten MT1 terminals of the triacs. **Figure 1**, summarises all connections on this board. Now fasten this board to the back panel using angle brackets and make sure no short circuit might occur between the triac circuitry and the rest of the project.

A second paxolin panel should be used over the triac board to prevent the lid from shorting out the connections underneath, if for instance, the case is accidentally damaged.

The project is ready for testing now, with ten bulbs and an audio source. The live connection for each bulb is taken from the mains terminal block and connected to the bulbs in turn.

Buylines

All the components are reasonably easy to obtain, but Magenta Electronics are producing a full kit of parts for those readers who can't be bothered to buy individual components. This kit is also very reasonably priced at £30.38 inclusive of case, VAT and postage — all you need is a plug. Not bad, eh? As an added incentive, Magenta have included in this price the circuit for Strobe and Chase facilities. You will find their advertisement on page 24 this month.

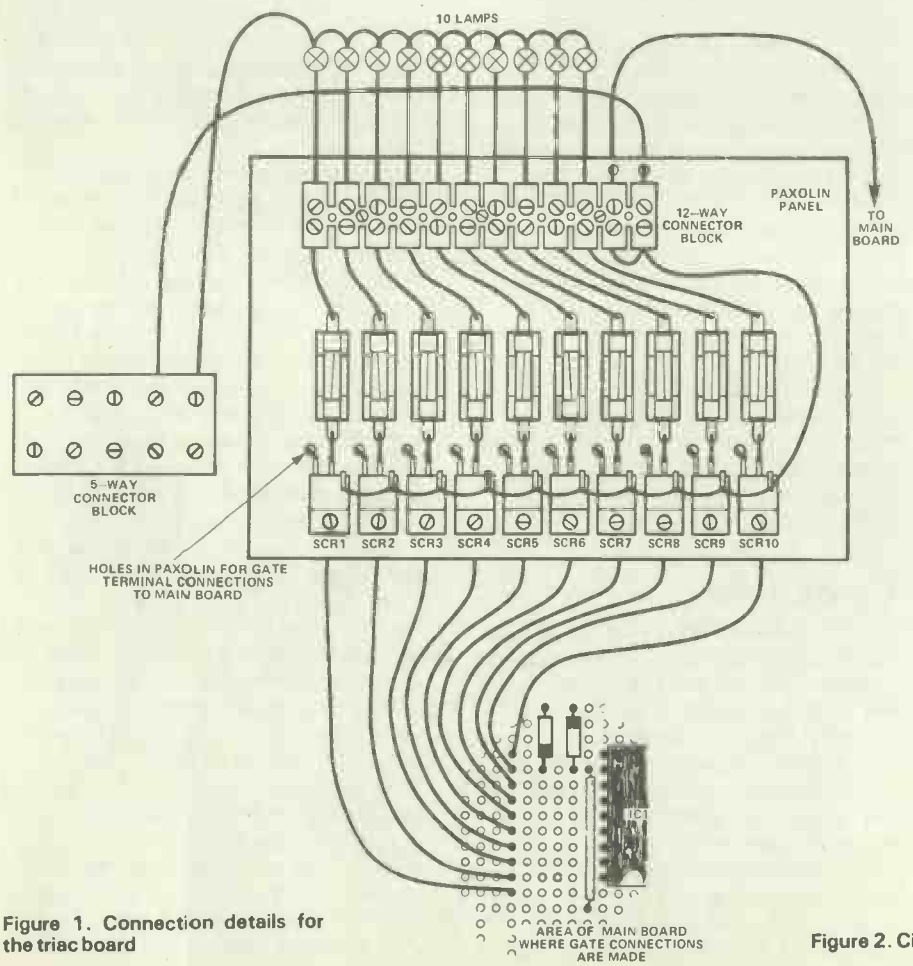


Figure 1. Connection details for the triac board

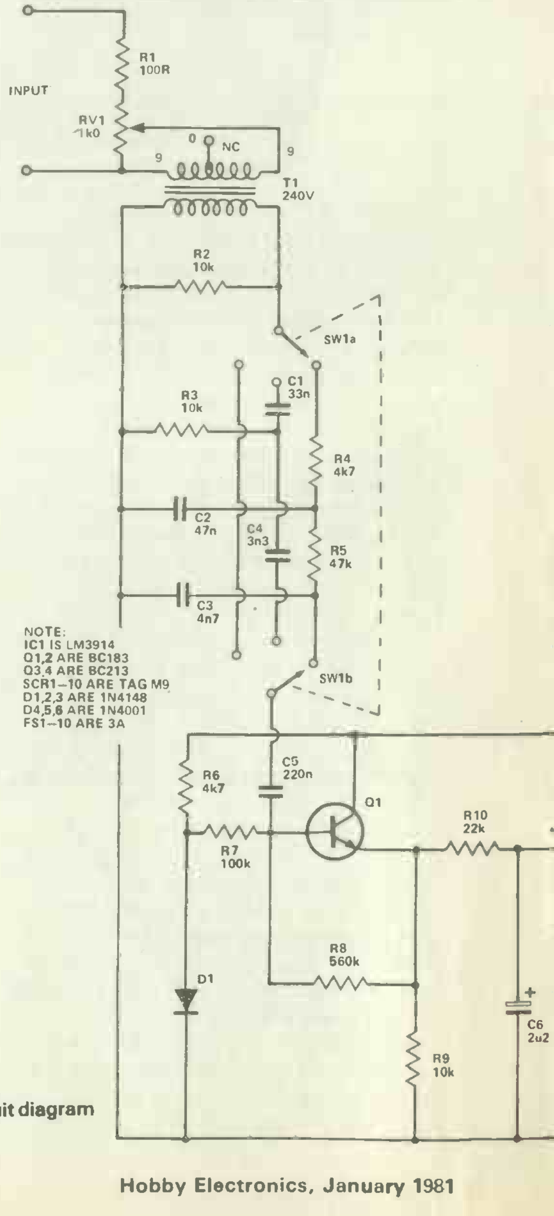


Figure 2. Circuit diagram

How It Works

The HE Ladder-of-Light controls each bulb in the display, according to the amplitude of the applied audio signal. The 10 bulbs are turned on and off by triacs SCR 1 to 10 in Fig. 2. These triacs can be considered as being electronic switches which are operated by pulses at their gates. The block diagram shown in Fig. 3 shows such a switch capable of turning on one bulb. Although we have only shown one triac, there are ten in the project.

The gate pulse to operate the triac comes from the dot/bar voltmeter IC1, an LM3914, which as our 'regulars' will know (we have used it once or twice before) drives either a bargraph or dot display, where the number of 'dots' illuminated depends on the applied DC voltage at its input. The LM3914 is most often associated with a 'line of LEDs' display, but this application sees it driving a line of triacs directly.

The DC voltage at the input of the LM3914 voltmeter is derived from the audio input, taken directly from your amplifier output. Transformer T1 is used as an isolating transformer to electrically separate the amplifier circuit from the Ladder-of-Light circuit (only magnetic coupling takes place). From here the signal is switched through a bank of filters (low-pass, high-pass or all-pass) by SW1, which means that various frequency bands — either bass, treble or middle — are used to control the light.

As the audio signal is AC and the required control voltage at the LM3914 is DC, the signal must be rectified and Q1 with its associated components performs this function. The resultant DC voltage of 0 V to 1.2 V is stored by capacitor C6.

Now, if a triac is turned on half-way through a mains cycle, radio frequency interference (RFI) can occur, because of the sharp edge on the wave — Fig. 4 shows such a waveform. The obvious way to prevent RFI from occuring, therefore, is to switch on the triac at the beginning of the mains cycle. The block diagram shows a section dedicated to detecting when the mains voltage crosses 0 V, the zero-crossing detector formed by Q2,3,4 along with associated components. Whenever this 0 V state occurs the LM 3914 is allowed (given the right control voltage) to turn on the triacs.

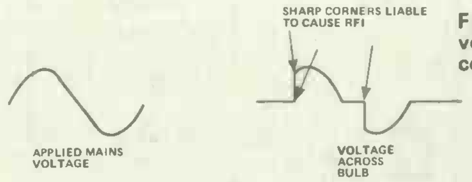


Figure 4. Input and output voltages to an ordinary triac power controller

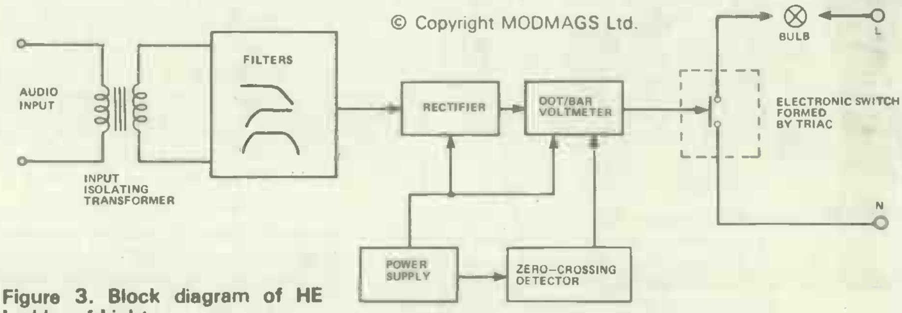
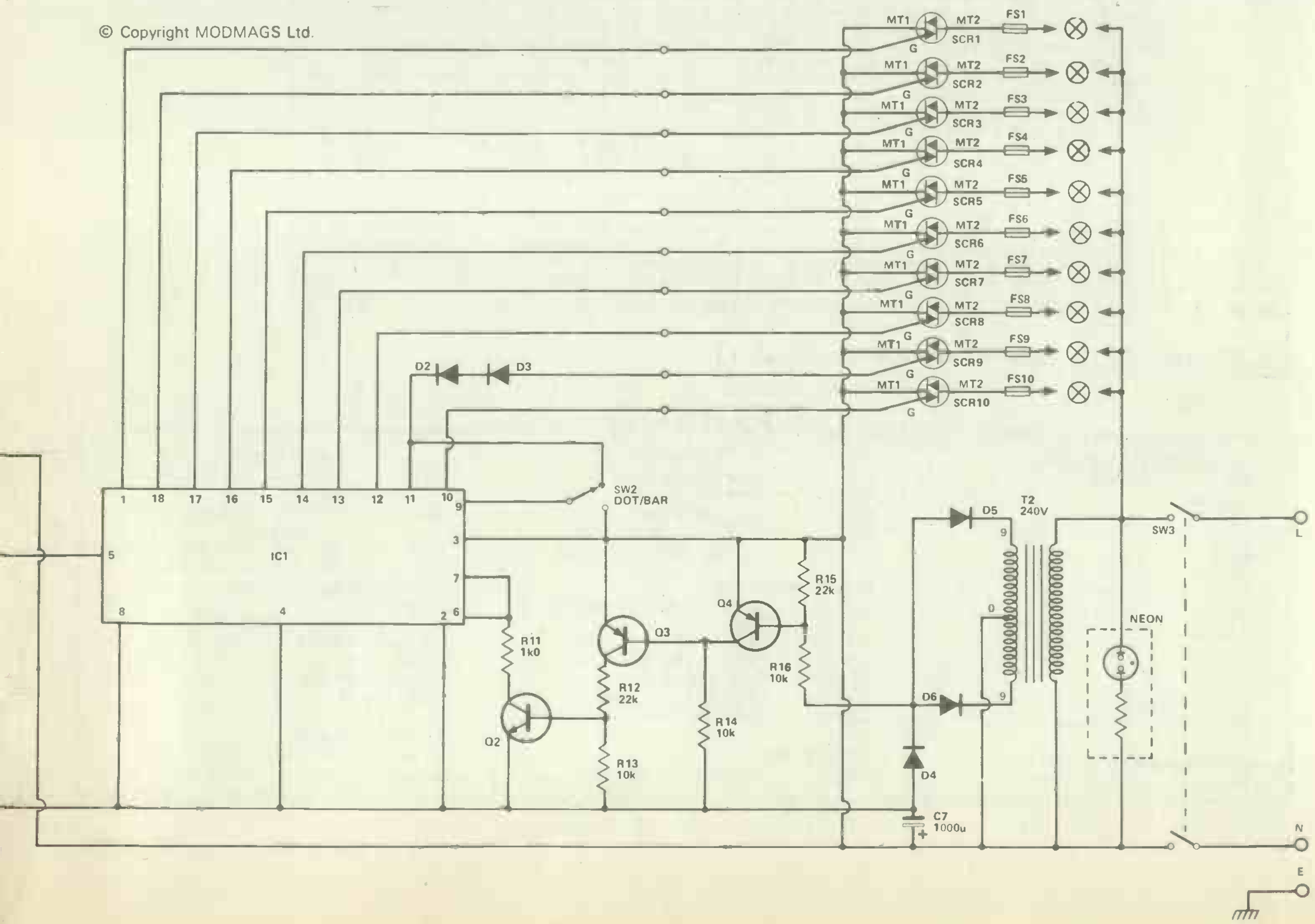


Figure 3. Block diagram of HE Ladder-of-Light



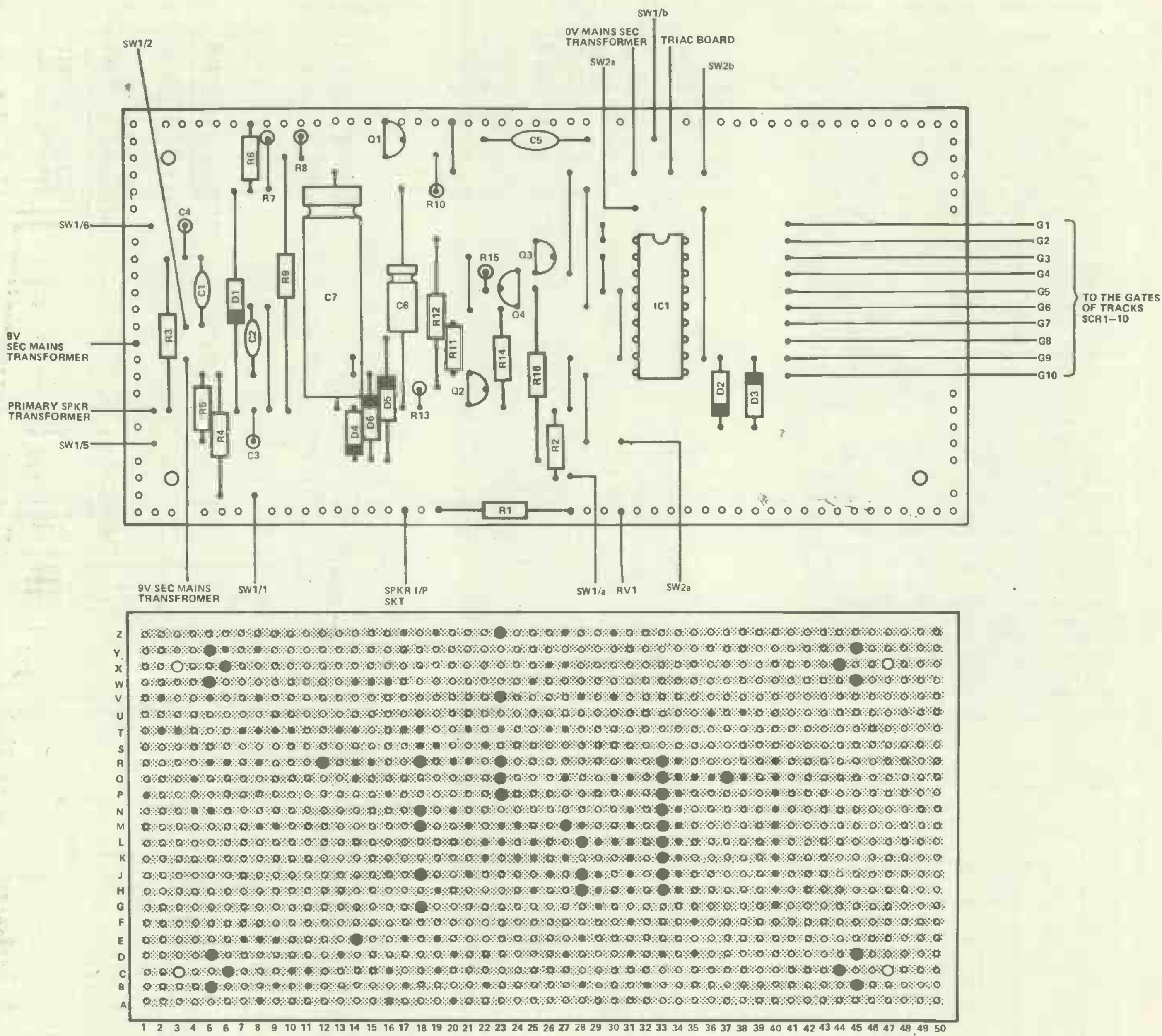


Figure 5. Veroboard layout and underside view showing track breaks

Parts List

RESISTORS (All ¼W, 5%)
- R1 — 100R
- R2,3,9,13,14,16 — 10k
- R4,6 — 4k7
- R5 — 47k
- R7 — 100k
- R8 — 560k
- R10,12,15 — 22k
- R11 — 1k0

POTENTIOMETER
- RV1 — 1k0 linear

CAPACITORS
- C1 — 33n polyester
- C2 — 47n polyester
- C3 — 4n7 polystyrene
- C4 — 3n3 polystyrene
- C5 — 220n polyester
- C6 — 2u2, 16 V electrolytic
- C7 — 1000u, 16 V electrolytic

SEMICONDUCTORS
- IC1 — LM3914 dot/bar display driver
- Q1,2 — BC183 NPN transistor
- Q3,4 — BC213 PNP transistor
- D1,2,3 — 1N4148 diode
- D4,5,6 — 1N4001, 1 A diode
- SCR1-10 — TAG M9 triac

MISCELLANEOUS
- SW1 — two-pole, three-way rotary switch
- SW2 — one-pole, two-way rotary switch
- SW3 — single-pole, single-throw rocker switch
- T1,2 — 9-0-9 V mains transformer
- FS1-10 — 3 A fuse + fuseholders
- neon with integral resistor
- cable grip
- 12-way connecting block (2 A)
- 5-way connecting block (10 A)
- speaker DIN socket
- IC socket (18 pin)
- knobs to suit
- case to suit
- 2 x angle brackets
- 26 strip x 50 hole 0.1" Veroboard
- 2 x paxolin panels of suitable size.

HE

TTLs by TEXAS

7400	11p
74S00	60p
7401	12p
7402	12p
7403	14p
7404	14p
7405	18p
7406	36p
7407	36p
7408	17p
7409	19p
7410	15p
7411	24p
7412	20p
7413	30p
7414	40p
74C14	90p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
7425	30p
7426	40p
7427	34p
7428	36p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	75p
7448	80p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	34p
7474	30p
7475	38p
7476	32p
7480	50p
7481	100p
7482	84p
7483a	90p
7484	100p
7485	110p
7486	34p
7489	210p
7490A	30p
7491	80p
7492A	46p
7493A	36p
7494	84p
7495A	70p
7496	65p
7497	180p
74100	130p
74107	34p
74109	55p
74116	200p
74118	130p
74119	210p
74120	110p
74121	34p
74122	48p
74123	60p
74125	70p
74126	60p
74128	75p
74132	75p
74136	75p
74137	50p
74141	50p
74142	200p
74145	90p
74147	190p
74148	150p
74150	130p
74151A	70p
74153	70p
74154	120p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	120p
74167	200p
74170	240p
74172	450p
74173	120p
74174	90p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	160p
74182	90p
74184A	150p
74185	150p
74186	500p
74188	325p
74190	120p
74191	120p
74192	100p
74193	100p
74194	120p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74221	160p
74251	140p
74259	250p
74278	290p
74279	110p
74283	140p
74284	360p
74285	360p
74290	150p
74293	150p
74298	200p
74365	100p
74366	100p
74367	100p
74368	100p
74390	200p
74393	200p
74490	225p

74LS SERIES

74LS00	14p
74LS02	16p
74LS03	18p
74LS04	16p
74LS05	25p
74LS08	22p
74LS09	21p
74LS10	20p
74LS11	40p
74LS13	40p
74LS14	50p
74LS20	20p
74LS21	40p
74LS27	38p
74LS30	20p
74LS32	27p
74LS37	30p
74LS38	38p
74LS42	70p
74LS47	75p
74LS51	24p
74LS55	30p
74LS73	50p
74LS74	27p
74LS75	36p
74LS76	45p
74LS83	70p
74LS85	80p
74LS86	40p
74LS90	40p
74LS92	70p
74LS93	60p
74LS96	110p
74LS107	45p
74LS109	80p
74LS112	40p
74LS113	40p
74LS114	45p
74LS122	80p
74LS123	60p
74LS124	180p
74LS125	50p
74LS126	50p
74LS132	60p
74LS133	30p
74LS136	55p
74LS138	65p
74LS139	75p
74LS145	120p
74LS147	220p
74LS148	175p
74LS151	80p
74LS153	60p
74LS154	200p
74LS155	80p
74LS156	90p
74LS157	60p
74LS158	60p
74LS160	90p
74LS161	75p
74LS162	140p
74LS163	100p
74LS164	90p
74LS165	140p
74LS166	180p
74LS173	110p
74LS174	100p
74LS175	100p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	100p
74LS193	100p
74LS195	140p
74LS196	120p
74LS197	90p
74LS221	120p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	150p
74LS245	250p
74LS247	140p
74LS251	140p
74LS253	90p
74LS257	90p
74LS258	160p
74LS259	160p
74LS266	100p
74LS273	170p
74LS279	90p
74LS283	90p
74LS298	120p
74LS323	400p
74LS324	200p
74LS348	200p
74LS365	48p
74LS367	100p
74LS368	100p
74LS373	150p
74LS374	150p
74LS375	120p
74LS377	160p
74LS378	140p
74LS390	120p
74LS393	120p
74LS399	200p
74LS445	140p
74LS670	400p

4000 SERIES

4000	15p
4001	22p
4002	20p
4006	95p
4007	20p
4008	80p
4009	40p
4010	50p
4011	20p
4012	25p
4013	50p
4014	84p
4015	84p
4016	45p
4017	70p
4018	89p
4019	45p
4020	100p
4021	110p
4022	100p
4023	27p
4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4034	200p
4035	110p
4036	295p
4039	295p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	45p
4050	45p
4051	80p
4052	80p
4053	80p
4054	150p
4055	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	50p
4067	450p
4068	27p
4069	20p
4070	30p
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4072	25p
4073	25p
4075	25p
4076	107p
4081	27p
4082	27p
4086	72p
4089	150p
4093	70p
4094	250p
4095	95p
4096	95p
4097	340p
4098	120p
4099	200p
40100	220p
40101	132p
40102	180p
40103	180p
40104	99p
40105	120p
40106	90p
40107	60p
40108	470p
40109	100p
40110	300p
40114	250p
4502	120p
4503	70p
4507	55p
4508	290p
4510	99p
4511	120p
4512	80p
4514	250p
4515	300p
4516	110p
4518	100p
4520	100p
4521	250p
4526	108p
4527	150p
4528	100p
4532	140p
4534	550p
4536	375p
4538	120p
4543	180p
4553	320p
4556	72p
4560	200p
4569	250p
4572	40p
4583	110p
4584	90p
4585	150p
4724	250p
40097	90p
14411	1100p
14412	1100p
14433	1100p
14500	700p
14599	290p

INTERFACE ICs

AD536A	£13
AD561J	1400p
AD7524	600p
DM8123	175p
DM8131	375p
DP8304	450p
DS8835	250p
DS8836	150p
DS8838	225p
MC1488	75p
MC1489	75p
25S10	350p
75107	160p
75110	325p
75150	175p
75154	175p
75182	230p
75322	300p
75324	375p
75325	375p
75361	300p
75363	400p
75365	200p
75451/2	72p
75491/2	70p
8T26	160p
8T28	250p
8T95	180p
8T97	160p
81LS95	120p
81LS96	140p
81LS97	120p
81LS98	140p
9602	220p

'93 SERIES

9301	160p
9302	175p
9308	316p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	360p
9368	250p
9370	300p
9374	200p

74S SERIES

74S00	60p
74S04	60p
74S05	75p
74S08	75p
74S10	60p
74S20	60p
74S30	60p
74S32	90p
74S37	90p
74S64	60p
74S74	90p
74S85	300p
74S86	180p
74S112	120p
74S114	120p
74S124	300p
74S132	160p
74S133	75p
74S138	225p
74S139	225p
74S157	250p
74S174	250p
74S175	320p
74S194	350p
74S241	450p
74S260	70p
74S373	500p
74S374	500p

LINEAR I.Cs

AY1-0212	600p
AY1-1313	668p
AY1-1320	320p
AY1-5050	140p
AY3-1270	840p
AY3-8912	650p
AY5-1224A	240p
AY5-1315	600p
AY5-1317A	775p
AY5-4007D	520p
CA3019	80p
CA3046	70p
CA3048	225p
CA3080E	72p
CA3086	48p
CA3089E	225p
CA3090AQ	375p
CA3130E	90p
CA3140E	50p
CA3160E	100p
CA3161E	140p
CA3162E	450p
CA3189E	300p
CA3280	160p
DAC1408-8	200p
FX209	750p
HA1388	280p
ICL7106	850p
ICL8038	300p
ICM7555	80p
LF13331	310p
LF351	48p
LF356P	95p
LM10C	425p
LM301A	27p
LM311	70p
LM318	200p
LM319	225p
LM324	45p
LM339	75p
LM348	95p
LM358P	50p
LM377	175p
LM380	75p
LM381AN	180p
LM386	95p
LM393	100p
LM709	36p
LM710	50p
LM725	350p
LM733	100p
LM741	18p
LM747	70p
LM748	35p
LM2917	250p
LM3302	140p
LM3900	70p
LM3909	70p
LM3911	130p
LM3914	225p
LM3915	225p
LM13600	125p
MB3712	150p
MC1310P	150p
MC1458	48p
MC1495L	350p
MC1496	70p
MC3340P	120p
MK50398	750p
ML920	775p
MM57160	620p
NE531	150p
NE555	20p
NE556	70p
NE562B	425p
NE564	420p
NE565	130p
NE566	155p
NE567	140p
NE571	425p
NE5534A	250p
RC4136	120p
S566B	270p
SAD1024A	1250p
SFF96364	1100p
SL490	400p
SN76477	175p
SP8515	750p
TA7205	140p
TAA621	275p
TBA641B11	300p
TBA651	200p
TBA800	90p
TBA810	100p
TBA820	90p
TBA950	350p
TCA220	350p
TCA940	175p
TDA1004	300p
TDA1008	320p
TDA1010	225p
TDA1022	570p
TDA1024	120p
TDA1034B	250p
TDA1170	300p
TDA2002V	325p
TDA2020	320p
TL071/81	45p
TL072/82	75p
TL074	130p
TL084	110p
TL170	50p
UAA170	175p
UDN6118	320p
UDN6184	320p
ULN2003	100p
XR2206	300p
ZN414	90p
ZN419C	225p
ZN424E	135p
ZN425E	400p
ZN427E	750p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		−ve	
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p
LM317T	200p
LM323K	500p
LM723	37p
78HGKC	600p
78H05KC	550p
78MGT2C	135p
79HGKC	600p
TL497	300p

OPTO-ELECTRONICS

2N5777	45p
OCP71	90p
ORP12	120p
ORP60	120p
ORP61	120p
TIL78	55p

OPTO-ISOLATORS

IL074	130p
MCT26	100p
MCS2400	190p
TIL111	90p
TIL112	90p
TIL116	90p

LEDS

0.125		0.2"	
TIL32	55p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18p		

DISPLAYS

3015F	200p
DL704	140p
DL707 Red	140p
FND357	120p
FND500	110p
FND507	110p
MAN3640	175p
MAN4640	200p
NSB5881	570p
TIL311	600p
TIL312/3	110p
TIL321/2	130p
TIL330	140p
7750/60	200p

DRIVERS

9368	250p
9370	300p
UDN6118	320p
UDN6184	320p

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6.144MHz	300p
7.0MHz	300p
7.168MHz	300p
8.00MHz	300p
8.867MHz	300p
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Clever Dick

Do you like our new cartoon? Good, well we're stuck with it for the next few months. Anyway down to business with this month's rather interesting selection of letters

I've heard some pretty feeble excuses from people trying to extract valuable binders from the HE staff but this one takes the biscuit. It's so cheeky that Ian Malcolm might just get one, if I remember.

