AUGUST 1983

Hobby Electronics

AN ARGUS SPECIALIST PUBLICATION

Project Electronics For Everyone

85p

ZX81/Spectrum Programmable Joystick Controller

Protect Your Car Aerial With The...

HE Auto-Winder!

Novel Remote-Control Mains Power Switch

RAM Pack and Interface Board for the Jupiter ACE

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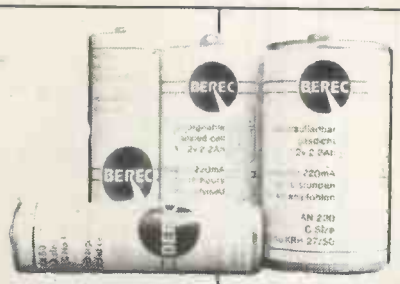

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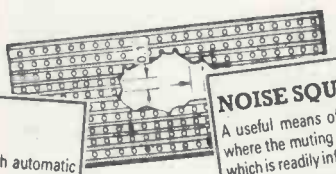

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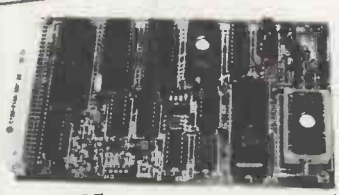

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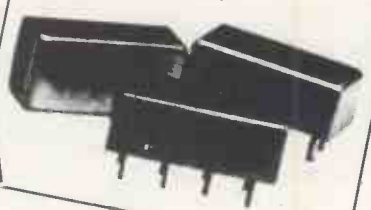

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VOL 5 No 8

Hobby Electronics

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The Hobby 'Scope: Once more we extend our apologies to readers awaiting the second part of this project. Due to unexpected technical and component supply problems beyond our control, it has had to be withdrawn again.

The final instalment of Components For Computing *has also had to be held over for a future issue.*

Editor: Ron Keeley
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Assistant Advertisement Manager: Joanne James
Managing Editor: Ron Harris BSc
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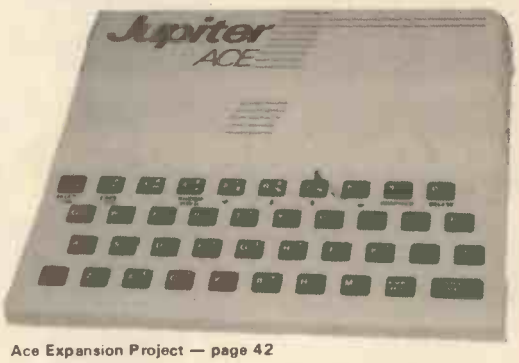

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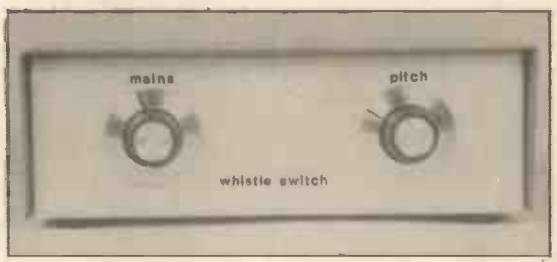

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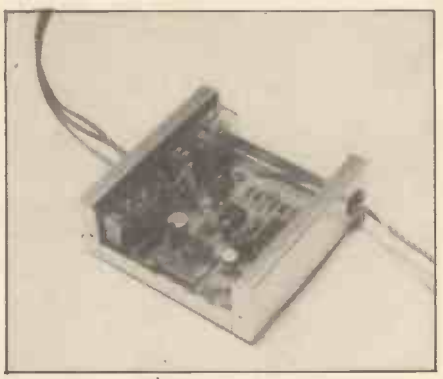

Auto-Winder for car radio aerials — page 56

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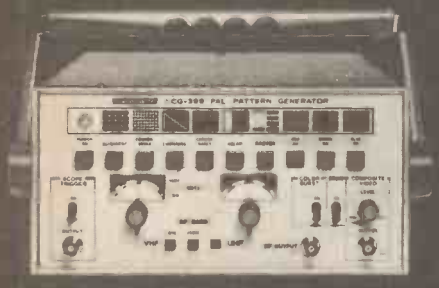
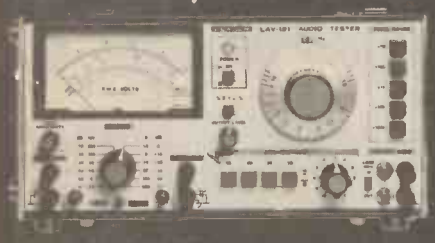


- Colour Bar Pattern Generators
- Sweep and Marker Generator
- CRT Tester
- Field Level Checker
- Signal Level Meter
- High Voltage Metered Probe
- Signal Generators

Audio Test



- Generators
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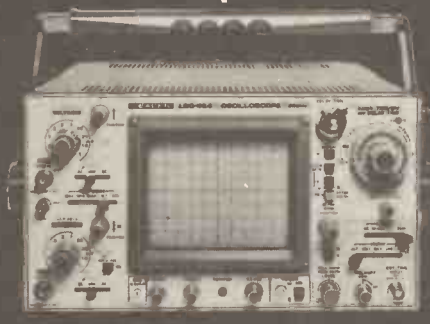

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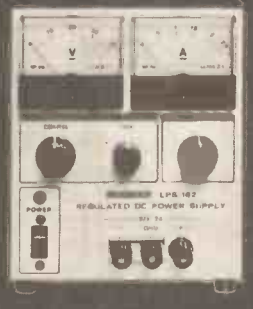

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TH02

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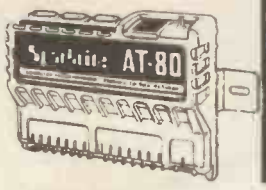

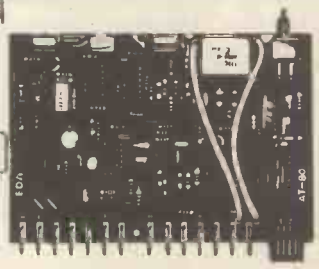

AT-80
Electronic Car Security System

- Arms doors, boot, bonnet and has security loop to protect fog/spot lamps, radio/tape, CB equipment
- Programmable personal code entry system
- Armed and disarmed from outside vehicle using a special magnetic key fob against a windscreen sensor pad adhered to the inside of the screen ● Fits all 12V neg earth vehicles
- Over 250 components to assemble

VOYAGER Car Drive Computer

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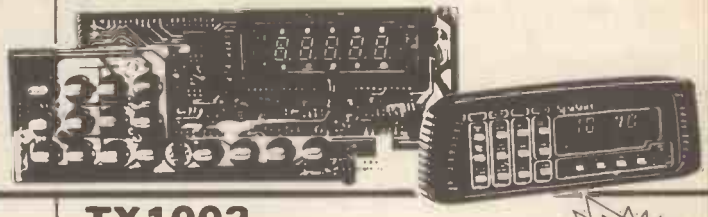
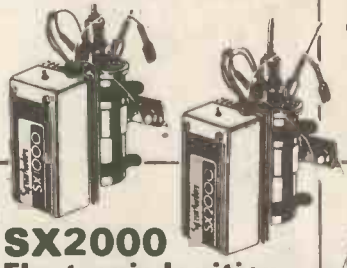


SX1000
Electronic Ignition

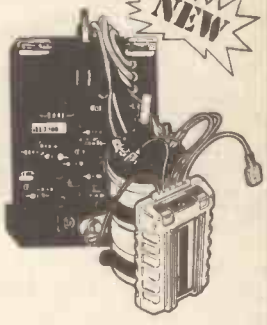
- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

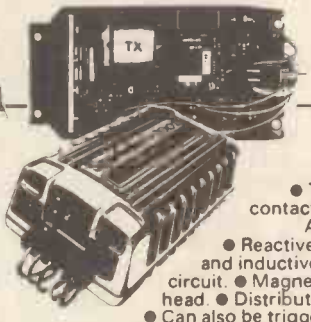


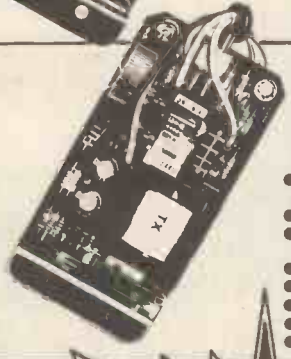
TX1002
Electronic Ignition

● Contactless or contact triggered ● Extended coil energy storage circuit ● Inductive Discharge ● Three position changeover switch ● Distributor triggerhead adaptors included ● Die cast weatherproof case ● Clip-to-coil or remote mounting facility ● Fits majority of 4 & 6 cyl. 12V. neg. earth vehicles ● Over 145 components to assemble.

NEW







SX2000
Electronic Ignition

- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

TX2002
Electronic Ignition

● The ultimate system ● Switchable contactless. ● Three position switch with Auxiliary back-up inductive circuit. ● Reactive Discharge. Combined capacitive and inductive. ● Extended coil energy storage circuit. ● Magnetic contactless distributor trigger-head. ● Distributor triggerhead adaptors included. ● Can also be triggered by existing contact breakers. ● Die cast waterproof case with clip-to-coil fitting ● Fits majority of 4 and 6 cylinder 12v neg. earth vehicles. ● Over 150 components to assemble

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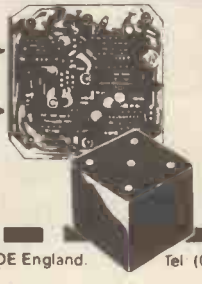

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MONITOR

Computer Data

A survey conducted by the **British Market Research Bureau** earlier this year, and published by **Gowling Marketing Services** of Liverpool, has produced some facts and figures which may be of interest to readers, although they are aimed primarily at companies marketing micros. The survey was conducted over 2000 households, which doesn't sound like a lot, but let's trust to the experience of the BMRB and see what they have come up with.

The picture that emerges is very much one of "A Portrait of the Micro Owner as a Young Man" and seems to be putting across the message that your proverbial 'computer society' is one which will grow up with the younger generation of users, rather than emerging fully fledged from the work done by industry and scientists — leaving aside that the one has only been made possible by the other.

The report shows that 4.9% of households, or about one in twenty, have a microcomputer — slightly under one million households in the UK. The most likely buyers are social groupings "AB, and C1", or, to put it another way, not only people with a certain amount of spending money to spare, but also people who have to ration 'non-essentials' (if you'll pardon the heresy!) fairly carefully.

"Males, *more particularly sons*" (our italics) "are the most likely users of the family home computer . . . Females appear to have little interest in computers." states the survey. (Significantly, the gels I know who actually like computing for its own sake work with mainframes, and think that micros are a waste of time!) The picture of earnestly struggling Dad being upstaged by Lad while Mum and Lass take no interest whatever rings true, doesn't it? Or does it? Any opinions?

"People living in modern "middle price" owner occupied housing with young families, and those living in traditional high status suburbia" are also indentified as outstanding users of micros.

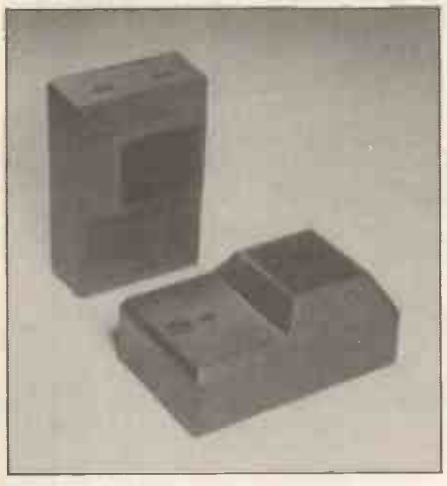
Unsurprisingly, the Sinclair ZX81 emerged as market leader with 43%, the Spectrum with 14% and the VIC20 with 12%. Also not totally surprising is that 40% of all micro sales were made in December, and 40% of all micros during the year were known to have been bought as gifts. These were mostly at the lower end of the price range.

Is it just a fad, like the Christmas puppy, which will soon be discarded, or is it a determined trend towards a micro in every home? Well, the marketing people certainly see it as a trend upwards. It looks as though Dad, not to mention Mum, had better start buttering up their BASIC before they come home one day and find they don't speak the same language as the electric cooker!

Another sign of the March of the Micros is the establishment, for the first

time in the UK, of a Computer Trade Association to represent the retailers, distributors, software houses, manufacturers, consultants, and all who operate on the commercial side of computing. As with the Video Trade Association, their main reason for forming is to fight software piracy and the unauthorised lending and copying of copyright software. They also hope to establish a professional code of conduct to govern dealings both within the trade and between the trade and the public.

Among the members are Atari, Bug-Byte, Buffer, Micro Shop, Camputers, Grundy, Silversoft, Tandy and Virgin Games (who are handling the press side). Any enquiries about the CTA to **The Computer Trade Association, The Secretary, Nigel Buckhurst, 108 Margaret St., Coalville, Leicester LE6 2LX. Tel: (0530) 35566.**



Infra-Red Alert

Riscomp have announced an addition to their range of security modules and accessories: an infra-red system known as the IR 1470. The unit, which operates from a conventional supply, consists of a separate infra-red transmitter and receiver, and provides a modulated beam of infra-red light over distances of up to 50ft. In the event of the beam

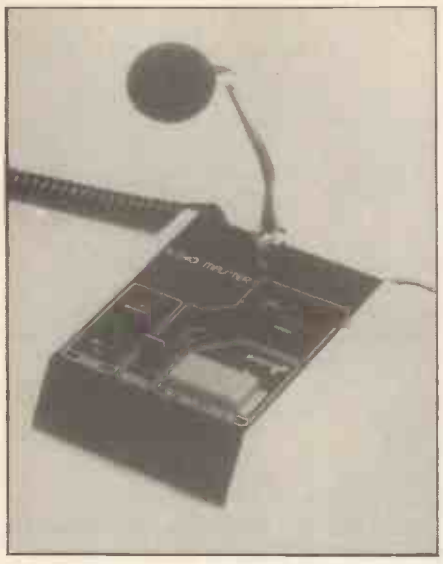
being interrupted, a relay in the receiver unit is energised. If this is connected to an appropriate warning device, it will sound an alarm. Both transmitter and receiver are housed in compact moulded enclosures and are easily mountable on most surfaces. An LED incorporated in the receiver indicates when the beam is lined up properly.

The system is British made and fully guaranteed, and is supplied with comprehensive data. It costs £25.60. Riscomp do a range of professional security modules, many of which are installable by anyone with adequate electrical and electronics knowledge. For futher information contact **Riscomp Ltd., 21 Duke St., Princes Risborough, Bucks HP17 0AT. Tel: (08444) 6326.**

A Word In Your VIC

SPT Electronics are marketing a versatile and low-priced software package for the VIC-20 and 64, by the highly descriptive name of Quick Brown Fox.

SPT boast that QBS offers more features than "industry standard" programs costing many times as much. Features include full editing, automatic reformating of whole texts, single-key command operations, compatibility with a wide variety of printers without complicated installation procedures, takes comparatively little memory space (and will run on the VIC-20's 5K without need for expansion) and — a unique feature — is apparently able to send and receive information from one computer



to another via built-in telecommunication facilities. This allows Fox systems to converse, and can work between QBS and some other systems as well.

The package costs £60 and, apart from converting the VICs into word processors, SPT see the system as the basis of a full professional letter-quality workstation for under £1000, a considerable reduction.

For more information contact **SPT Electronics Ltd., Tollesbury, Essex CM98SE. Tel: (0621) 868484.**

Get Miked Up

Sadelta Microphones, of Spain, have appointed **Telecomms,** of Portsmouth, as their sole UK distributors. To coincide with this, Sadelta have announced several new mikes in their range.

The Bravo O is a preamplifier compressor base microphone in a 'deluxe' style housing with a normal/vox switch for amateur radio use. The maximum compression is 20dB. The Bravo 2 version has two VU meters for monitoring compression and preamp gain. The Bravo O is £29.95, the Bravo 2 is £39.95.

The HM-20 is a mobile hand-mike, designed for maximum comfort and ease of use. Sadelta claim that it can improve transmission in all frequency bands and modulation modes — mentioning DX and CB as good examples of 'worst conditions, peturbations and interference'! The HM-20 has four switching circuits and is adaptable to electronic and relay switch equipment, with a four wire cable which makes it compatable with all transceivers with three to seven pins. It has output level control on a revolving control switch in the thumb position.

The Sadelta Echo Master is a preamp desk mic with a built-in reverb 'echo chamber', for use with both radio and discos. Powered by an external 12V power supply, the Echo Master includes a VU meter for monitoring the modulation output, adjusted by a sliding pot. The price is £57.56.

Lastly, and most unusually, the LM-20 is a voice-operated microphone in two parts: a necklet with the actual mic on it, and a control box, connected to the necklet by a thin wire which can easily be connected or disconnected. The microphone is triggered by the sound of the operator's voice (with a slight delay in switching off — to allow the speaker to draw breath or pause!) — and its sensitivity is controlled by a setting on the control box. The control box also has red and green LEDs which light when the rig is transmitting or receiving, and a switch to deactivate the mic for normal conversation.

We don't have a price for this one or for the HM-20, but information can be had from the distributors, **Telecomms, 189 London Rd., North End, Portsmouth. Tel: (0705) 660036 and 882145.**

Breadboard Sighted!

The time draws near when a hobbyist's fancy lightly turns to thoughts of **BREADBOARD '83.** You have extra planning time this year, as the dates have (by popular demand) been moved nearer to Christmas; the 25th, 26th and 27th of November, to be precise.

This year's venue will be the plush, carpeted Cunard International Hotel at Hammersmith, right on the doorstep of the tube and bus services, and with easy access to the prime shopping areas of Kensington, Knightsbridge and Central London.

Features so far planned will include an extended programme of lectures, a bigger, better Computer Corner, Ham Radio Today's Action Centre, and a special package deal that will include rail travel, Breadboard ticket, bed and breakfast at a first class hotel, discount vouchers, etc. More details of this will follow.

Specially for model railway enthusiasts is the Computer Controlled Railway Layout competition for a control system based on any microcomputer on a layout of not more than 6ft x 2ft x 6in. Get you entry forms by writing to **Peter Freebrey, Argus Specialist Publications, 145 Charing Cross Rd., London WC2H 0EE,** sending a small SAE.

Cassette Cleaner

Nu-Way Styli have produced a cleaning cassette for recorders. The difference between this cassette and many other 'cleaning cassettes' is that this one uses moving felt pads to clean the tape heads, and not an abrasive moving tape, and therefore causes far less wear and tear on the (expensive and troublesome to replace) tape heads.

The pack includes a cleaning lubricant, which is used to damp the two felt pads lightly. The cassette is then placed in the recorder and the recorder switched to 'play'. The pads move back and forth, cleaning the dirt and oxide not only from the record and playback heads but also the pinch and capstan rollers (dirty rollers can cause mistracking, which leads swiftly to the dreaded Magnetic Spaghetti which cheap or neglected cassette players love to feed on . . .) Once done, a pause of half a minute to let the cleaning fluid evaporate, and you're ready to roll again.

Regular cleaning like this (according to the instructions, of course) not only improves the sound quality but protects the player and the cassettes from damage. 90% of cassette player aggro is caused by dirt on the moving parts! So, if you can't clean the heads and whirly bits by hand, a cassette of this kind is the best option. It's especially useful for car players and other portables where the heads and rollers are hard to reach. The only recorders it may not do the job on are three-head machines — if you're lucky enough to have one!

MONITOR

The 3 Point Cassette Cleaner is made by **Nu-Way Styli Components Ltd., of 15 Haywood Ind. Park, Tameside Drive, Castle Bromwich B35 7BJ. Tel: 021 749 2240.** It costs £2.99 and is available from hifi retailers.

Mini Multitrack

Bandive Ltd. reckon that the cost of multitrack recording has been dramatically cut by the introduction of their Fostex X15 Tracker, which they call their 'musical sketch box'. This creature gives the impression, from the picture, of being a fairly meaty machine, but they claim that you can 'hold it in the palm of your hand', and at 3 x 11½ x 9in and 2.1kg, you could, too, if you happen to have fairly substantial hands.

The X15 is designed to run from an external AC adaptor (which is an optional extra) or a clip on battery pack (ditto), car battery or other battery.

All the essential features for taping and mixing for multitrack recording are in the X15, and all you need to add are microphones and headphones.