Dear Mr C Dick,
In my capacity as Chief Tester for the National Binder Inspection Board, I would be very grateful for a sample of your HE binders for close scrutiny.

While I'm writing I may as well ask about the feasibility of constructing a communications system between myself and a pillion passenger fortunate enough to experience the thrill of roaring down the High Street on my big, fast Yamaha.

Most helmets cannot be easily adapted for such a system so your suggestions would be most welcome. I believe that the number of bikers on the road today would justify such a circuit.

Please don't forget the binder — we have a duty to protect the consumer and it is your interest to ensure your binder's get the Board's approval.
Ian Malcolm
County Armagh

First things first, the helmet intercom is quite practical, in fact they are manufactured commercially. If you want to make your own then all you'll need are two small amplifiers (we've published many in the past few months) and a helmet headphone/mike kit from Wintjoy Ltd. See the inside back cover for the address. Now, your request for a binder has been considered at length. We've weighed all the pro's and cons ('we know all about cons) and have decided to submit a binder to the Board for testing but we require a 4000 word report by return of post plus £3.95 to cover our expenses.

Back across the Irish Sea and up a bit we have this letter from Steven Johnson who says:

Dear Clever Dick,
Here are a few questions:
(1) Where can I obtain a 240 volt/12 volt 6 VA transformer for use in the Battery Eliminator project in the November issue?
(2) What's happened to Short Circuits?
(3) Are HE Tee Shirts still available and if so how much do they cost?
(4) Have you ever produced an HE diary?
Thank you for such a magnificent magazine.
PS How's HEBOT?
PPS Your Binders look nice!!!
Steven Johnson
Co Durham

(1) Nothing special about the transformer, try Watford Electronics, Maplin, Magneta etc. etc.
(2) They're back next month after a short holiday.
(3) The old HE T-shirts have sold out but the NEW design will be on sale shortly: keep your eyes open for details.
(4) No, but you you never know, we just might.
Thank you for such a nice letter.
PS HEBOT is okay and sends his regards to everyone.
PPS Yes they do don't they, why not buy one?

Back in London, Martin Green also asks about the absent Short Circuits.

Dear CD
A few questions:
(1) Where did Short Circuits go, they were brilliant.
(2) Problem: I had a subscription to HE from March '79 to February '80. In January I renewed my subscription, so far I have received every issue except the April issue. Can you help me?
PS Am I HE's youngest reader at 13? Do I deserve a binder?
PPS Thanks for the superb mag
Martin Green
London

As I said earlier Short Circuits are back next month. Sorry about the missing issue, but by the time you read this one should have been sent. I don't think you are our youngest reader but if you are we will certainly send you a binder. If any of you lot are younger than Martin drop us a line but remember to get your parents to put a note on the letter so we can be sure you're not having us on.

YO HO HO, Hobby Electronics certainly gets around. WEMN C. Phillips currently floating around somewhere has a 'messy' problem.

Dear Clever Dick,
Being in the Royal Navy and living in a Mess with 29 other people I have a problem. We are all fed up with answering the Mess door only to find that the person required is not in. Could you please design a Mess call-up system. The following idea is proposed.

Each Mess member has a personal number. The caller requiring, for example, Number 18 taps out the number required on a keypad at the door. Inside the Mess two 0.5 inch digit LED displays show the number and a siren sounds for about 5 seconds. To answer the called a Mess member presses either a 'Yes Wait' or a 'No' button which will illuminate one of a pair of LEDs on the door. In the event of the

Mess being empty the 'No' light should come on after 30 seconds and reset for further use.
WEMN C. Phillips
BFPO
Ships
London

Well, that all sounds a little complicated to me. How about a simple intercom like the Hobbycom for instance. We can't really think of anything off hand but our readers have a reputation for coming up with brilliant ideas. If any of you have a suggestion for WEMN Phillips then could you send it to us and we'll forward them. By the way what does WEMN stand for?

Our penultimate letter this month comes from David Livings. David has been having difficulties in obtaining some batteries. This problem took quite some time to sort out.

Dear CD,
Is it still possible to obtain 45, 60 and 90 volt dry batteries for valve equipment? If so could you please tell me where I can obtain them and a rough idea about cost. If you can answer this question I will be very grateful.
David Livings
Herts

The problem with this question was that we assumed that such batteries were no longer produced. After several hours head scratching and looking through catalogues from the Vintage Wireless Company we suddenly had the bright idea of looking through the Ever-Ready catalogue. Lo and behold they still make high tension battereies for valve equipment. The nearest ones we could find were the B101 at 67.5 volts. B126 for 90 volts. For the 45 volt battery we suggest two B122s (22.5 V) or one B123 (30 V) and one B121 (15 V) in series. As these batteries are for specialist applications you may have to order them through your local retailer.

Just time for one last letter this month, it comes from Colin Mills who is having Multi Option Siren Problems.

Dear CD,
Just a quick one this. I built the Multi Option Siren in the October '79 issue and something seems to be wrong. I can only get a variable oscillation. I remember seeing a correction on it, and after going through all my back copies I find someone has swiped my November '79 issue so I bet it was there. Can you help.
Colin Mills
Rotherham

Of course we can. The problem was on the overlay diagram (Figure 3). The connection for SK1 was mixed up with the connection for SW1. The wire coming from the junction of R12c and R13 should be marked SK1 not SW1.

Times up once again. Thanks for the hundreds of letters each month, I'm just sorry we can't answer them all. Remember the best chance of being answered is to keep your letters as short as possible. See you next month. **HE**

Top Ten Electronic Games

Looking for an electronic game? Rick Maybury has been playing with over 100 of them recently and reports on his special selection

THE HE OFFICES have been looking like Santa's grotto for the last few months as a result of our latest special 'Gadgets and Games'. We thought it would be a good idea, with Christmas just a few weeks away, to have an exclusive mini-survey, just for Hobby Electronics. From the hundred or so games we've looked at we have selected just ten. The ten games in our list are those we consider to offer the best value for money, are fun to play with and offer the most in terms of challenge and playability: we'll deal with all of these factors in turn.

Value For Money

This was possibly the hardest criteria to establish. Not all of us are multi-millionaires, not least those working for Hobby Electronics. This is especially hard for us to judge as our games are supplied free (though we have to give them back .... eventually!). The games we have chosen are those that we would probably buy ourselves if we had the money to spare. This may sound rather hypocritical with one game costing nearly £200 and a couple of others close to £100 but we sincerly believe that they are worth that kind of money, as much as our cheapest game costing £10.95 is worth every penny.

Most of the games we've reviewed are, quite frankly, a rip-off. Electronic games manufacturers sometimes seem to think that a couple of flashing LEDs and a squeaking noise can justify a £30 price tag. We don't. *We* know all about modern technology and how much it costs.

Fun Factor

To scientifically establish whether a game is fun to play or not we lent our sample games to a group of carefully selected juveniles (the HE and ETI staff) and listened to their comments. For the most part it was incoherent babble but a clear pattern did emerge. If the game was beaten too quickly a flood of tears resulted in the game being thrown against the nearest wall and a replacement demanded with equal ferocity. If the game was a success then the combined efforts of the Editor and Assistant Editor were needed to prise the game from its tearful player. This expert panel was also used to judge the value for money of each game. After each game had been returned (one way or another) the gameless employee often enquired how much of his pocket money would be needed to buy one. If our reply was returned with just one swear word the game was cheap. If two or three expletives came forth then it was a reasonable buy. If he or she had to be physically restrained then it was classed as poor value for money and if they laughed then we had to assume the game was considered over priced.

Playability

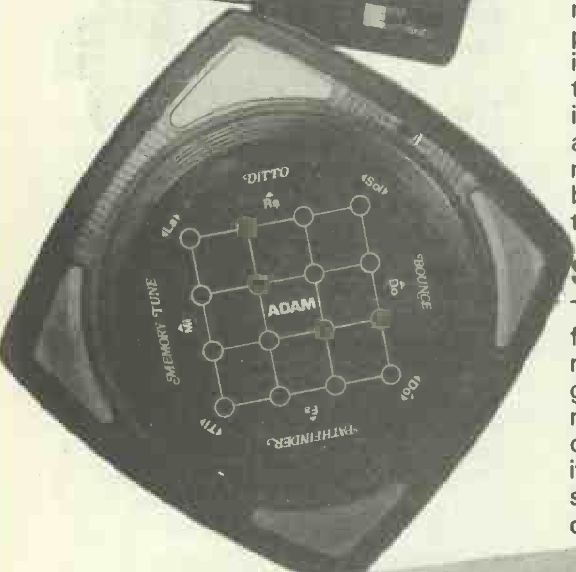
Again our expert panel's comments were used to classify each game. For this test we divided our testers into three groups roughly proportional to intelligence. This we assumed would give us an idea as to how easily each game could be beaten. The three groups were as follows: Editorial staff (naturally the most intelligent), Artists, (quick on the uptake now and again) and Advertisement department (most of them know how to tie their bootlaces). Each game was given to the Ad Department first. Most of the 100 games completely baffled this group. Those games that were left unbeaten (or survived intact) were then passed on to the artists. Again the most of the games left met with a dismal fate. Those that were unbeaten were passed on to the Editorial staff (noted for having large brains and heads to match). After exhaustive testing and much head scratching we came up with our final selection.

The Games

Our ten games have been divided into two groups: the hand-held or table-top games and the TV or video games. We'll look at the hand-held games first.

MICROVISION

Not to be confused with titchy tellys this game is the first cartridge-programmable hand-held game. It comes in two parts, the display and control module and the memory cartridge that is needed for each game. The display module in unusual in that it uses a 2" liquid crystal display (LCD) element for each game. All of the graphics are based upon hundreds of square blocks, this may not sound very



dramatic but believe us, it is. Some very clever design work has gone into this device.

The Microvision comes with just one cartridge as standard called 'Blockbuster' and is better known by the name of 'Breakout' in its more usual video format. Other games include 'Four In A Row', a logical sequence game similar to a board game of the same name. The three remaining games include a space game, 'Shooting Star', 'Bowling' and 'Pinball', both of these are dexterity games based on the pastimes of the same names.

Microvision is currently on sale for £40.00, this price includes the Blockbuster cartridge. Each additional cartridge costs £12.95. Our initial reaction was that this game was overpriced but after prolonged 'field tests' it has become more than apparent that the difficulty of the Blockbuster game is such that it has yet to be mastered by anyone in the HE office. For that reason alone it looks as though it will be played here regularly for quite some time to come.

SPACE INVADERS

There are something like twenty different space invader games on the market ranging from superb video games to quite disgusting hand-held rubbish purporting to be something other than the ten bob's worth of LEDs it actually is. Our choice for a hand-held space invader game comes from a new company called Entex. This version compares quite favourably with the genuine pub or arcade video game. All of the familiar elements are there including the flying saucer that flits acrfoss the screen from time to time offering bonus points when hit. The limitations of the LED display have meant that the aliens are limited in number but this does not detract from the overall game that is both fast and furious and constantly being played with. Price for this game is around £22.95.

ADAM

Adam is not new. In fact, like the first Adam, it is getting quite long in the tooth by now. It is a table-top unit that can play four diffferent compelling games. Game number one is called 'Ditto'. This is a sequence game that relies on the player(s) memory to repeat and ever growing sequence of sounds and lights on the four coloured playing keys. If the player fails to get the right combination Adam responds with an electronic 'raspberry' noise. The sequence is, as far as we can tell, limitless. Our best score on Ditto is a 20-note sequence and we're quite proud of that.

The second game is called Pathfinder and involves the player finding their way out of a hidden maze, again by using the four keys to denote direction of movement of the LED 'man'.

Game number three is called Bounce this is a two or four player reaction game. The players have to press their nearest control key when one of a row of LEDs lights up in the appropriate order. This game is particularly suited to parties where a number of people can join in.

The fourth and final game is not really a game at all. It is called Memory Tune and makes use of the four player keys to record and replay up to 36 notes and spaces. Each of the four individual keys and combinations thereof can be used to create the usual 'doh' 'ray' 'Me' etc. notes and the accompanying song book lists dozens of simple tunes that can be played on Adam's keyboard.

Adam is available under a variety of different names but in general we have found the original Adam to be the cheapest. You can expect to part with £19.95 for this game.

RAISE THE DEVIL

This game is rather inappropriately named because it is actually a LED pinball game. It is an electronic interpretation of the mechanical pinball table that was popular before the video machines took over. This game also comes from Entex (just like Space Invaders) and is well designed and built, sufficiently so to stand up to the harsh treatment metered out by our assessment panel.

Basically the game board consists of an array of LEDS that variously represent the ball, bumpers or flippers. The game is played in exactly the same way as the full-size pinball and the scoring is displayed on a two-digit, seven-segment display at the top end of the table.

It's worth shopping around for this game: if you're lucky you can pick one up for as little as £19.95.

ENTERPRISE

Like Adam, Enterprise has been around for quite some time. It is basically a full function calculator that plays games. Three games are included the first two being 'Speedway', a simple reaction game and 'Brain Drain', a hidden code game that bears more than a passing resemblance to the very popular Mastermind game. The third game is called 'Pontoon': we think it is really the gambling game Blackjack but you'll know what we mean if you manage to get your hands on one.

Overall each of the three games is fun to play, and that alone is a good recommendation. Couple this up with a proficient calculator and you have one of the best deals ever for just £19.95.

CASIO MG-880

Our last hand-held game is another game/calculator combination, ideal for whiling away boring business meetings or school lessons. Unlike the Enterprise the Casio MG-880 has just one game but its a good 'un.

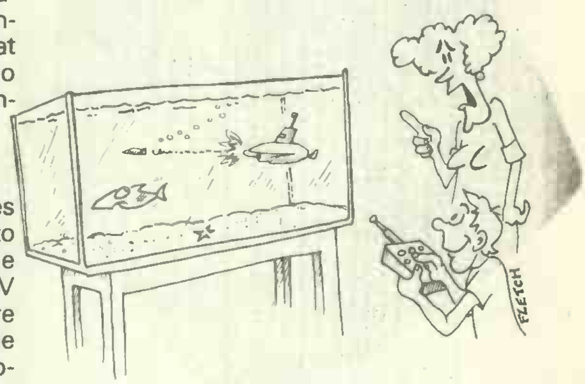
The calculator is an LCD full-spec machine that has a musical note assigned to each key so that even simple sums can become quite jolly. In the game mode the player has to 'destroy' an army of alien digits that try to cross the display. To destroy a digit the player has to match the randomly-generated alien digit by pressing a button marked 'aim'. This controls the player's gun digit, and each press of the aim button increments the gun digit up by one. When the gun digit and the alien digit match the 'fire' button is pressed and the alien is destroyed. The game starts slowly but gradually speeds up to the point where the expert Editorial button pushers were giving up. At just £10.95 this is a cheap calculator: with the game its a bargain.

Video Games

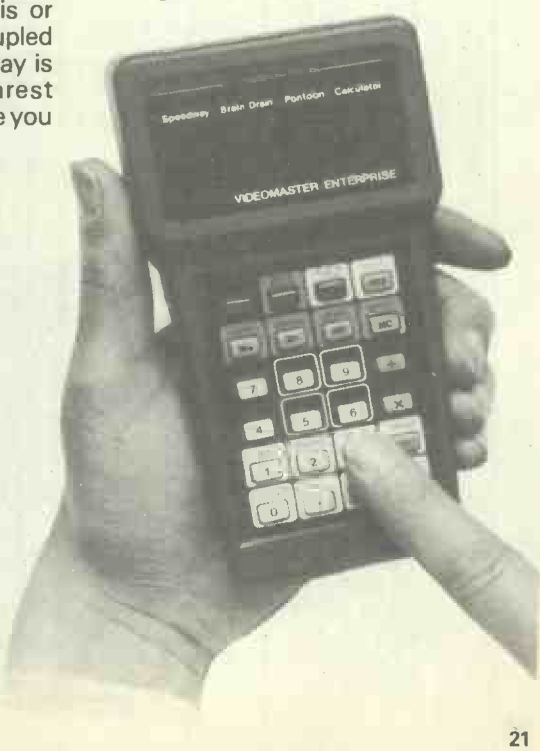
The last four games are all video games. They all rely upon a domestic television receiver that can be used as a display. All of these games are in colour and only work on PAL encoded 625 line receivers. That's unfortunate if you've only got a 405 line black-and-white set but then if you're old fashioned enough to still use an old set like that some new fangled electronic gizmo like a TV game won't be of much interest to you will it?

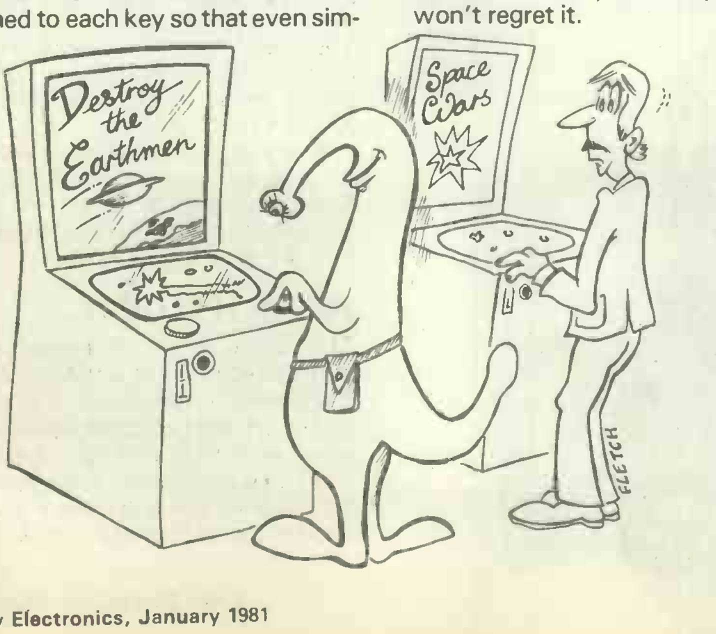
MATELL INTELLIVISION

There really aren't enough superlatives in the English language to do justice to this amazing piece of design work. The Intellivision is quite simply the best TV game ever. It is expensive but so are Rolls Royces and there's no shortage of customers for them. We're not going to bore you with long descriptions of how marvellous each game is or how versatile it can be when coupled up to a keyboard unit. All we'll say is find £200, go to your nearest stockists and buy one: we promise you won't regret it.



"I TOLD YOU TO LEAVE THE FISH ALONE!"





Top Ten Electronic Games

ATARI VIDEO COMPUTER SYSTEM

If you haven't just rushed out to buy an Intellivision because you are not lucky enough to have £200 (and that's the only permissible excuse) then the Atari programmable TV game is a reluctant second choice. The Atari has been around for a couple of years now so again we'll omit the boring details. Price for the basic unit is currently around £99.00. For that you get the main console plus an Air-Sea battle game. There are something like 32 other cartridges available costing from £15 to £35. Worth looking out for are the Space Invaders games, Surround, Maze, Chess and Superman. The game is well established, new cartridges appear on a monthly basis and at least one other company is producing cartridges for this machine so there is little chance you'll ever get bored with it providing you can keep it fed with new games.

ROWTRON TV GAME

We've included this TV game for two reasons. Firstly it is British designed and built (we're nothing if not patriotic) and secondly the games are unusually fun to play. Unlike the Atari machine more thought seems to have been put into the 'thinking games', games that don't rely purely on manual dexterity. Although only a few cartridges are available at the moment it would seem that Rowtron are busily writing new games right here in this country.

The actual games unit is rather old fashioned looking by contemporary standards and the graphics are not quite up to the excellent Intellivision standards. It is nonetheless an excellent attempt by British industry to regain the market now dominated by American and Oriental machines. (We are sufficiently impressed with this machine to offer it as a prize in our January competition.)

But back to the game: our favourites are undoubtedly the Four In A Row and Maze games. These require a great deal of logical thinking and quick reactions to play. Overall we have no hesitation in recommending this, because the £69.95 price tag for the game and £11.95 for each cartridge makes it an attractive buy for rich dads.

BINATONE 6

At the low end of the TV game market is is the last of our ten games. It is the Binatone 6. The machine is based squarely on the General Instruments AY38500 games chip developed in Scotland about four years ago. It uses the familiar 'ball and paddle' graphics to play Soccer, Table Tennis, Squash and Solo. The rather wicked looking gun supplied with it is used for the two shooting games that make up the fifth and sixth games.

This game is in colour and can be mains powered via an optional adaptor. The sound effects do not come out on the TV speaker! instead they are fed to a speaker within the games console. This game is tried and tested, comes from a reputable manufacturer and above all is almost in the 'pocket money' price bracket. You should be able to find it for as little as £18.95 complete with the gun.

As you may have gathered the ten games we have chosen are a personal choice. That aside our selection has been arrived at after looking at something like 150 different electronic games. You may have noticed that we have left out specialised games like chess, backgammon and bridge — we felt that they were only of interest to those people who regularly play those games.

All that remains now is to wish you happy times with the game of your choice and if you're still undecided then why not have a look at a copy of Gadgets and Games for some more hints and tips on how to buy electronic games.

HE

COMPETITION

Fast, furious and frantic, that's how we've been for the past couple of weeks. Why? Well, we've been compiling our super famous, stupendous Christmas Competition.

As you can see the theme is electronic games. Our prizes include the amazing new Rowtron programmable TV game and a selction of cartridges, and remember: this game's British.

Our second prize is the very popular Space Invader game from Entex. This is certainly the best hand-held Invader game we've ever seen.

The twenty runners up will all receive the latest Hobby Electronics T-Shirt, never before worn in public. These are strictly limited edition so they'll certainly become collectors' items in the next fifty years or so.

Now how do you win these fabulous prizes? Simple, all you have to do is answer the six simple questions below, complete the phrase and send the answer form, not forgetting your T-Shirt size, to the address below.

Here are the questions:

1) Which component is used as a 'White Noise' gererator in the Chuffer project this month?
2) What is the maximum power rating of each channel in the Sound-To-Light project?
3) How many times is the word 'games' used in this months' feature on electronic games?
4) Who sells the cheapest BC109 amongst the advertisers in this month's HE?
5) What is the maximum number of 'revs' that can be displayed on the HE Tachometer project?
6) What is the impedance of the High-Impedance Voltmeter that will be appearing in next month's HE?

Complete the following limerick

Right in the middle of Modmags
Clever Dick was opening his mail
As he opened on pack
It made a loud 'crack'

. . . .

Name . . . . (1) . . . .
Address . . . . (2) . . . .
. . . . (3) . . . .
. . . . (4) . . . .
T-Shirt size (S,M or L) . . . . (5) . . . .
(6) . . . .

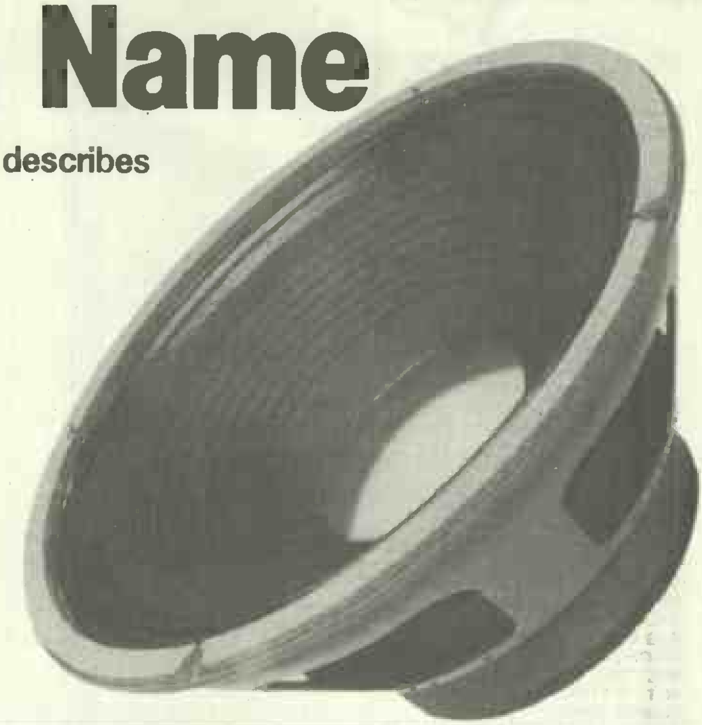
My suggestion for the last line is: . . . .
. . . .

Send this form to: Hobby Electronics Competition. 145 Charing Cross Road, London WC2H 0EE.

All entries should arrive no later than 1st January 1981. Winners will be notified by post. No correspondance regarding this competition will be entered in to. The Editors decision is final.

What's In A Name

This month's sense is sound: Rick Maybury describes some of the devices for producing it



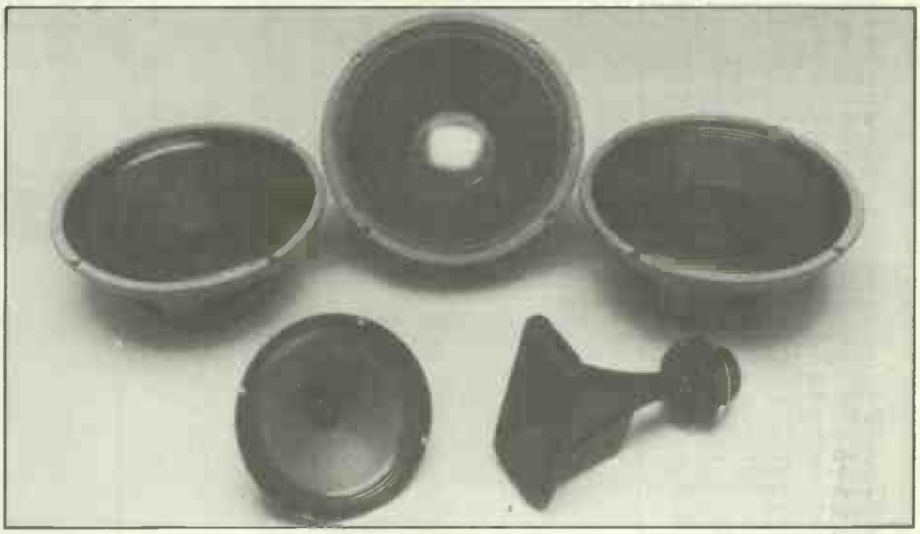
LAST MONTH, you may remember we began a short series looking at electronic systems and components that duplicate our own five senses. For the next two months we shall be looking at the subject of Audio Electronics — components or devices that respond to or generate sound. This month we shall look at devices that make noises.

To understand the action of the electronic counterparts of our vocal chords, it is first necessary to have some idea of what sound actually is.

Sound is basically a mechanical vibration that can travel through any medium (though not a vacuum) whether it is solid, liquid or gaseous. The old analogy of ripples on a pond is still the best way of visualising a sound wave. If we throw a stone into a still pond then a series of ripples spread outwards from the centre. If we compare this with the action of sound in air we can see that the high point of each ripple or wave corresponds to a peak of air pressure, the trough or low point of each wave corresponding to an area of low air pressure.

You can perhaps understand this better if I tell you the story of a lunatic Frenchman at the turn of the century. He devised and built an enormous whistle, many feet long and several feet wide. A huge blast of compressed air down the whistle produced a note that was only a couple hertz in frequency. It was said that one of his assistants standing in front of the whistle was killed instantly. Although the note was too low to be heard by human ears the pressure wave was so great that, at the high-pressure peak, his body was literally enveloped in compressed air and a quarter of a second later it was subjected to a partial vacuum as he was hit by the low pressure wave. His body was literally sucked apart — a nasty way to go!

If we want to generate sound electronically we have to devise some way of creating high and low pressure waves in the air. The simple way is to take a large flat surface, couple it in the centre to a strong electromagnet and pass an alternating current through the coil of the electromagnet. This will have the effect of moving the flat surface forwards and backwards thus creating an alternating pattern of high- and low-pressure waves. The idea has been refined and improved upon mechanically by exchanging the flat surface for a shallow cone supported in a circular metal frame. We all know this as our old friend the loudspeaker.



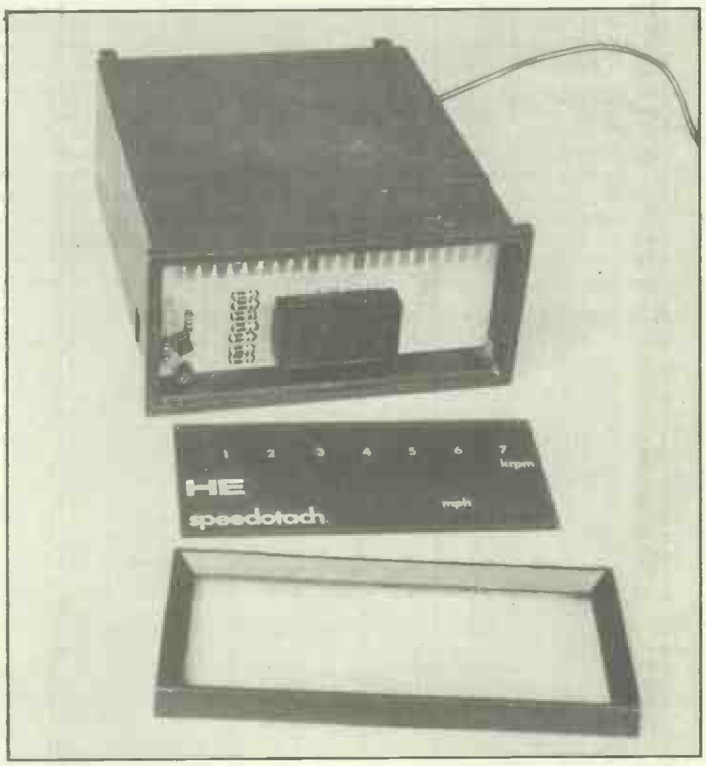
The speaker isn't the only device that can make noises. On a smaller scale headphones and earphones use a variety of moving coil, piezo-electric or electrostatic devices to vibrate the acoustic surfaces or diaphragms. The use of the piezo-electric effect in earphones relies upon the mechanical distortion of quartz crystal when a voltage is applied across the face of the crystal. The crystal is then coupled mechanically to the diaphragm. Electrostatic loudspeakers and headphones use the attractive and repulsive properties of high- voltage charges on two plates in close proximity to each other. In some older types of loudspeaker the cone was attached to a permanent magnet that was inside an open-wound electromagnet: not surprisingly these are known as moving-magnet loudspeakers. As you can imagine there are dozens of ways electrically and electronically generating sound: the one thing to remember, however, is that all rely upon a mechanical action to create waves of varying air pressure. Next month we'll look at how we can turn these sound waves back into electrical signals and also the similarities between our own ears and electronic microphones. **HE**

Car Rev Counter

Yet another application of the now famous LM3914 dot/bar voltmeter chip — this tachometer project is designed to complement our Digital Speedo in both style and size — fit them both into the same case or use them individually.

NO, IT'S NOT true! We haven't got shares in National Semiconductor, the manufacturer of the LM3914. Neither do we accept bribes (unless they are in cash — used £1 notes — and handed to us in a plain brown envelope). The simple fact of the matter is that the LM3914 is so versatile and adaptable that literally thousands of projects can be built around it, so it is no wonder that we do tend to use it a lot (see our Sound-to-Light Converter in this issue). The HE Rev Counter uses two LM3914s coupled in series mode, so that not just the normal ten LEDs (associated with the chip) but *twenty* LEDs give indication of engine revs in a direct-reading, linear display.

You will see from the photographs that we built our model into the same case as the Digital Speedo — that is the reason for the cut-out in the Speedo display board — so that a neat combination of digital-speed and 'line of LED' — revs readouts is obtained which is good enough to take pride of place in either your Metro or your Silver Spirit. Alternatively both projects can be constructed and used individually (and then you can put one in each car!).



The HE Car Rev Counter in the same case as the HE Speedo. Another name for a rev counter is a tachometer - hence the HE Speedotach

For adaptability, the Rev Counter has been designed so that it can be used with most car engines; ie 4-cylinder 4-stroke; 6-cylinder 4-stroke; 8-cylinder 4-stroke, but it is possible that the device may function with other engines. A simple calculation tells you if your engine will suit: you need to know the number of cylinders of the engine (n) and how many strokes each cylinder makes between ignition cycles (m). Next, divide the value of n by that of m.

Taking, for example a 4-cylinder 4-stroke engine the calculation is:

$$\frac{4}{4} = 1.$$

The answer for the chosen engine must fall (as in the above example) within the range 1 to 2. If so, the engine suits the Rev Counter. One final point is that the engine must be petrol-driven as diesel types do not have the necessary ignition circuitry.

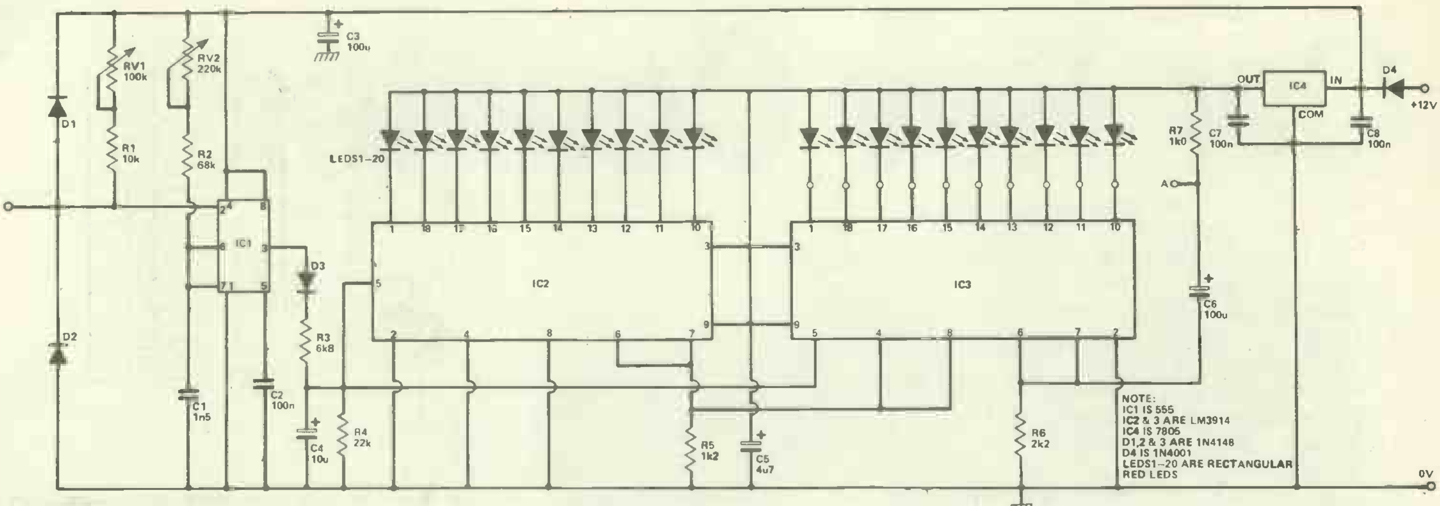


Figure 1. Circuit diagram of the HE Car Rev Counter

How It Works

A standard car engine relies on the combustion of an explosive mixture of petrol and air within a confined chamber. The combustion is brought about by a spark generated at the spark plug gap with a very high voltage across it. A particular engine might have two of these explosions per revolution of the engine, thus at say 1000 RPM there will be 2000 high voltage pulses every minute, generated by the elctrical system of the car. Thus, the number of pulses gives a direct measure of the revolution rate of the engine.

Now, a change of voltage within a length of conductor, such as the main high tension lead from the car's coil to distributor, creates a changing magnetic field around the conductor. Similarly, if another length of conductor is placed in close proximity to the first, the changing magnetic field produces a secondary changing voltage in the second conductor. (Incidentally, this is the principle of operation of all transformers — see last month's O Level Q & A).

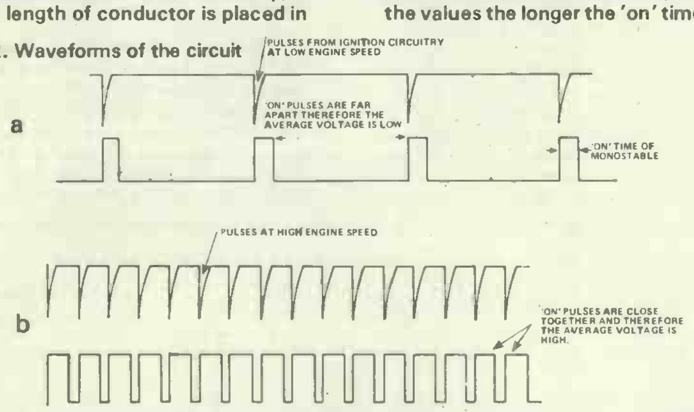
The HE Rev Counter uses this secondary pulse to trigger a monostable multivibrator, built around IC1, a 555. Figure 2 shows input and output waveforms of this part of the circuit. From this you will see that no matter how often the input pulses occur (two per engine revolution), the output waveform has an 'on' time which does not change — the output pulses simply get closer together or further apart depending on the input frequency. Capacitor C1 and resistors RV1 and RV2 define the 'on' time, the larger the values the longer the 'on' time. It can also be seen from this diagram that the average voltage at the output of IC1 will be at a maximum when the pulses are close together and at a minimum when the pulses are far apart. Consequently, as the RPM rate goes up so does the average output voltage. The resistor/capacitor combination R3, 4 and C4 smooths out the voltage so that a steady DC voltage, which changes only with engine speed, is obtained across C4.

The remainder of the circuit, formed by two LM3914s and associated components, is a bargraph voltmeter. This simply measures the voltage across C4 and illuminates a line of LEDs. The higher the voltage, the more LEDs in the line light. Preset RV2 is adjusted so that at a known engine speed the correct LED *just* lights up.

By connecting point A on the PCB to one of the LED cathodes by a wire link, a facility is used whereby the LEDs in the upper half of the display flash whenever the voltage corresponding to the LED is exceeded. For example, if A is connected to the LED which indicates 5000 RPM, whenever the engine speed reaches 5000 RPM the LEDs in the upper half flash to warn the driver that he is over-revving the engine. If the Tacho is scaled (as ours was) up to 7000 RPM then any engine speed in the range 4000 to 7000 RPM can be used to trigger this flashing display.

Finally, IC4 is a voltage regulator which provides a stable 5 VDC supply for the LEDs and IC2 and 3.

Figure 2. Waveforms of the circuit



Construction

Construction of the PCB is reasonably straightforward. Insert the four links first followed by resistors, capacitors and IC sockets. All semiconductors (except LEDs) should be put in next, noting correct polarity. Bend the pins of voltage regulator IC4 at right angles, about ⅛" from the body and mount it flush to the board.

The leads of LEDs 1 to 20 need to be shaped correctly so that they all fit onto the edge of the board. We used rectangular LEDs which are exactly 0.15" on their narrowest width, so 20 fit along a 3" length of board. Each LED fits up to the edge of the board with the cathode above the board and the anode below. Following the diagram in **Fig. 3**, and using a good pair of fine, long-nosed pliers, bend the leads at right angles at exactly the distances shown and

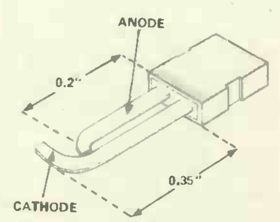


Figure 3. The leads of all 20 LEDs need to be bent to fit the board

then cut off the excess leads as in the diagram. These measurements are fairly critical to enable the LEDs to fit on the board. When the leads are correctly shaped each LED can then be inserted — this is a fiddly job, so take care not to damage the devices. Solder them in place, making sure they all line up perfectly.

The final thing to do on the PCB is to link up point A to whichever LED you require the flashing display to occur on. If you don't want this facility, simply omit this link.

When completed, the board will slide directly into its case — the DIN style case used in the Digital Speedo. Each circuit, the Speedo or the Rev Counter will work individually so they can be built into separate cases if you wish, but for a really neat project both fit in the same case with excellent results which you can see in the photographs. Note that for correct operation (ie with the LED display reading from left to right), the Rev Counter PCB needs to be 'upside-down' — with the component side facing down.

Only three connections are made to the board, power supply (via an in-line 1 A fuse and holder) through the ignition switch circuitry, and the sensor. The sensor is simply a length of thin multi-strand wire which goes from the PCB to the high tension lead between the car's coil and distributor. There is *no* electrical connection involved — the pick-up is purely electromagnetic. Cable ties can be used to hold the wires.

The procedure for setting up is reasonably easy. Presets RV1 and RV2 are adjusted fully clockwise. Then, with the car engine running at tick-over speed, RV1 is slowly adjusted anti-clockwise until the line of LEDs burst into life. The preset adjusts the threshhold of the Rev Counter and its setting is not in the slightest critical (about mid-position should suit most applications) but it can be used to prevent spurious triggering in certain applications.

Preset RV2 is now adjusted so that a particular LED lights up at a known engine speed. Ideally, for this purpose you will need a calibrated tachometer or rev counter to compare yours with, operating at a set speed of say 3000 RPM. As a last resort (if you can't obtain a calibrated tacho) you can simply adjust RV2 at tick-over till the first couple of LEDs in the line are lit. This is, however, only an approximate calibration and cannot be as accurate as the suggested method.

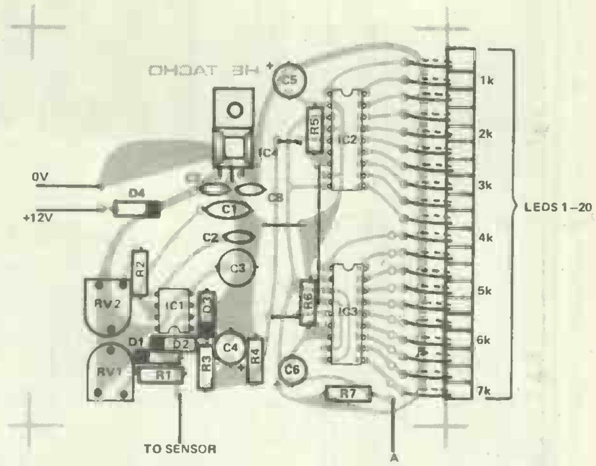


Figure 4. Overlay of the circuit board

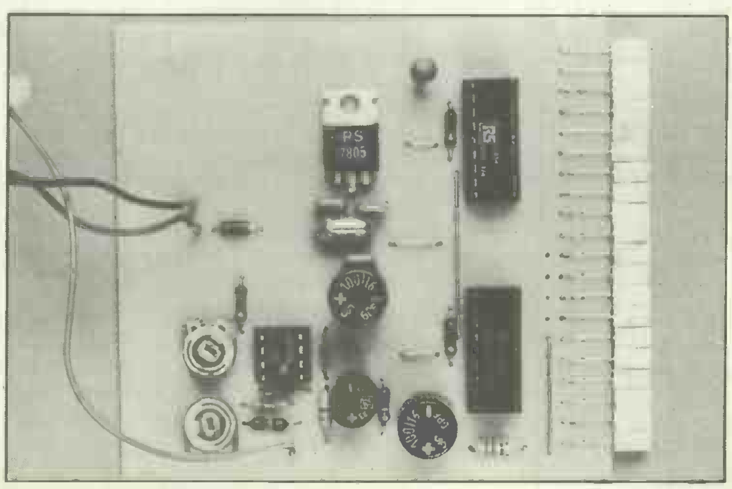
Parts List

RESISTORS (All ¼ W, 5%)	
R1	10k
R2	68k
R3	6k8
R4	22k
R5	1k2
R6	2k2
R7	1k
POTENTIOMETERS	
RV1	100k miniature horizontal preset
RV2	220k miniature horizontal preset
CAPACITORS	
C1	1n5 polystyrene
C2,7,8	100n resin dipped ceramic
C3,6	100u 16 V printed circuit electrolytic
C4	10u 35 V tantalum
C5	4u7 35 V tantalum
SEMICONDUCTORS	
IC1	555 timer
IC2,3	LM3914 dot/bar display driver
IC4	7805 5 V, 1 A voltage regulator
D1,2,3	1N4148 diode
D4	1N4001 1 A diode
LED 1-20	rectangular red LEDs
MISCELLANEOUS	
case to suit (see Buylines)	
in-line fuse holder + 2A fuse	

Buylines

All parts for our Rev Counter are fairly standard and should be easily obtained. The approximate cost of all components (excluding as usual, the case and PCB) should be around £18 — the most expensive items being the 20 LEDs. The rectangular LEDs can be replaced by ordinary circular LEDs if you wish, but they must measure no more than 0.15" in diameter, or they will simply not fit the board.

The case is the same as used in the HE Digital Speedo (see this and last month's issue) and is RS Components stock number 508-683. Your local component supplier should be able to obtain it for you. Of course, If you are building both projects they will fit in the same case, saving the need to buy two.



HE

AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

LINEAR ICs - NUMERIC LISTINGS

TBA120S	1.00
L200	1.95
U237B	1.28
U247B	1.28
U257B	1.28
U267B	1.28
LM301H	0.67
LM301N	0.30
LM308H	0.96
LM308N	0.65
LM339N	0.66
LM348N	1.86
LF351N	0.38
LF353N	0.76
LM374N	3.75
LM380N-14	1.00
LM380N-8	1.00
LM381N	1.81
ZN419CE	1.95
NE544N	1.80
NE555N	0.30
NE556N	0.50
NE560N	3.50
NE562N	4.05
NE564N	4.29
NE565N	1.00
NE566N	1.60
NE570N	3.85
SL624	3.28
TBA651	1.81
uA709HC	0.64
uA709PC	0.36
uA710HC	0.65
uA710PC	0.59
uA741CH	0.66
uA741CN	0.27
uA747CN	0.70
uA748CN	0.36
uA753	2.44
uA758	2.35
TBA810AS	1.09
TBA820M	0.75
TCA940E	1.80
TDA1028	2.11
TDA1029	2.11
TDA1054	1.45
TDA1062	1.95
TDA1072	2.69
TDA1074A	5.04
TDA1083	1.95
TDA1090	3.05
HA1137	1.20
HA1196	2.00
HA1197	1.00
TDA1220	1.40
LM1303	0.99
LM1307	1.55
MC1310P	1.90
MC1330	1.20
MC1350	1.20
HA1370	1.90
HA1388	2.75
TDA1490	1.86
MC1496P	1.25
SL1610P	1.60
SL1611P	1.60
SL1612P	1.60
SL1613P	1.89
SL1620P	2.17
SL1621P	2.17
SL1623P	2.24
SL624C	3.28
SL1625P	2.17
SL1626P	2.44
SL1630P	1.62
SL1640P	1.89
SL1641P	1.89
TDA2002	1.25
TDA2020	3.00
ULN2242A	3.05
ULN2283B	1.00
CA3080E	0.70
CA3089E	1.84
CA3090AQ	3.35
CA3123E	1.40
CA3130E	0.80
CA3130T	0.90
CA3140E	0.46
CA3189E	2.20
MC3357P	2.35
LM3900N	0.60
LM3909N	0.68
LM3914N	2.80
LM3915N	2.80
KB4400	0.80
KB4406	0.60
KB4412	1.95
KB4413	1.95
KB4417	1.80
TDA4420	2.25
KB4420B	1.09
KB4423	2.30
KB4424	1.65
KB4431	1.95
KB4432	1.95
KB4433	1.52
KB4436	2.53
KB4437	1.75
KB4438	2.22
KB4441	1.35
KB4445	1.29
KB4446	2.75
KB4448	1.65
NE5044N	2.26
NE5532N	1.85
SD6000	3.75
SL6270	2.03
SL6310	2.03
SL6600	3.75
SL6640	2.75
SL6690	3.20
SL6700	2.35
ICL8038CC	4.50
MSL9362	1.75
MSL9363	1.75
HA11211	1.95
HA11223	2.15
HA11225	1.45
HA12002	1.45
HA12017	0.80
HA12402	1.95
HA12411	1.20
HA12412	1.55
LF13741	0.33
SN76660N	0.80

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LN1242	19.00
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MSM5523	11.30
MSM5524	11.30
MSM5525	7.85
MSM5526	7.85
MSM5527	9.75
MSM55271	9.75
ICM7106CP	9.55
ICM7107CP	9.55
ICM7216B	19.25
ICM7217A	9.50
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95H90PC	6.00
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CMOS 4000 SERIES

4001	0.17
4000	0.17
4002	0.23
4008	0.80
4009	0.58
4010B	0.58
4011AE	0.20
4011B	0.20
4012	0.55
4013	0.55
4015	0.95
4016	0.52
4017	0.80
4019	0.60
4020B	0.93
4021	0.82
4022	0.90
4023	0.17
4024	0.76
4025	0.17
4026	1.80
4028	0.72
4029	1.00
4030	0.58
4035	1.20
4040	0.83
4042	0.85
4043	0.85
4044	0.80
4046	1.30
4047	0.99
4049	0.52
4050	0.55
4051	0.65
4052	0.65
4053	0.65
4063	1.09
4066	0.56
4068	0.25
4069	0.20
4070	0.20
4071	0.20
4072	0.20
4073	0.20
4075	0.20
4076	0.90
4077	0.20
4078	0.20
4082	0.20
4093	0.78
4175	0.95
4503	0.69
4506	0.51
4510	0.99
4511	1.49
4512	0.98
4514	2.55
4518	1.03
4520	1.09
4521	2.36
4522	1.49
4529	1.41
4539	1.10
4549	3.50
4554	1.53
4560	2.18
4566	1.59
4568	2.18
4569	3.03
4572	0.30
4585	1.10