Tracks may be recorded indisidually, and monitoring for overdub is switched automatically. A built-in mixer, and tone control during record and playback allow skillful recordings to be made. Battery operation, remote punch-in, powerful headphone monitoring are among the features included.

Noise reduction is Dolby B; there are three positions on the input selector for mike, line or tape out signals going to the level control, equaliser facilities for input and output, gain and pan controls for each channel at overdub and mixdown, and plus or minus 15% pitch control for tuning and special effects.

For more information contact **Bandive Ltd., Brent View Rd., London NW9 7EL. Tel: 01 202 4155.**

New Spectrum Software

Oxford Computing Publishing have some new programs available for the ZX Spectrum.

Those currently available are a Machine Code Test Tool (with a version for the ZX81), including a character generator for the Spectrum version (£9.95), and Address Manager which will handle up to 1500 names or 400 full addresses on the 48K Spectrum (less on the 16K, obviously) and boasts the qualities of very high speed, super friendliness, multiple indexing and full-screen editing (£8.95) and "The Turk" chess program with six levels of difficulty and chess against the clock amongst its features (£8.95).

Later in the year other programs including Edit/Assembler, Financial Manager, VAT Manager and a Bridge Program will be released.

Having resolved certain problems with their GPO Box number, mail order turnaround at OCP is now usually 48 hours.

Information from **Oxford Computer Publishing Ltd., "Brimrod", 48 High St., Chalfont St. Peter, Buckinghamshire SL9 9QB. Tel: (0753) 888866.**

New Electronics Club

Newly formed is the **National Electronics Correspondence Club** — newly, that is, back at the end of April when first we heard of them just in time to miss the deadline for our July issue! According to their letter, the club has been set up with the express purpose of providing a communications link for all hobbyists who are remote from local electronics clubs — an excellent idea, and I'm sure they won't be turning away members of other electronics clubs who want to join, either.

Club features such as a bi-monthly newsletter with hints on project construction, topical features, circuit ideas, views and advertisements, plus special offers on equipment, are planned, and members will be free to correspond with the club and with other members for help and encouragement.

Membership will be £4.50 a year, and anyone interested should write to **Mr. E. Foley (Secretary), N.E.C.C., 95 Albert Rd., Levenshulme, Manchester M19 2FU,** enclosing 25p for information and application form (which will be refundable on membership). It would be nice to see this club flourish, as active hobby clubs are a benefit to everyone.

Sinclair Sound

Timedata are expanding their business to include add-ons for Sinclair computers, and the first product they have come up with is a tidy-looking sound box for use either with the ZX81 or the Spectrum, without the need for an adaptor.

The ZXM Sound Box is based on the 9812 three channel sound chip to give a wide range of programmable effects. The unit has a nine pin I/O socket which can be used with Atari and Commodore joysticks, and other Sinclair add-ons can be plugged into the back of the box. The built in amp and loudspeaker can also be used to boost the Spectrum's 'beep'.

The ZXM retails at £29.95 all inclusive. Order and enquiries to **Timedata Ltd., 16 Hemmells, High Rd., Laindon, Basildon , Essex SS15 6ED. Tel: (0268) 418121.**

Teach Yourself The Lot

Electroni-Kit, already well known for their popular Chip Shop kits, straightforward construction kits with all the parts (even solder!) included, and simple no-prior-knowledge instructions

which even include a recommendation of which books to go on and read if you want to know more about electronics) are going about to make a whole new name for themselves distributing a new line in building-block, teach-yourself electronics and computing kits by **Denshi Block Mnfg. Co** and the **Gakken Co.**, of Japan.

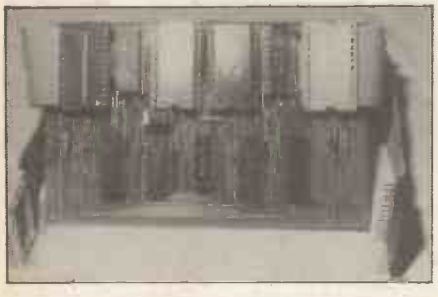
The FX-Computer is a contraption about the size of a substantial transistor radio. Within this battery-operated unit (no messing about with mains) is a series of interchangeable component blocks which enables scores of circuits to be built up without soldering or waste. The FX has two manuals, one for the electronic circuits, the second and longer containing 100 computer programs aimed at youngsters and complete beginners. The whole unit costs £69.95 plus £3.00 p&p, and the manuals are said to be excellent. A longer look at the FX-Computer will be appearing in HE in due course.

Along the same lines but somewhat smaller and less ambitious are the EX-System electronics construction kits, basically the same principle but with a lesser range of experiments. The kits range from the EX-15, with 15 projects to build, up to the EX-150, plus additional add-on sets. Prices range from £22 to £55.

For price lists and brochures, contact **Electroni-Kit Ltd., 388 John St., London EC1V 4NN. Tel: 01 278 0109.**

Shorts

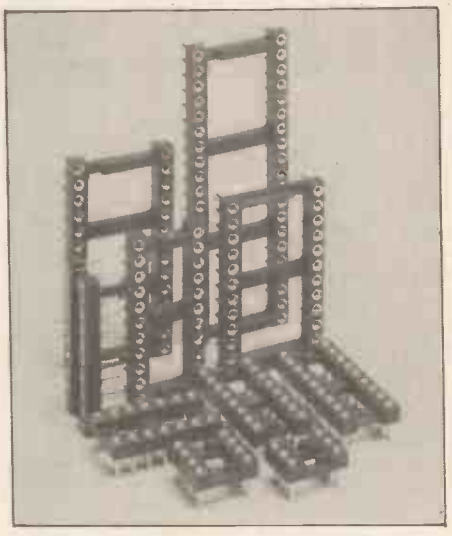
From J P Designs comes a multiplexed RAM card, Interface 84, which allows different microsystems to 'speak' to each other. Interface 85 plugs directly into 24 pin RAM or EPROM



sockets, via ribbon cable headers. A select switch allows onboard memory to be mapped on either microsystem. This feature gives the card the ability to alter the memory contents from the master microsystem, whilst acting as an EPROM on the developing system. This is particularly useful when software debugging 'dumb' controllers.

The internal static CMOS memory has a fast access time of less than 250nS, making the card usable with nearly all microsystems. Interface 84 comes fully tested complete with user notes at £49.95 plus VAT. Enquiries to **J P Designs, 37 Oyster Row, Cambridge, CB5 8LJ. Tel (0223) 522234.**

Possibly the world's lowest profile DIL IC sockets, the new **EMC** 21,000 series, available in 6 to 64 pin, 0.3, 0.4, or 0.6 in pitch options, allows the IC to sit only 2.92mm (0.115in) from the board. With the new funnel entry, short four finger style, Mini-Tulipe contact with bored out, closed-end, anti-wicking tail, this new range of stockets is suitable for manual or automatic IC loading and readily accepts both short and long IC legs.



Needing only standard layout 0.813mm (0.032in) PCB piercings and available in various gold/tin plating options, this new beryllium copper contact is rated for 1A but offers typical contact resistance of only 4.3mR. Capable of operating over a temperature range of -65°C to +175°C and utilising 94-VO rated glass reinforced polyester, the socket body is of an open frame design that will not twist, bend or soften during installation but still allows maximum cooling air flow plus easy cleaning and inspection and if you can follow that lot — ! — and want to know more, contact **EMC Interconnection Specialists, 50 London Rd., Sevenoaks, Kent. Tel: (0732) 460525.**

Made-to-measure dustcovers for video recorders can be ordered for £3.95 from **Helbri Products Ltd., 51 Birstwith Rd., Harrogate HG1 4QT Tel: (0423) 889704.** Please supply all dimensions (and make sure you leave room for switches sticking out beyond the line of the casing) including dimensions and location of the front panel clock so that a transparent window can be incorporated. Protection from dust prolongs videorecorder life in general, especially the expensive and fragile heads. Helbri do not say whether they make dust covers for other similar bits of equipment, but it is probably worth enquiring.

Elkan Electronics have announced their EASI-CALC 1251 program for the Sharp PC1251 pocket computer. Coupled with the CE125 printer-recorder this gives a "spreadsheet" with as many as 26 lines across and up to 100 rows deep, with over 200 "cells" or co-ordinates on the sheet. As well as being a problem-solving tool answering "What if . . . ?"-type questions, EASI-CALC 1251 can be a portable mini data base storing up to 100 names and phone numbers. The package consists of a data-quality micro-cassette tape and a twenty-page user's manual. No programming knowledge is needed.

EASI-CALC costs £14.95 from **Elkan Electronics, 11 Bury New Road, Prestwhich, Manchester M25 8JZ. Tel: 061 798 7613.**

Robotic arms producers **Colne Robotics** have produced a computer vision system costing only £395. Aimed at the educational market, the COLVIS system consists of a solid-state camera connected to a powerful microcomputer, which can extract and learn information from the image received from the camera. It can use parameters such as area, perimeter and centre of gravity to recognise the object in view, and deduce its position and orientation. It can be used with any microcomputer which has or can be fitted with an 8-bit bi-directional port.

Enquiries to **Colne Robotics Co. Ltd., Beaufort Rd., Off Richmond Rd., East Twickenham, Middx. TW1 2PQ. Tel: 01 892 8197.**

Namal Electronics have announced their ROMBLO 1248 EPROM blower for the Apple microcomputer. This device will program all common 24- and 28-pin EPROMS of type 2508, 2516, 2564, 2716, 2732 and 2764 or any pin compatible 5V EPROMS. The software is on-board, eliminating the need for disk drives.

The price is £95. Enquire to **Namal Associates Ltd., "Gatehouse", 25 Gwydir St., Cambridge CB1 2LG. Tel: (0223) 355404.**

Anybody wanting to sell or buy leisure goods in the south-east can contact **Leisure Line.** They are a telephone sales company who keep a register of goods on computer. They have expanded to include a listing of clubs, schools, organisations and private teachers involved in leisure pursuits. The service is free to those seeking information, charged to those advertising. Contact **Leisure Line Data Ltd., 238-246 King St., Hammersmith, London W6 0RF or phone 01 741 8301 9am to 9pm Monday to Friday.**

Dawne Instruments have also added a high standard multimeter, the Unigor 3n, to their range. It features 62 measuring ranges, costs £100, and is said to be the standard multimeter used by many professional European organisations. Special points mentioned by Dawne include single rotary switch for thirty-two measurement ranges, nearly 32k ohms/volt sensitivity, better than 0.5% accuracy, 0 to 500Rohms on the low range and 50MR on the highest, and a number of others.

More information from **Dawne Instruments and Electronics, Shields Rd., Bill Quay, Gateshead NE10 0RS. Tel: (0632) 695117.**

HE

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RADIALS (PCB wires one end) Matsushita only.

µFd	V	
10	16	6p
22	16	6p
22	16	7p
47	16	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
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8n2 to 47nF	8p
56nF to 150nF	10p
100V	
100nF to 150nF	11p
180nF to 270nF	14p
330nF to 390nF	20p
470nF to 560nF	26p
680nF	30p
1µF (10mm)	35p

POLYESTER 250V RADIAL (C280)

10nF, 15nF, 22nF, 33nF, 47nF, 68nF, 100nF	7p
150nF, 220nF	10p
330nF, 470nF	13p
680nF	18p
1µF	22p
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3.3 35V	18p
4.7 16V	18p
4.7 35V	20p
6.8 25V	20p
6.8 35V	21p
10 16V	18p
10 35V	27p
15 10V	22p
15 16V	30p
15 25V	32p
22 6.3V	26p
22 16V	29p
33 10V	30p
47 3V	14p
47 6.3V	34p
47 16V	39p
100 13V	32p
100 10V	55p

ELECTROLYTICS
Mainly Matsushita (Panasonic) & Siemens

AXIALS (Wires each end)

µFd	V	
.47	63	8p
47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	16p
10	25	8p
10	40	12p
10	63	14p
10	100	16p

µFd	V	
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	32p
220	100	40p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
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2N2222	24p
2N2222A	25p
2N2223	2.60
2N2223A	4.15
2N2368	25p
2N2369	19p
2N2369A	20p
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	3.47
2N2923	25p
2N2924	15p
2N2925	15p
2N2926	10p
2N3053	27p
2N3054	56p
2N3055	60p
2N3055H	120p
2N3250	36p
2N3251	36p
2N3439	98p
2N3440	90p
2N3441	1.25
2N3442	1.35
2N3442RCA	1.85
2N3445	4.80
2N3446	6.09
2N3447	5.72
2N3448	6.56
2N3468	1.00
2N3512	1.06
2N3553	2.65
2N3638	55p
2N3638A	70p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3716	3.60
2N3773	1.99
2N3819	25p
2N3820	38p
2N3821	1.84
2N3822	90p
2N3823	45p
2N3824	1.70
2N3866	90p
2N3903	13p
2N3904	13p
2N3905	13p
2N3906	13p
2N4030	75p
2N4031	b5p
2N4032	69p
2N4036	63p
2N4037	49p
2N4240	3.00
2N4347	2.26
2N4400	15p
2N4401	27p
2N4402	30p
2N4403	30p
2N4409	36p
2N4410	42p
2N4427	79p
2N4870	80p
2N4871	55p
2N4888	99p
2N4901	1.69
2N4902	1.85
2N4903	1.98
2N4904	2.15
2N4905	2.75
2N4906	2.99
2N4907	3.20
2N4908	3.15
2N4910	2.90
2N4918	65p
2N4919	75p
2N4920	85p
2N4921	55p
2N4922	69p
2N4923	99p
2N5086	36p
2N5087	39p
2N5088	37p
2N5089	37p
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2.88
2N5293	98p
2N5294	1.28
2N5295	1.37
2N5401	35p
2N5415	1.10
2N5416	1.54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5472	72p
2N5551	37p
2N5884	5.95
2N5886	5.95
2N6121	57p
2N6122	59p
2N6123	65p
2N6124	59p
2N6125	65p
2N6126	75p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6253	1.45
2N6254	1.55
2SC1306	95p
2SC2078	1.70
2SJ49	3.50
2SJ50	3.75
2SJ82	4.29
2SK134	3.50
2SK135	3.75
2SK226	4.29
3N128	1.12
3N140	1.07
3N200	6.93
3N201	2.98
40360	60p
40361	67p
40362	67p
40363	2.95
40406	1.39
40407	75p
40408	1.58
40410	1.80
40411	2.85
40412	90p
40673	83p
40822	1.80
40871	79p
40872	79p
AC125	49p
AC126	32p
AC127	32p
AC128	35p
AC132	68p
AC141K	28p
AC142K	28p
AC151	51p
AC152	45p
AC153	55p
AC153K	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
AF239	55p
AF240	1.00
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p
BC140	29p
BC141	37p
BC142	29p
BC143	30p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	20p
BC148	10p
BC148A	12p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
BC157A	12p
BC157B	13p
BC158	10p
BC158A	12p
BC158B	13p
BC159	11p
BC159A	12p
BC159B	13p
BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	10p
BC167B	13p
BC168	10p
BC168B	10p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC177	16p
BC177A	25p
BC177B	26p
BC178	16p
BC178A	24p
BC178B	25p
BC179	20p
BC179A	25p
BC197B	25p
BC179C	27p
BC182	10p
BC182A	12p
BC182B	13p
BC182L	10p
BC182LA	13p
BC182LB	14p
BC183	10p
BC183A	11p
BC183B	12p
BC183C	13p
BC183L	10p
BC183LA	13p
BC183LB	13p
BC183LC	14p
BC184	10p
BC184B	12p
BC184C	13p
BC184L	10p
BC194LB	13p
BC184LC	14p
BC186	24p
BC187	24p
BC212	10p
BC212A	12p
BC212B	13p
BC212L	10p
BC212LA	13p
BC212LB	14p
BC213	10p
BC213A	11p
BC213B	12p
BC213C	13p
BC213L	10p
BC213LA	13p
BC213LB	13p
BC213LC	14p
BC214	10p
BC214B	12p
BC214C	13p
BC214L	10p
BC214LB	13p
BC214LC	14p
BC237	14p
BC237A	16p
BC237B	17p
BC237C	18p
BC238	14p
BC238A	15p
BC238B	16p
BC238C	17p
BC239	15p
BC239A	15p
BC239B	17p
BC239C	18p
BC300	45p
BC301	44p
BC302	43p
BC303	47p
BC327	14p
BC328	14p
BC337	15p
BC338	15p
BC440	32p
BC441	33p
BC460	32p
BC461	33p
BC516	40p
BC517	40p
BC547	13p
BC547A	14p
BC547B	14p
BC548	12p
BC548A	13p
BC548B	14p
BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	30p
BC550C	33p
BC557	15p
BC557A	16p
BC557B	16p
BC558	14p
3C558A	15p
BC558B	16p
BC558C	17p
BC559	16p
BC559B	16p
BC559C	17p
BC560	32p
BC560C	34p
BC650	45p
BC651	46p
BC107	16p
BCY71	19p
BCY72	19p
BD131	44p
BD132	44p
BD135	40p
BD136	40p
BD137	42p
BD138	39p
BD139	39p
BD140	39p
BD237	98p
BD238	98p
BD239A	57p
BD240C	64p
BD240A	73p
BD240C	73p
BD241A	61p
BD241C	67p
BD242A	65p
BD242C	70p
BD243A	72p
BD243C	85p
BD244A	82p
BD244C	1.00
BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BD249A	2.00
BD249C	2.31
BD250A	2.11
BD250C	2.46
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1.20
BD530	1.30
BD535	75p
BD536	75p
BD537	80p
BD538	80p
BD539	80p
BD539C	1.10
BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1.32
BD712	1.32
BDX14	1.30
BDX18	1.59
BDX32	3.47
BDY54	1.70
BDY55	1.75
BDY56	1.80
BDY57	5.25
BDY58	6.15
BF194	12p
BF195	12p
BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	1.49
BF224J	32p
BF225J	35p
BF240	38p
BF241	38p
BF244A	35p
BF244B	39p
BF245A	30p
BF245B	51p
BF246	52p
BF246A	39p
BF246B	53p
BF247A	54p
BF247B	55p
BF254	39p
BF255	42p
BF256A	35p
BF256B	48p
BF256C	62p
BF257	30p
BF258	32p
BF259	35p
BF457	46p
BF458	58p
BF459	62p
BF470	86p
BFR39	22p
BFR40	22p
BFR41	22p
BFR79	22p
BFR80	22p
BFR81	22p
BFR90	2.11
BFS28	2.95
BFS61	1.00
BFS98	1.10
BFX29	26p
BFX30	27p
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BSX19	24p
BSX20	24p
BSX21	40p
BU104	2.22
BU105	1.70
BU108	3.95
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU226	3.95
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU500	2.95
BUY18S	3.95
E430	5.95
J300	48p
J310	53p
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ4502	3.99
MJ15003	4.85
MJ15004	5.55
MJ15015	2.45
MJ15016	3.34
MJE340	53p
MJE350	1.50
MJE2955	99p
MJE3055	69p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p
MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	42p
MPSL51	48p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
DC20	2.30
DC25	2.50
DC28	1.70
DC29	2.35
OC35	2.35
OC43	70p
OC44	82p
OC70	50p
OC71	50p
DC72	50p
OC82	50p
OC83	75p
TIP29A	29p
TIP29C	38p
TIP30A	35p
TIP30C	36p
TIP31A	33p
TIP31C	34p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	65p
TIP49	1.20
TIP50	1.40
TIP53	1.87
TIP54	1.58
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	84p
TIP127	84p
TIP130	93p
TIP132	93p
TIP135	99p
TIP137	99p
TIP140	1.04
TIP142	1.04
TIP145	1.15
TIP147	1.15
TIP162	4.95
TIP2955	77p
TIP3055	70p
TIS43	40p
TIS88A	62p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX450	39p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p
ZTX650	45p

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	4p
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	3p
1N4150	18p
1N4448	22p
1N5400	12p
1N5401	13p
1N5402	14p
1N5403	15p
1N5404	18p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1S44	10p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA155	15p
BA156	38p
BA157	25p
BA158	30p
BA159	32p
BA182	40p
BA201	18p
BA202	26p
BA318	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAX13	10p
BAX16	11p
BY127	25p
BY127	22p
BY134	52p
BY182	1.26
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	55p
MZ2361	1.80
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p