TTL N and LSN

7400N	0.13
74LS00	0.20
7401N	0.13
74LS01	0.20
7402N	0.14
74LS02	0.20
7403N	0.14
74LS03	0.20
7404N	0.14
74LS04	0.24
7405N	0.18
74LS05	0.26
7406N	0.28
7407N	0.38
7408N	0.17
74LS08	0.24
7409N	0.17
74LS09	0.24
7410N	0.15
74LS10	0.24
7411N	0.20
74LS11	0.24
7412N	0.17
7413N	0.30
7414N	0.51
74LS15	0.24
7416N	0.30
7417N	0.30
7420N	0.16
74LS20	0.24
7421N	0.29
74LS21	0.24
7423N	0.27
7425N	0.27
7427N	0.27
74LS27	0.44
7428N	0.35
74LS28	0.32
7430N	0.17
74LS30	0.24
7432N	0.25
74LS32	0.24
7437N	0.40
7438N	0.33
74LS38	0.24
7440N	0.17
74LS40	0.24
7441N	0.74
7442N	0.70
74LS42	0.99
7443N	1.15
7444N	1.12
7445N	0.94
7446N	0.94
74LS47	0.89
7448N	0.56
74LS48	0.99
74LS49	0.99
7451N	0.17
74LS51	0.24
7453N	0.17
7454N	0.17
74LS54	0.24
74LS55	0.24
7460N	0.17
74LS63	1.24
7470N	0.28
7472N	0.28
7473N	0.32
74LS73	0.38
7474N	0.27
74LS74	0.28
7475N	0.38
7476N	0.37
74LS76	0.38
74LS78	0.38
7480N	0.48
7481N	0.86
7482N	0.69
7485N	1.04
74LS85	0.99
74LS86	0.40
7489N	2.05
7490N	0.33
74LS90	0.90
7491N	0.76
74LS91	1.10
7492N	0.38
74LS92	0.78
7493N	0.32
74LS93	0.99
7494N	0.78
7495N	0.65
74LS95	1.14
7496N	0.58
74LS96	1.20
7497N	1.85
74LS107	0.38
74109N	0.63
74LS109	0.70
74110N	0.54
74111N	0.68
74LS112	0.38
74LS113	0.38
74LS114	0.38
74118N	0.83
74120N	1.15
74121N	0.42
74122N	0.46
74123N	0.73
74LS124	1.75
74125N	0.38
74LS125	0.44
74126N	0.57
74LS126	0.44
74128N	0.74
74132N	0.73
74LS132	0.78
74LS136	0.40
74LS138	0.60
74141N	0.56
74142N	2.65
74143N	3.12
74144N	3.12
74LS145	0.97
74147N	1.75
74148N	1.09
74LS148	1.19
74150N	0.99
74151N	0.55
74LS151	0.84
74153N	0.64
74LS153	0.54
74154N	0.96
74155N	0.54
74LS155	1.10
74156N	0.80
74157N	0.67
74LS157	0.55
74LS158	0.60
74159N	2.10
74160N	0.82
74LS160	1.30
74161N	0.92
74LS161	0.78
74LS162	1.30
74163N	0.92
74LS163	0.78
74164N	1.04
74LS164	1.30
74165N	1.05
74LS165	1.04
74167N	2.50
74LS169	2.00
74170N	2.30
74LS170	2.00
74LS174	1.20
74175N	0.87
74LS175	1.10
74176N	0.75
74177N	0.78
74181N	1.65
74LS181	3.50
74LS183	2.10
74184N	1.35
74185N	1.34
74LS190	0.92
74192N	1.05
74LS192	1.80
74193N	1.05
74LS193	1.80
74194N	1.05
74196N	0.99
74LS196	1.10
74LS197	1.10
74198N	1.50
74199N	1.60
74LS247	0.93
74LS257	1.08
74LS260	1.53
74LS279	0.52
74LS283	1.20
74LS293	0.95
74LS365	0.49
74LS366	0.49
74LS367	0.43
74LS368	0.49
74LS374	1.80
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78Lseries	0.35
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79MGT2C	1.75
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LM337MP	1.48

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8214	3.50
8216	1.95
8224	3.50
8251	6.25
8255	5.40
6800P	7.50
6810	5.95
6820	7.45
6850	4.90
6852	4.85
MC2708	7.50
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AM/FM RX:-	
3rd OT 30pF HC25U	1.65
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Pairs FM	3.25
Pairs AM	3.10

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100kHZ	3.85
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4.000MHz	2.00
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6.5536MHz	2.10
10.0MHz	2.50
10.6985MHz	2.50
10.7015MHz	2.50
10.245MHz	2.50
10.7MHz	3.00
11.52MHz	2.50
100MHz	3.00

LEDs

5MM RED	0.12
3MM RED CLEAR	0.15
3MM RED	0.15
2.5 X 5MM RED	0.17
5MM GREEN	0.15
3MM GN CLEAR	0.16
3MM GREEN	0.16
2.5 X 5MM GN	0.20
5MM YELLOW	0.15
3MM YELLOW CL	0.16
3MM YELLOW	0.18
2.5 X 5MM YE	0.20
5MM ORANGERED	0.20
5MM ORA CL	0.29
3MM ORANGERED	0.19
2.5 X 5MM ORA	0.24
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BPW41 IR DET	1.51
IR OPT CPLR	1.44
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SRA3 .025-200MHz	10.25

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BB109	0.27
MVM125	1.05
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KV1210	2.45
KV1211	1.75
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BA244	0.17
BA379	0.35
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1N4148	0.06
1N4001	0.06
1N4002	0.07
1N5402	0.15
OA91	0.07
AA112	0.25
BRIDGES:	
1A/50V	0.35
6A/200V	0.75

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AUDIO DEVICES

BC237	0.08
BC238	0.08
BC239	0.08
BC307	0.08
BC308	0.08
BC309	0.08
BC413	0.10
BC414	0.11
BC415	0.07
BC416	0.08
BC546	0.12
BC556	0.12
BC550	0.12
BC560	0.12
BC639	0.22
BC640	0.23
2SC1775	0.18
2SA872A	0.14
2SD666A	0.30
2SB646A	0.30
2SD668A	0.40
2SB648A	0.40
2SD760	0.45
2SB720	0.45
2SC2546	0.19
2SA1084	0.20
2SC2547	0.19
2SA1085	0.20

AUDIO POWER DEVICES

2SB753	2.34
2SB723	2.34
2SK133	3.00
2SJ 48	3.00
2SK134	3.10
2SK135	3.75
2SJ 50	3.75
BD535	0.52
BD536	0.52
BD377	0.33
BD378	0.33
BD165	0.30
BD166	0.31

SMALL SIGNAL RF DEVICES

BF194	0.18
BF195	0.18
BF224	0.22
BF241	0.18
BF274	0.18
BF440	0.21
BF441	0.21
BF362	0.49
BF395	0.18
BF479	0.66
BF679S	0.55
BFR91	1.33
BFW92	0.60
BFT95	0.99
BFY90	0.90
40238	0.85

RF POWER DEVICES

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2N3866	0.85

SMALL SIGNAL RF FET/MOSFET

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2SK168	0.35
J310	0.69
J176	0.65
40823	0.65
40673	3SK51
3SK45	0.49
3SK51	0.54
3SK60	0.58
MEM680	0.75
BF961	0.70
BF960	1.24
3SK48	1.64

CAPACITORS
All 5mm or less spacing

CERAMIC 50v
2P2,3P3,4P7,6P8
8P2,10P,15P,18P..0.04
22P,27P,33P,47P
56P,68P,82P,100P.0.05
150P,220P,270P
330P,390P,470P...0.055
1N0,2N2,3N3,4N7..0.06
10N (0.01uF)....0.05
22N,47N.........0.06
100N,220N........0.09
MONOLITHIC CERAMIC
10N,100N.........0.16
FEEDTHRU
1N0 SOLDER IN....0.09
POLYESTER (SIEMENS)
10mm LEAD SPACING
10N,22N,33N......0.17
47N,68N,100N.....0.19
220N,470N........0.22
1uF..............0.29
POLYESTER (GENERAL)
10mm LEAD SPACING
10N,15N,22N,33N..0.06
47N,68N,100N.....0.08
220N.............0.11
20mm LEAD SPACING
220N,330N,470N...0.18
MYLAR
5mm LEAD SPACING
1N0,10N,22N,33N..0.08
100N.............0.09
20mm LEAD SPACING
220N,470N....... 0.17
POLYSTYRENE
10P,15P,18P,22P,
27P,47P,56P,68P...0.08
100P,180P,220P,
270P,330P,390P...0.09
470P,680P,820P...0.10
1N0,1N2,1N5,1N8..0.11
2N2,2N7,3N3,3N9..0.12
4N7,5N6,6N8,10N..0.13
TANTALUM BEAD CAPS
16v: 0.22,0.33,
0.68,1.0.........0.18
16v: 2.2,4.7,10..0.19
6v3: 22,47.........0.30
10v: 22,100......0.35

ALUMIN ELECTROLYTICS RADIAL (VERT. MOUNT)
(uF/voltage)
1/63,2.2/50,4.7/35
10/16,15/16,22/10
33/6.3...........0.08
22/16,33/10,
47/10............0.09
10/63,22/50,33/50,
47/16,100/16.....0.10
47/63,100/25,220/16
470/6.3..........0.12
100/63,470/16,
1000/10..........0.18
1000/16,470/63...0.23
1000/63,2200/16..0.30
3300/25..........0.69
1000/100.........0.88
10000/70.........3.00
AXIAL (HORIZ. MOUNT)
1/25,4.7/16,6.4/25
10/16............0.08
4.7/63,22/10,22/16
33/16............0.09
47/25,100/16.....0.10
100/25...........0.11
1000/16..........0.25
2200/16,1000/25..0.36
1000/35,4700/16..0.45
1000/50..........0.58

RESISTORS
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1ohm-10M.........0.02
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HORIZ CARBON PRESETS
10mm TYPE
100ohms-2M5......0.12
HORIZ CERMET PRESETS
1k, 10k..........0.27

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O Level Q & A

It's time for some semiconductors. Nick Walton describes how diodes work and how they can rectify, detect, light up and. . . . break down

THIS MONTH we continue our examination of the London Board's Alternative O level Electricity and Electronics syllabus with a look at the way conduction takes place in metals and semiconductors, and this leads us to consider the simplest semiconductor device of them all, the diode. As we will see it is found in many forms and fulfils many functions.

Detailed scientific theories on conduction are complicated and not needed for any O or A level, so what follows is just an outline of the scene. As you know, conduction of electricity occurs when the negatively-charged electrons move from one atom to the next pushed by voltage (looked on, remember, as energy in joules supplied to the charge expressed in coulombs). These electrons are the same as those involved in chemical reactions and when performing this chemical role are called valency electrons. They can have differing amounts of energy and these energy values are known collectively as the valence band of energies. But before they can actually leave a particular atom to drift off and help conduct current they need to enter another series of energy levels called the conduction band.

An insulator has its conduction band well above its valence band so in no way will an electron be able to find the energy to move up from valence to conduction band, hence the lack of conduction electrons and high electrical resistance. Metals on the other hand conduct well because the two bands are close together, sometimes even overlapping, so it is easy for an electron to find its way into the conduction band (**Figs. 1a and b**). You could say that an insulator holds tight to its electrons while a metal is more permissive and lets them roam.

In between these two extremes come our friends the semiconductors, most commonly silicon and germanium. They do have a distinct gap between the valence and the conduction band (**Fig. 1c**), and at low temperatures electrons just cannot find the energy to jump the gap. But as things warm up it becomes easier. According to Bennett in 'Electricity and Modern Physics' (Arnold), at room temperatures 1 in every 10^{11} electrons are in the 'high' state where they are capable of shifting from the valence band into the conduction band.

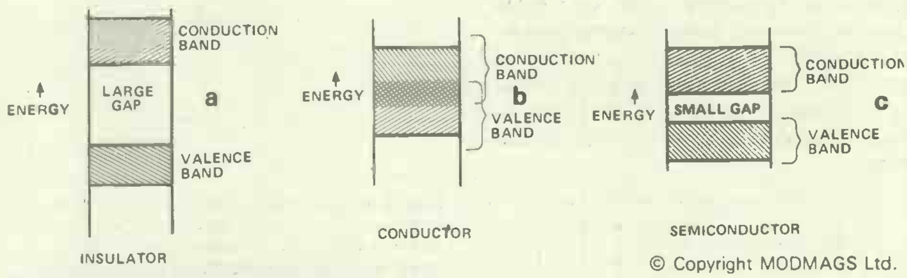

Figure 1. Conduction bands for a) insulators (well separated), b) metal (very close) and c) semiconductors (small gap)

Moving Holes

Perhaps a little surprisingly this leads not to one type of conduction but two. Clearly the energetic electron that has jumped up into the conduction band is now able to flow, but consider what it has left behind. The atom from which it came now has an unoccupied space or 'hole' which can be filled by an electron from somewhere else. Now this somewhere else can be the valence band (*not* the conduction band) of a neighbouring atom, to which the hole would now be transferred. Thus a hole can move around and make its own contribution to conduction separate from the electron that left home in the first place. For practical purposes we can regard this hole movement as that of positively charged particles, each unit having a charge equal to that of the electron but positive not negative.

In a pure semiconductor this naturally occurring conduction is described as 'intrinsic'. But the production of conduction electrons and the equivalent number of positive holes does not occur in sufficient quantities for practical advantage. The real use comes about when you increase either the number of conduction electrons or the number of positive holes. This is achieved by a process known as 'doping' which involves putting a different type of atom into your silicon or germanium crystal. Both these elements have four valence electrons and form a type of pyramid-structured crystal (**Fig. 2a**), like diamond, in which each atom is double-bonded to four other atoms by a pair of shared valency electrons. This is shown in **Fig. 2b**, which is just one unit of the crystal and you have to reckon that all the many silicon atoms are attached to four others. If now an atom of comparable size takes the position of one of the silicon atoms in the crystal, and if that atom (eg antimony or arsenic) has five valency electrons, it will use up four of these electrons in the bonding. The fifth is now free to roam the lattice as a conduction electron. Thus the impurity atom appears as a donor of electrons and we have what is called an n-type semiconductor (electrons being negative).

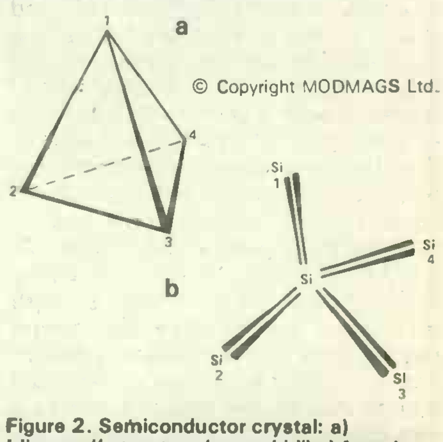

Figure 2. Semiconductor crystal: a) 'diamond' structure (pyramid-like) form in which silicon and germanium crystallise, b) central silicon is bonded to four others, one at each apex of the pyramid

Conversely if an impurity with only three valency electrons (eg gallium or indium) were to take the place of a silicon atom in the crystal there would be a tendency to complete the electron structure, perhaps from a neighbouring electron thus creating a hole. Since holes are regarded as positive, this type of semiconductor with an impurity which accepts electrons (an 'acceptor' impurity) is called p-type.

Now what happens when you have some n-type and p-type semiconductor together in a single crystal? The answer is that you have what is called a p-n junction diode and that it conducts in one direction but not in the other.

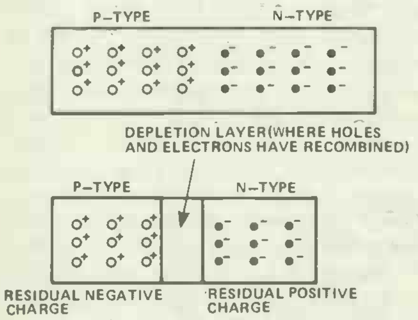

Figure 3. p-n material: a) holes in p-type and electrons in n-type single crystal before any interaction, b) depletion layer formed because of the recombination of electrons and holes, leaving residual negative charge in the p-type region and residual positive charge in the n-type region

p-n Junction Diode

Consider Fig. 3a with p-type semiconductor on the left. It contains positive holes (represented as o+) drifting around though, of course, the net charges balance out. On the right is the n-type material with electrons (represented as ●−) drifting around. Sooner or later an electron is going to drift into the left-hand region and fall into a hole, or a hole might drift right and meet up with an electron. Notice that each time an electron moves into the p-type region, it makes it negative and leaves a residual positive charge in the n-type region it has left. Thus a situation develops where at the junction of p-type and n-type, holes and electrons have combined leaving a region depleted of current carriers. This is called the 'depletion layer' and being without carriers it has a high resistance. Furthermore, the n-type region now has a residual positive charge and the p-type a negative charge due to the electron and hole movement.

It might help to picture this imbalance of charge as having the same effect as an imaginary cell connected up as shown in **Fig. 4a**. If now an external cell B is connected to our p-n junction with connections shown as in **Fig. 4b**, the voltage at the positive terminal of this external cell will push the positive holes towards the junction and that of the negative terminal will push the electrons also towards the junction, effectively narrowing the depletion layer and letting current flow. This state is called 'forward bias'. Looking at it from the point of view of the imaginary little cell, you can see it is connected so as to aid the current flow.

If the external cell is connected the other way round (called 'reverse bias') the depletion layer is widened or our imaginary cell is opposing the external one. Whichever way you look at it, current flow is discouraged and resistance appears high.

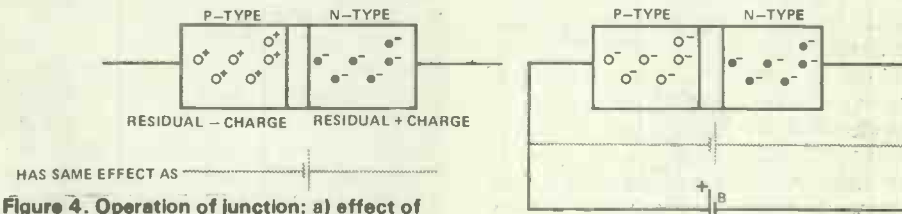

Figure 4. Operation of junction: a) effect of imaginary 'cell', b) external cell B connected to p-n junction in 'forward bias'. The imaginary cell appears to be connected to assist current flow

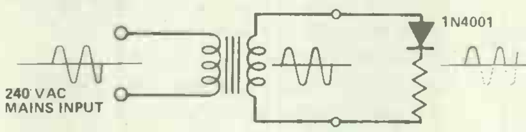

Figure 5. Rectifying action of a diode (half wave rectification)

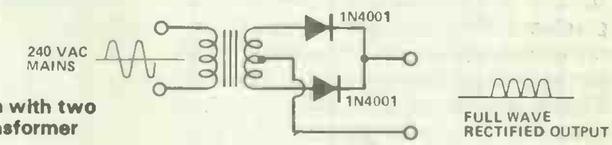

Figure 6. Full-wave rectification with two diodes and a centre-tapped transformer

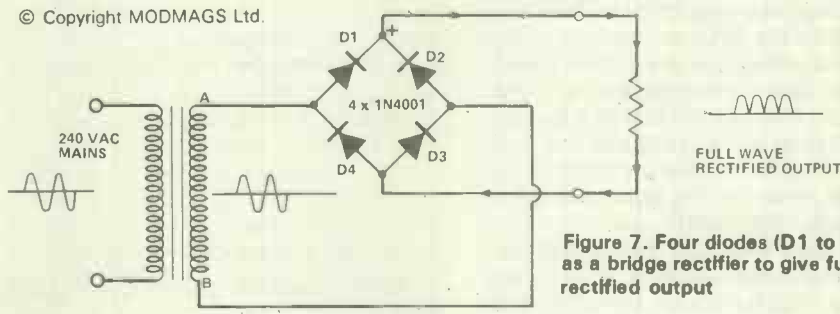

Figure 7. Four diodes (D1 to 4) used as a bridge rectifier to give full-wave rectified output

Rectification

Perhaps the most important and widespread use of the diode (circuit symbol —▶|—) occurs in rectification; that is, changing AC to DC. If you apply AC to a diode the current is only allowed to flow one way. Thus a single diode will only let one half of the AC wave through and, for the AC input shown in **Fig. 5**, the result is the loss of the lower half of the wave. It is necessary to include the resistor (a value of between 100R to 1kR will do for this) to limit the current flow. If you want to measure the waveforms indicated in **Fig. 5**, then connect an oscilloscope first across the secondary winding of the transformer (or other 10 VAC source used) and then across the resistor. Because you end up with just half the wave across the resistor this process is called *half-wave* rectification. Apart from demonstrations it is hardly ever used. The reason is that full-wave rectification is easy to achieve with two diodes from a transformer with a centre tap (**Fig. 6**).

You can save the cost or inconvenience of the centre tap if you use four diodes in a configuration called a bridge (**Fig. 7**). When the output of transformer A is at positive voltage relative to B then current flows in the diodes D1 and D3 and is blocked by D2 and D4. When B is positive relative to A, D2 and D4 conduct and D1 and D3 block. So the (conventional) current always flows in the resistor from top to bottom.

Smoothing Out the Bumps

Thus we get squirts of DC. The flow builds up from nothing and then drops to nothing, rather like the flow you get when you milk a cow. Putting in a capacitor which takes time to charge up and discharge has the effect of smoothing out the bumps as shown in Fig. 8 and you only get what is called a ripple which is as good an approximation to DC as we require.

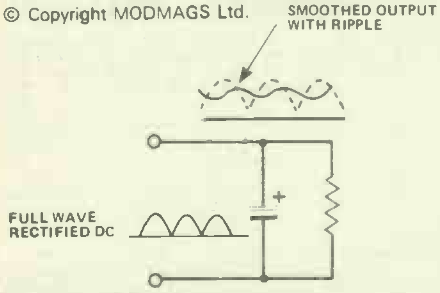

Figure 8. Action of a capacitor in smoothing full-wave rectified DC

Diodes for Detection

Another widespread use of the diode is in radios in the process called detection or demodulation. To understand this we need to take a very potted view of what happens in a (non-FM) radio. radio signals are carried at high frequencies: for instance, BBC Radio 4 is transmitted at a frequency of 200 kHz — that's 200,000 waves every second, and what we hear comes about by changing (modulating) the amplitude (size) of our high-frequency carrier wave, a process called 'amplitude modulation' or AM. Suppose a flute was being broadcast playing a note of frequency 500 Hz. The carrier wave would have its amplitude changed at a frequency of 500 Hz as shown in Fig. 9, though if we wanted to be entirely accurate we would need to draw 400 complete carrier waves for each complete flute wave. Before this can be fed into the audio amplifier and be heard, the bottom part of the signal has to be chopped off and this is done by means of a diode. The result is shown in Fig. 10. The action of the diode here is called detection or demodulation.

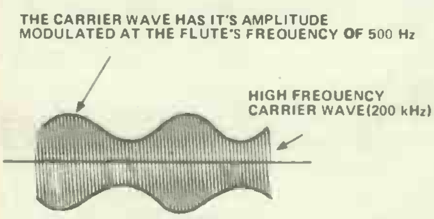

Figure 9. Amplitude modulation of a radio-frequency carrier wave

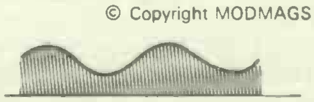

Figure 10. Effect of a diode in demodulating a radio signal before it is fed into the audio amplifier

Breaking Down a Zener

We have seen that a diode allows current to flow one way but not the other. But any diode will break down if you apply a big enough reverse voltage. With an ordinary diode that is usually the end of its useful life but there is a special sort — a zener diode — which is made so that it breaks down at a precisely-defined voltage and without damage. It has a current-voltage graph as shown in Fig. 11, and the important aspect is the 'knee' on the reverse voltage side. This indicates that when this reverse voltage is reached the diode conducts more and more current rather than change voltage. Obviously it can be damaged if you try hard enough and exceed its power rating.

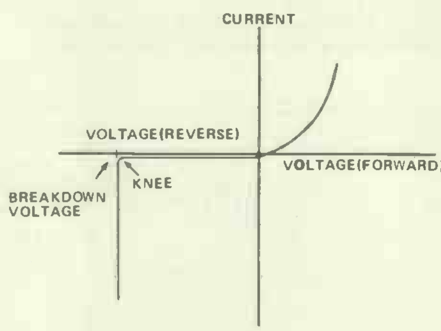

Figure 11. Current-voltage curve for a zener diode

The zener diode finds widespread use when a fixed voltage is needed somewhere, for instance in a power supply. Its action can be readily demonstrated with a variable voltage (eg by using a potentiometer) connected across the zener diode in series with a resistor as in Fig. 12. As the voltage is raised from zero the zener will exhibit a high resistance and most if not all of that voltage will appear across it. At 4.7 V (zeners, like resistors, come in preferred values) it will suddenly start to conduct and it will go on conducting whatever current is necessary to keep the voltage across it fixed at 4.7 V.

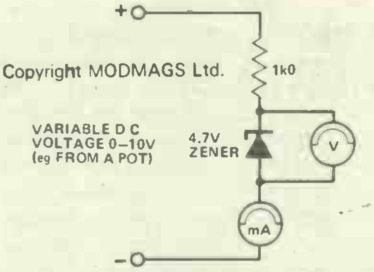

Figure 12. Circuit to demonstrate action of a zener diode

Luminous Diodes

There is one other type of diode we cannot overlook and that is because it actually emits light at us from places like the luminous display of a calculator. I do not mean the liquid crystal (non-luminous) display but the red or green type still common. The device is actually called a light-emitting diode or LED. When an electron jumps down into a hole it gives up energy and for a pn junction diode made of heavily-doped gallium arsenide (GaAs) the light emitted is infra-red. The addition of phosphorus to the compound (GaAs P!) brings the light into the visible region of the spectrum. The most restful colour for the eye is green, achieved with a GaAs P and some nitrogen. You can also get LEDs that produce green, orange or yellow light but as yet manufacturers have not been able to produce a blue LED. If they could, they would have red, green, and blue — the primary colours which could lead to interesting possibilities with mixtures. Each numeral in the display on your claculator is merely seven individual long-shaped LEDs arranged in a square figure of eight and each segment can be switched on and off separately (see Fig. 13a). Thus for instance the number six is obtained by having all segments lit except the top right upright, as shown in Fig. 13b.

Figure 13. Seven-segment display in a calculator: a) make-up of display, b) to generate a 6, all segments are lit up except the top right upright

That just about switches off the display for this month. I hope you managed to recover from the misprints in the November issue. Thanks for staying with me — you must have done or you wouldn't be reading this now—and we'll meet again next month. **HE**

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AC178	£0.29	BC177	£0.18	BD135	£0.44	MPSA06	£0.23	2N2193	£0.44
AC179	£0.29	BC178	£0.18	BD136	£0.40	MPSA55	£0.23	2N2194	£0.44
AC180	£0.23	BC179	£0.18	BD137	£0.40	MPSA56	£0.23	2N2217	£0.25
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CA3036	£1.15	LM380	£0.98	NE566	£1.73	72747	£0.69	TBA810S	£0.86
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200 THY600ma/200v	£0.44	800 THY7A/800	£0.05
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Volts No	**Price**	**Volts No**	**Price**
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100 THY1A/100	£0.32	100 THY10A/100	£0.65
200 THY1A/200	£0.37	200 THY10A/200	£0.71
400 THY1A/400	£0.44	400 THY10A/400	£0.80
600 THY1A/600	£0.52	600 THY10A/600	£1.13
800 THY1A/800	£0.67	800 THY10A/800	£1.40
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3 Amp		IS70/200 200v	£1.38
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IN5401 100v	£0.17	IS70/600 600v	£2.58
IN5402 200v	£0.18	IS70/800 800v	£2.87
IN5404 400v	£0.19	IS70/1000 1000v	£3.45
IN5406 600v	£0.24		
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400 TR12A 400	£0.82	400 TR110A 400	£1.29
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volts		volts	
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Type No.	Price	Type No.	Price
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200v RMS BR10 200	£1.96	200v RMS BR25 200	£2.53

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AAY30	£0.10	BY114	£0.25	BYZ16	£0.47	OA182	£0.15
AAZ13	£0.17	BY124	£0.25	BYZ17	£0.41	OA200	£0.09
BA100	£0.12	BY126	£0.17	BYZ18	£0.41	OA202	£0.09
BA102	£0.37	BY127	£0.18	BYZ19	£0.41	SD10	£0.07
BA148	£0.17	BY128	£0.18	OA5	£0.69	SD19	£0.07
BA154	£0.14	BY130	£0.20	OA10	£0.40	IN34	£0.08
BA155	£0.16	BY133	£0.24	OA47	£0.09	IN34A	£0.08
BA173	£0.17	BY164	£0.58	OA70	£0.09	IN914	£0.07
BB104	£0.46	BY176	£0.86	OA79	£0.12	IN916	£0.07
BAX13	£0.08	BY206	£0.34	OA81	£0.12	IN4148	£0.07
BAX16	£0.09	BYZ10	£0.52	OA85	£0.12	IS44	£0.06
						IS920	£0.07

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O/no	Size	Colour	Price
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1502	125	GREEN	£0.16
1503	125	YELLOW	£0.16
1504	2	RED	£0.10
1505	2	GREEN	£0.16
1506	2	YELLOW	£0.16
1509	2	CLEAR (Ill Red)	£0.12
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uA7824 TO220	£0.75	uA7918 TO220	£0.85
uA7818 TO220	£0.75	72723 14 pin DN	£0.52
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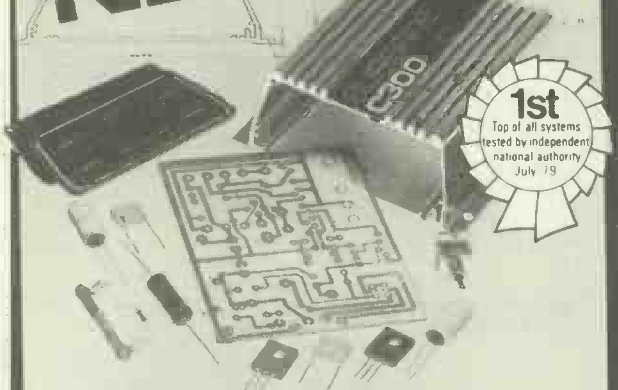

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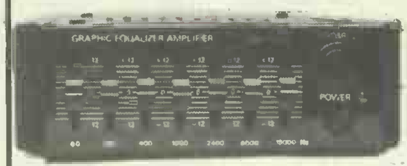

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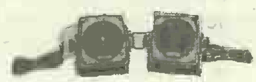

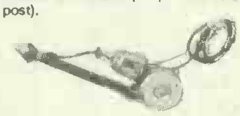

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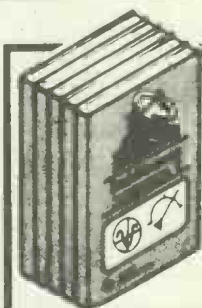

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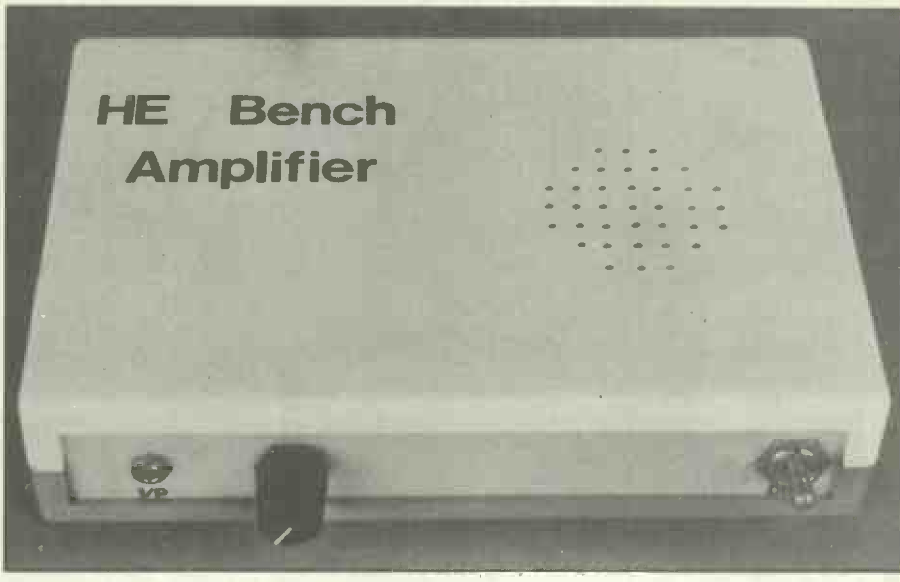
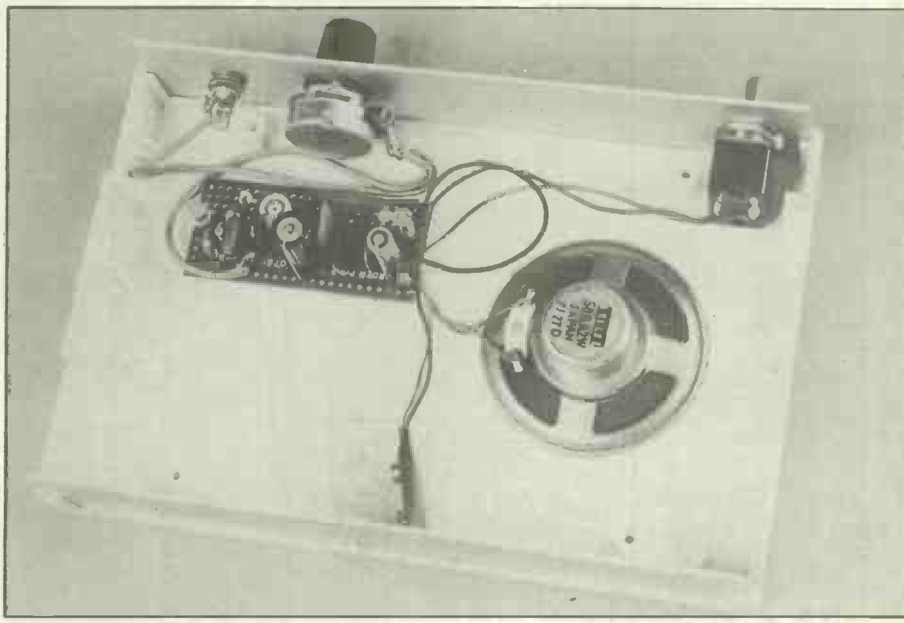




Beginners in electronics often assume that the more complex equipment is the more useful it is likely to be in the workshop. In fact it tends to be the more simple pieces of equipment that get worn-out! Probably the most useful items of equipment are a multimeter, power supply unit, a signal source of some kind and a simple amplifier such as the one described here.

Maximum output power of the HE Bench Amplifier is around 150 mW RMS, which should be sufficient for normal test purposes. An output power of about 1 W RMS can be achieved if an 8 R impedance speaker is used in place of the specified high-impedance type, but a large 9 V battery (PP9) or a mains power supply would then be necessary as the current consumption would average over 100 mA at high volume levels. The amplifier should not be found lacking in sensitivity since only about 2.5 mV RMS into 47k is needed for maximum output, and even low-level signal sources such as guitar pick-ups and microphones will drive it fully.

Construction

The circuit can be built onto one of our standard Veroboards using the component layout and wiring shown in Fig. 2. Break the tracks where indicated using a spot-cutting tool or a hand-held ⅛" drill bit. Hold the tool onto the hole in question and gently rotate it clockwise until the track breaks cleanly. The component layout is very compact, but there should be no problems here, provided modern miniature components are used, and care is taken to avoid accidental solder bridges between the copper strips.

As with any high-gain amplifier, it is advisable to use screened leads at the input so that stray feedback and pick-up is minimised. Using a metal case also helps to avoid stray pick up of mains hum, etc, but a plastic one like we used is satisfactory for most purposes. The input leads and speaker leads should be kept reasonably well separated so that stray feedback is avoided.

A speaker grille must be made in the case, and this can simply consist of a matrix of small holes about 3 to 5 mm in diameter. This is not as easy as you might think, and must be done very carefully if a neat finish is to be obtained. The loudspeaker is glued in place using one of the more powerful adhesives that are available (such as an epoxy or cyanoacrylate type), making sure that none of the adhesive is smeared onto the speaker's diaphragm (or on your fingers!).

The circuit is powered by a PP6-sized battery, which uses the standard PP3 type battery connector.

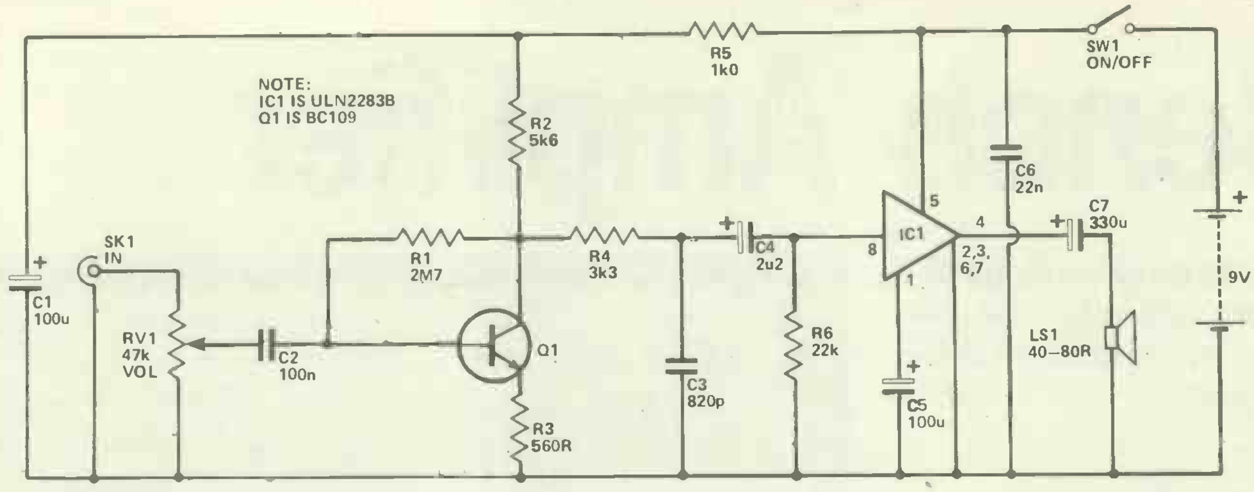


Figure 1. Circuit diagram

Parts List

RESISTORS (all ¼ watt 5%)

R1	2M7
R2	5k6
R3	560R
R4	3k3
R5	1k
R6	22k

POTENTIOMETER

RV1	47k log carbon

CAPACITORS

C1	100u 10 V electrolytic
C2	100n polyester
C3	820p ceramic
C4	2u2 63 V electrolytic
C5	100u 10 V electrolytic
C6	22n ceramic
C7	330u electrolytic

SEMICONDUCTORS

IC1	ULN2283B power amplifier
Q1	BC109 NPN transistor

MISCELLANEOUS

SW1	single-pole, single-throw toggle
SK1	3.5 mm jack socket

10 strip by 24 hole Veroboard
40-80R miniature speaker
case to suit
battery and clip
knob to suit

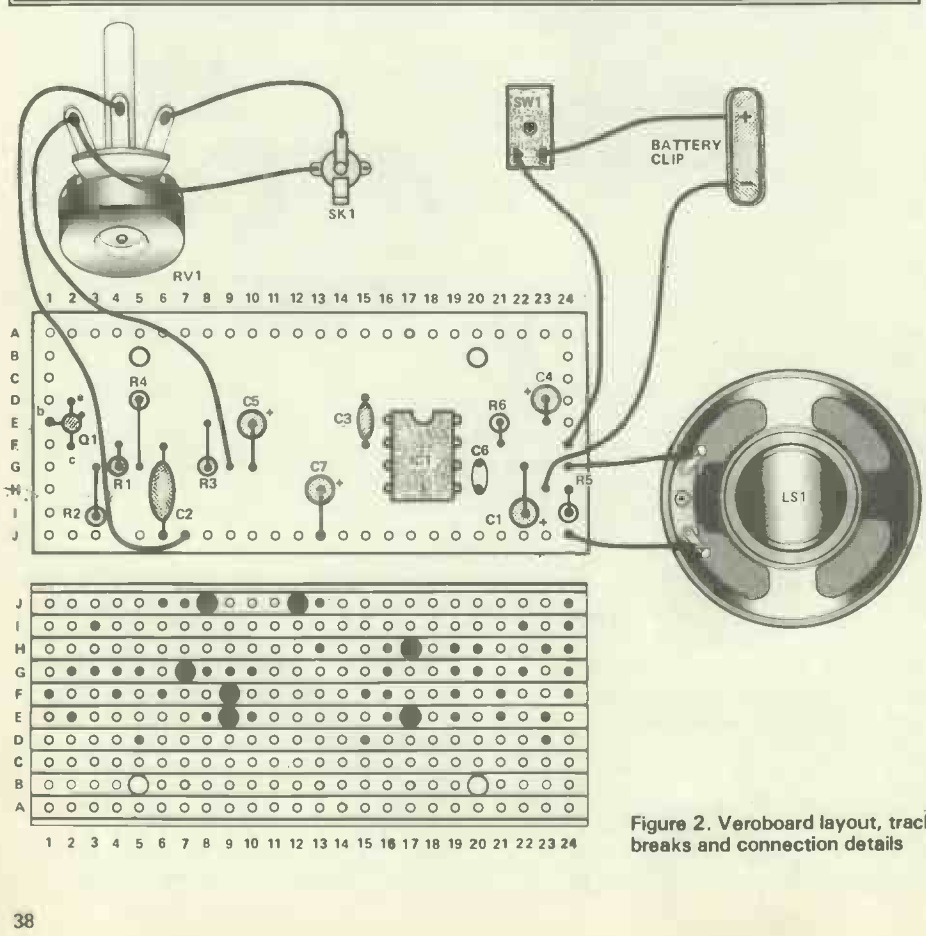


Figure 2. Veroboard layout, track breaks and connection details

How It Works

The circuit uses an integrated circuit power amplifier stage preceded by a single transistor preamplifier, as can be seen from the circuit diagram in Fig. 1. A ULN2283B device is used for IC1, which has its voltage gain set at approximately 43 dB (140 times) by an internal negative feedback circuit. Capacitor C6 decouples the supply, aiding the stability of IC1, and C5 decouples the supply to the input stages of IC1; also aiding stability. Capacitors C4 and C7 merely provide DC blocking at the input and output. Resistor R6 provides bias for IC1.

Transistor Q1 is used as a low-noise emitter-follower amplifier which boosts the sensitivity of the circuit by a factor of ten. The innate voltage gain of the circuit is far higher than is required here, and R3 is therefore used to provide negative feedback which boosts the input impedance of the stage and reduces its voltage gain to the appropriate figure. The input signal is applied straight to volume control RV1, and C2 is used to couple the signal from the volume control to the input of Q1.

Because of the very high gain of the circuit it is necessary to roll-off the response at high frequencies to avoid instability. Together, R4 and C3 form a simple low-pass RC filter which is included in the signal path between Q1 and IC1.

The output stage of IC1 is in class AB, and the quiescent current consumption of typically 12 mA increases significantly (to a maximum average value of about 40 mA) at high output levels. It is therefore necessary to decouple the preamplifier stage from the main supply with R5 and C1 so that low-frequency instability due to feedback through the supply lines is avoided.

Buylines

All components are common types with the exception of the ULN2283B device used for IC1. This is available from Ambit International, 200 North Service Road, Brentwood, Essex, CM14 4SG.

Approximate price for the project (excluding case) should be about £6.

HE

Building Site

What to do with diodes — important practical advice for project builders from HE's Project Editor

NOW, BEFORE WE START I want to make one thing clear! I'm not going to bore anyone with any theory of what a diode is and/or how it works — you can find that out in any number of textbooks on electronics. (It's worth looking at this month's O Level Q & A too.) I'm going to talk about *how* we use a diode rather than *why*. So the only thing to remember as far as we're concerned here is that electric current will flow through a diode in one direction but if the diode is turned round *no* current will flow — simple, isn't it? The symbol used to represent a diode (see **Fig. 1**) is a graphical portrayal of this. You can think of it as an arrow head with a bar across the tip of the arrow. The direction of current which will flow (from +ve to −ve) is the same as the arrow head, from anode to cathode. (The terms 'anode' and 'cathode' originated with thermionic diodes.) If the diode is turned round so that the cathode is +ve and anode −ve, nothing will happen — it's as if the current has come up against a barrier (the bar in the diode symbol) which prevents it from flowing.

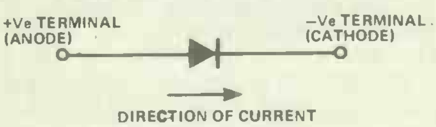


Figure 1. The symbol for a diode

Manufacturers of diodes quite often carry this symbolic representation of a diode over to the markings on the actual diode itself. The two diodes used most often in HE projects are good examples — the 1N4001 and the 1N4148. **Figure 2** shows a photograph of these two devices and you can see the bar marked at one end of their bodies. The end with the bar is, of course, the cathode, although it isn't necessary to think of a diode in terms of 'cathode' and 'anode' as long as its body is marked with this bar. All you need to do with such a diode is line up the bar so that it is the same way round as indicated in the circuit diagram.

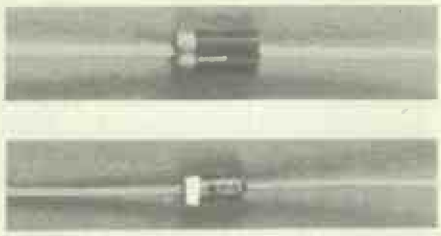


Figure 2. A 1N4001 diode (above) and a 1N4148 diode

Diode Ratings

How does one diode differ from another? Usually in terms of only two parameters: the maximum forward current and the maximum reverse voltage which the diode can handle. For instance, the 1N4001 has a maximum forward current of 1 A, and a maximum reverse voltage of 50 V, while the values for 1N4148 are 75 mA and 75 V. So you'd obviously use the 1N4001 in a large-current circuit, say a power supply, and the 1N4148 in a circuit demanding less current, say an audio circuit or logic circuit, although the 1N4148 can operate under higher reverse voltage conditions.

Branching Out

Although the above type of diode is the most important, it is by no means the only member of the semiconductor diode family tree. There are a number of different types of diode (tunnel, Gunn, photodiode, to name just a few), but only two are of *real* importance to the hobbyist. The first is the zener diode and the second is the LED (light-emitting diode). Fundamental to the action of a zener diode is that, in the *reverse* mode, it maintains a constant voltage across itself, regardless (within limits) of the current being passed through it.

A typical circuit using a zener diode is shown in **Fig. 3**. Note that the diode appears to be the 'wrong way round' (ie its cathode is positive). Look at the symbol for the zener diode — it's the same as an ordinary diode but with one edge of the bar bent down, signifying that it has a 'breakdown' or constant voltage. This can be used to advantage as a voltage reference — a very stable DC voltage. The applied voltage at the input to the circuit may vary quite considerably but the output voltage is fixed, and it depends entirely upon the breakdown voltage of the zener.

Zeners are sold by two main ratings, their breakdown voltage and the maximum power they can dissipate. Individual diodes can be selected according to their breakdown voltage, and these vary from about 3 V to over 30 V in approximately ½ V steps.

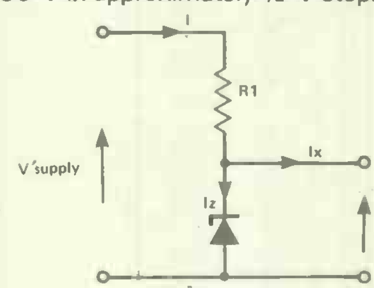


Figure 3. Typical circuit using a zener diode

The power which a zener diode dissipates should never exceed its power rating and simple calculations can be used to check this. If, in the example shown in **Fig. 3**, the zener voltage is, say 4 V and resistor R1 is 100R, then the current I through the resistor is, from Ohm's Law equal to:

$$I = \frac{V}{R1},$$

Where:

$$I = \frac{12-4}{100} = \frac{8}{100}$$

$$= 0.08 \text{ A} \quad (80 \text{ mA}).$$

If no current (I_x) is taken by any following circuitry then all the current flowing through the resistor will flow through the zener.

Therefore,

$I_z = I$,

and the power P dissipated by the diode is given by:

$P = IV$,

or

$0.08 \times 4 = 320$ mW.

A device should be chosen whose power rating is more than this, eg 400 mW.

Normally, the breakdown voltage of the zener diode will be printed on its body, for example 6V3 — meaning 6.3 V (9V1 would be 9.1 V). Otherwise the device will probably look identical to any other semiconductor diode and thus have a bar at the cathode end. Remember that a zener diode appears to go the *'wrong way round'* in a circuit! If you insert it so that the cathode is negative you may well damage it, because the forward current rating of the zener is quite small.

LEDs

The other important diode-based device is the LED. This produces a coloured glow (of one of three colours, red, green or yellow/amber — although a blue LED is currently being developed), when a forward current is applied through it. A typical LED circuit is shown in **Fig. 4** and you can see that the symbol of a LED is that of a standard diode but with arrows to indicate that it emits light.

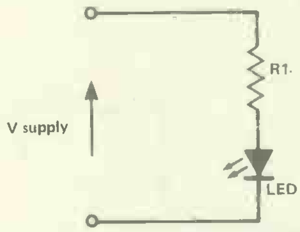


Figure 4. An LED in circuit

Light intensity of LEDs increases with applied current but the manufacturer will state a maximum forward current

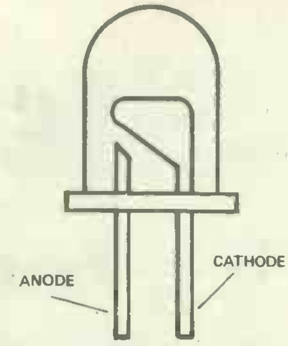


Figure 5. By holding the LED up to a bright light the junction can be seen

beyond which damage may occur. As a rule-of-thumb, a current of 20 mA produces adequate illumination from any of the commonly available LEDs.

Cathodes and anodes of LEDs are marked in a number of ways, depending on the manufacturer. Typical identification marks are painted spots, a notch or flat on the body, or different-length leads, denoting which lead is cathode and which is anode. These methods are quite standard. What is not standard, however, is whether it is the cathode *or* the anode which has been denoted by one of these markings: one manufacturer may mark the anode while another may mark the cathode. Don't despair, though, the puzzle is soon solved by a quick check of the published data usually supplied with these devices.

If you have a LED but have no data, there is a simple way of working out for yourself which lead is which. Hold the LED up to a bright light and look through the body. You will see the junction between the two leads where the light is emitted (see **Fig. 5**). The feature to note is that one side of the junction (the cathode) appears to lean over the other.

To confuse the issue at this point, I'm going to add that the rectangular kind of LED used in the HE Rev Counter project this month (see page 27) has an opaque white plastic shield around the body of the LED (to prevent emission of light from the sides). This means that you can't work out cathode and anode just by looking at it. All is not lost however — with a battery (say a PP3) and a 2k2 resistor for R1, you can build up the circuit shown in **Fig. 4** simply by holding the resistor, LED and battery, in series in your hands — whichever way round the LED lights is correct and then you can mark or just remember cathode and anode. You can use this technique for any LED (see **Fig. 6**).

It's worth noting that LEDs aren't usually as easily damaged as zeners, so if you still are uncertain which lead is which, put it in circuit — if it doesn't work, turn it round — you shouldn't damage it.

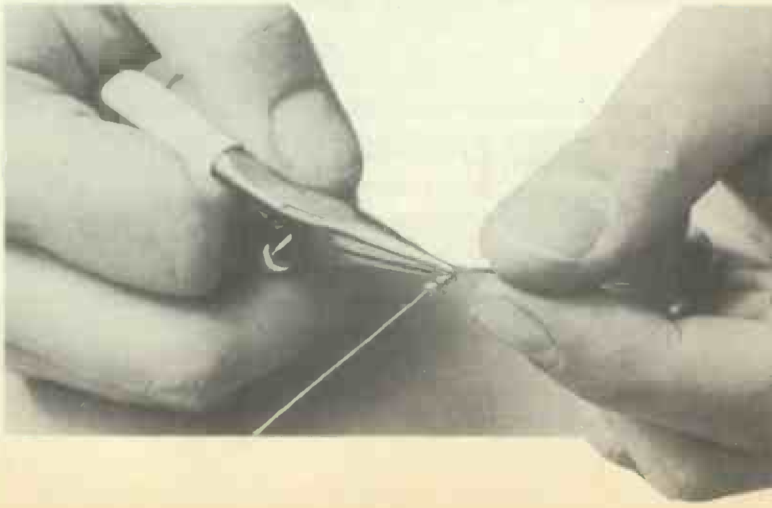
Cracking Up

Finally, a word concerning the insertion of a diode into a circuit board. Many types of diode (such as the 1N4148, most zeners and some LEDs) have a brittle body. If you bend the leads to fit the board with your fingers, you may crack the casing and the devices can literally fall apart. Using a pair of fine, long-nosed pliers you can prevent damage by holding the diode firmly and bending the lead at the far side of the nose of the pliers. (see **Fig. 7**).

Diodes with all-glass bodies are also easily damaged by too much heat, so be careful when soldering them into circuits. A good hint is to let the whole area cool down after soldering one lead, before tackling the other. You may waste a minute of your time waiting for the diode to cool, but it could save you the expense and bother of renewal. **HE**

Figure 6. By holding a LED, resistor and battery in series you can find out which lead is which

Figure 7. Use a fine pair of pliers to hold the diode while you bend the lead



Digital Speedo - 2

Part two of our Speedo project deals with final construction and suggests methods of connecting the pickup sensor to your car

After following last month's constructional advice builders should, by now, have reached the stage where they possess two made-up boards which need only to be connected with 10 jump leads between the two. **Figure 1** shows where all interboard connections are to be made — leads of about 4" length are OK. You can then either cable-tie them or simply leave them all floating.