SCRs, TRIACS, DIACS

THYRISTORS
4, 8 & 12 Amps
Texas TO220
Suffix: A = 100V
B = 200V
C = 300V
D = 400V
M = 600V

TIC106A	46p
TIC106B	47p
TIC106C	48p
4A TIC106D	49p
TIC106M	68p
TIC116A	66p
TIC116B	68p
8A TIC116C	71p
TIC116D	73p
TIC116M	80p
TIC126A	72p
TIC126B	72p
2A TIC126C	73p
TIC126D	77p
TIC126M	96p

TRIACS
Texas 400V
TO220 Case

TIC206D(4A)	66p
TIC225D(6A)	74p
TIC226D(8A)	88p
TIC236D(12A)	1.16
TIC246D(16A)	1.22
TIC253D(20A)	1.90
TIC263D(25A)	2.11

DIACS

BR100	25p
ST2	25p

ZENER DIODES

400 500mW
E24 Series
2.4 47v 7p
1.3 Watt
E24 Series
3.3 82v 14p

BRIDGE RECTIFIERS

(PIV shown in brackets)
1½ amp type

W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p

2 amp type
Square with hole

S01 (100)	37p
S02 (200)	40p
S04 (400)	40p
S08 (800)	55p

6 amp type
Square with hole

PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	85p
PW06 (600)	90p

25 amp type
Metal clad with hole

K01 (100)	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40

OPTO

LEDs
R = Red
G = Green
Y = Yellow
Large diffused

	1+	50+
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p

Small diffused

R2D	8p	6p
G2U	12p	10p
Y2D	12p	10p

Micro 0.1"

R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p

Large clear

R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p

Super bright high efficiency
Large (100 times brighter)

R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p

Rectangular
Stackables LEDs

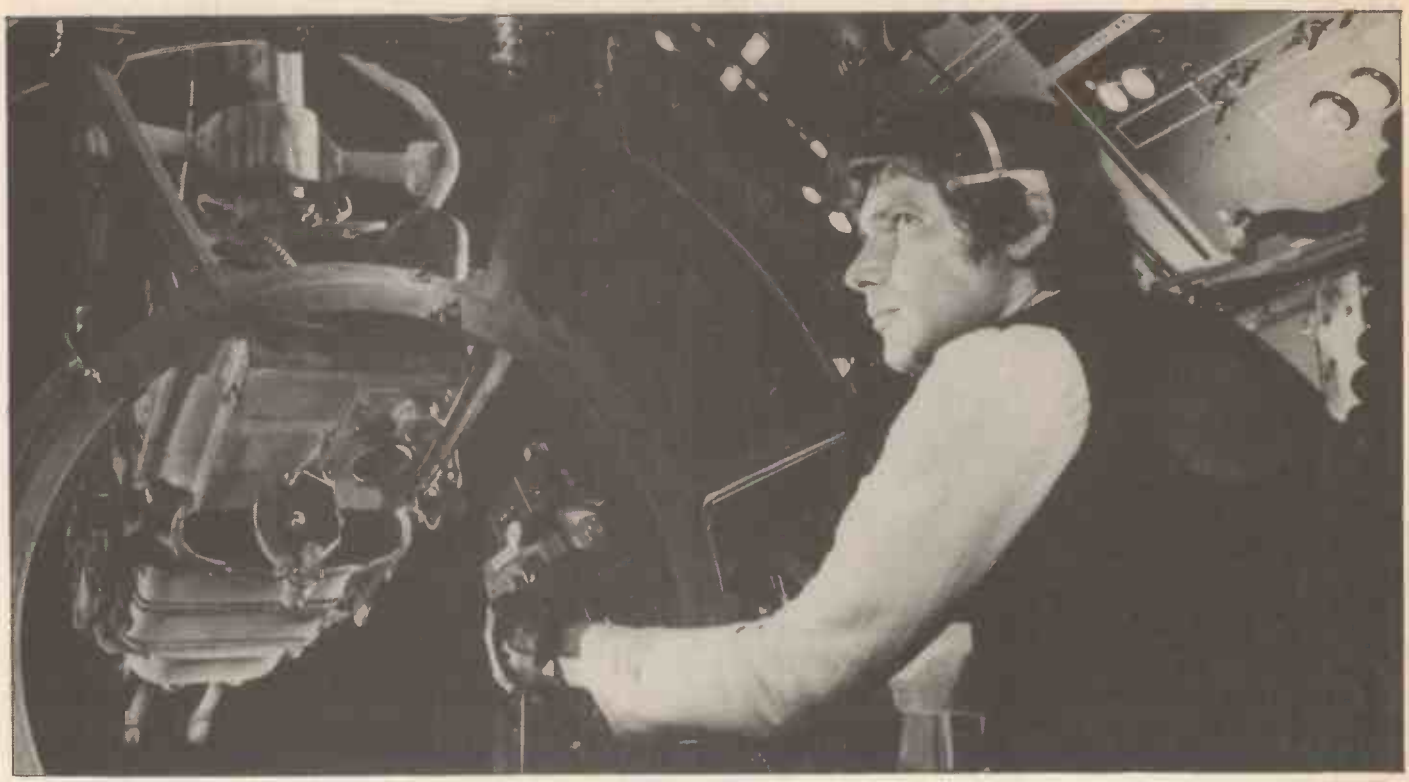
R6L	17p
G6L	18p
Y6L	19p

LINEAR ICs

AY1-5050	95p
AY3 8910	3.66
AY3-8912	4.40
CA3048	2.15
CA3059	2.80
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	95p
HA1366W	2.40
HA1388	2.54
ICL7106	6.85
ICL7107	9.50
ICL7611	97p
ICL8038	2.95
ICL7555	80p
ICL7556	1.50
LC7120	3.20
LC7130	3.20
LC7137	3.95
LF347	1.50
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1.09
LF398	4.59
LM335Z	1.19
LM348N	62p
LM349N	1.09
LM350K	4.60
LM379S	4.50
LM380N14	75p
LM380N8	1.50
LM381AN	2.26
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386	88p
LM388N	2.43
LM391N60	1.70
LM391N80	1.93
LM723CH	95p
LM723CN	35p
LM725CH	3.40
LM725CN	3.19
LM733	69p
LM741CH	96p
LM741CN	15p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1871	3.25
LM1872	4.38
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907N8	2.80
LM2917N	1.89
LM2917N8	1.89
LM3900	49p
LM3911	1.20
LM3914	2.50
LM3915	2.50
LM3916	2.50
LM13600	95p
OM335	7.20
NE531N	1.36
NE543N	2.50
NE544N	1.95
NE555	16p
NE556	45p
NE558	1.89
NE560	3.25
NE565	1.18
NE566	1.49
NE567	1.37
NE570	4.07
NE571	3.99
NE5534A	95p

74 TTL

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	19p
7407	19p
7408	14p
7409	14p
7410	15p
7411	16p
7412	18p
7413	18p
7414	25p
7416	19p
7417	19p
7420	15p
7421	19p
7422	19p
7423	19p
7425	19p
7426	19p
7427	19p
7428	26p
7430	14p
7432	22p
7433	22p
7437	25p



ZX81:Jupiter Ace:Spectrum

Programmable Joystick Controller

Paul Moody and Chris Lloyd

Set your fingers free! Banish keyboard cramp! Play action games as they were always meant to be played, with the HE Joystick Controller!

This project is a completely new idea in Joystick design because it is fully programmable and can be used with *any* games software for the ZX81, Spectrum or Jupiter Ace.

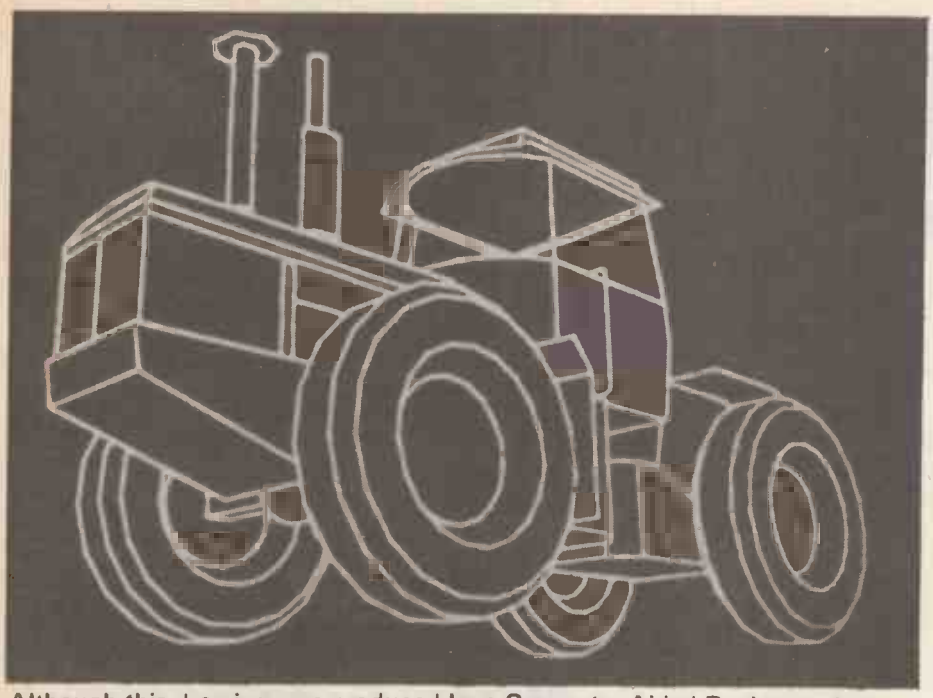
THE ZX81, Spectrum and Jupiter Ace keyboards are excellent for entering programs, but they are very difficult to use for playing any fast moving games. This is a great pity because there is a wide range of excellent games software written for the ZX81 and Spectrum. The Ace has perhaps been a little slower to catch on, but now that its versatility and speed are being appreciated, a number of good games have appeared for it.

The Joystick Controller described here can transform your computer from a toy into a true arcade style machine, and its unique design allows its use on *all* software. You won't need to buy software especially written for a joystick, because *all* your existing programs will work with it.

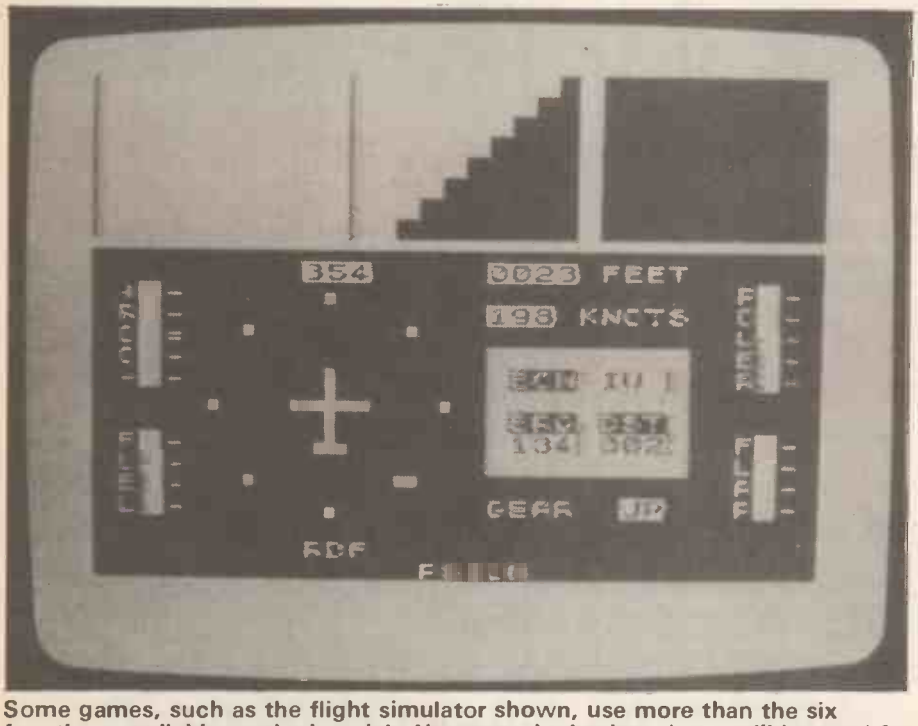
Basic Ideas

The way most joysticks work is to mimic the action of the keyboard, so that when the joystick is moved, the computer is fooled into believing that a key has been pressed. The problem that arises is simply this: which keys should the joystick mimic? One convention is to use the "arrow" keys — 5, 6, 7 and 8 for left, down, up and right, and 9 for fire. But unfortunately only a limited amount of software uses these keys — mainly because it is very awkward to use keys so close together. The result is that many people buy a joystick and then find that they can't use it on any of their old software, or that many programs that they would like to buy won't work with the joytick.

This article describes a completely



Although this drawing was produced by a Computer Aided Design package, similar 'sketches' could easily be made using the joystick and a simple drawing programme. The 'fire' buttons could also be used, for example to delete points back along the plotted track and, on the Spectrum, to change the foreground colour.



Some games, such as the flight simulator shown, use more than the six functions available on the joystick. However the keyboard can still be used for flaps, undercarriage etc provided the joystick controls are not operated simultaneously.

new idea in joystick design — the joystick is actually programmable and can mimic the action of *any* keys. To make things even easier for you, a program is included which remembers which games use which keys, so if you want to play a game that you've played before then you don't need to reprogram the joystick — simply give it the name of the program and it will do the rest.

To understand how the joystick works let's first take a look at the Sinclair keyboard.

The Keyboard

The keyboard consists of a five by eight grid of wires, with a key over each crossing point (**Figure 1**). When a key is pressed, it connects together the two wires passing beneath it. The keyboard is read, one row at a time, by taking each of the eight address lines low, in turn, leaving the other seven high. Say, for instance, that the computer wishes to read the row containing the letters "QWERT", then it sends A10 low with A8, 9, 11, 12, 13, 14, 15 all high. Now if none of the keys on that row are pressed, the outputs labeled KBDO-4 will all be at logic 1 — because they are all tied via resistors to +5 volts. But now consider what happens when key "W" is pressed: it connects A10 to KBD1, pulling KBD1 low and sending a logic 0 to the ULA (or to a tristate buffer in the case of the Ace, which has no ULA). So, by scanning through each row in turn the computer is able to build up a complete picture of the keyboard, and it does this every 1/50th of a second.

If you are wondering what those diodes are doing in the address lines, consider what would happen if they were not there and two keys in the same column were pressed at the same time; address lines would be shorted together and the computer would crash instantly!

Input/Output

But how does the CPU distinguish between reading the keyboard and reading memory? In both cases it puts out an address, but for reading the keyboard it sends out a low on $\overline{IORQ}$ instead of on $\overline{MREQ}$. This signal, combined with a low on A0, tells the ULA (or tristate buffer, in the case of the Ace) that it is reading the keyboard, and it transfers the values of KBDO-4 to the lower data lines, DO-4.

In A Nutshell . . .

To explain the operation of the Joystick Controller, we'll use the very simplifed (and highly schematic) circuit diagram of **Figure 2**. It consists of five basic blocks, plus a certain amount of control circuitry, represented here by a single two-input or gate.

The joystick itself is a simple array of six microswitches operated by the control lever; the output lines are connected to a +5V when one or more switches are closed.

An 8-into-3 line encoder operates on the CPU's address lines, A8 - A15, that are consecutively taken low during a Keyboard Read operation. The encoder simply reduces the number of address lines required for the memory by utilising the fact that only one of A8 to A15 will be low at any one time during a keyboard read. Since there are only eight possible states for A8-A15 at these times, only three lines ($2^3 = 8$) are needed to contain this information.

These three lines become the top three address lines to the Controller's Random Access Memory. The lower order address lines are derived from one of two sources, depending on whether the Controller is being programmed for use, or is in use. The address lines are selected by an electronic switch, operated by the CPU's Write Enable line, $\overline{WE}$.

When the controller is being programmed (this is further explained, later), $\overline{WE}$ is taken to logic 0 and the

'switches' are in the position shown, connecting the RAM's low-order address lines to the CPU's address lines. At the same time $\overline{WE}$ enables the RAM so that data can be written to it, and simultaneously connects the RAM's data lines to accept information from the CPU's data lines (this is actually done not by a switch as shown in Figure 2 — but this will be explained in a moment!).

Now the keyboard is not actually located at a single address; in fact any time A0 is low and an IN instruction has been issued (either by the CPU's Monitor program or by a user program — the Sinclair ULA can't tell the difference) the computer is performing a keyboard read operation. So, when programming the Controller, the keyboard is read by the program written for the purpose and the CPU will return, on data lines D0 - D4, a five-bit 'word' corresponding to whichever key has been pressed, if any. This data now has to be stored in the Controller RAM, and the location in RAM at which it is stored is determined by the CPU's address lines A1 - A7. This address is set up by a single number, entered as part of the set-up routine, which corresponds to a particular joystick position. What happens, in effect, is that the data corresponding to a particular key — 'Q', say, — is stored in the Controller RAM at a location which corresponds to a certain joystick position.

Now when a game is being played, the joystick output lines are connected to the RAM via the electronic switch (because $\overline{WE}$ is kept high).

Normally the ZX81 monitor performs a keyboard read about 50 times per second, and during these times both $\overline{IORQ}$ and A0 will be low, so the Controller RAM Chip Select pin will be enabled and data will be read from it, as well as from the keyboard. The RAM address, now depends on the physical joystick position, rather than a number representing it, and at that location will be found data corresponding to a particular keyboard letter!

As mentioned before, the RAM data lines are connected to the CPU's data lines by a 'switch' that is not really a switch. In fact 'it' is five high-power tri-state buffers, each bypassed by a resistor. When the buffer outputs are in a high impedance condition ('off') the resistors allow data to be written to the Controller RAM. However when the $\overline{WE}$ input is high the buffers are active (the 'switches' are then in the opposite position to that show in Figure 2) and they have sufficient 'muscle' to override the CPU data. Thus the computer receives data corresponding to the joystick position, rather than the actual keyboard data, whatever it may be. And, since the joystick position

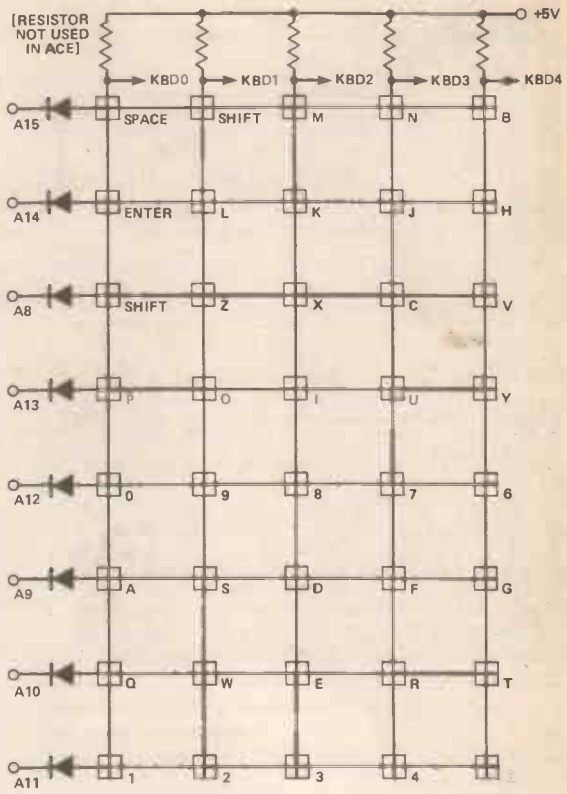


Figure 1. The keyboard circuit shown is typical of the ZX81, Spectrum and Ace, with minor variations between them. Each square over a pair of crossed wires represents a switch which, when closed, pulls a KBD line to logic 0 when the corresponding address line is at 0. The Monitor programme performs a keyboard scan about once every 20 milliseconds by consecutively pulling each address line to 0. The diodes prevent two address lines being shorted if two keys are pressed together. The keyboard is also scanned by an INKEY instruction in a user-programme.