That almost concludes the building side of the project. After drilling the case at the back and inserting grommets for the power lead and sensor wire, the main board can be inserted into the case between the bottom pair of PCB grooves — which leaves the display board to drop in the front. The acrylic panel should now fit into the front and when the rectangular bezel is clipped in place, all boards should be firmly held in the case.

So far so good, but now we move on to the tricky bit — positioning the pickup sensor on the car. As we explained in the last issue the operation of the sensor relies on the fact that magnets, going past a coil, induce a current in it. From this seemingly simple statement we can see that the magnets need to be positioned on some rotating shaft which rotates with a velocity proportional to the vehicle's linear velocity. It happens that the drive shaft of a car does just that — so the magnets (four in all) are positioned on the shaft in a similar manner to that shown in **Fig. 3**. They should, ideally, be equidistant around the shaft and first secured with pads of double-sided adhesive foam. The centripetal force which they encounter (remember that at 70 MPH the shaft will rotate at approximately 70 Hz) will be quite large and so the pads should be only a temporary fixing while you fasten the magnets permanently with cable ties. Although the circumference of the shaft will be more than the length of one cable tie, two or more can be connected together to make a longer one.

Two separate bands of ties should be used to hold the magnets to the shaft.

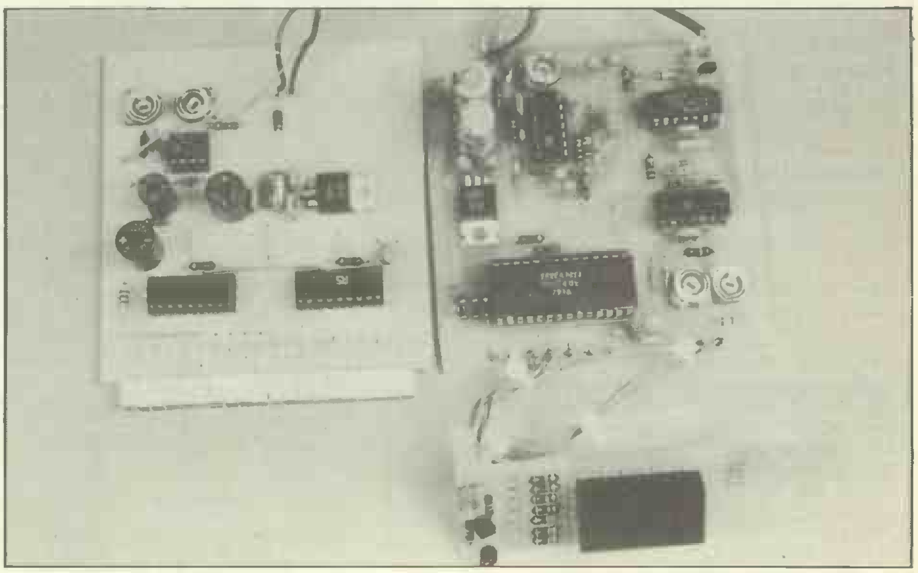
The positioning of the sensor along the length of the drive shaft needs also to be considered and obviously, is dependent on the individual car. Somehow the coil has to be fixed on the body of the car so that it is close enough (within 2") to the magnets. The rear axle is, of course liable to vertical movement and hence, the drive shaft at the rear is too. So the pickup is best positioned toward the front of the drive shaft. Position the coil so that the magnets are never further away than 2" from the coil. Care should also be taken to ensure that the coil isn't *too close* (say less than ½") to the magnets to prevent actual contact under bumpy road conditions!

The diagrams give an idea of how we fixed the sensor to the car used. The car had a central, fixed point to the drive shaft (which was actually part of the body) and so the coil was fastened to a length of aluminium bar, shaped to fit and bolted at each end, to the car floor panel. This is the area where readers may need to put on their thinking caps and use a bit of ingenuity — the problems encountered will depend on the particular make and model of car used — we can obviously only give general guidelines for a solution.

In summary, however, it doesn't seem to make any difference to the operation of the Speedo in what polar direction the magnets are travelling. The coil appears to pick up an adequate signal for the circuit to process as long as it is within 2". The main point, though, is that the central soft metal core of the coil should be perpendicular to the face of the magnets.

It only remains to run a length of screened lead from the coil to the inside of the car and to the Speedo. Power is connected to the Speedo via an in-line fuse (1 A) and the ignition switch and your project is complete.

The two Speedo boards with that of the Rev Counter



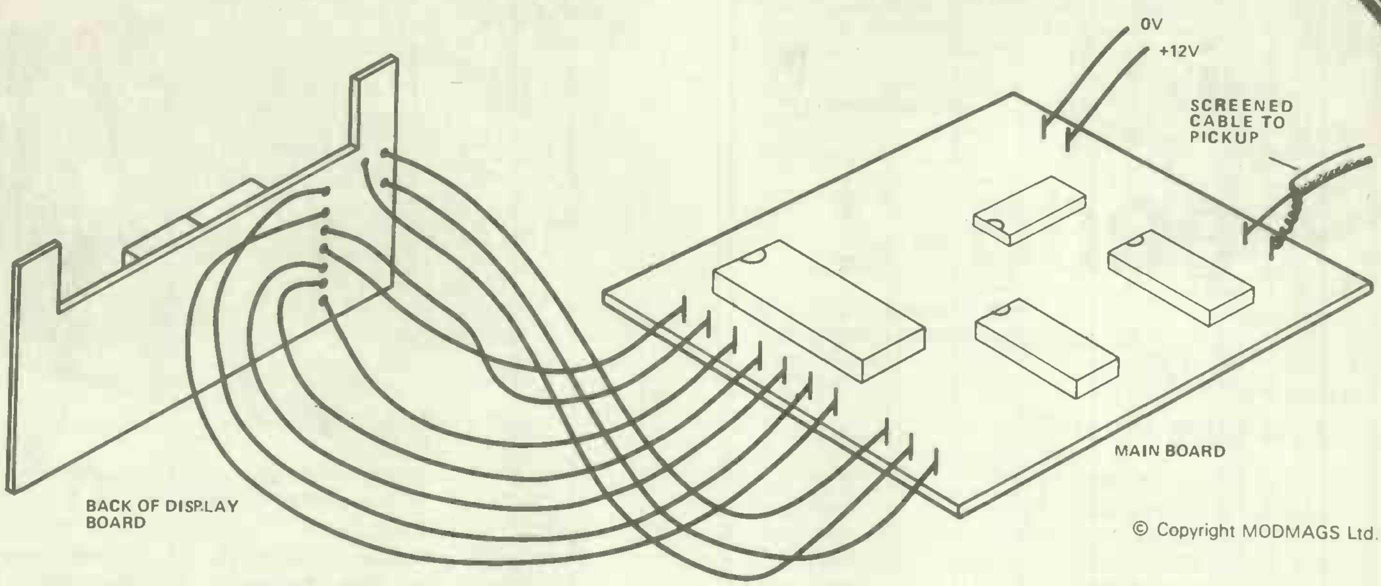


Figure 1. Connection details of the two boards of the Speedo

How It Works

The operation of the pickup sensor depends on the elctromagnetic effect of a changing magnetic flux in the vicinity of a conductor — causing a current to flow in that conductor. This effect is also used in the pickup of the HE Tacho project in this issue.

As the magnet approaches the coil in a particular direction a current is induced in it, producing a voltage across the coil as shown in Fig. 2. The voltage increases first in one direction and then reverses as the magnet passes the coil (the magnetic flux changes direction). The output is approximately sinusoidal around the area (waveform a).

If the magnet rotates with a faster velocity the sinusoidal 'blips' occur closer together and (because the change of magnetic flux is more rapid) a larger voltage is produced (waveform b).

The output voltage from the coil is passed onto the rest of the circuit for processing as explained last month.

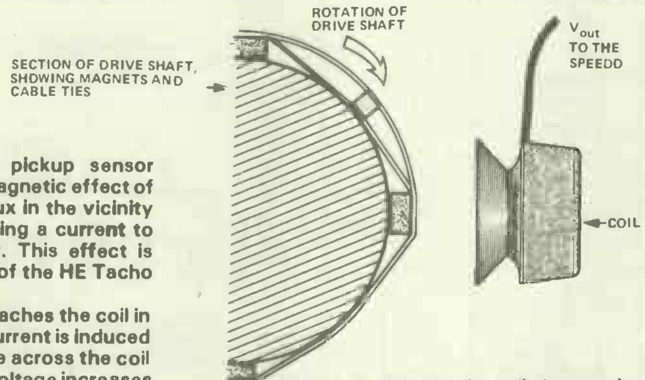
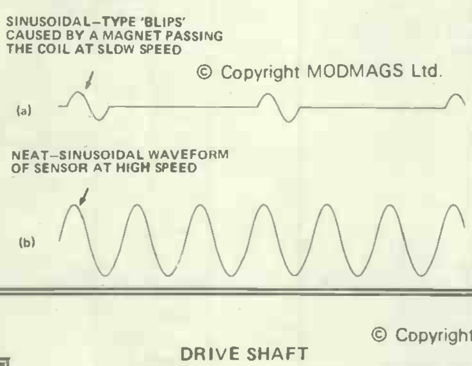


Figure 2. Positioning the coil close to the drive shaft results in the waveforms below



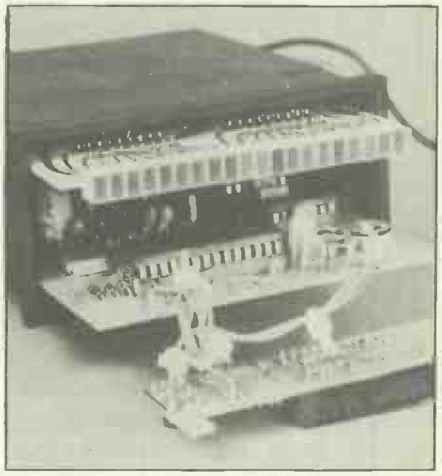


Figure 3. It's a tight fit — but all three boards of the Speedo and the Rev Counter do fit in the case

Parts List

MISCELLANEOUS
4 small magnets (reed switch type)
telephone pickup coil — Altai TC200
cable ties

Buylines

The magnets are standard reed switch operating types and should be available at any good component stockist. Likewise the telephone pickup coil should be no problem — we only specify the particular variety mentioned in the Parts List because it was the first we could lay our hands on. You may like to experiment with other types if you can't obtain that one.

The cable ties are made by Vero.

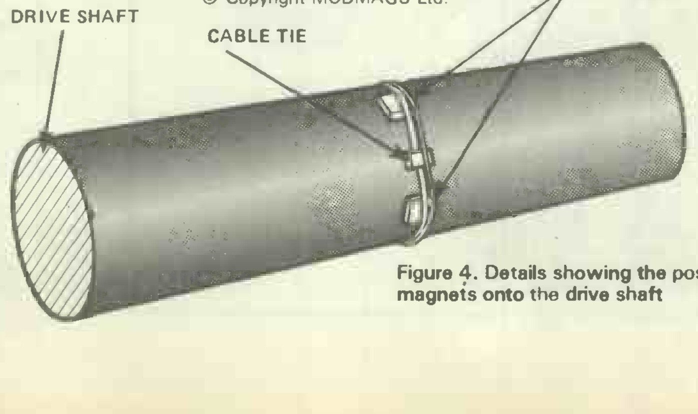


Figure 4. Details showing the positioning of magnets onto the drive shaft

HE

Into Digital Electronics

More advanced circuits this month as Ian Sinclair describes how to use binary counter ICs, a seven-segment display and SISO, PIPO, PISO and SIPO shift registers

A BCD COUNTER, a we've seen, can be made from four flip-flop units, with a gate for detecting the ten (1010) output and operating the reset. This BCD counter arrangement is so common that all its flip-flops and gates are manufactured in IC form, ready for use. There are several BCD counter ICs, but the one we'll use is a very common variety, the 74LS90.

The pinout of the 74LS90 is shown in **Fig. 5.1**. The four outputs are labelled QA-QD, QA being the lowest significant digit (the one on the right hand side when we write a binary number) and QD the highest significant digit. There are two counting inputs, A and B. The A input is an input to one of the flip-flops, whose output, reasonably enough, is QA. The B input is to the remaining chain of three flip-flops, which are gated so that they divide by five. For a BCD count, therefore, a connection has to be made from QA to input B, and the signals to be counted are taken to the A input.

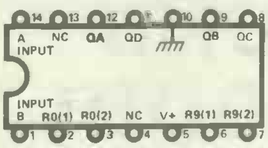


Figure 5.1 Pinout for the 74LS90 BCD/binary counter chip

There are also four reset terminals. The two terminals marked RO will reset the 74LS90 to zero when both are allowed to go high. For normal counting, therefore, at least one of these inputs must be earthed. Similarly, the inputs marked R9 will reset the counter to nine (1001) unless one of these terminals is earthed. By making use of gating and these reset terminals, various count numbers can be obtained, but the 74LS90 is practically always used just as a straightforward decade (scale of ten) counter with BCD outputs.

We can try it all out quite easily using the Eurobreadboard. Remove the J-K flip-flops from the board, and plug in the 74LS90 (a 14-pin IC) with its pin 1 on line 10A and pin 14 on line 10B. Keep your 74LS132 oscillator in place to provide clock pulses, and make sure that all the switches are wired as they were at the beginning, so that up gives logic 1 and down gives logic 0 — **Fig. 5.2** is a reminder of this switch wiring.

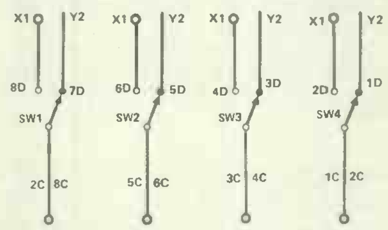


Figure 5.2 The conventional switch arrangement — a reminder

Now make the connections which are needed to use the 74LS90 as a decode counter, displaying its count on the LED's. The circuit is shown in **Fig. 5.3**. One of the spare gates of the 74LS132 is used to control the clock pulses, so that SW1 acts as a count/wait switch. Switch SW4 is wired to the reset (0), terminal, so that the counter can be reset with this switch up.

When the wiring is complete, switch on and use SW4 to reset. This counter, like any device containing flip-flops, will always give an unpredictable output at switch on, so that it must always be reset after switching on. Circuits (such as computers) which contain a large number of flip-flops need what is called an 'initialisation procedure' which resets all the flip-flops, otherwise the circuits would be unusable.

Now watch the LEDs as you switch SW1 up to start the count. The wiring given in the diagram has been arranged so that the LEDs are in the correct order to show a binary number, with QD indicated on the left-hand side and QA on the right-hand side.

Decimal Readouts

All this binary readout with LEDs is very interesting, but for most readouts we want to see decimal numbers which we're accustomed to. To show a decimal digit there are several types of display systems, but by far the most common is the LED seven-segment display. The arrangement of a seven-segment display is shown in **Fig. 5.4**, and it consists of seven bars of LED material arranged in a figure eight pattern. There is often an eighth segment, a decimal point, but this is not activated by the decade counter so we'll ignore it for the moment.

Now at this point we have a problem of a type which gets more familiar (and more complicated) as we go on with digital electronics. There are four outputs from the 74LS90 counter and there are seven segments to drive. In addition, the signals from the counter are TTL signals, 0 V or +5 V, and the signal needed at the display to make a segment glow is about 2 V. We need some method of converting BCD signals into seven segment signals, and TTL levels into LED segment levels. This sort of problem is an interfacing problem, and like most interfacing problems it's solved by using another IC.

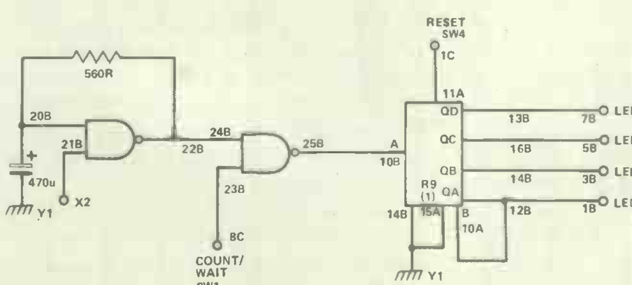


Figure 5.3 A clock-pulse oscillator driving the decade counter through a gate. The outputs of the counter are taken to LEDs

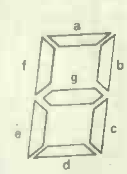


Figure 5.4 Layout of a seven-segment display. The lettering which is shown against the segments is always used to indicate these segments

The other IC is a BCD-to-seven-segment decoder. Its inputs are the BCD signals from the counter and its outputs are the seven segment lines. These will still deliver signals at TTL levels, so we connect the decoder outputs to the display inputs by resistors, which will limit the amount of current. without these resistors, the display would be bright, but not for long!

It's straightforward so far, then, but there is one minor complication. There are two varieties of seven-segment displays using LEDs. Each LED in a display has an anode and a cathode. We don't need to have separate connections to each anode and cathode, so we can connect one lot together.

Common-cathode LED displays have one cathode terminal, and the inputs are the separate anode terminals. Common-anode LED displays have one anode terminal, and the inputs are to the separate cathode terminals. Because the display glows when an anode is taken positive or a cathode negative, the two types must use different decoders, or one decoder type, with seven inverters for the opposite type of display.

For our board, the most convenient display is the DL728, available from Maplin (order number FR38R). This is a common-cathode display, and the decoder which goes with it is the 74LS48. We're using 470R resistors to limit the current in each segment to about 6 mA. This is more out of consideration for your power supply than for the display, which could take quite a bit more, up to 20 mA per segment.

Counter Circuit

The circuit for the complete counter and display is shown in **Fig. 5.5**. We've used quite a lot of the board for this, and several new components. The 74LS48 is placed with its pin 1 in line 18C and pin 16 in line 18D, replacing a 74LS76. Note that this is a 16-pin chip. Incidentally, the 74LS48 is sometimes quite hard to get — lots of people advertise it but can't necessarily supply it. If you're unlucky, just reorder for the 7448 instead — it will take more current but it operates in the same way. The display is mounted on columns C and D of the Eurobreadboard. The pinout, looking from the top, is shown in **Fig. 5.6** and the mounting position is with pin 1 in line 10C and pin 14 in line 10D. The connections are then as shown in **Fig. 5.5**. Check your connections before testing the circuit, and then set SW1 down (to isolate the clock) and SW4 up (to reset the counter). Switch SW2 is connected to the LAMP TEST pin of the 74LS48 (line 20C) and SW3 is connected to the RB input (lines 22C, 21C). Indicator LED 1 on the board is connected to the RB output pin of the 74LS48 — we'll explain these RB inputs and output later on. For the moment, keep the SW2 up and SW3 down.

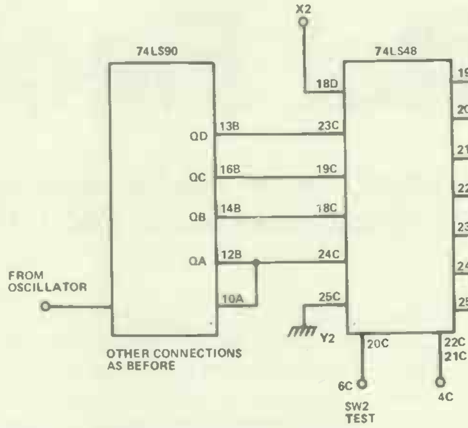
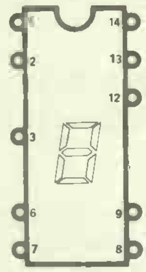


Figure 5.5 Counter-decoder-display circuit. Connections to the 74LS90 counter are the same as they were in Fig. 5.3, but the outputs Qa to Qd are connected to the decoder inputs, and the decoder outputs are connected through 470R resistors to the display



74LS48
1.QB INPUT
2.QC INPUT
3.LAMP TEST
4.RB OUT
5.RB IN
6.QD INPUT
7.QA INPUT
8.EARTH
9.E OUTPUT
10. D OUTPUT
11. C OUTPUT
12. B OUTPUT
13. A OUTPUT
14. G OUTPUT
15. F OUTPUT
16. +5V

DISPLAY

PIN	FUNCTION
1	ANODE F
2	ANODE G
3	NO PIN
4	CATHODE
5	NO PIN
6	ANODE E
7	ANODE D
8	ANODE C
9	ANODE DP
10	NO PIN
11	NO PIN
12	CATHODE
13	ANODE B
14	ANODE A

ONLY ONE CATHODE CONNECTION NEED BE USED

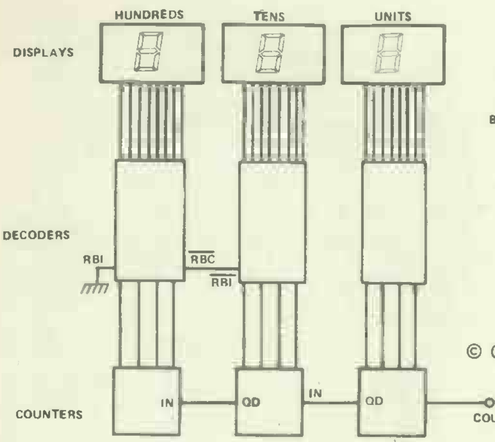
Figure 5.6 Pinouts for the display and for the 74LS48 decoder

Switch on, and you should be rewarded with a zero on the display, since the counter is reset to zero. With SW2 down, the remaining segment will light up, because the 'LAMP TEST' input does just that — it switches on each segment of the LED display. That way, you can test displays without having to watch each stage of a count. Put SW2 up again, so that the zero shows, and switch SW1 up, to start the count. The display should now start to go through a normal counting sequence 1, 2, 3 and so-on up to 9. On the next clock pulse, the gates in the 74LS90 will reset the counter so that the zero shows again.

Suppose you wanted to display tens and hundreds? It's just a matter of repeating these circuits, and the method is shown in **Fig. 5.7**, though we haven't room to construct it. The units counter has its QD output connected to the A-input of the next counter, and the ripple-blanking input to the next output as shown. Each counter has its own decoder and seven-segment display.

Ripple-blanking? That's a useful feature of the 74LS48 which we don't need in our circuit, but which is handy when we connect up a lot of counting units together. When the RB connections are 'daisy-chained' **(Fig. 5.7)** then the display suppresses leading zeros. In plain English, that means it would never, for example, show 0012, only 12. The zeros which come before any other numbers are simply not displayed — the ripple-blank input acts to gate them off.

Before we leave counting, there's one important point about the 74LS48. At each of the possible input binary numbers from 0000 to 1111, there is a different set of digits on the seven output lines. This is a simple form of read-only memory chip, because a definite output is always obtained for each input. If we thought of the 74LS48 as a memory circuit, the inputs A, B, C, D would be called the 'address', and the outputs the data. For example, an address of 1000 (eight) gives a data output of 1111111 (all segments lit). Why read-only? Well, there's nothing we can do to change the data which comes out of the 74LS48. An input of 1000 will always give an output of 1111111, and we can't make it 1010101 by any sort of juggling with the chip. The memory circuits for microprocessors are also circuits which will output a different set of bits at each input address, and if you're familiar with chips like the 74LS48, then memory circuits don't seem quite so unfamiliar.



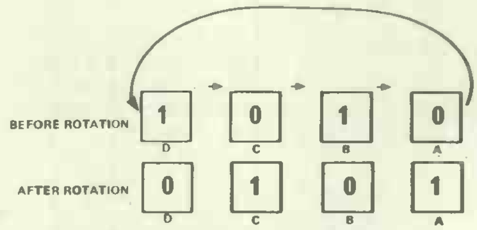


Figure 5.8 Rotating a set of bits with a shift register

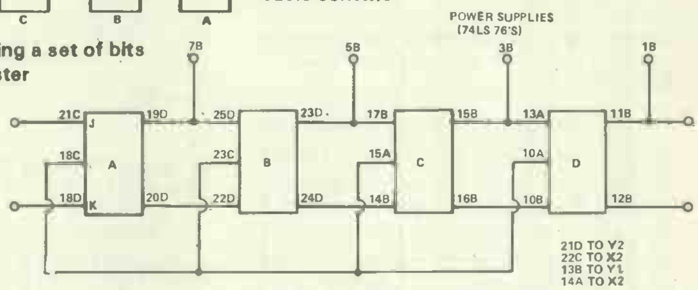


Figure 5.9 Basic shift register layout. The display and the 74LS48 have been removed from the board, and the 74LS76s replaced, wired as shown. The next series of diagrams will consist of additions to this basic scheme

Figure 5.7 How a count of up to 99 can be achieved. Each digit needs one 74LS90, equivalent to one 74LS48 decoder, and a seven-segment display. The Qd of the units counter is connected to the input of the tens counter, and the Qd of the tens counter is connected to the input of the hundreds counter. The hundreds and tens decoders have their ripple-blanking connections made so that leading zeros are suppressed

Back to the Beautiful Movers

Decimal counting and display is just a brief interlude in a lot of binary circuits, and we need now to return to shift registers. We make a shift register from four J-K flip-flops, but nowadays, a shift register would be bought as a complete IC. Shift registers, despite the name, aren't used just for shifting, and we need to know a bit more about their uses nowadays, because microprocessors contain a lot of shift registers.

There are four basic types, labelled SISO, PIPO, PISO, and SIPO. As usual, the letters are the first letters of words, S for serial, P for parallel, I for input, O for output, and the letters therefore describe how each shift register can be used. In the descriptions which follow, remember that a bit means a binary digit, 0 or 1.

SISO

The SISO shift register is serial in, serial out. A register of this type would have one input and one output, with a clock terminal. A bit at the input is shifted in by a clock pulse, and won't appear at the output until several clock pulses later. How many? That depends on how many flip-flops are in the register, a complete shift through the register will take as many clock pulses as there are flip-flops. It's a useful way of delaying a set of bits on their way through a circuit, or of storing bits for a set number of clock pulses.

PIPO

The opposite extreme is the PIPO register, parallel in and parallel out. We can use this one without ever applying clock pulses, simply as a latch to hold some data bits. If a serial input is also provided, this can rotate a set of bits (**Fig. 5.8**), so that the bits which you read out are not in the same positions as they were when you put them in. It, too, has its uses.

SIPO & PISO

The SIPO and PISO are both extremely useful forms of registers. The PISO is parallel in, serial out, so that a complete group of bits can be stored in the register, using one line for each bit, and them read out one by one along a single line. This is how information in groups of bits (like the eight bit unit, or byte, which is used by most microprocessors) can be sent along a single wire to a video terminal, a printer or a cassette recorder. The PISO register is, of course, only a part of the whole system but its part is the important one — conversion from parallel eight bits to serial one-at-a-time.