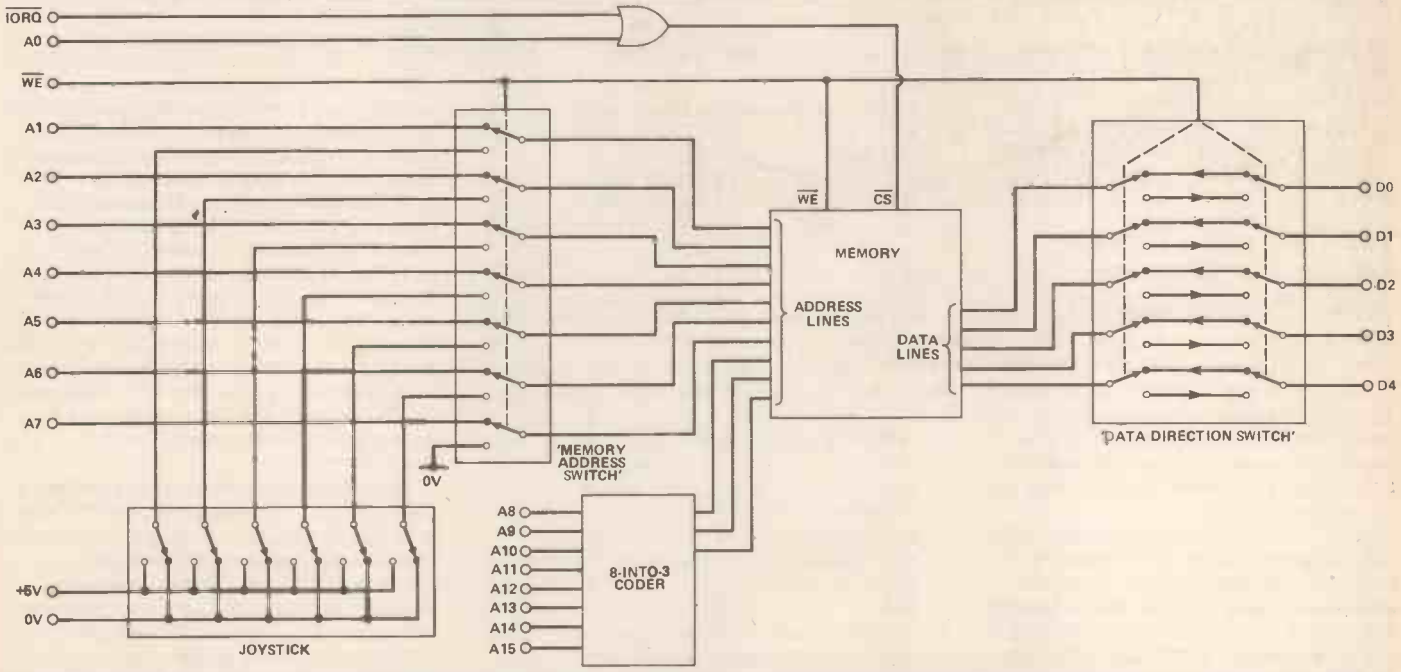


Figure 2. A highly representational block diagram of the Controller. When it is being programmed, the memory address lines are connected to the computer's address bus and data is accepted from the data bus, as shown. In use the "switches" are reversed; the joystick provides the addresses and previously programmed information is forced onto the data bus, overwriting information from the keyboard.

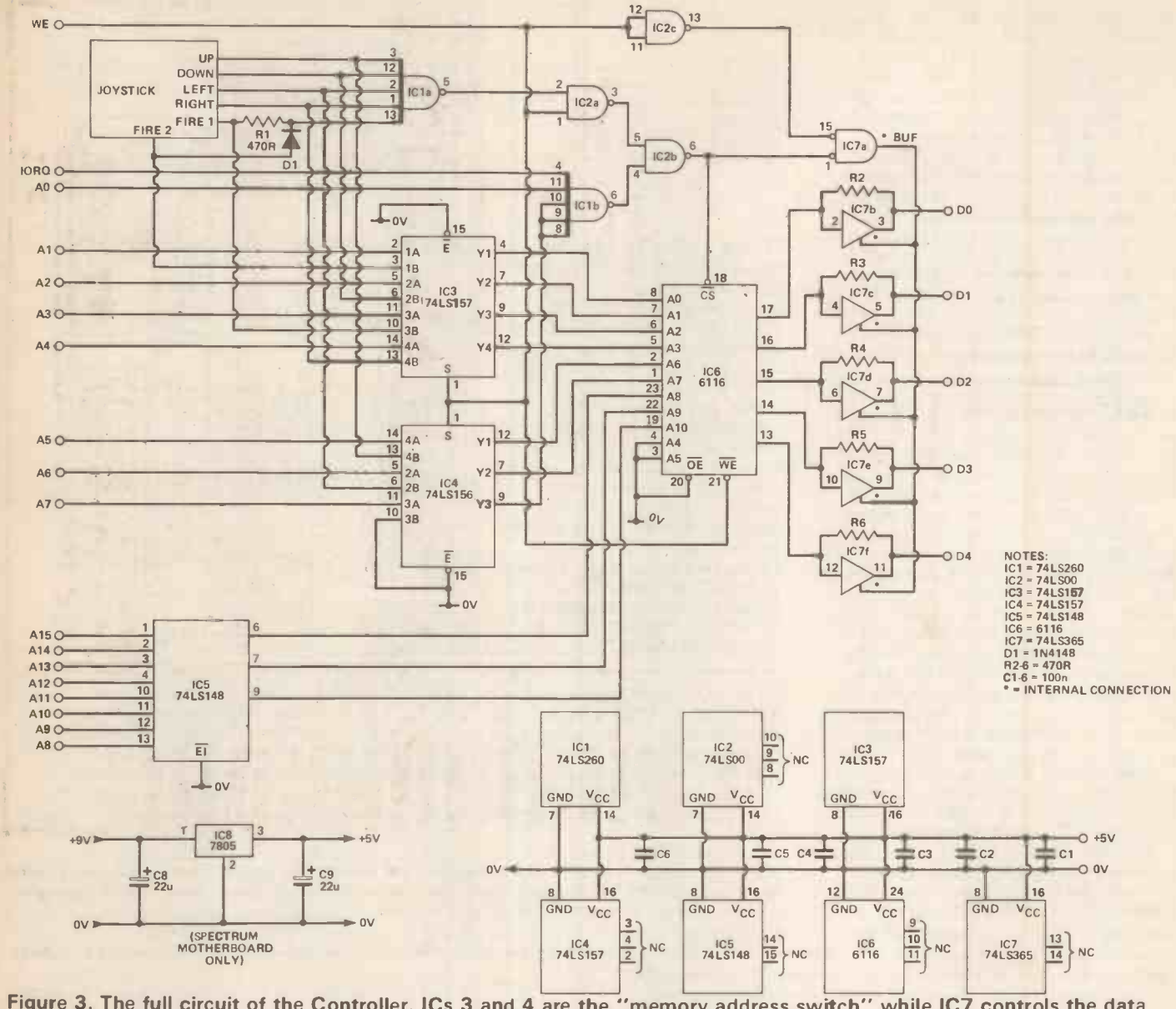


Figure 3. The full circuit of the Controller. ICs 3 and 4 are the "memory address switch" while IC7 controls the data direction.

has been set-up to correspond to a particular key, the computer receives the appropriate command — unless the Invaders have just bombed you out of the game!

The Complete Circuit

Figure 3 gives the complete circuit for the joystick interface. As before, A8 to A15 are encoded by 1C5 to give three address lines for the memory, IC6, a 6116 2K by 8-bit static CMOS RAM. IC3 and IC4 are 2-into-1 multiplexers connected as electronic switches — when SELECT (S) is at logic 0 the A inputs are connected to the outputs, and when at logic 1 the B inputs are selected.

First consider how the memory is programmed. To do this, an OUT command is given along with an address (on the ZX81 this command can only be given in machine code — there is no OUT command in ZX81 BASIC). The address must have both A0 and A7 low; A0 is always low for a keyboard read while A7 must be held low to avoid the Joystick memory being accidentally written to by the CPU when it gives control signals to the logic circuitry.

The OUT command sends both $\overline{IORQ}$ and $\overline{WE}$ low. Since $\overline{WE}$ is connected to the select line on the multiplexers IC3 and 4, the A inputs are selected, and in particular Y1 is connected to A7 and is thus at logic 0. This means that IC1a has all zero inputs and so gives out a logic 1. Then, since one of the inputs to IC2a is $\overline{WE}$, at logic 0, its output is at logic 1; therefore IC2b has both inputs at logic 1 and so it gives a 0 output. Thus IC6's $\overline{CS}$ pin is taken low, enabling the RAM. And, since the output of IC2c is a 1, BUF is 0 and the buffer outputs are open circuit, this allows data to be read into the memory from the data lines via R2 - R6.

Now consider what happens when the computer tries to read the keyboard. When the joystick is not being used it is important that the keyboard functions normally, and it is the function of IC1b to detect whether or not the joystick is being used. When the joystick is not being used, IC1b has all zero inputs and so gives a 1 output. D1 and R1 are included because IC1b has only five inputs while the joystick has six outputs; D1 and R1 form a hardware OR gate, thereby reducing the number of inputs to the IC1b. So, when the CPU tried to read the keyboard $\overline{IORQ}$ is 0 and $\overline{WE}$ is at 1; this, combined with the 1 from IC1b, gives a 0 on IC2a which gives a 1 at the output of IC2b. This takes the BUF line to 0 and the buffers are not selected, allowing the keyboard to be read normally.

When the joystick is being used, at least one of the inputs to IC1b is high and so its output is low, and this gives a 1 at the output of IC2a. Now, because $\overline{WE}$ is 1 during a keyboard read Y1 is connected to 1B and hence is at logic 0. Thus all the inputs to IC1a are 0 and so its output is at logic 1. Then the two 1 inputs at IC2b give a 0 output, selecting the memory, IC6. And, since IC2c is outputting a 0, BUF is at logic 1 and the output from the

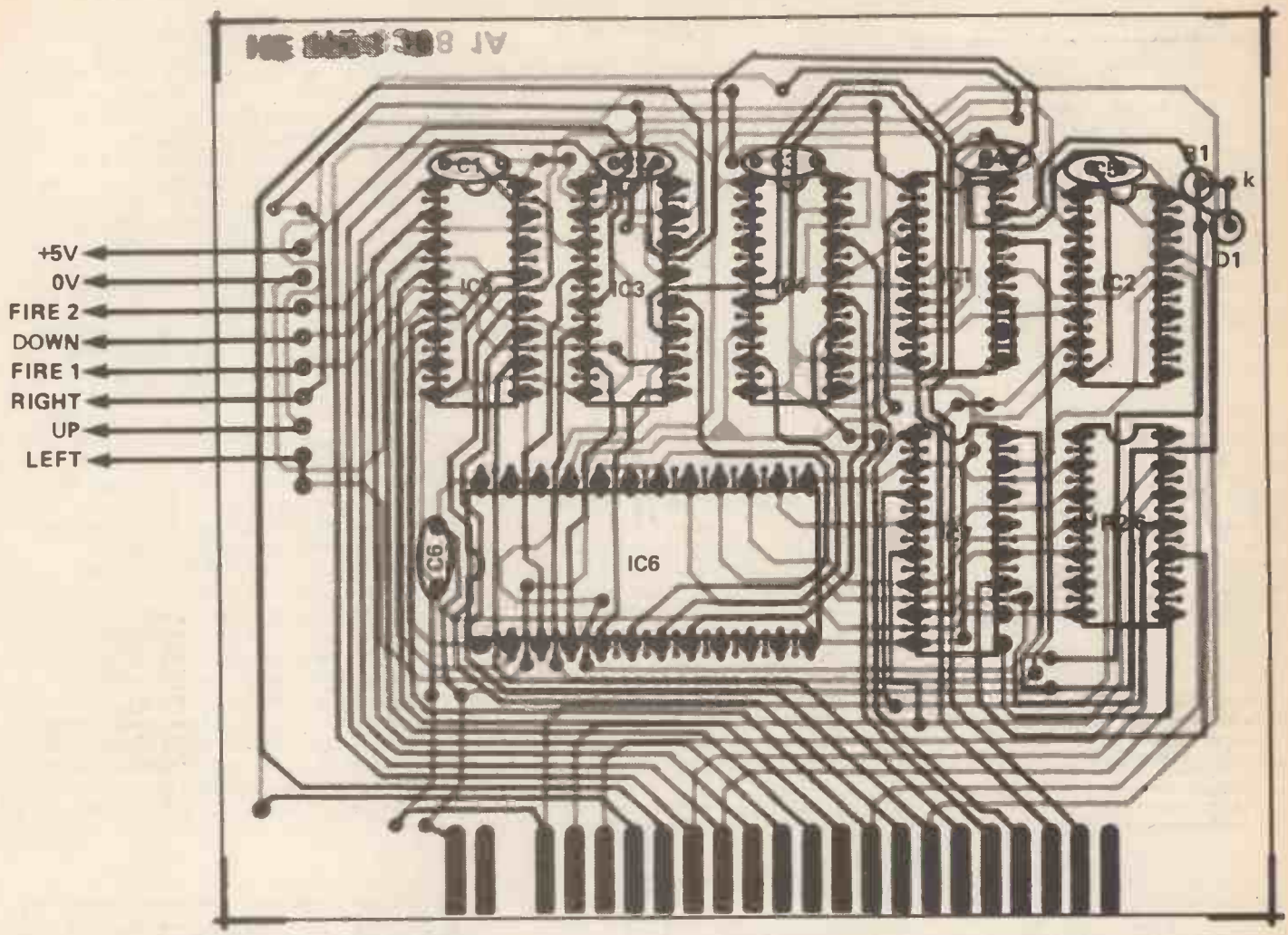


Figure 4. The component layout shown over the double-sided PCB patterns (the component-side tracks are in red). The Controller PCB plugs into a motherboard which carries the correct edge connector for whichever computer is being used. The Spectrum motherboard (not shown) also carries a 5V regulator circuit.

Parts List

RESISTORS
R1 – R6 ..... 470R

CAPACITORS
C1 – C7 ..... 100n disc ceramic
C8, C9 ..... 22u 16V radial electro

SEMICONDUCTORS
IC1 ..... 74LS260 dual 5-in NOR
IC2 ..... 74LS00 quad 2-in NAND
IC3, 4 ..... 74LS157 quad 2-in selector
IC5 ..... 74LS148 8-into-3 decoder
IC6 ..... 6116 2K x 8-bit CMOS static RAM
IC7 ..... 74LS365 hex tri-state buffer
IC8 ..... 7805 +5V regulator

MISCELLANEOUS
PCB; motherboard, wire, solder etc.

BUYLINES ..... page 34

memory is buffered onto the data lines, overwriting the keyboard data.

Construction

The interface is built on two double sided PCBs. The main board plugs vertically into a smaller motherboard, which plugs into the edge connector; the main board is the same for the ZX81, Spectrum and Jupiter Ace, while the three motherboards are different. The ZX81 and Ace motherboards provide their own edge connectors so that rampacks may be plugged on, while the Spectrum motherboard has its own power supply — this is needed because the 48K Spectrum cannot supply enough current for the joystick interface. The interface actually needs very little power, but even the little that it does draw would be enough to make the Spectrum unreliable if the extra supply were not provided.

Construction of the main board is relatively easy — but take care with the 6116 memory. Since it is a CMOS IC it can be damaged quite easily by static charges. It has internal protection diodes which are effective up to about 4,000V, but since you can quite easily generate over 10,000V simply by walking on a nylon carpet you can destroy it simply by touching the pins! To avoid damage make sure that you don't remove the chip from its protective conductive foam until you are ready to use it, and earth yourself (eg by touching a water tap) before handling it.

Testing

When you have finished building the main board, plug it into the motherboard, plug the motherboard onto the computer edge connector and plug the joystick into the DIN socket in the main board. Now switch on the computer — it should behave normally. Now move the joystick into the UP position and try the keyboard. The keyboard should be completely inoperative, since it is being overruled by the joystick. Test the other joystick positions to make sure that the keyboard remains inoperative.

Software

Consider the BASIC program given in **Program 1** written for the Spectrum. It is a much simplified version of the complete joystick program, but it clearly demonstrates the ideas involved.

The program first accepts an input,

J, a number between 1 and 6, corresponding to the joystick position which is to be programmed — 1 corresponds to UP, 2 to DOWN, 3 to LEFT, 4 to RIGHT, 5 to FIRE 1, and 6 to FIRE 2. It then asks you to press a key, so that when the joystick is moved into the appropriate position *it will be as though that key has been pressed.* Say, for instance, that you enter 1 for the joystick position and then press "Q" for the key. Then, whenever the joystick is moved into the up position, the computer will believe that "Q" has been pressed.

Line 40 simply waits for you to press the key before entering the next section, a FOR/NEXT loop which reads the keyboard and then transfers the data to the joystick memory. The variable N counts through each row of the keyboard in turn; let's consider the case where J = 1 and it is the first time through the loop, when N = 8. Then the address, A in line 60 is equal to 65280 - 2↑J + 2, which in binary is 1,111 1110 0000 0010. This address has A0 = 0, which it must have for a keyboard read, and in addition the higher address lines (A8 to A15) are set to read the row SHIFT to V on the keyboard (see **Figure 1** again!). So, in line 70, "IN A" reads this line on the keyboard and "OUT A" transfers this to the joystick memory — and puts it into the memory location which has A1 = 1. So later, when the computer tries to read this line of the keyboard and the joystick is in the up position, A1 will again be 1 (since it is coming from the joystick) and the joystick memory will output the data that had been transferred to it during the OUT operation. The counter N scans through the entire keyboard, making each of the address lines A8 to A15 low in turn, and transferring the keyboard data to the joystick. The overall result is that the joystick saves a copy of the keyboard which it will later output when the joystick is moved into the appropriate position.

This program seems to do everything we require, but it does suffer from two faults. The first problem is simply that it won't work with the BREAK key; as soon as this key is pressed the Sinclair BASIC monitor breaks out of the program and data is not transferred to the joystick. The only solution is to write the program in machine code, where it is safe from the BASIC monitor. The second problem is more difficult to cure. It arises whenever two or more functions are used on the joystick at the same time, for example when the joystick is moved into the UP position and FIRE button 1 is pressed. This sends both A1 and A5 high at the same time, but since the memory location this corresponds to has not been programmed, the joystick will not work. The answer is to rewrite the simple program, making it into two parts; the first part reads the keyboard, line by line, and saves the data for the second part which transfers the data to the joystick, filling up every memory location with the appropriate data. The software tape which is being supplied with the Joystick kit (see Buylines for details) actually contains three complete programs, one each for the ZX81, Spectrum and Ace. They are all very easy to use and are able to remember which keys are used by which programs, so you need only program the Joystick once for each game.

HE

PROGRAM 1

```
10 INPUT "Which joystick position?",
J
20 PAUSE 50
30 PRINT "Press the key
corresponding to this position — and
keep your finger on the key"
40 IF INKEY$ ="" THEN GOTO 40
50 For N = 8 TO 15
60 LET A = 65280 - 2↑N + 2↑J
70 OUT A, IN A
80 NEXT N
90 CLS
100 PRINT "Now take your finger off
the key"
110 IF INKEY$<> "" THEN GOTO 100
120 CLS
130 GOTO 10
```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7426	18p
7427	18p
7428	18p
7430	14p
7432	18p
7433	22p
7437	22p
7438	22p
7440	15p
7441	55p
7442A	30p
7443	70p
7445	50p
7446A	50p
7447A	36p
7448	45p
7451	15p
7453	15p
7454	15p
7460	15p
7470	30p
7472	25p
7473	25p
7474	18p
7475	22p
7476	25p
7480	48p
7481	120p
7482	65p
7483A	38p
7484	65p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7495A	35p
7496	35p
7497	90p
74100	80p
74107	22p
74109	25p
74112	170p
74116	50p
74118	55p
74119	60p
74120	60p
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74122	30p
74123	36p
74125	30p
74126	30p
74128	36p
74132	30p
74136	28p
74141	55p
74142	175p
74143	200p
74144	200p
74145	40p
74147	75p
74148	60p
74150	50p
74151A	36p
74153	36p
74154	50p
74155	36p
74156	40p
74157	30p
74159	75p
74160	40p
74161	40p
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74185	90p
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LF347	150p
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LF353	95p
LF356P	95p
LF357	110p
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LM301A	25p
LM307	45p
LM308	45p
LM308N	75p
LM310	120p
LM318	150p
LM319	215p
LM324	30p
LM334Z	90p
LM335Z	140p
LM339	50p
LM348	65p
LM358P	60p
LM377	175p
LM380	75p
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The Story So Far

Last month, we looked at electricity itself: what it is (a flow of electrons) and its three fundamental quantities (potential difference, current, resistance) which are tied together in a physical way defined by Ohm's Law. Put into mathematical formulae, Ohm's Law can be expressed by:

$$V = IR$$

$$I = V/R$$

$$R = V/I$$

So, if two of the quantities in any electronic circuit are known, the third can easily be calculated.

There are two main types of electricity: DC (direct current), where the potential difference, or voltage, remains constant — this is the sort of electricity which is obtained from a dry-cell battery — and AC (alternating current), where the potential difference alternates between two extremes. House electric systems are AC and here the voltage alternates between equal positive and negative amounts to give an overall voltage of 240V.

We saw that electricity need not always consist of large currents and large voltages, hence the need to divide the units of current (the ampere) and voltage (the volt) up into smaller parts, such as a microamp:

ie, $1 \times 10^{-6} = A$

or, say, a millivolt:

ie, $1 \times 10^{-3} = V$

Voltages and currents such as these are the sorts which we may find from such a device as a microphone which converts sound waves into electricity. We tend to call such voltages and currents *signals* — they *represent* the sound in an electrical way, just a traffic signals represent what to do next in a way which the motorist can understand. Now that we have seen exactly what electricity is, we're going to turn out attention to what electricity does. In other words, we are going to study the main *effects* of electricity.

Let There Be . . . Heat!

The first effect, observed every day when a light bulb is turned on is the creation of heat. Any conductor, if a high enough potential difference is applied across it, will conduct enough electricity to get warm. The thinner the conductor, the lower the potential difference it takes to heat it. What happens in a light bulb is that the conductor (known as the filament) is so thin that it doesn't take much electricity to heat it up. And it gets hot! So hot that it radiates enough energy to glow white hot — in other words, it gives off light.

Heat is also dissipated from the bar of a bar fire or a ring of an electric cooker, but here the electricity used only makes the bar or ring glow red hot — *even though more electricity is used and more heat is given off than with a light bulb filament.*

The reason for this generation of heat is connected with the very reason why electricity flows at all, ie, because the atoms of conductors allow their electrons reasonably free movement. The key phrase here is "reasonably free movement". No atom gives up its electrons without a struggle, however good a conductor it is and force (or energy) is always required to take the electron away from the atom. The potential difference applied across the conductor provides this energy by literally pulling the electrons out of orbit towards the positive side of the voltage source. When the electron jumps along to the next atom to take its place in 'orbit', some of that energy is then given off and is released as heat (**Figure 1**).

Thick And Thin

In a large mass of conducting material the effect of these small heat releases is to raise the temperature only by a small amount. In a thin conductor, however, the temperature obviously rises more dramatically with the same potential difference, even though the actual power released is identical. So, light bulbs are manufactured with a very thin filament so that only a small amount of power is used up or dissipated for the amount of light emitted.

Naturally, there is a mathematical relationship between the amount of electricity and the power dissipated as heat. It is summarised by a formula which can be used to calculate the power dissipated by any conductor with a voltage across it:

$P = IV$ (measured in watts)

So, for example, a potential difference of 100V across a conductor, with a current of 10A through it, would mean that the conductor will dissipate a power of:

$100 \times 10 = 1000$ watts = 1kW
(ie, one kilowatt)

But, from Ohm's Law we know that $V = IR$ and $I = V/R$. So also: $P = I^2R = V^2/R$.

This means power is also dissipated by a *resistor* in a circuit, not just a conductor, and we can calculate the power dissipated by that resistor if we know its value and the value of the current through it, or the voltage across it. Enough said for now, but next month when the whole topic of resistance is discussed in depth, you'll see how the question of power plays an important rôle in our choice of resistor in a given electronic circuit.

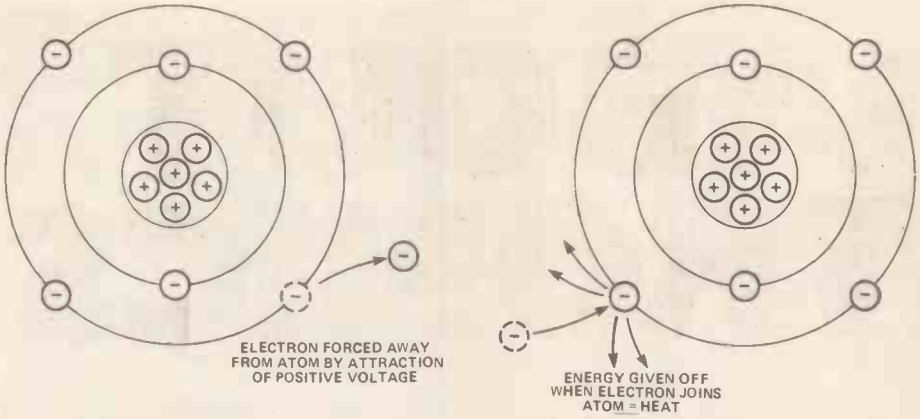


Figure 1. An electron can be forced away from its atom with the application of a voltage, but the energy used to force it away is released when the electron finds another atom with a missing electron.

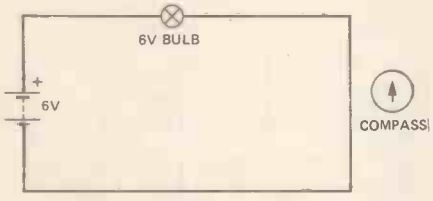


Figure 2. When the circuit is completed the needle of the compass will jump to a new position. As the circuit is disconnected the compass needle will once again point north.

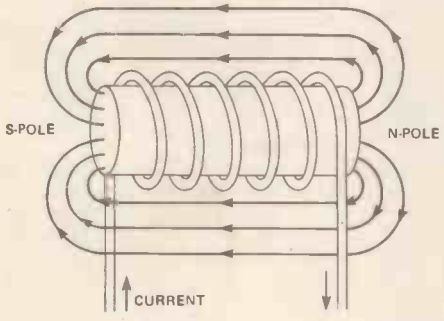


Figure 3. When current passes through a coil of wire, the electromagnetic field is stronger than that from a single length of wire. A north- and south-pole are generated.

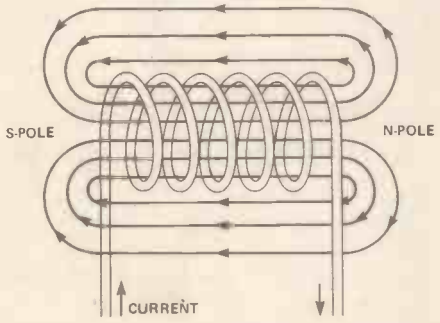


Figure 4. Winding the coil around a soft iron former concentrates the electromagnetic field.

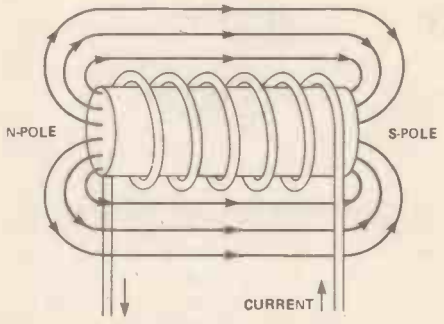


Figure 5. Reversing the direction of the electric current reverses the magnetic field.

Electromagnetism

The second effect of electricity we shall now look at is the magnetic field which is formed whenever a current is passed through a conductor. You can 'see' this magnetic field if you have a magnetic compass, a battery, a bulb and connecting wire. Simply position the compass close to the middle of the length of wire (**Figure 2**) and then connect the two ends of the wire to the battery. As you connect the circuit the compass needle will jump, then steady. Similarly, when you disconnect the wire, the needle of the compass will once again jump, then steady and point north.

This magnetic field is caused, like heat, by the energy electrons give off when jumping back to an atom. It is termed *electromagnetic* radiation to distinguish it from magnetic radiation from a permanent magnet (eg, bar-magnet, horseshoe-magnet) — electro-magnetic radiation only occurs in a conductor when an electric current is flowing.

If you do the experiment in **Figure 2** you will see that the field generated is not a very powerful one. If might have caused the compass needle to move but it certainly would not have been strong enough to pick up a piece of metal, a pin for example. One way to increase the field should be obvious: increase the current. But there is a limit to how much current is available from a power source such as a battery. A better way to increase the magnetic field is to loop the wire into a coil, as in **Figure 3**. Each turn of the wire radiates its own field and the total effect is to create a magnet which is n times as strong as the single wire, where n is the number of loops in the coil.

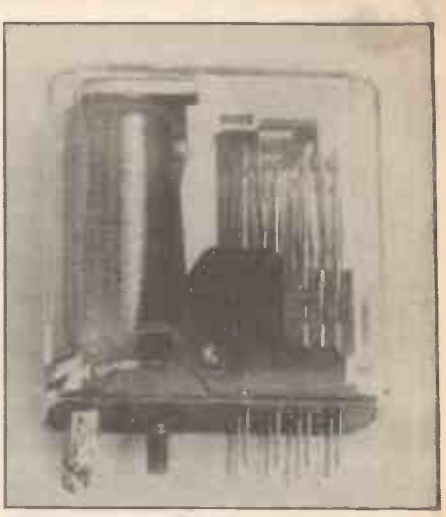


Figure 6. A relay can be used to switch currents (some relays have as many as 10 sets of switch contacts) upon application of a small current to pass through the coil.

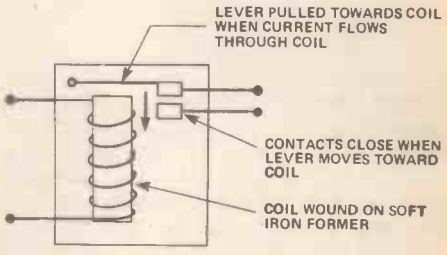


Figure 7. Inside a typical relay.

Loop The Loop

Another way to create a stronger magnetic field is to form this loop around a metal core (soft iron is best). The soft iron core (**Figure 4**) concentrates the field, producing a stronger electromagnet. **Figure 4** shows how the coil is now effectively a single magnet with the usual north (N) and south (S) poles. When the current flows as shown, ie, anti clockwise, the north pole is at the right hand end of the electromagnet. However, if the current flows clockwise as in **Figure 5** the poles reverse ends!

We have now seen the magnetic field which is generated around a conductor with a current flowing and the next question must be to ask, how can we use this effect? After all, an electromagnet is an electromagnet and by itself it must have only limited use. The most important use in the form is probably in a relay, an example of which is shown in **Figure 6**. Such a rely has an electromagnetic coil inside, which is operated by a specific voltage and

current. When current flows through the coil it creates a field which pulls a lever towards it (**Figure 7**) activating switch mechanisms. The current to activate the coil is small but the current which is switched by the switch mechanism can be large and at a high voltage. So, for example a relay can be used to turn on and off a 240V mains-powered heater with only a 9V battery as in the circuit in **Figure 8**.

Undeniably though, electromagnetism doesn't seem to offer much until we consider the electromagnet in use alongside another, say a permanent magnet. If we remember the statement "like poles repel, opposites attract", then we can begin to understand the real usefulness of being able to switch magnetism, the force that pulls opposite poles together and pushes like poles apart, on and off at will.

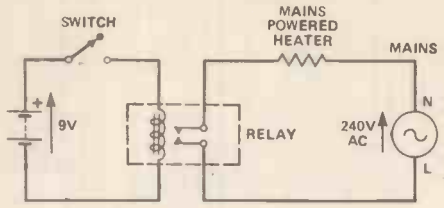


Figure 8. Showing how a relay and a 9V battery can turn a mains-powered heater on and off.

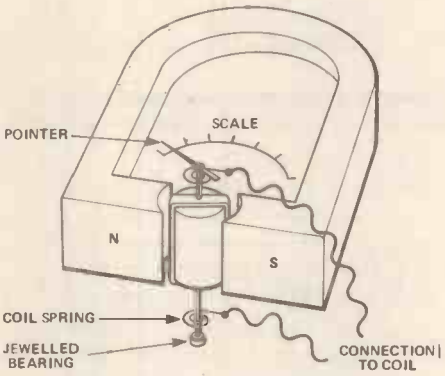


Figure 9. Inside a moving-coil meter.

Testing, Testing

The single conductor and compass experiment of **Figure 2** shows such a force making the needle of the compass (a permanent magnet) jump. Obviously, if we take our coil of wire formed around a soft iron core and pass a current through it, then put it beside a strong permanent magnet, the force between the two magnets will be a lot stronger. And, more important, because the strength of the electromagnetic field depends on the current through the coil, the force between the two magnets *depends on the current passed through the coil.*

This principle is used in the common test meters used everyday in electronics. **Figure 9** shows the basic part of a meter. The main items include a permanent magnet, a coil wound on a former, and a pointer attached to the coil. The coil is mounted on bearings so that it can rotate. The magnet's poles are shaped so that the field produced is radial and equal at all points on the coil. A coil-spring ensures the coil always returns to the same position when no current is passed.

When a current is passed through the coil, the electromagnetic field, interacting with the permanent magnetic field, forces the coil to rotate. When the force produced equals the force which the spring exerts against it an equilibrium is set up — in other words, the coil stops turning. The pointer therefore indicates on a scale the strength of the magnetic field produced by the coil and, because the field depends on the current through the coil, the position of the pointer on the scale is *an indication of the size of this current.*

For accurate measurements, all parts of a meter obviously need to be carefully designed and manufactured, but modern day meters can exhibit full-scale deflection (FSD), ie, the pointer goes from zero to maximum, when currents of only 1 uA or so are passed through the coil. A modern multimeter suitable for a selection of general-purpose test measurements in electronics is shown in **Figure 10**. This multimeter has a switch in order that the measurement range can be changed, so that larger currents can be measured. Also on the switch dial are locations so that voltage and resistance measurements can be taken, all with the same meter!

Now, how can this be done? How can we use the same meter to measure current, voltage and resistance at the flick of a switch? For the answer we must look at some circuits to understand exactly what we are measuring. Then we will see how to measure them.

Current

Figure 11a shows a circuit of a battery and a resistor. Battery voltage is 10V and the resistor has a value of 10k (ie, 10,000 ohms). So we can calculate, using one of the formulae associated with Ohm's Law, the current in the circuit:

$$I = \frac{V}{R} = \frac{10}{10{,}000} = 1 - 10^{-3}A = 1mA$$

Figure 11b shows how we measure current. The meter must be part of the circuit — in this way the current actually passes through the meter coil. If the meter has FSD of 1mA then the pointer of the meter will be at its maximum position. If the meter had FSD of 10mA the pointer will be only 1/10th of the way across the scale.

But what happens if the meter has FSD of only 1uA? The pointer will try to go off the scale! The current going though the coil (1mA) is one thousand times greater than the current the coil was designed to withstand and it may "burn-out" ie, the heat generated by the current may actually be great enough to melt one or more of the loops of the coil. Once this occurs a break in the circuit

Figure 10. A typical digital multimeter with test probes.

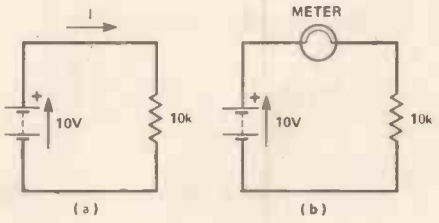


Figure 11a) Current flows when a resistor is connected to a battery b) measuring the current using a meter.

will be made and the meter is ruined. For this reason you must be very careful when using a test meter not to attempt to measure greater currents and voltages than the meter is switched to read at FSD. It is easy to adapt a meter with a very low FSD to measure currents of much greater value as shown in **Figure 12a**.

The meter can only be used to measure a maximum current of 1uA but the current in the circuit is 1uA (as **Figure 11a**). So to use this meter we need to sample only 1uA of the 1mA circuit current and bypass the meter with the other 999uA. We do this as in **Figure 12b** by putting a resistor, R2, in parallel with (ie, across) the meter. The resistance is calculated to allow 999uA through for every 1uA which the meter allows through.

Now the voltage across the meter is the same as the voltage across the meter resistor (because they are joined at both ends — they are in parallel) whatever happens. So from Ohm's Law

$$IR\ (meter) = V = IR\ (resistor)$$

That is, the current though the meter coil multiplied by the coil resistance must equal the current through the resistor multiplied by its own resistance. We know that the current though the meter has to be 1/999 of the current though the resistor so

$$\frac{1}{999} \times R\ (coil) = I \times R2$$

So; R2 = R/999 (coil). If the coil resistor

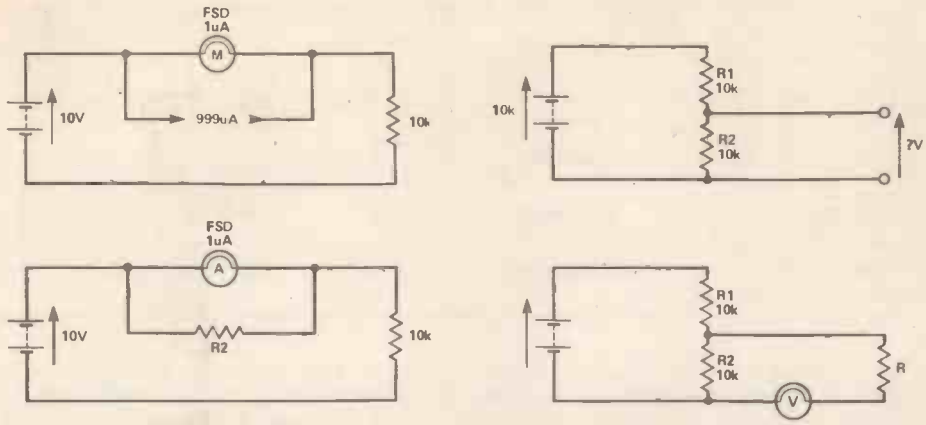


Figure 12 a) measuring a current which is larger than the FSD current of the meter — some of the current has to bypass the meter coil b) a shunt resistor (ie, in parallel) allows some current to bypass the coil

Figure 13 a) The voltage across a resistor b) measuring the voltage using a meter with a series resistor.

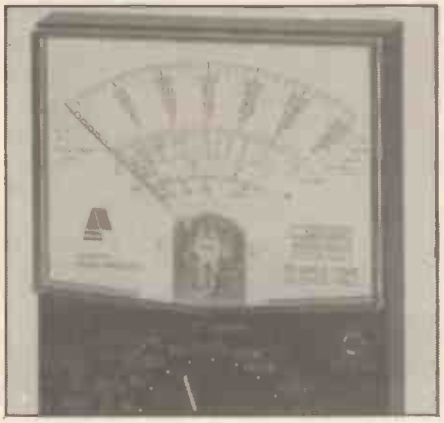
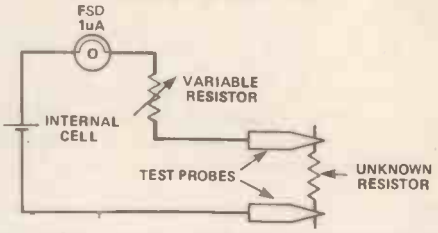


Figure 14. A typical analog multimeter scale. Note the reverse-reading resistance scale.

Figure 15. A typical use of a meter to measure an unknown resistance value.



is say 1k, then R2 = 1000/999 = IR. In this example we must put a resistance (which is 1/999 of the meter coil resistance) in parallel with the meter to let the meter which has FSD of 1uA measure up to 1mA. Other current values can be measured simply by putting another value of resistor, calculated as above, in parallel with the meter. All the switch does in a multimeter such as that of **Figure 10** is to connect in a different value resistor for every range of current to be measured.

Voltage

Voltage measurement is slightly different. The circuits in **Figure 13** show why. Say we went to find out the voltage across R2 in **Figure 13a**. We can calculate the voltage using Ohm's Law if we want, but in such a simple example it is possible to calculate the voltage by introspection. Look at the circuit: there are two equal resistors in the series (ie, in a line) across a source of 10V. So the mid-point of the resistor will have a voltage at the mid-point of the source voltage: 5V.

If we use the same meter as above, ie, with FSD of 1μA and a coil resistance of 1k, then we can calculate from Ohm's Law the current which will pass through the coil if the meter is simply placed across the resistor to measure 5V:

$$I = \frac{V}{R} = \frac{5}{1{,}000} = 5\text{mA}$$

(ie, 5000 times the FSD current!)