A SIPO register is the gubbins you need for the opposite conversion. When you have bits in serial form coming along a single line, and you want to assemble them into groups to deliver to some system which deals with groups (display, microprocessor or whatever), then the SIPO register provides the method. The bits enter the serial inputs, are shifted along the register at each clock pulse, and can be read at the parallel outputs after the correct number of clock pulses. We've simplified all this, of course, because there are usually other problems to solve. You have to be sure that when you send bits out serially, each of them is doing something. There's no point, for example, in sending bits at a rate of 100,000 bits per second to a printer which can cope with only a few hundred bits per second. Taking another example, if you're reading serial bits into a register, you have to make sure that you are grouping them correctly, and not taking some bits from the end of one group and some from the start of the next. There are several ways of ensuring that these actions go smoothly: one of them is the use of bits to identify stop and start, but we don't need to go into these problems right now.

Practical Shifting

What we do need, however, is some first hand experience with a shift register. We could use various IC shift registers to demonstrate all of these actions, or even use a 74LS295, which has both serial and parallel inputs and outputs to demonstrate all four types of registers, but the easiest and least pricy method is just to use the 74LS76s which we already have. After all, it's the actions we want to show, not the look of the IC.

To start off with, then, place the two 74LS76 ICs back on the Eurobreadboard. Integrated circuit ICA should have its pin 1 in line 10A and pin 16 in line 10B and ICB should have its pin 1 in line 18C and pin 16 in line 18D. We'll need the 74LS132 as well, with its pin 1 on line 19A and pin 14 on line 19B. The power supply connections are as shown in **Fig. 5.9** and all the switches are connected conventionally: a reminder is also shown in **Fig 5.2.**

With these preliminaries over, we can start. The board should now contain the three chips, with power supply links, but no interconnections. Link up the J and K inputs to the Q and $\overline{Q}$ outputs in the usual form of a shift register (**Fig. 5.9**) and we now have the basic unit which we'll use to demonstrate all the types of shift register.

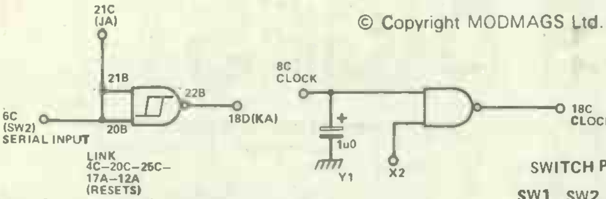


Figure 5.10 The additions to the basic shift register circuit for implementing a SISO register

Start off with SISO. For this one we want to be able to place bits in serially at the input of F/FA. To do this, we need an inverter between JA and KA, and one of the gates of the 74LS132 can be pressed into service for this task. We'll use a switch to clock the register, SW1, and another of the gates of the 74LS132 is used as a simple debounce circuit for the switch. Switch SW2 is now used to provide the serial input, and LED4 indicates the serial output at QD (Fig. 5.10).

With four flip-flops in the register, any bit placed at the input using SW2 should need four clock pulses from SW1 to complete its movement through the shift register. We must first ensure that all the flip-flops are cleared, and that SW3 has been arranged to do this.

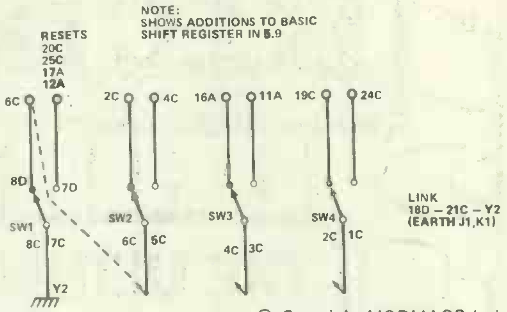
With the circuit wired as shown, turn on the 5 V supply, and reset all the flip-flops, using SW3. Switch SW2 up to place a 1 on the input, and operate SW1 once to shift this 1 to QA. Switch SW2 down so that the input now remains at zero, and operate SW1 three more times. This should result in a 1 appearing at the output (LED4).

The PIPO shift register needs a different set of switch connections, but the NAND gates are not required. Three switches, SW2, SW3, SW4 are used to set the flip-flops, and one to reset (SW1). The switches have been deliberately arranged so that no flip-flop can have both set and reset terminals earthed simultaneously (Fig. 5.11).

All four of the LEDs are now used to indicate the state of the register, LED 1, for flip-flop A, 2 for B, 3 for C and 4 for D. With the wiring shown, reset by pushing the slider of SW1 down.

Push the sliders of switches SW2, 3, 4 so as to select one flip-flop to set — Fig. 5.12 shows how the switches are set for each flip-flop. Switch SW1 is then pushed up to set that flip-flop. Unless SW1 is pushed down again, the flip-flops which have been set, indicated by the LEDs, will remain set — which is the principle of the PIPO register. We haven't used clock pulses — for this sort of application we don't need them.

Figure 5.11 The switch modifications for a PIPO register. The connections made in Fig. 5.10 must be removed first



SWITCH POSITIONS				–SETTINGS–			
SW1	SW2	SW3	SW4	A	B	C	D
L	X	X	X	0	0	0	0
H	H	X	H	1	0	0	0
H	H	X	L	0	1	0	0
H	L	H	X	0	0	1	0
H	L	L	X	0	0	0	1

Figure 5.12 Table of switch operations for Fig. 5.11

Next on the list is the PISO. With our ration of four switches, we can't set the flip-flops individually and still have the register free to be clocked. Figure 5.13 shows the circuit, SW3 and 4 are used for setting, and SW2 selects set or reset. Switch SW1 lets you isolate the set and reset so that the register can be clocked, using the slow clock pulse generator formed by one of the 74LS132 gates. Indicator LED4 is used to show the state of QD which is the serial output JA = 0, KA = 1, so that the first flip-flop is reset when the clock pulses start. This ensures that the register is emptied by four clock pulses. One of the NAND gates is connected so that clocking starts when the set inputs are isolated.

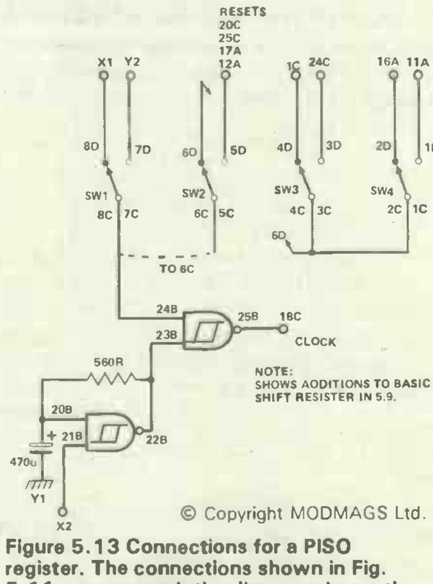


Figure 5.13 Connections for a PISO register. The connections shown in Fig. 5.11 are removed: the diagram shows the additions to the basic circuit in Fig. 5.9

Wire up, switch on, and use SW2 (down) and SW1 (down) to reset the flip-flops. Now switch SW1 up to isolate the set/reset inputs, and SW2 up to select set. Switches SW3 and SW4 can now be arranged so that either 1 and 3 or 2 and 4 will be set when SW1 is pushed down again. Whenever SW1 is pushed up again, the clock pulses will start to operate the flip-flops, and the bits which have been set will shift right at each clock pulse. After four clock pulses, all the original bits have been shifted out (remember that some of the original bits were zero) and the register is filled with zeros.

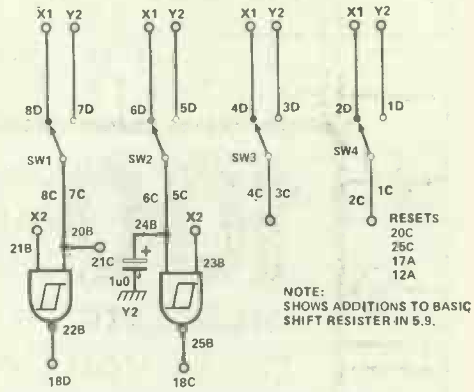


Fig. 5.14 The SIPO register connections. Once more, this shows the additions to the circuit in Fig. 5.9, with previous additions removed. This also restores the switches to normal operation for the next set of operations to be described next month

The SIPO shift register is easier on switches (Fig. 5.14). This time each LED shows the state of one of the flip-flop outputs, and the 'signals' are fed in at each clock pulse. Switch SW4 resets the flip-flops, SW1 is used to switch the serial input high or low, and SW2 is used as the clock pulse generator, along with its debouncing circuit, one of the NAND gates of the 74LS132.

Wire up, switch on, and use SW4 to reset, so that all of the LEDs are extinguished. Now use SW1 to place a 0 (down) or 1 (up) at the input, and load this in with a complete switch cycle (up to down) of SW2. Pick another value (0 or 1) for SW1, and use SW2 again. At each load, a value will feed into F/F A, and the previous value will be shifted along to F/F B. After four clock pulses, the register will be full, ready to read out its content over four lines.

By now we've covered most of the really important basic digital circuits with one important exception — the adder. We'll keep that for next month. **HE**

Nicad Charger

Recharge your vital equipment with this practical, money saving device from HE

ISN'T IT SAD — just when you want to listen to your favourite radio programme on your little tranny, you inevitably find the batteries are defunct. And don't they cost a lot to replace? Well, here is the answer to all your problems — rush out and buy some nicad cells for your battery-powered calculator, transistor radio or cassette player etc. Although they are more expensive initially, you can recharge them again and again on the HE NICAD Charger, thus saving £££££s overall! With this project whenever your batteries run down an overnight charge will revitalise them to their full vigour.

Nicad cells can be recharged many hundreds of times but they need a regulated charge current. Our charger provides this regulation and, in the mode shown in **Fig. 2**, it will handle up to six AA sized (HP7 type) cells. It can be easily modified to suit other sizes as described below.

Nicads need a constant current charge. For example AA cells need about a 65 mA charge, for a set period (normally 12 hours and so an overnight charge is ideal). For other sizes of cells, different charge currents are required. The table in **Fig. 1** shows typical values of current required for various-sized cells. Altering our charger to suit other cells is a cinch, as the output current is set solely by R1.

Its value in ohms is equal to:

$$\frac{0.65}{\text{the required charge rate in amps}}$$

So, for any required charge current, choose the nearest preferred value of resistor to the calculated value.

Output currents of more than 80 mA will require a larger mains transformer because this should have a secondary current rating at least 20 mA more than the charge current. Higher charge currents might also make it necessary to fit Q1 with a more substantial heatsink.

Construction

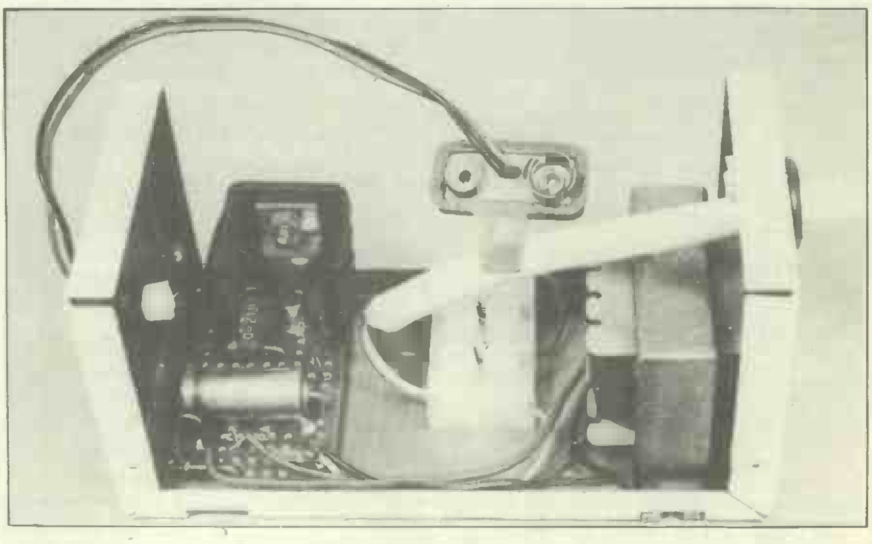
The components are mostly assembled on one of our standard-size (24 holes by 10 strips) 0.1" pitch stripboards as can be seen from the wiring diagram of Fig. **3**. Transformer T1 is not mounted on the board, but is bolted to the inside of the case. For reasons of safety the case should be a type having a screw-on lid, and must not be a clip-on type. If a metal case is used it must be connected to the mains earth. It is likely that T1 will have flying leads rather than tags, and a connector block will then be needed to facilitate the connections between the mains lead and T1. The earth lead to the component panel can also be taken via this block. Connector blocks are usually sold in twelve-way strips, and the required three-way block can be cut from one of these using a sharp knife.

The output of the unit can be taken to a PP3-type battery connector, making quite sure that it is connected with the correct polarity. Plastic battery holders for AA (HP7) size cells are readily available, and these have a PP3-type connector. These holders connect the batteries in series (connected '+' to '−') — the batteries must never be connected in parallel '−' to '−' and '+' to '+').

Q1 may become quite hot in use and should be fitted with a small heatsink.

SIZE OF CELL	CHARGE CURRENT (FOR 12hr CHARGE)
PP9	100mA
AAA	20mA
AA	65mA
C	250mA
D	500mA

Figure 1. Table of charge curents for various cells.



Parts List

RESISTORS (All ½ watt 5%)
R1 10R
R2 680R

CAPACITOR
C1 100u 25 V electrolytic

SEMICONDUCTORS
Q1 TIP41A NPN power transistor

Q2 BC109 NPN Transistor
D1,D2 1N4002

MISCELLANEOUS
T1 12-0-12 V 100 mA mains transformer
10 x 24 hole 0.1" Veroboard
case, battery holder, battery clip, mains lead, connector block, fitted heatsink, etc.

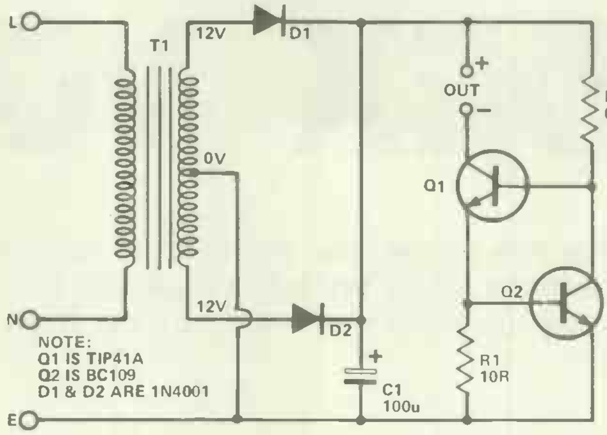


Figure 2. Circuit diagram

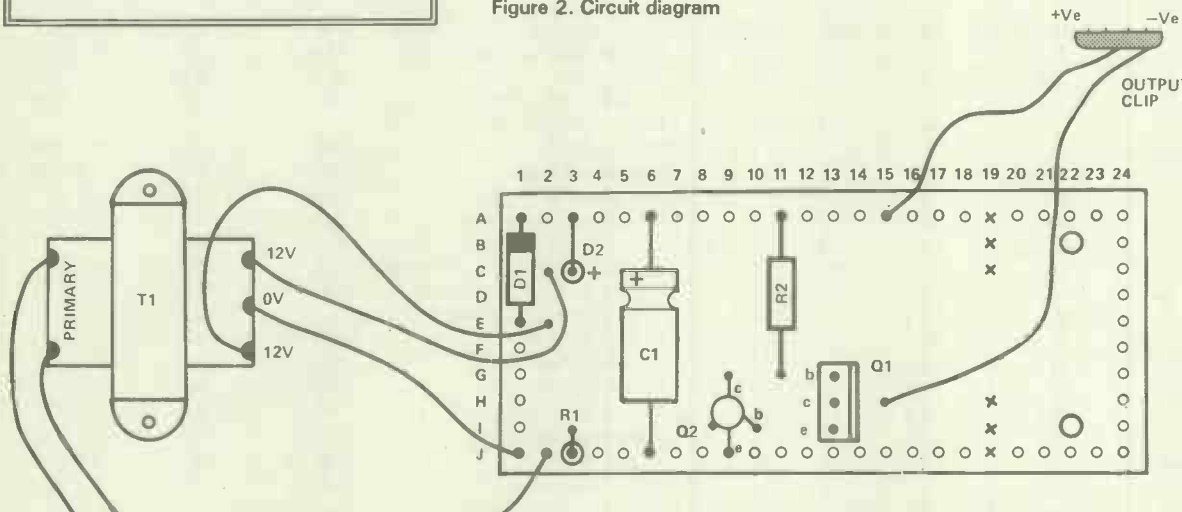


Figure 3. Veroboard layout and connection details. No track breaks are required

Buylines

All components are readily available and the approximate cost will be around £5. This price excludes the case, of course.

How It Works

The mains voltage is stepped down to a more suitable potential by transformer T1, with D1, D2, and C1 then full-wave rectifying and smoothing the output of T1 to give a low voltage (about 14 V under load) DC supply. This supply cannot be connected directly across the nicad cells as these have an extremely low internal resistance, and would place virtually a short circuit across the supply. The supply in turn would damage the cells, which should not be charged at a higher current than that recommended by the manufacturer, and would also result in the destruction of the supply circuit!

A current regulator must be included to ensure that the cells are charged correctly, and this is the purpose of Q1, Q2, R1 and R2, which are used in a conventional constant-current generator configuration. Transistor Q1 is biased hard into conduction by R2, and a current therefore flows through R1, Q1, and the cells being charged. The current is limited to a safe level by Q2 which becomes biased into conduction by the potential developed across R1. The results in Q2 tapping off some of the base current for Q1, so that the impedance of Q1 increases.

Therefore, even with a low impedance across the output, such as that of the nicad cells, the output current passed by Q1 is stabilised by Q2 at a safe level, since Q2 can reduce the bias on Q1 to practically zero if necessary. As Q2 is a silicon device it requires a base bias voltage of about 0.65 V to bring it into normal conduction, and so the circuit stabilises with about this potential across R1. From Ohm's Law it can be seen that about 65 mA flows through R1, Q1, and the cells under charge (0.65 V divided by 10R gives 0.065 A, or 65 mA), which is about the correct charge for AA size cells.

HE

INDEX VOL. 2

Another year has passed, so it's time once again for the annual HE alphabetical Index. Here we have a complete listing of all of the major features, projects and short circuits from Volume 2 of Hobby Electronics.

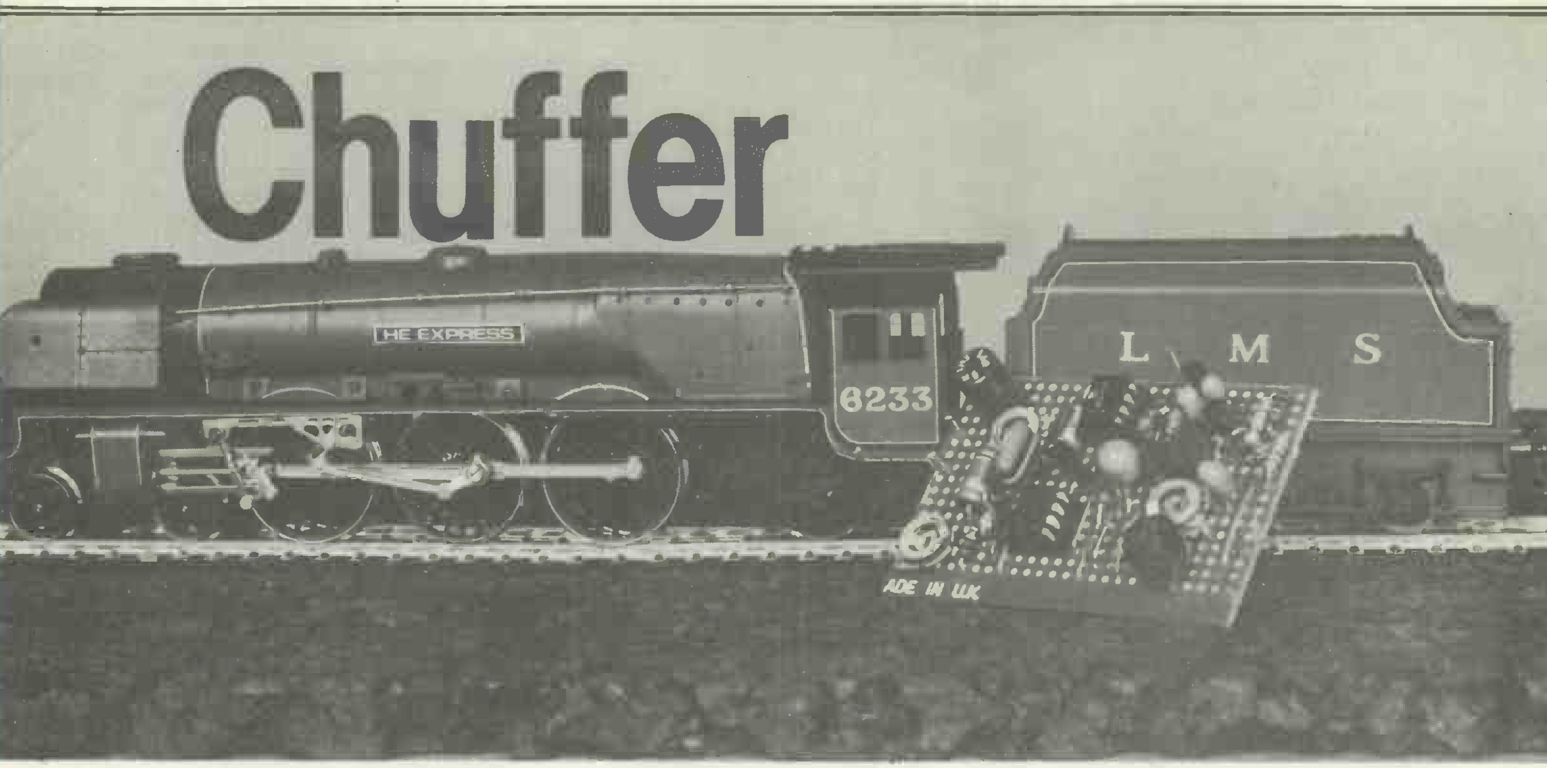
PROJECTS

FEATURES

GENERAL FEATURES

SHORT CIRCUITS

Chuffer



Add realistic sound effects to your world of trains with this circuit. First of a series of 'funny noises' for model railway enthusiasts

OVER THE NEXT couple of months HE intends to devote project space to the model railwayites — that odd breed of beings who choose to sit at home in the attic or spare bedroom, surrounded by miles of track and scaled-down trains, stations and scenery. And what do they hear as they sit there? Certainly nothing resembling *real* train sounds.

Now, this sub-world can be made more complete by building some of our model train sound effects starting with the HE Chuffer, a device designed to simulate the sound of a steam train. A preamplified output means that the device can be plugged into an external amplifier (this month's Bench Amplifier is ideal) and preset controls allow it to be used with a wide range of train systems, to give the required sound. The project is purpose-designed to complement the HE Train Controller of last month's issue although it will also perform well with standard (variable resistor type) controllers.

The two IC and three transistor circuit picks up and measures the voltage applied to the track by the controller and converts this into a varied rate of 'chuffs'. The higher the voltage, the faster the chuff rate. When the train is stationary only a faint background or 'parking' hiss is heard, but as soon as the train pulls away, the chuffs commence — slowly at first, until full power is applied, when chuffs are fast and furious as the train hurtles round the track.

Construction

The circuit is built up on a 16-strip by 26-hole piece of Veroboard. Although this method of construction is very convenient for the hobbyist you must remember that certain procedures must be followed if the project is to be fault-free. The copper strips or track must be broken in the correct places as shown in the underside diagram of the board in **Fig. 3.** This can be accomplished using a hand-held ⅛" drill bit (if you haven't got the proper tool for the job) but in either case make sure that no loose bits of copper swarf bridge nearby tracks.

Next, insert and solder the wire links into the board as in the overlay diagram. Resistors and capacitors can then be soldered in. Polarised capacitors need to be inserted the right way round — check them carefully before solderingl IC sockets should be inserted and soldered now.

Finally, all semiconductors should be put in, but like polarised capacitors they should be checked for correct insertion before soldering.

We have included no details of casing the project this month as it is our intention to house it and forthcoming model train sound effects in one case, later.

Setting Up

First set the three preset resistors at mid-position. Connect the circuit to an amplifier and a battery or 9 VDC power supply. Switch on. By adjusting RV3, a white noise signal of up to 100 mV should be available to the amplifier. The setting of RV3 will be best found by experience and personal choice but as a rough guideline only, adjust it till just a faint hiss is heard from the amp.

Now, connect the input of the circuit to your model train track and set a train running around the track at medium speed. Readjusting RV3 should now give a variable output of white noise from sharp clonking pulses to a continuous hiss — choose the best overall sound.

Buylines

All components are common types and should cause no difficulty. The approximate cost of parts will be around £8.