Obviously such a current will damage the meter, so we need to restrict the amount of current to be no greater than the meter's FSD current (1uA). When we measured large currents using the meter we connected a resistor in parallel to restrict the current flow through the coil. Things are different, however, when we want to measure a large voltage — *we add a resistor in series* (**Figure 13b**).

To calculate the value of this resistor we must remember that the aim is to restrict current flow through the meter to 1 A. So the total resistance of the meter coil to the added resistor must only pass 1 A of current. From Ohms Law therefore,

$$R\ (\text{total}) = \frac{V}{I} = \frac{5}{1\text{x}10^{-6}}$$

$$= 5 \times 10^{6}\ \text{ohm} = 5\text{M}\ (5\ \text{Megohm})$$

The meter coil resistance is 1k so the added resistor should have a value of 4999000 ohms. It is not possible to manufacture a resistor to this sort of accuracy so in fact a resistor of 5M would be used. In a multimeter such as that in **Figure 10** different values of series resistors are switched in to measure different voltage ranges in the same way that different values of parallel resistors are switched in to measure current.

Resistance

Measurement of resistance is a lot different! A resistor is a passive device: unless a current is passed through it no voltage occurs to be measured and unless a voltage is applied across it no current can be measured, so a meter by itself will not be able to measure resistance. Any multimeter therefore has an internal battery cell to provide voltage and current. The current which passes through the resistor is given by Ohm's Law:

$$I = \frac{V}{R}$$

and the voltage is fixed by the voltage of the cell. So the current which flows is determined *by the value of the resistor being measured.* If we measure this current, using the meter as we've already seen, the position of the pointer will therefore indicate the value of the resistor.

An important point to note with a multimeter switched to measure resistance is that the current (therefore the pointer position) is *inversely proportional* to the resistance of the resistor being measured. In other words the meter appears to read backwards — the higher up the scale the pointer is, the lower the value of resistance. This also means that the scale is non-linear, ie, equal amounts of resistance are not equally spaced. An example of a typical multimeter scale is shown in **Figure 14.** You can see the linear scales of voltage and current and also the non-linear reverse scale of resistance. A typical resistance measuring circuit is shown in **Figure 15**. The main component to note is the variable resistor in the circuit which allows for varying voltages due to the cell discharging with time and use.

Using a resistance meter (or ohmeter) is a little bit different to a voltage meter (voltmeter) or current meter (ammeter) in that you first have to set the meter to read zero resistance on the scale, by adjusting the variable resistance when the ohmmeter probes are in good contact. This makes sure that at every resistance reading the varying voltage from the internal cell has been allowed for.

Safety First

An important characteristic of any meter is its sensitivity, ie, how far the pointer moves for a given current. It is normally expressed in ohms-per-volt (R/V). The more sensitive a meter is, the higher the R/V ratio will be. Any meter can be given such a rating by dividing its FSD current into one volt. For example a 1uA FSD gives:

$$\text{sensitivity} = 1\text{V}/1\text{uA} = 1 \times 10^{6}\ \text{R/V}$$

If you are going to purchase a multimeter for use in electronic

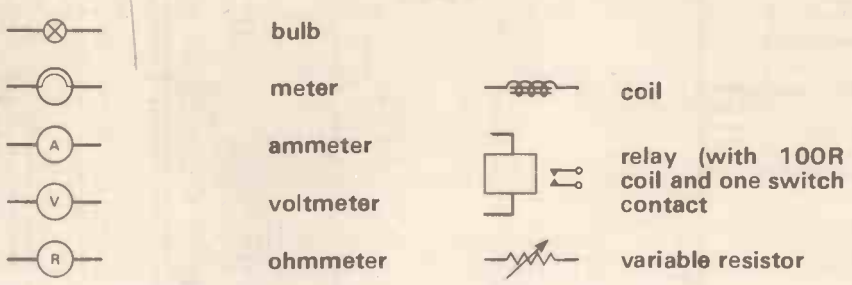
Table 1. Circuits symbols for this month's new components.

Table 2. Standard abbreviations for measurements and values used universally in electronics. It is important to distinguish between capital and lower case abbreviations, as they can mean different things.

Table 2

DC	direct current
AC	alternating current
V	voltage/volts
I	current
R	resistance/ohms
A	amperes/amps
m	1 x 10^{-3} eg, one milliamp = 1mA
u	1 x 10^{-6} eg, one microvolt = 1uV
n	1 x 10^{-9} eg, one nanovolt = 1nV
p	1 x 10^{-12} eg, one picofarad = 1pF
k	1 x 10^{3} eg, one kilovolt = 1kV
M	1 x 10^{6} eg, one megohm = 1MR
P	power
W	watts

Table 1



measurements, make sure you get one with as high a sensitivity as you can afford. Buy one with a sensitivity of at least 50,000 ohms/volts, preferably 100,000 ohms/volts.

The last thing to remember about multimeters is that there are a few rules you must follow which ensure the meter isn't damaged in any way:

- When you measure a current, voltage, or resistance which is unknown always measure it first on the highest range and step down range by range until you obtain a good measurement. This will make sure that the meter coil is not burned out by too large a current.
- The meter has to be polarised when taking DC voltage and current measurements ie, the negative terminal of the multimeter goes to the more negative side of the circuit and the positive terminal to the more positive side of the circuit. This prevents the meter pointer going in the reverse direction and being bent or damaged. AC measurements are different, however. A small circuit inside the multimeter converts AC to DC and always makes sure the coil turns in the right direction.
- Resistance measurements must not be taken with the resistor in circuit. A voltage may be present across the resistor when in circuit and too much current may flow through the coil due to this voltage and the coil may be damaged.

Finally, **Table 1** gives a list of the new circuit symbols we've met this month and **Table 2** lists some common abbreviations in electronics. Learn them well, you will see them time and time again. Next month, we will go deeper into the bits and pieces used in electronics — the components which go together into circuits — and show you how they work.

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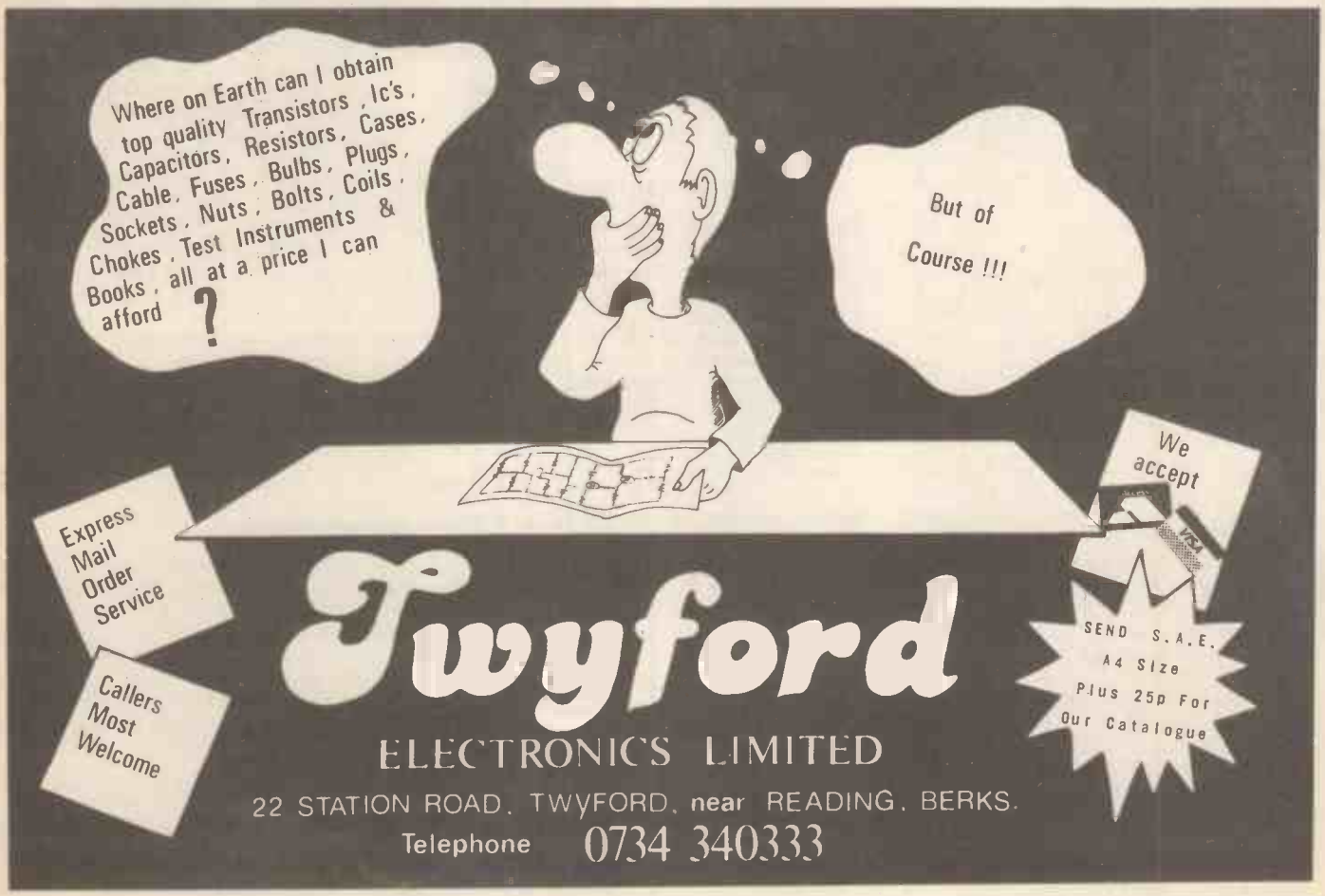

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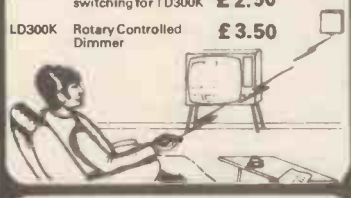

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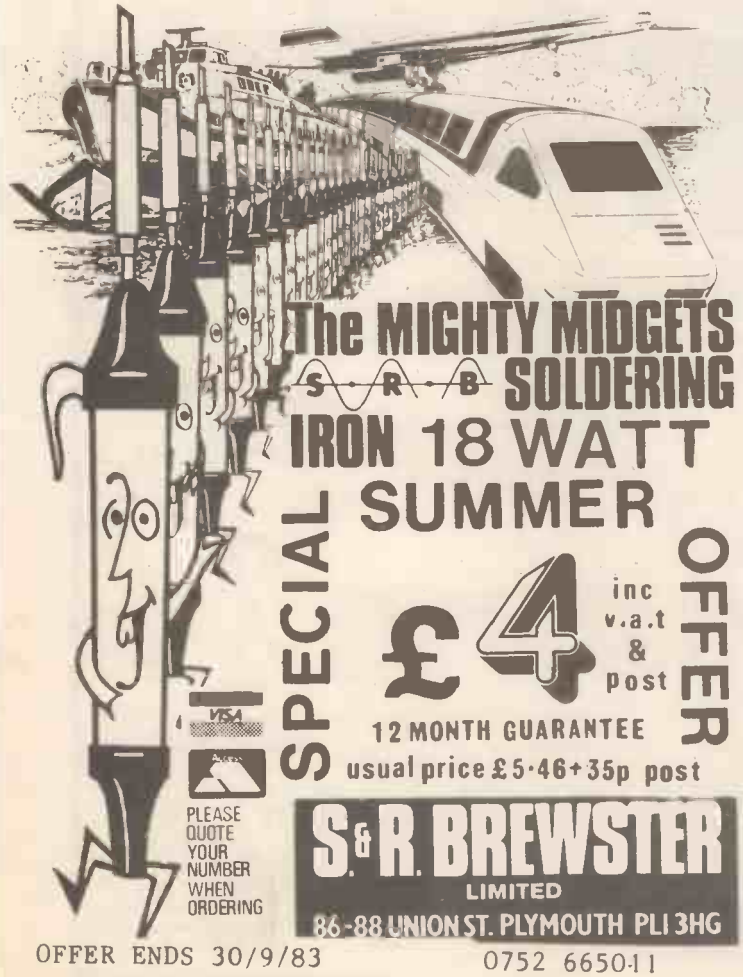

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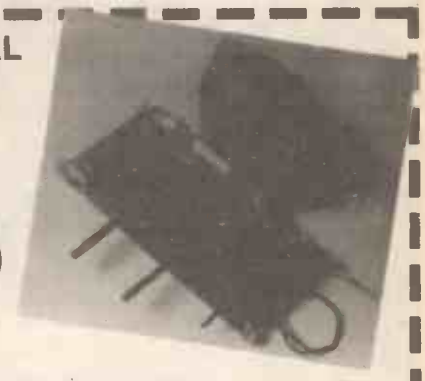

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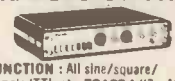

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POINTS OF VIEW

Feel like sounding off? Then write to the Editor stating your Point of View!

Calling Mr. Giggs

If there is a Mr. Giggs out there, who wanted a Heathkit manual for a C-3U R-C Bridge, please could he get in touch? We know somebody who has one.

Atari In The Islands

Dear Sirs,
I receive your very helpful magazine a little later than some of your readers but it is better than gold. In February's issue which has just arrived you comment about the hobbyists in remote corners of the country – well we here in the middle of the South Pacific are in a rather remote part of the world, so all we can get hold of in the way of news and information is even more valuable than to those who can buy magazines off the bookstall and whose public libraries are stacked with the latest books.

I teach Physics here – and computing, and when I was visiting Britain last year I bought myself an Atari 400. I explained to the supplier that I was going to a rather remote part of the world and would value keeping in touch. He promised all sorts of help – including the VAT back on my machine after I'd left the country. That is the last I've heard from him.

I am delighted with the capabilities of the 400, but had problems with the program recorder; I wrote to the supplier, and also Atari in the States. I heard back from the States saying I'd be having a reply to my problem – that was February 3rd, and I'm still stuck.

I have regular classes that I teach – imagine my frustration setting up programs the night before and finding that when the engineers at the power station have changed over from one generator to the other there has been a break in the power and I've lost everything – my hair which is already thin is going even faster!

My idea in teaching computing is to give a chance to young men and women to get "hands-on" experience which they would not, and do not get otherwise. I'm also experimenting with the use of the 400 as a multi-purpose piece of physics equipment which I hope will lead the way to teachers in other third-world countries 'discovering' the micro as a means of doing much more with little capital outlay. However I am very limited with no means of storing programs.

Just after I came back I encouraged a local electronic music shop owner to become an Atari stockist, he is all enthusiastic and has gone ahead, but we need outside help and advice beyond our own capabilities. I hope this letter may stir some.

Much as we enjoy the sunshine here we are also keen on keeping up with the latest technology.
Yours sincerely,
Rob Pattison,
Physics Dept.,
Lelean Memorial School,
Box 66,
Nausori,
Fiji.

PS. Our school is one of the only three with a computer in Fiji.

You seem to be doing a lot with a little, and good luck to you. It's a pity about dealers who take the 'out of sight, out of mind' line but I hope Atari either in the UK or the States (or both) will help you out with your problems. You may have to nag them .

I am ignoring our usual custom and printing Mr. Pattison's school address so that readers and teachers in similar situations can write to him and exchange ideas.

Mr. Pattison would also like to know whether there are any broadcast satellites that he could tune into with the right receiver in his part of the world (the Pacific Islands, for non-geographers!) In between coping with cyclones and hurricanes, that is. . .

In Search Of A Job

Dear Sirs,
I am a regular reader of HE and was very interested in your article on Careers in Electronics in May '83.

I am about to start the last term of a full-time TEC Higher Certificate in Electronics course I am taking at Liverpool Polytechnic, which I am advised I should successfully pass, so I am beginning to look around for appropriate employment. The few approaches I have so far made to local firms have been unsuccessful, some so strange to electronics as to assume I was looking for employment as an electrician's mate!

Anyway, I am writing to ask if you could advise me where I might obtain names and addresses of the major firms in the Electronics field, anywhere in the country, so that I can contact them regarding employment prospects. Any help you could give me would be very much appreciated.
Yours faithfully,
J. A. Richardson,
Middlesborough,
Cleveland.

Yes. Random approaches to firms, while they can turn up an unexpected gem of opportunity, very often result in blank stares and puzzlement.

To get the names and addresses of electronics firms, you need to consult professional magazines and trade papers advertising for posts (this is not to say you can only apply for the posts being advertised). Find the largest reference library you can and try to get hold of papers like *Electronics News* and *Electronics Weekly*. Ask the librarian for assistance in tracing electonics journals and also any trade directories which lists electronics firms. Also, don't forget the Yellow Pages phone directories.

This is the long, laborious, individual way of looking for an employer. The other one is to contact your local Educational Authority and ask to be put in touch with their Careers Office. Go and talk to them.

Doesn't your polytechnic have a technical library and/or a careers office.

In Search Of Electronics

Dear Editor,
HELP!!

I've spent many years in the software side of the computer industry, however, I've caught the BUG to know and learn more about th hardware element.

I want to be able to read and understand circuit diagrams upwards, because I want to build my own microcomputer. The principle application will be the knowledge I would have gained in actually building it.

The snag is, I don't want to go back to college, so I would like to know of home/correspondence courses and books available, no matter what the cost.

Can you PLEASE, PLEASE inform me of those bodies etc. that can help.
Yours in much need,
Richard Lanyon-Hogg,
Husbourne Crawley,
Beds.

Now *there* is an encouraging noise! Someone who wants to know how the things *work*. Stick with it — people who know about the innards as well as the outards (is there such a word as outards?? There is now . . .) of microcomputers are going to be in demand.

Bodies: Well first of all, there is HOBBY ELECTRONICS. We have just started a new series for beginners, *All*

About Electronics; going back a bit, Hobby has run *Into Electronics* (Nov '78 to June '79), *Into Digital Electronics* (Sept '80 to Jan '81), *Into Electronics Components* (Aug '81 to July '82) and *Into Electronics Construction* Feb '80 to July '80). All these articles are available from our Backnumbers service, £1.50 an issue.

Then there is the *British Amateur Electronics Club*. Contact **The Secretary, Mr. J. G. Margetts, 113 South Rd., Horndean, Hants PO8 0ER** for information.

Check out your local main library for information about part-time courses in electronics run by your local education authority.

For information on books, check out some of the publishers mentioned in *Look In The Book* (HE February '83) and write for their technical catalogues.

You could also try *Electronics, Its Easy*, the popular collection of reprints on basic electronics compiled by our sister magazine ETI and available for £4.95 from the same address as HE Bookshelf, viz. **513 London Rd., Thornton Heath, Croydon, Surrey CR4 6AR**, which has just been reprinted for the third time.

And you could always contact The Open University, Milton Keynes (right up your street — literally!) — and write to the Courses Information Department and ask what they have. You don't have to commit yourself to doing a degree, and can work entirely at home.

Correspondence courses are a bit outside our frame of reference, but you will find them advertising in many semi-pro electronics magazines, including ETI. One address plucked at random is the **British National Radio and Electronics School, Reading, Berks RG1 1BR**.

Keep and eye on MONITOR which sometimes features self-teaching kits, and electronics and computing clubs.

Build something! But start with a kit, if in doubt — you will have fewer variables to cope with. It's not as complicated as it looks.

Self-education is a convoluted process, full of mysteries. Get a decent multimeter, cultivate an elegant soldering technique, double-check for dry joints, have patience and keep reading Hobby Electronics — and you can't go far wrong . . .

Sine Errato

Dear Sir,
In the HE June '82, Ian Sinclair lets his poetic license run away with him: the sine wave is not so called because it is snake-like but because it is the plot of an actual sine wrt time. The Romans used 'sinus' to describe anything in the curvaceous department. Our 'sinusoid' is the plotting of another curve but just happens to be a curve in itself.

The curve in question is the arc, TQ, of a circle. TQ comes from drawing a tangent TS, a radius OT and a secant OS cutting the circumference at Q. P is the vertical projection (shadow) of Q on OT. To be fair, we don't measure TQ but its height, PQ – because its always harder to measure a curve, even with bits of string. Although 'sine' means a curve (like the sinus in your head), we already have another Latin word, 'arc'. In this context we have corrupted the translation of 'sine' to mean not the curve TQ but its straight height.

As you know, in engineering, navigation etc, useful ratios are:

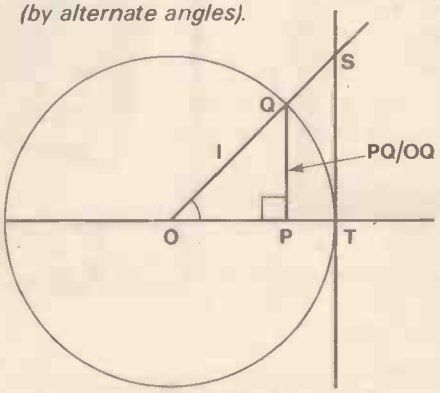
$$\text{sine unit-}^1 \text{ radius} = \frac{PQ}{OQ}$$

$$\text{secant unit-}^1\text{radius} = \frac{OS}{OT} = \frac{OQ}{OP}$$

(by alternate angles) and

$$\text{tangent unit-}^1 \text{ radius} = \frac{TS}{OT} = \frac{PQ}{OP}$$

(by alternate angles).



The unit circle as described in our letter.

The basis for simplifying these long names is to assume a unit circle to begin with. For any such right angled triangle POQ, you can always invent a unit circle with sine PQ/OQ and a radius of one unit (one yard, French loaf, yard per minute, etc.) Now *'sine per unit radius' equals numerically 'sine', since the radius is a unit. Ie, PQ/OQ over 1 equals PQ/OQ, which is why we say simply that the sine of POQ is PQ/OQ. Similarly secants, tangents and the co-functions. I'll leave you to work out the hyperbolics!!!*
Yours faithfully,
Kathy Louise Saint-John Crostorry,
Machen,
Gwent.

Ian Sinclair replies:
"Thanks for the letter. Methinks the lady doth protest too much. The point I was making is that there has to be some reason for calling a ratio of two straight lines a sine, and the shape of the graph of sine (angle) plotted against angle is a good reason, just as the name of the tangent, (from tangere, to touch) must come from the appearance of a graph of tan(angle) plotted against angle."

Well, if you will take advice from a nation which tried to build circles out of straight lines, what can you expect? They spoke Latin too, and where are they now? And now we've got typesetters quoting ancient Greek at us. It's getting "out of hand" (ex digitas), if you ask me . . .

Meet Your Match

Dear Sir,
I have written to three of your advertisers, but none has been able to help me. Would it be possible for you to give me the name of a manufacturer or supplier for the following information?

I would like to obtain five matched pairs of 47uF capacitors or a pair of matched capacitors of the values of 47, 94, 141, 188 and 235 which must be 10-volt working.
Yours faithfully,
R Head.
Heanor,
Derbyshire.

Capacitors are not sold as matched pairs, nor are they available in any of the values you require except 47uF.

To match capacitors, you must have a reasonably large number of the nominal value and then measure the exact value, choosing the closest pair. You'll find our Digital Capacitance Meter, a project published in HE April '82, quite suitable for the job.

As for the odd values, you'll have to make them up by selecting the appropriate values and then correcting them in series or parallel as required.

Capacitor networks are the opposite of resistor networks. Two capacitors in series have the total value of:

$$Ct = \frac{C1C2}{C1+C2}$$

while capacitors in parellel are simply added together, re:

$$Ct = C1 + C2$$

So, to make up a capacitor of 95uF, you need 47 = 47uF. A 141uF capacitor is three 47uf in parallel and so on.

Microlog Transformer

Dear Sir or Madam,
After reading HE December '82, I am building (or trying to build!) an HE Microlog computer.

However, I have had considerable difficulties (apart from postage problems to Dubai) in obtaining a suitable transformer (3VA, 240V, 20-0-20). Please could you send me some information on possible buylines for the transformer (no reference to it was given in the Buylines section of HE) as my only other alternative is a multi-purpose transformer costing over £10.00.

Thank you.
Yours faithfully,
D. Horton-Szar,
Dubai,
UAE.

This is a fairly standard transformer, stocked by many companies who advertise in HE. Try Cricklewood Electronics. **HE**

When you need to update yourself with all that is available in the "Do-it-yourself" market, then you need the Hobby Herald.

Packed with product information essential to the electronics enthusiast, this new electronics catalogue lists over 60 exciting products ranging from All Purpose Cutters to Verobloc, the solderless breadboard. All products are available throughout the U.K. from over 200 stockists.

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7402	11p	7430	13p	7476	28p
7403	12p	7432	20p	7480	45p
7404	12p	7433	20p	7482	65p
7405	14p	7437	23p	7483	30p
7406	19p	7438	24p	7485	60p
7407	19p	7440	14p	7486	19p
7408	13p	7442	30p	7489	180p
7409	13p	7444	85p	7490	19p
7410	13p	7446	58p	7491	34p
7411	15p	7447	36p	7491	24p
7412	17p	7448	43p	7493	24p
7413	17p	7450	14p	7494	33p
7414	23p	7451	14p	7495	33p
7416	19p	7453	14p	7496	38p
7417	19p	7454	14p	7497	86p
7420	14p	7460	14p	74100	78p
7421	19p	7472	22p	74107	22p
7422	19p	7473	24p	74109	24p

CMOS

4000	10p	4020	42p	4042	38p
4001	10p	4021	40p	4043	40p
4002	12p	4022	45p	4044	40p
4006	50p	4023	16p	4046	40p
4007	14p	4024	33p	4047	35p
4008	38p	4025	12p	4048	38p
4009	24p	4026	75p	4049	21p
4010	24p	4027	20p	4050	21p
4011	10p	4028	40p	4051	42p
4012	18p	4029	45p	4052	48p
4013	20p	4030	14p	4053	48p
4014	45p	4031	125p	4054	78p
4015	40p	4034	140p	4055	80p
4016	20p	4036	249p	4059	430p
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4018	45p	4040	40p	4063	80p
4019	25p	4041	40p	4066	22p

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FORWARD BIAS

Questions, answers and errata from readers and writers.

The **Soft Fuzz** project, published in Hobby Electronics last month, was originally designed as a two-step unit to which extra steps could be added at the constructor's whim, to experiment with different effects. The author has a few words (and numbers!) to add on the subject:

"From the explanations given in the Soft Fuzz article, it is a small step to design a feedback network to produce any required type of compression. First of all, you should draw a graph of the required characteristics. When you are satisfied with the shape of the graph, read from it the slopes (hence the gains needed), and the output voltages at which the slope of the graph changes.

Taking a two-step circuit as an example, suppose that you wanted the gain to be 1 for large signals. For smaller signals let us say that we want a gain of 13½ for outputs up to 1V2 and a gain of 5.2 from 1V2 to 2V.

First of all, since the final gain is to be 1, R13 must be the same value as R3 (3k3) — simple. Next, calculate for the gain of 5.2. For this, R11 + R12 + R13 must be equal to 5.2 x R3.

Therefore, since R13 = 1 x R3, R11 + R12 = 4.2 x R3 = 13k86.

Similarly, for the gain of 13.5, R1 + R2 + R11 + R12 + R13 must be equal to 13.5 x R3. Since R11 + R12 + R13 = 5.2 x R3, R1 + R2 = 13.2 – 5.2) x R3 = 27k39.

The next step is to calculate the ratios of the resistors. Since we know the total resistance of each pair, it is simple (with a calculator) to multiply the total value by the appropriate fraction, and then pick the nearest preferred value to the answer.

The best way to find the required ratios is to start with the lowest voltage breakpoint, 1V2. This is the charge from the highest gain to the intermediate gain, so resistors R1 and R2 are the ones concerned.

In order to switch to TR1 or TR2, a voltage of OV6 must be developed across R1. For a 1V2 breakpoint, this allows OV6 across all other resistors together. This means that R1 is half of the total resistance value, which is 13.5 x 3k3 = 44.55k =>R1 = 22k275 equals about 22k. Since R1 + R2 = 27k39, R2 should be 5k39, so pick the nearest preferred value: 5k6.

In order to make it simple to calculate R11 and R12, you can remove TR1, TR2, R1 and R2 from the calculation.

Once TR1 or TR2 has switched on, R1 and R2 have no further resistive effect on the feedback. The effect of the network is to subtract a voltage from that appearing across the rest of the feedback network. This voltage is:

$$\frac{(R1 + R2)}{R1} \times OV6 =$$

$$\frac{(22 + 5.6)}{22} \times OV6 = OV753$$

Therefore when the output reaches 2V, there will be 1V247 across the rest of the feedback network. The calculation is now carried out much as above: for OV6 across R11, R11 = OV6 x R11 + R12 + R13 (ie 17k16 => R11 = 8k256 — so choose the preferred value of 8k2.

To find the final resistor, R11 + R12 + R13 + 17k16 and R11 + R13 = 313 + 8.2 = 11.5 => R12 = 17.16 – 11.5 = 5k66, so choose the preferred value of 5k6.

That's it! All calculated!

With enough patience for tedious sums, this can be extended to many more stages.

Incidentally, if you happen to possess a 'scope and a triangle wave generator, and if you dislike sums, you could make up the circuit with resistor values chosen by "finger in the air" methods, display the performance on the scope, and modify the values until the performance pleases you."

Or — we suppose — you could attach it to an electric guitar and see what happens! Just remember to disconnect the power before you change any components, that's all . . .

COLLECTED BOOBS

Starting right here, Forward Bias is going to reprint all the official Hobby Electronics Errata Cards, going back to January 1979, for the benefit of those readers who are either struggling with a project which has some nameless disease, or who are thinking of embarking on an old Hobby project.

Photocopies of Errata Cards are still available on request with an SAE or International Reply Coupons, but regular readers will now have the chance to build up their own file.

Let's get started:

Flash Trigger
(HE January '79)

Figure 3: 'RV1' label on the right hand side of the board should read 'RV1 Wiper'.bng.

The **Parts List** should read:

R1, 2 ..... 33k
R3-5 ..... 330k
R6 ..... 100k
R7 ..... 470R

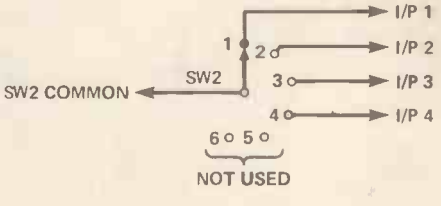
Also:

RV1 ..... 50k linear

Some switch details were omitted. They are:

SW1 ..... SPST On/Off
SW2 ..... 2 pole 6 way rotary (only 1 pole 4 ways used)

SW2 should be connected as follows:



Drill Speed Controller
(HE June '79)

Figure 1: On the Circuit Diagram, the link shown shorting Q1 base and collector, and Q2 base and collector together is incorrect. The PCB and overlay give the correct version.

Starburst *(HE September '79)*

PCB Overlay: the OV and +9V notation should be swapped over. Also, reduce R7 - R11 to 15 - 18k for reliable switching.

Recent Errata

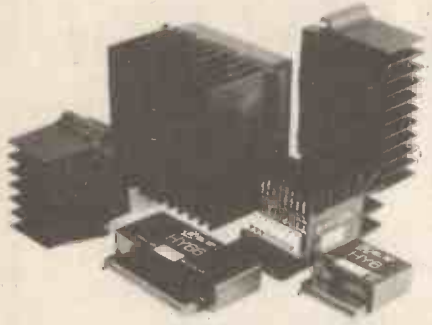
HE Starburst (HE September '79) see *Projects From The Past,* Points of View HE May '83.
Big Ear (HE December '82) see *Ear Errata,* Points of View HE March '83.
Microlog (HE December '82) see *Microlog Mistake,* Points of View HE March '83, and *Microlog Errata,* Monitor and PCB Printout HE January '83.
HE Echo-Reverb (HE May '82) see *Designer On The Dole,* Points of View, HE December '82.

Past Project Progress

There is now a PCB available from our PCB service for the **Low Cost Alarm** (HE December '82) — see the PCB Printout, HE June '83.
The troublesome **Telephone Timer** (HE June/July '82) is being re-examined from the bottom up by our technical team (all of him), but the solution is not yet on schedule for publication and probably won't be for some time. The **Echo Reverb** (HE May '82 may also be coming in for scruitiny shortly.

HE

GET BIG POWER



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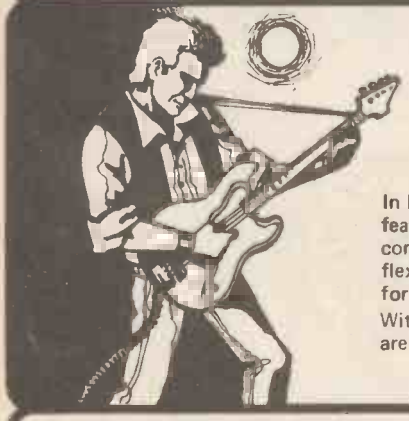

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HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
HY364	180	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

Protection: Full load line, Slew Rate: 15v/µs. Risetime: 5µs. S/N ratio: 100db.
Frequency response (−3dB) 15Hz – 50KHz. Input sensitivity: 500mV rms.
Input Impedance: 100K Ω . Damping factor: 100Hz > 400.

PRE-AMP SYSTEMS

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HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp.
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PSU 21X	1 or 2 HY30	£11.93
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PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	£17.07
PSU 53X	2 x MOS128	£17.86
PSU 54X	1 x HY248	£17.86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	£21.75

Model Number	For Use With	Price inc. VAT
PSU 72X	2 x HY248	£22.54
PSU 73X	1 x HY364	£22.54
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

Please note: X in part no. indicates primary voltage. Please insert "0" in place of X for 110V, "1" in place of X for 220V, and "2" in place of X for 240V.

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	DISTORTION I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.54

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/µs. Rise time: 3µs. S/N ratio: 100db
Frequency response (−3dB): 15Hz – 100KHz. Input sensitivity: 500mV rms
Input Impedance: 100K Ω. Damping factor: 100Hz > 400.

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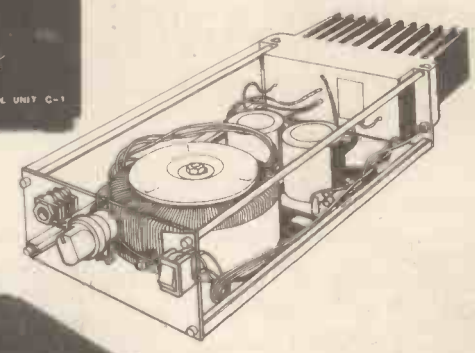

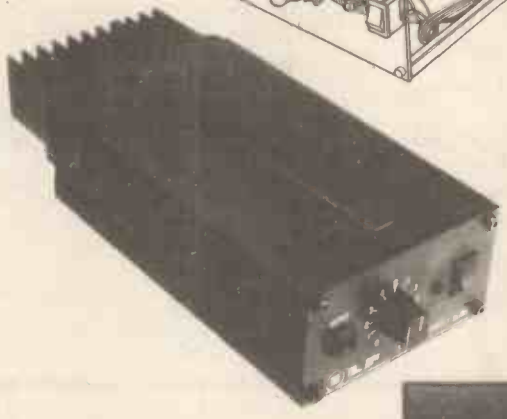

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Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

Hi Fi Separates

UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, (<0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

UNICASES

HIFI Separates					Price inc. VAT
UC1	Preamp				£29.95
UP1X	30 + 30W/4–8Ω	Bipolar	Stereo	HiFi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8Ω	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipolar	Mono	HiFi	£74.95
UP6X	60W/4–8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4–8Ω	MOS	Mono	HiFi	£84.95
Power Slaves					
US1X	60W/4Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4–8Ω	MOS	Power	Slave	£69.96
US4X	120W/4–8Ω	MOS	Power	Slave	£89.95

Please note X in part number denotes mains voltage. Please insert '0' in place of X for 110V, '1' in place of X for 220V (Europe), and '2' in place of X for 240V (U.K.) All units except UC1 incorporate our own toroidal transformers.

TO ORDER USING OUR FREEPOST FACILITY
Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to I.L.P. Electronics Ltd. if sending cash, it must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order.

PAYMENT MAY BE MADE BY ACCESS OR BARCLAYCARD IF REQUIRED

ILP ELECTRONICS LTD

Post to: ILP Electronics Ltd., Freepost 4, Graham Bell House, Roper Close, Canterbury CT2 7EP, Kent, England.
Telephone: (0227) 54778.
Technical: (0227) 64723.
Telex: 965780.

Please send me the following _____

Total purchase price _____

I enclose Cheque ☐ Postal Orders ☐ Int. Money Order ☐

Please debit my Access/Barclaycard No. _____

Name _____

Address _____

_____

Signature _____

BUYLINES

Joystick Controller

A full set of parts and components for this project, including the PCB and a two-button joystick, is being supplied by **Cambridge Computing,** 1 Benson Street, Cambridge CB4 3QJ. A motherboard is provided as part of the package so don't forget to specify which computer (ZX81, Spectrum or Ace) you intend to use with it. An instruction sheet for assembling the Spectrum motherboard, which carries a 5V regulator, will be included where appropriate.

The cost of the kit is £26.00, including VAT, packaging and postage, and a cassette of joystick operating software for all three computers.

Expanding The Ace

Usually it's easy enough to locate a single supplier for all the components of a Hobby Electronics project, but not always! For this project you'll need to go to at least two suppliers for all the requisite bits and pieces.

For the semiconductors, try **Technomatic,** who stock a very large range of digital components. They can also supply the IC sockets which, while not essential, provide some flexibility when first completing the project.

The interface section of the project is connected to the real world via two 12-way inter-PCB plugs, and one of the few sources for these gadgets is **Ambit International.** Order them using Ambit's stock code numbers: 10-03012 for the plugs, 10-03003 for the cable shells and 10-03030 for the crimp terminals (don't forget that you need 24 of them). Ambit can also provide the ICs and the passive components, if you dont already have them.

Finally there is the PCB edge connector socket that plugs onto the Ace expansion port. Like the ZX81, the Ace uses a 23+23-way (double-sided) edge connector, but differs in that the polarising key is in position 23, at the extreme left of the expansion port as viewed from the rear (our numbering of the Ace port pins thus follows the convention established in the many volumes of literature on the ZX81 and Spectrum, where the pins are numbered from right to left as viewed from the rear).

Again, there are alternative sources of supply for the socket; **Technomatic** can supply a 25+25 way unpolarised socket which can easily be modified to place the polarising key in the correct position (if you state that the component is for this project and ask them nicely. Technomatic will do the modification for you).

Alternatively a 23+23-way socket with the key in position 23 is available from **Innovonics,** 147 Uplands Road, East Dulwich, London SE22 0DF.

Whistle Switch

A novel project, this, but one for which the imaginative constructor will find many uses!

The standard components — resistors, capacitors, most of the semiconductors — are all easily obtainable. Where there might be some problem is in finding the transformer, and the relay.

T1 is a sub-miniature 12-0-12V type, rated at 50mA per winding (1.2VA total) and, somewhat unusually, is not intended for printed circuit board mounting. The required type should measure about 30 x 27 x 25mm, and the fixing centres should be at 36mm to fit the holes marked out on the PCB. However if the exact type can't be had, it should be easy enough to drill the PCB to accept slightly wider fixing centres. Alternatively the transformer could be mounted off the board and wired into the appropriate PCB points (this will mean a bigger case, too).

The specified relay is an ultra-miniature mains relay with a single changeover contact rated at 10A; it is an unusual device, with unusual pin-outs and so it will be hard to find a substitute unless you're prepared to re-design the PCB tracks!

The alternative to modifying the project (a course we do not recommend, as it happens), is to contact **Magenta Electronics,** who have kindly arranged to stock exactly the type of relay and transformer required for the project.

The most important IC to find is the 567 tone decoder/PLL; it may be either an NE567 or an LM567 — they're equivalent, so it doesn't matter. Similarly a TL071 could be substituted for the specified 081, with some improvement in the noise performance, and any of the standard general purpose silicon PNP transistor types could be used in place of the BC109 — BC149, 319, 549 and so on.

All these other bits and pieces are also available from **Magenta,** of course, and the cost of the project excluding case and PCB should be around £10.00. A Vero type GP3 case, which measures 180 x 110 x 55mm, is £2.28 and the price of the PCB can be found by looking at our PCB Service page.