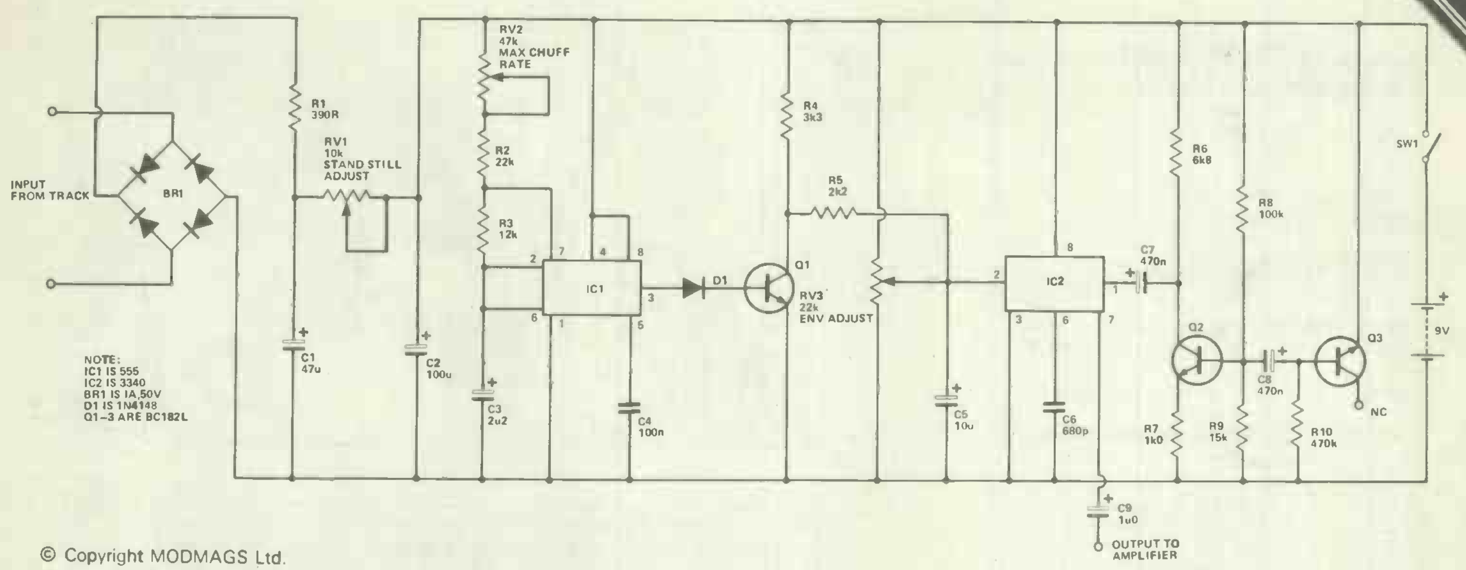


Figure 1. Circuit diagram of the HE Chuffer

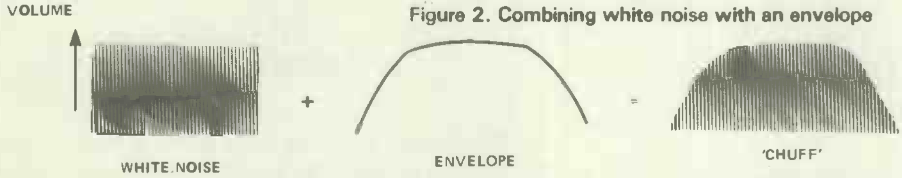
How It Works

The main sound generated by a (full-sized) steam train is a more or less equal mixture of all frequencies — in electronics this sort of sound is known as white noise, so called because of this mixture of *all* audible frequencies (analogous to white light!). One way of electronically producing white noise is with a transistor connected as Q3 in the main circuit diagram in Fig. 1. You will see that its collector is open-circuit and its emitter is, unusually, taken positive relative to its base. Connected so, Q3 acts as a zener diode, maintaining a constant voltage across itself. A white noise signal occurs at its base which is amplified by Q3 and fed to IC2.

The 'chuff-chuff' sound required of the circuit is formed by adding an envelope to the white noise. Figure 2 shows this in diagrammatical form. As can be seen, the enveloped white noise means that the noise increases from zero, maintains this maximum level for a while, then decreases back to zero — forming a resounding 'chuff' sound. By repeating this envelope every so often as the train goes round the track, the required sound is obtained.

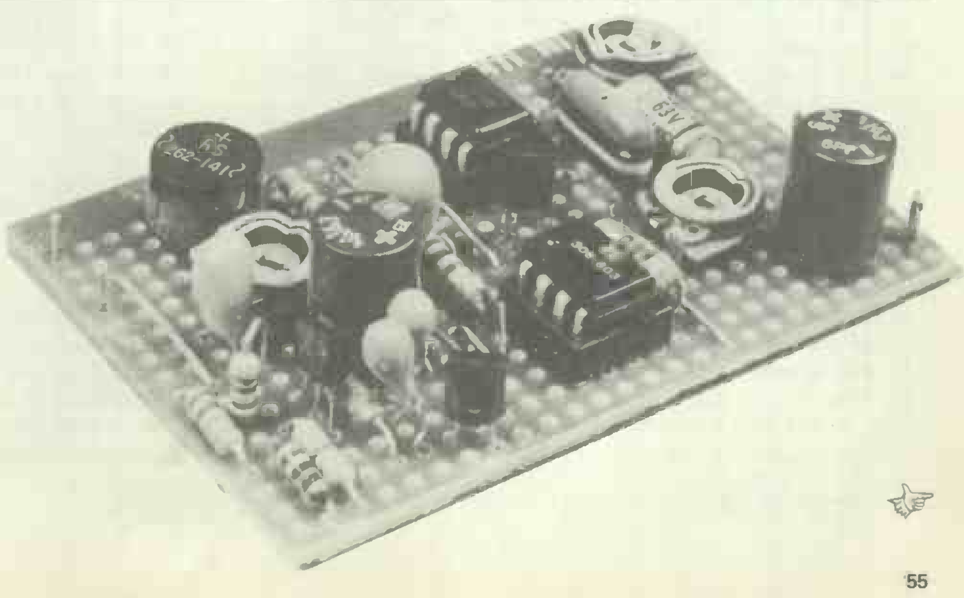
The rest of the circuit is designed to trigger the envelope at a rate which corresponds to the speed of the train; ie, at full speed the chuffs are rapid and at standstill, only a background hiss is heard to simulate a stationary steam engine. To do this the voltage present on the railway track is rectified and smoothed by BR1, R1, RV1, C1 and C2, to produce a DC voltage which increases and decreases with the speed of the train. This changing voltage is used to power an astable oscillator (IC1-a 555). As its power supply increases and decreases so does its oscillation rate. Preset RV2 gives overall control of oscillation rate (the chuff rate). Transistor Q1 buffers and inverts this pulse which is then used to trigger the envelope described above.

Figure 2. Combining white noise with an envelope



Using the train controller, stop the train. Adjustment of RV1 should provide a 'turn-off point' when no modulated noise is available (ie when the train is stationary — no 'chuffs' are heard). Fine readjustment of RV3 will now give a background gentle hiss at this stage, simulating a stationary steam train.

Finally, run the train at maximum speed and adjust RV2 until the required maximum 'chuff rate' is found. It may be necessary to retrim the presets until the best combination of background hiss, stationary turn-off and maximum chuff rate is obtained.



Parts List

RESISTORS (All ¼ W, 5%)	
R1	390R
R2	22k
R3	12k
R4	3k3
R5	2k2
R6	6k8
R7	1k
R8	100k
R9	15k
R10	470k
POTENTIOMETERS	
RV1	10k miniature horizontal preset
RV2	47k miniature horizontal preset
RV3	22k miniature horizontal preset
CAPACITORS	
C1	47u 10 V, tantalum
C2	100u 6V3, tantalum
C3	2u2 16 V, electrolytic
C4	100n polyester
C5	10u 16 V, printed circuit mounting electrolytic
C6	680p polystyrene
C7,8	470n 35 V, tantalum
C9	1u 16 V, printed circuit mounting electrolytic
SEMICONDUCTORS	
IC1	555 timer
IC2	MC3340 voltage controlled attenuator
BR1	1 A,50 V bridge rectifier
Q1,2,3	BC182L NPN transistor
D1	1N4148 diode
MISCELLANEOUS	
SW1	single-pole,single-throw toggle switch
16 strip x 26 hole Veroboard	
battery clip	
IC sockets	

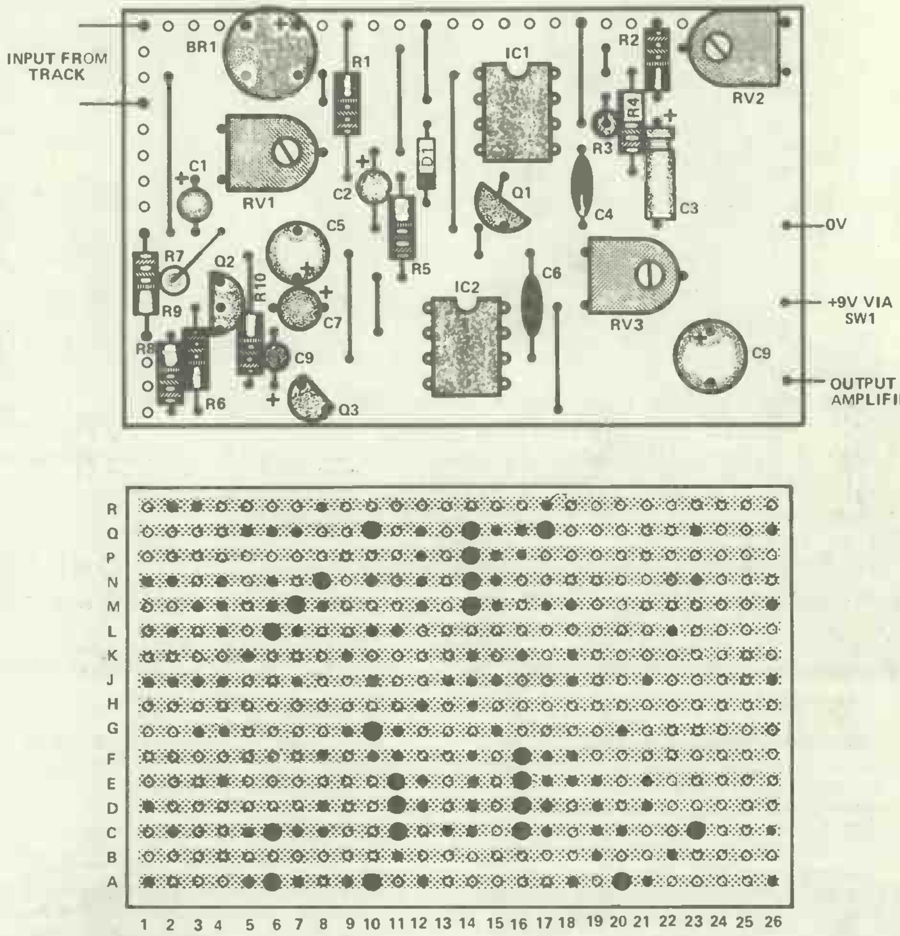


Figure 3. Veroboard layout and underside view, showing track breaks

HE

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electronics today INTERNATIONAL

NEXT MONTH

Look out for the February issue on sale January 2nd

Digital Designers' Circuit Supplement

In only 10 years digital circuits have shifted from simple single-function chips to microprocessors and horrific dedicated multifunctional devices — creating increasing problems for the digital designer. Tim Orr's Digital Designers' Circuit Supplement helps you make sense of this digital nightmare.

Roulette

At last: a hand-held battery-powered project that brings you the thrills of the casino. ETI's roulette has a circle of LEDs and gives you the choice of biased (in favour of the house) or unbiased (no house) options. It even has sound effects.

IR Beam Alarm

ETI's IR Beam Alarm features a dual beam IR link. The two beams, a few inches apart, must be broken simultaneously to activate the alarm. So it won't trigger falsely when a fly lands on the transmitter or receiver. The link has a 10 m range and could form the basis of a house alarm system.

SPL Meter

This is a first for a UK electronics magazine: an accurate, calibrated Sound Pressure Level Meter based on a special-purpose, but modestly-priced precision microphone insert. The SPL can be used to check absolute levels of sound level or loudness: use it to set up the graphic equaliser in your hi-fi system!

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

CORDLESS PHONE SPECIAL OFFER

Imagine the luxury of having use of a phone in every room. This is now possible with this month's very special offer from Modmags. We are now in a position to offer to you, at a never-to-be-repeated price the fabulous Freedom Phone FF1500. This brilliantly engineered little device consists of a base station transponder and a cordless handset. Facilities include full duplex two-way transmission, incoming and outgoing calling, push-button dialling with memory and re-chargeable nickel cadmium batteries for low operating costs.

The range of the Freedom Phone is in excess of 200 yards, enough for even the largest back-garden: it will enable you to be in telephone contact at all times. Never again will you miss that all-important business call and the built-in paging facility will allow anyone to get in touch with you, no matter where you are within the transmission area.

Each unit comes complete with the base station transponder/charger plus secondary charger, full fitting instruction (only two wires to the existing phone line), re-chargeable batteries and the personal handset. Price for each unit (including post, package, etc) is just £125.00.

SEND YOUR CHEQUE/POSTAL ORDER TO: PHONE OFFER, Modmags Ltd., 145 Charing Cross Road, London WC2H 0EE.

Please note that these devices are at present not licenceable for use in the UK.

I enclose a cheque/postal order for £ . . . .

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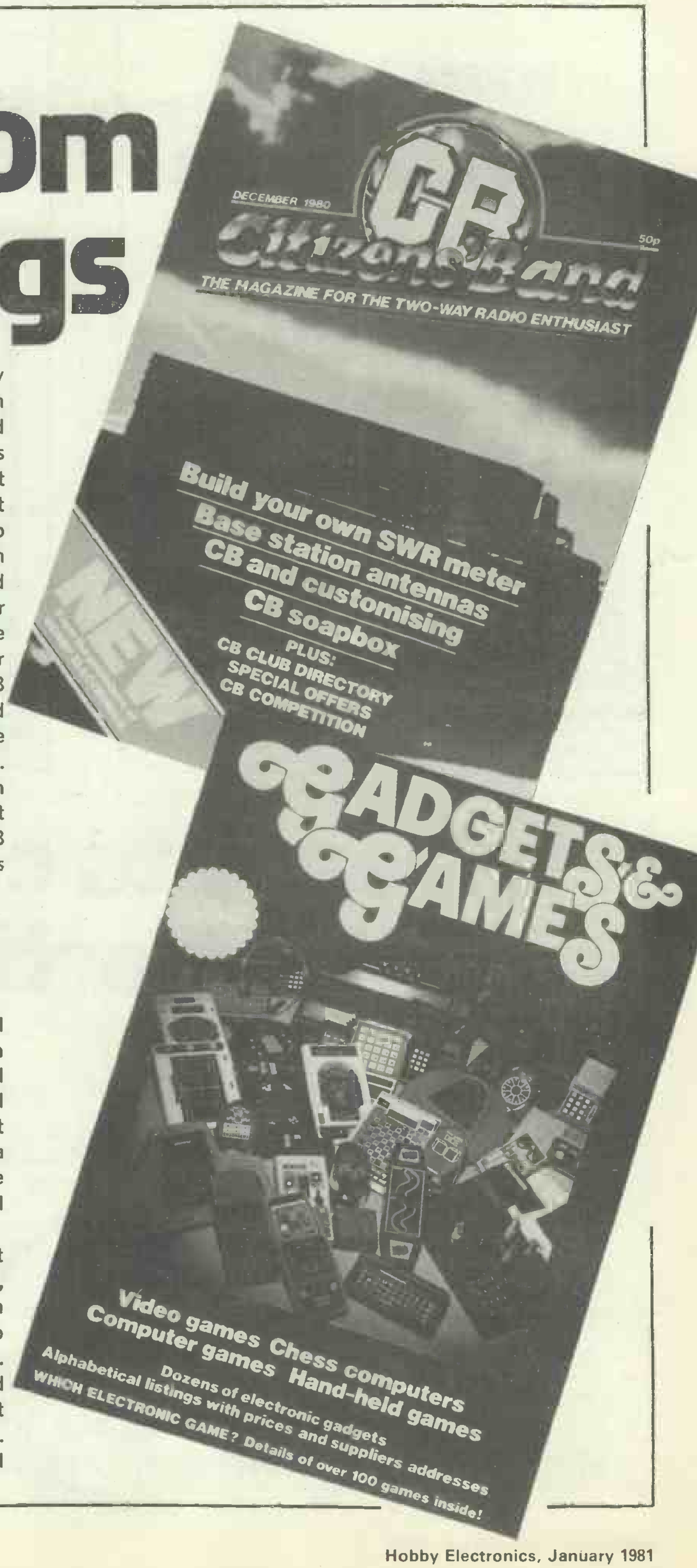
NEW from Modmags

CITIZENS BAND is the new monthly magazine for all CB enthusiasts.Every month we publish all of the latest news,views and information.Our team of technical reviewers bring you test reports of all of the latest equipment.Our project team get together to design simple and cheap to build projects that are of interest to both CBers and radio enthusiasts alike.And for people with something to say our regular monthly forum 'CB Soapbox' gives anyone a chance to publicly air their views.For those still unsure of the working of CB we have a new monthly feature called 'Inside CB' in which we explain in a simple down-to-earth way how CB works.

CITIZENS BAND will be on sale on the third Friday of each month price just 50 pence.If YOU are interested in CB then you just can't afford to miss CITIZENS BAND'



GADGETS & GAMES is the answer to all of your problems.Inside this Special edition from Hobby Electronics we have reviewed over 100 of the best electronic Gadgets and Games on the market.From the simplest hand-held LED game to the ultra sophisticated video games right up to the most powerful chess computers,they're all here.

In the Gadgets section we have put together a selection of the most fascinating, innovative and revoloutionary gadgets,from the smallest television set in the world to the worlds first talking language translator. As a special bonus we have also compiled a list of hundreds of software games that can be played on your home computer. All this for just 85 pence.In your local Newsagent NOW.

CB Breaker One Four

The publishers of HOBBY ELECTRONICS would like to point out that it is at present a contravention of the Wireless Telegraphy Act of 1949 and 1968 to use, manufacture, install or import CB transmitting equipment. It is not the intention of Modmags Ltd to incite, encourage or condone the use of such equipment.

With issue number one of CITIZENS BAND on the bookstalls and the Breadboard show underway it's been a very busy month. Rick Maybury has the latest news

THIS HAS been the busiest month we can remember for a long time. With the first edition of Citizens Band now on sale and number two just about going to press we've hardly had time to breathe.

The Government Green Paper has just about done its stuff: closing date for replies was a couple of weeks ago, and it now remains for the Home Office to make some kind of recommendation about CB in this country. Whatever it decides will make absolutely no difference to the present situation, because we now reckon there are some 500,000 rigs in the country at the moment and in our opinion that means *we have CB.* The fact that it is not a legal system is neither here nor there. It is working and seen to be working: we are hearing more and more reports of channel 9 being used for emergency calls and these being acted upon by the Police and Ambulance services. To our rather uncertain knowledge at least three lives have been saved in the past month by the quick actions of CBers. At least one Police force has unofficially admitted that CB has been a help to them on several occasions. The 24-hour monitoring service in London and a couple of other large cities more than justifies the existence of CB.

What happens now will largely depend upon how much notice the Home Office takes of public opinion. Most CBers will agree that 27 MHz is at best a compromise. It is a noisy and to an extent unreliable waveband. We're sure that most CBers are law abiding citizens and would welcome a legal waveband that embodied all of the advantages of 27 MHz without the attendant problems of noise and interference. We could have it tomorrow and it wouldn't cost any more to buy a rig than it does to obtain a 27 MHz rig on the black market. We need a frequency *now.* Time and time again it has been proven that 928 MHz is totally unsuitable. We have proved that the VHF band on 41 to 49 MHz would be suitable for such a service. Industry has agreed that the equipment could be manufactured in this country with the consequent improvement in the UK unemployment situation. So why are we waiting? A new series of demonstrations will be starting by the time you read this. You MUST make your feelings known. We know that most of these demos will be arguing for 27 MHz. That's OK but we must admit to ourselves that this cannot really be the final answer. Push for 27 MHz by all means but let the Home Office know that you want a quality system, a system that will give this country a chance to become a world leader in personal communications. OK, enough table-thumping for one month, back to the news scene to see what's been happening.

Mass Eyeball

Cast your minds back a couple of months to the November edition of BOF. You may remember we mentioned the Midlands Radio Fare and Mass Eyeball which was held on the 9th of November. It turned out to be an enormous success, so much so in fact that already the organisers are planning three more functions in the next five months. They are:

Sunday, January 18th 1981 at the Festival Inn, Trowell, Notts. (Same venue as first Mass Eyeball)

Sunday March 8th 1981 at the Lincolnshire Exhibition Centre, Lincoln.

Easter Sunday, April 19th 1981 at the Festival Inn, Trowell, Notts.

If you would like further details of these events then write to TVC Ltd., Station Road, Long Eaton, Nottingham or phone Long Eaton 62247.

Multitesters 100,000 opv

AC volts:- 0 — 5 — 10 — 250 — 1000
DC volts:- 0 — 05 — 25 — 10 — 50 — 250 — 1000
DC current:- 0 — 10ua — 25ua — 500ua — 0 — 5 ma — 50 ma — 500 ma — 10 amp
AC current:- 10 amp
Resistance:- 0 — 20 ohms — 200 ohms — 5 K ohms — 200 K ohms — 50 K ohms — 200 K ohms — 5 meg ohms — 50 meg ohms
As a transistor tester
HFE:- 0 — 5 (NPN) — PNP)
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Dims:- 90 x 61 x 30 mm
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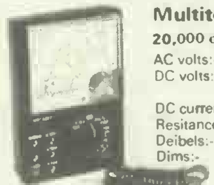

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AC volts:- 0 — 10 — 50 — 100 — 250 — 500 — 1000
DC volts:- 0 — 0.5 — 5 — 25 — 125 — 250 — 500 — 1000
DC current:- 0 — 50 ma — 0.5 ma — 250 ma
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Club Corner

Literally dozens of new clubs are springing up all over the place. If you've read CITIZENS BAND you'll know that we have published the most comprehensive club listing ever and we will continue to do so every month. Here is this month's selection of new clubs:

WORTH VALLEY BREAKERS
B. Widsop
c/o 19 Woodhouse Road,
Keighly,
Yorks.

AIRE VALLEY BREAKERS
Call Ch 19 AM or 30 USB.

CB MUSKETEERS
PR. J.L. Smith.
61 Gibbwin
Great Linford,
Milton Keynes,
Bucks.

COPY CAT CLUB
Martholme Grange,
Altham,
Accrington,
Lancashire.

REDDITCH AREA CB CLUB
80 Heronfield Road,
Churchill,
Redditch

ST HELENS CB CLUB
33 Broadway,
St Helens,
Merseyside.

Two sneak previews of this year's Breadboard show. Above some of the CB goodies on the Wintjoy stand. Below, Glyn Hall (Wintjoy) menacing the customers asking if he sells rigs.

CB Books

Our last item this month concerns the sudden increase in the number of books about CB. As you might expect most of these works are of American origin and as such can be slightly irrelevant to our own needs. That aside a couple of books we've seen recently are actually applicable to any CB system working on 27 MHz. Best so far is called Modern CB Radio Servicing. It is published by Hayden and is being imported by NIC. This book costs £4.60 and believe us, it's worth every penny. The book contains step-by-step instructions that will enable any competeent, electronically-minded person to carry out simple repairs on all kinds of common CB rigs. Mind you, we can't actually encourage anyone to do such a thing — after all CB *is* illegal and no one really has any rigs that might go wrong . . . . . .

Shop Scene

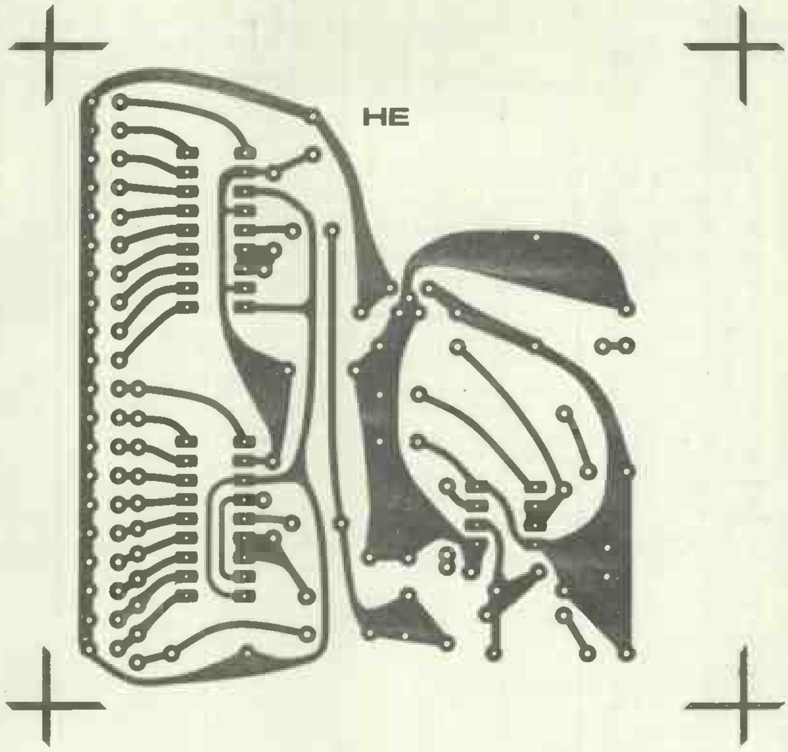
Walthamstow is fast becoming the North London CB centre as it now boasts two specialist CB accessory dealers. Latest arrival is called Globe Communications. Previously Globe were TV aerial specialists but within the last two months they have turned their attention to selling CB gear. Already they have built up a strong local reputation for low prices and I must admit they're certainly the lowest I've seen in London. Globe is run by Jack Glover, Mick Dingley, (they're the governors) and ably assisted by Jim Wild and Steve Dingly (Mick's son). Globe can be found at 110 Hoe Street, Walthamstow. Phone 521-7221 for details.

And Finally . . . . .

Just in case you ever wondered how large some CB clubs can get the UBA now boast a membership in excess of 70,000. Impressive eh? Stay Lucky and see you next month.

HE

PCB FOIL PATTERNS



Only one foil pattern this month: the HE Car Rev Counter

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150 ASSORTED RESISTORS £1. 100 Assorted Capacitors £1. 100 1N4148 £1. P. & p. 20p. S.A.E. lists of components, mikes, meters.—Dept. H, D.B. Products, 1 Holly Tce., York YO1 4DS.

BURGLAR ALARM KIT. Contents include control module and steel box, steel bell box (pvc coated), keyswitch 106dB FBI siren, 6 contacts, attack button, 3 pressure pads, batteries, cable clips, screws, instructions. £83.30 inclusive Sigma Security Systems, 13 St Johns Street, Oulton, Leeds LS26 8JT. W. Yorks.

OSCILLOSCOPE £12. Easy build converter plugs into TV aerial socket and converts to large screen oscilloscope. (Components cost under £12). Circuit and plans £3. — Kerr, 27 Coles Road, Milton, Cambridge CB4 4BL. (Callers by appointment).

ZX80 GAMES. Free Game sent on request. Send s.a.e.: Mastercode, Simon Says, Dr. Who, Alien Invader. The 4 on cassette, £3.—Bobker, 29 Chadderton Drive, Unsworth, Bury, Lancs.

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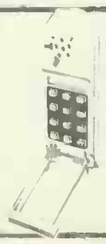

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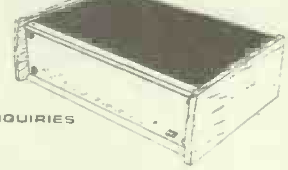

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