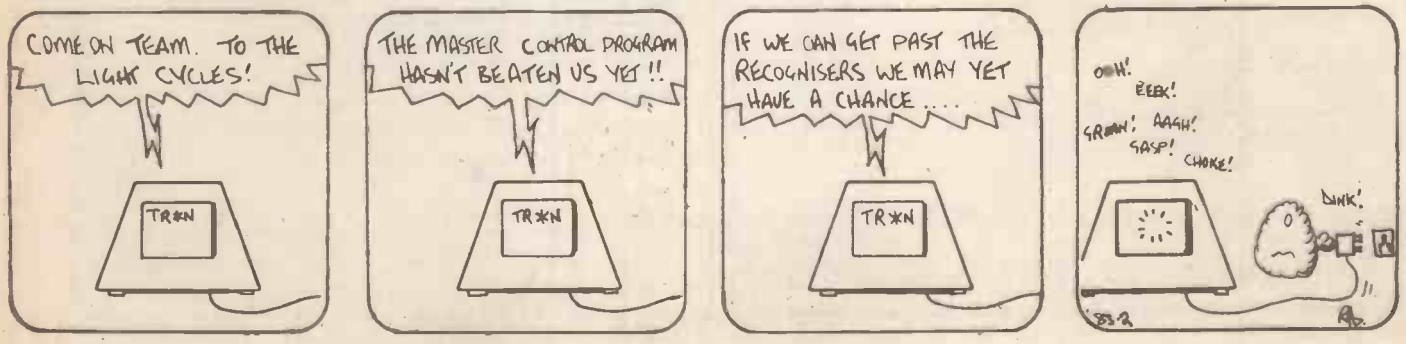
Auto-Winder

No problems with this project — all the components are stock-standard and available from regular mail order companies such as **Rapid Electronics** in Colchester.

The relays are both 12VDC/160-240R coil types with contacts rated at 5 amps or better. If the relays and PCB are mounted in one case, it should measure approximately 4" x 4" x 1½" (101 x 101 x 64mm); if the relays are mounted separately the case for the PCB alone will need to be at least 4" x 2" x 1½" (101 x 50 x 64mm). Either way, use a metal case — folded or diecast aluminium — not plastic!

The cost of the Auto-Winder project ought to be under £10 including the relays but not the PCB or the metal box.

BEASTIES BY AH



Rapid Electronics

MAIL ORDERS:
Unit 2, Hill Farm Industrial Estate,
Boxted, Colchester, Essex CO4 5RD.
TELEPHONE ORDERS:
Colchester (0206) 36412.

ACCESS AND BARCLAYCARD WELCOME

LINEAR

555CMOS	80	ICL7106	790	LM339	45	LM3911	120	NE566	140	TL064	96
556CMOS	150	ICL7611	95	LM348	60	LM3914	175	▶NE567	100	TL071	30
709	25	ICL7621	180	LM358	50	LM3915	195	▶NE570	370	TL072	50
▶741	14	ICL7622	180	LM377	170	LM13600	105	NE571	370	TL074	95
748	35	ICL8038	295	▶LM380	85	MC1496	68	▶RC4136	55	▶TL081	25
9400CJ	350	ICL8211A	200	▶LM381	120	MC3340	135	▶RC4558	60	TL082	45
AY-3-1270	720	ICM7224	785	LM382	120	▶MF10CN	350	SL480	170	TL084	95
AY-3-8910	370	ICM7555	80	LM384	130	ML922	400	SL490	250	TL170	50
AY-3-8912	540	▶LF351	45	LM386	65	ML924	195	SL76018	150	UA2240	120
CA3046	60	LF353	85	LM387	120	ML925	210	▶SN76477	380	ULN2003	85
▶CA3080	65	LF356	90	LM389	100	ML926	140	SP8629	250	ULN2004	90
CA3089	190	LM10	360	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3090AQ	375	LM301A	25	LM711	60	ML928	140	TBA800	75	ZN414	100
CA3130E	85	LM311	70	LM725	350	ML929	140	TBA810	96	ZN423	135
▶CA3140E	36	LM318	120	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3161E	100	LM324	40	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3189	290	LM334Z	100	LM747	60	NE531	150	TDA1008	320	ZN426E	330
▶CA3240E	110	LM335Z	125	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	650
				LM2917	200	▶NE555	16	TDA1024	125	ZN428E	480
				LM3900	45	▶NE556	45	TL061	40	ZN459	285
				▶LM3909	70	NE565	110	TL062	60	ZN1034E	200

TRANSISTORS

			BC517	40	BF337	40	MPSU56	60	ZTX108	8	2N3055	50
			BC547	7	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
			BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶2N3702	6
AC125	35	BC149	9	BC549	10	▶BFR81	20	TIP29C	37	ZTX301	16	2N3703	9
AC126	25	BC157	8	BC558	10	BFX29	25	TIP30A	35	ZTX302	15	▶2N3704	6
AC127	25	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
▶AC128	20	BC159	8	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30	2N3706	9
AC176	25	BC160	45	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD142	120	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	50	ZTX504	25	▶2N3773	195
AD161	40	BC172	8	BD135	40	BFY52	23	TIP33C	75	2N697	20	▶2N3819	18
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	BD138	30	BFY56	32	TIP35A	105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC182L	8	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
AF239	75	BC183	10	BD204	110	BSX29	35	TIP36C	135	2N1613	30	2N3905	6
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	2N2218A	45	2N3906	10
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	2N2219A	25	2N4037	45
▶BC108	10	BC184L	7	BF180	35	BU206	180	TIP120	90	2N2221A	25	2N4058	10
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90	2N2222A	20	2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
▶BC109	10	BC213	10	BF185	25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
BC109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF195	12	MJE521	95	TIP147	110	2N2646	45	2N5458	36
BC115	22	▶BC214L	8	BF196	12	MJE3055	70	TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	8	BF197	12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40	2N2905	22	2N5777	45
BC137	40	BC308	12	BF199	18	MPSA05	22	TIS44	45	2N2905A	22	2N6027	30
BC139	40	BC327	14	BF200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF244B	22	MPSA12	30	TIS91	30	2N2906A	25	40361	50
BC141	30	BC337	14	BF245	30	MPSA55	30	VN10KM	45	2N2907	25	40362	50
BC142	25	BC338	14	BF256B	45	MPSA56	30	VN46AF	75	2N2907A	25	40408	70
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF	85	2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		
BC148	8	BC479	30	BF259	35	MPSU55	60	ZTX107	8	2N3054	55		

CABLES

20 metre pack single core connecting cable ten different colours.	65p
Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	65p/m
20 way rainbow ribbon	120p/m
10 way grey ribbon	38p/m
20 way grey ribbon	80p/m

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	SPECIAL OFFER!	
LM317T	120	78P05 10A +5V	
LM323K	350	only 390p each.	

DIODES

BY127	12	▶1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	12
OA202	8	1N5404	16
1N914	4	1N5406	17
▶1N4148	3	400mWzen	6

OPTO

▶3mm red	7	▶5mm red	7
▶3mm green	10	▶5mm green	10
▶3mm yellow	10	▶5mm yellow	10
Clips to suit - 3p each.			
Rectangular		TIL32	40
▶red	12	TIL78	40
green	17	▶TIL111	60
yellow	17	ORP12	85
▶TIL38	40	TIL100	90
2N5777	45	Dual colour	60
Seven segment displays:			
Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500		FND507	
0.5"	100	0.5"	100
TIL313 0.3"115		TIL312 0.3"115	
TIL322 0.5"115		TIL321 0.5"115	
LCD: 3½ digit 580p. 4 digit 620p.			

HARDWARE

PP3 battery clips	8
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	350
▶6V Electronic buzzer	60
▶12V Electronic buzzer	65
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25

POTENTIOMETERS

Rotary. Carbon track Log or Lin 1K - 2M2. Single 32p, Stereo 85p. Single switched 80p. Slide 60mm travel single Log or Lin 5K - 500K 63p each.
Preset submin. hor. 100 ohms - 1M 7p each.
Cermet precision multiturn, 0.75W ¾" 100 ohms to 100K - 88p each.

TRIACS

	400V 8A	65
	400V 16A	95
400V 4A	50 BR100	25

MULTIMETERS

HT-120 4,000 opv
A smart looking 11 range pocket sized multimeter with an impressive spec. Complete with battery, etc. 650p each.
HT-320 20,000 opv.
Highly sensitive 19 range multimeter including transistor tester. Overload protection, DC volts — 1000, AC volts — 1000; DC current 0.25A. 4 resistance ranges. Complete with batteries, leads, etc. 1395p

CAPACITORS

Polyester, radial leads, 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2, 50p.
Tantalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

BRIDGE RECTIFIERS

	2A 200V		40
	2A 400V		45
	6A 100V		80
	6A 400V	95	
1A 50V	20	VM18 DIL	0.9A
1A 400V	35	200V	50

EPSON PRINTERS

Latest generation printers from Epson. Logic seeking, bi-directional, bit image printing, 9 x 9 Matrix, Auto underline, Centronix 8 Bit Parallel Interface as standard.

RX80 100 CPS 80 column
Tractor feed £288.00

FX80 160 CPS 80 column
Tractor Feed £398.00

Carriage £7 per printer.

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	60p	85p	125p	170p
Right angle	120p	180p	240p	350p
Sockets lugs	90p	130p	195p	290p
Right angle	160p	210p	290p	440p
Covers	100p	90p	100p	110p

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors: PL259 Plug 40p. Reducer 14p. SO239 square chassis skt 38p. SO239S round chassis skt 40p. IEC 3 pin 250V/6A.
Plug chassis mounting . . 38p
Socket free hanging . . . 60p
Socket with 2m lead . . . 120p

SCRs

▶C106D	30
400V 8A	70
400V 12A	95

SOLDERING IRONS

Antex CS 17W Soldering iron	460
2.3 and 4.7mm bits to suit	85
CS 17W Iron: 450, element:	210
Antex XS 25W	480
3.3 and 4.7mm bits to suit	85
Solder pump desoldering tool.	480
Spare nozzle for above	70
10 metres 22swg solder	100

TOOLS

Small trimming tool	22
Small pocket screwdriver	16
Large pocket screwdriver	13
6 piece precision screwdriver set in plastic case	170
Low cost side cutters	160
High quality side cutters	650
Low cost pliers	160
High quality pliers	650
Wire strippers	120
Expo reliant drill	695
Expo Titan drill	1025
Drill stand	1200

VERO

VEROBLOC Size 0.1 matrix:	350
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	85
3.75 x 5	95
VQ board	160
Veropins per 100:	
Single sided	50
Double sided	60
Spot face cutter	105
Pin insertion tool	162
Wiring pen and spool	310
Spare spool 75p Combs	6

SWITCHES

Submin toggle.
SPST 55p, SPDT 60p, DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 12p.
Push to make 14p.
Push to break 22p.
Rotary type adjusable stop. 1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST 100p.

MICRO

		6116P3	320	6852	240	8228	220
		6502CPU	325	6875	495	8251	250
		6522VIA	295	8880	100	8253	390
		6532	570	81LS95	85	8255	225
		6551ACIA	650	81LS96	85	8259	390
2114L2	75	6800CPU	220	81LS97	85	MC1488	55
2716	205	6802CPU	250	8080A	250	MC1489	55
2532	290	6809CPU	620	8085AC	340	Z80ACPU	290
2732	290	6810RAM	115	8156	350	Z80APIO	260
2764	540	6821PIA	110	8212	110	Z80ACTC	260
4116P20	70	6840	360	8216	100	Z80ASIO	900
5101L-1	220	6850	110	8224	120	Z80ADMA	1150

SOCKETS

	Low profile	Wire wrap
8 pin	6p	25p
14 pin	8p	35p
16 pin	9p	42p
18 pin	12p	52p
20 pin	13p	60p
22 pin	16p	70p
24 pin	18p	70p
28 pin	23p	80p
40 pin	25p	98p

Soldercon pins 60P/100

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) 530
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . 875
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets 425
Nut and Bolt kit (total 300 items): 180p
25 6BA ¼" bolts 50 6BA washers
25 6BA ¼" bolts 50 4BA ¼" bolts 50 6BA washers
50 6BA nuts 25 6BA ½" bolts.

RESISTORS

¼W 5% Carbon film E12 series 4.7 ohm - 10M . . . 1p each.
½W 5% Carbon film E12 series 4.7 ohm to 4M7 . . . 2p each.
¼W 1% metal film E24 series 10 ohm - 1M . . . 6p each.

PCB MATERIALS

Alfac transfer sheets — please state type (e.g. DIL pads etc.)	45
Dalo etch resistant pen	100
Fibre glass board 3.75 x 8"	80
Fibre glass board 8 x 12"	200
Ferric Chloride crystals	100

BOXES

		Aluminium	
		3 x 2 x 1"	65
Plastic with lid		4 x 2¾ x 1½"	95
& screws		4 x 2¾ x 2"	95
3 x 2 x 1"	56	6 x 4 x 2"	120
4½ x 3 x 1¼"	88	7 x 5 x 2½"	165
7 x 4 x 2"	160	8 x 6 x 3"	205

CMOS

		4016	20	4034	140	4054	78	4081	12	40193	65	4528	45
		4017	30	4036	249	4055	80	4082	12	4502	60	4529	150
		4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
4000	10	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
4001	10	4020	42	4041	40	4063	80	4089	125	4508	110	4538	60
4002	12	4021	40	4042	38	4066	22	4093	18	4510	45	4543	50
4006	50	4022	45	4043	40	4067	225	4094	68	4511	40	4549	360
4007	14	4023	16	4044	40	4068	14	4095	65	4512	40	4553	215
4008	36	4024	33	4046	40	4069	13	4097	290	4514	118	4555	35
4009	24	4025	12	4047	35	4070	13	4098	70	4515	115	4556	35
4010	24	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
4011	10	4027	20	4049	21	4072	13	40106	40	4518	40	4560	140
4012	15	4028	40	4050	21	4073	13	40109	110	4520	50	4584	35
4013	20	4029	45	4051	42	4075	13	40163	60	4521	130	4585	60
4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
4015	40	4031	125	4053	48	4077	14	40175	75	4527	50		

LS TTL

	LS20	12	LS75	20	LS123	34	LS160	35	LS197	45	LS353	60
	LS21	12	LS76	17	LS125	24	LS161	35	LS221	50	LS365	28
	LS22	12	LS78	17	LS126	25	LS162	35	LS240	60	LS366	28
LS00	11	LS26	14	LS83	35	LS132	38	LS163	35	LS241	55	LS367	28
LS01	11	LS27	12	LS85	48	LS136	26	LS164	40	LS242	55	LS368	29
LS02	11	LS30	12	LS86	16	LS138	30	LS165	55	LS243	55	LS373	58
LS03	12	LS32	13	LS90	24	LS139	30	LS166	60	LS244	55	LS374	60
LS04	12	LS37	14	LS92	25	LS145	70	LS170	75	LS245	70	LS375	43
LS05	12	LS38	15	LS93	24	LS147	150	LS173	60	LS247	48	LS377	60
LS08	12	LS40	13	LS95	38	LS148	75	LS174	45	LS251	28	LS378	57
LS09	12	LS42	28	LS96	95	LS151	38	LS175	48	LS257	32	LS390	45
LS10	12	LS47	35	LS107	40	LS153	38	LS190	35	LS258	32	LS393	40
LS11	12	LS48	45	LS109	21	LS154	75	LS191	35	LS259	55	LS399	156
LS12	12	LS51	14	LS112	21	LS155	33	LS192	35	LS266	20	LS541	78
LS13	19	LS55	14	LS113	21	LS156	36	LS193	36	LS273	58	LS670	135
LS14	30	LS73	18	LS114	22	LS157	26	LS195	32	LS279	30		
LS16	12	LS74	17	LS122	35	LS158	29	LS196	45	LS283	38		

TTL

	7413	17	7444	85	7483	30	74122	38	74161	46	74190	40
	7414	23	7446	58	7485	60	74123	38	74162	46	74191	40
	7416	19	7447	36	7486	19	74125	33	74163	46	74192	40
7400	11	7417	19	7448	43	7489	180	74126	33	74164	46	74193	40
7401	11	7420	14	7450	14	7490	19	74132	30	74165	46	74194	40
7402	11	7421	19	7451	14	7491	34	74141	54	74167	150	74195	40
7403	12	7422	19	7453	14	7492	24	74145	48	74170	115	74196	40
7404	12	7427	18	7454	14	7493	24	74147	75	74173	58	74197	40
7405	14	7428	25	7460	14	7494	33	74148	60	74174	53	74198	80
7406	19	7430	13	7472	22	7495	33	74150	48	74175	45	74199	80
7407	19	7432	20	7473	24	7496	38	74153	38	74176	35		
7408	13	7433	20	7474	19	7497	86	74154	47	74177	42		
7409	13	7437	23	7475	28	74100	78	74155	36	74179	75		
7410	13	7438	24	7476	25	74107	22	74156	36	74180	38		
7411	15	7440	14	7480	45	74109	24	74157	28	74181	100		
7412	17	7442	30	7482	65	74121	24	74160	55	74182	55		

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Just Whistle

R. A. Penfold

It won't fetch you a private taxi, fix you a long, cool cocktail or come running up with your tennis ball when you call it, but it *will* turn you household gadgets off and on, and doesn't require tactful handling or regular feeding!

The Whistle Switch unit is a novel form of remote control which enables an item of mains powered equipment to be switched on and off at will, simply by whistling the appropriate note! Although the system was designed originally for its novelty value, it is in fact a practical form of remote control and has the advantage over most other systems of not requiring a transmitter of some kind to activate the receiver. The unit could also be very useful to a disabled person, so it is not purely frivolous.

The maximum range that can be obtained depends on a number of factors such as the sensitivity of the microphone used, but a range of about 6 meters or so can be readily achieved using the prototype equipment, and this is more than adequate since the unit is only intended for the control of equipment in the same room as the user (like the popular infra-red and ultrasonic remote control systems). Using the specified relay the unit can control mains equipment having a power rating of up to 2400 watts.

Tone Decoder

The device at the heart of the Whistle Switch is an NE567 phase locked loop tone decoder. The block diagram of **Figure 1** shows the internal arrangement of this device plus the discrete components required in order to make it function correctly.

A fairly conventional phase locked loop circuit is formed by the phase comparator, amplifier, and current controlled oscillator (CCO). Most phase locked loops use a voltage controlled oscillator (VCO) rather than a CCO, but the basic method of operation is the same using either type. With no input signal the CCO receives a control current that sets its operating frequency at roughly the centre of its operating range. The values of R2 and C1 set this free running frequency.

If an input signal is applied to the circuit, and is at the same frequency and in phase with the signal from the CCO (in other words the two signals rise and fall in amplitude precisely in unison and with the same polarity) there is no change in the output signal from the phase comparator and the following amplifier stage. If the

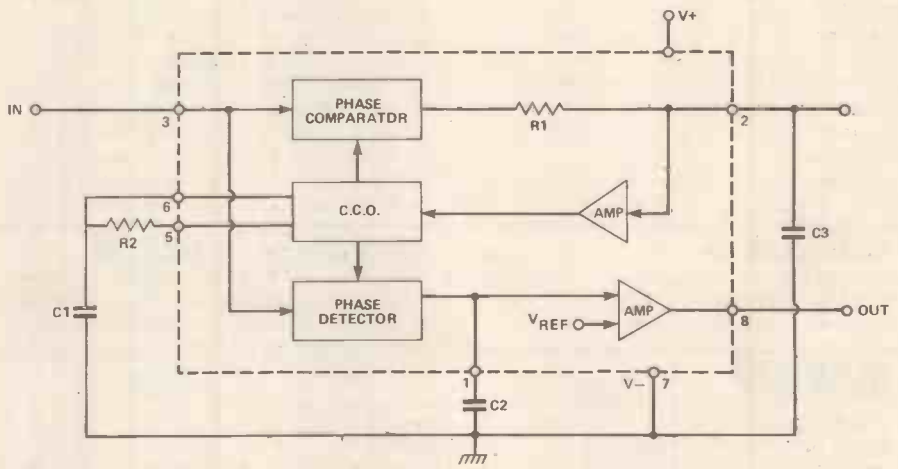
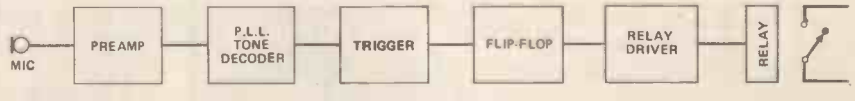


Figure 1. The block diagram, with internal units and components.

How It Works

Basically the unit is very straight forward, as can be seen from the block diagram. The output signal from the microphone is extremely small and is first amplified by a high gain preamplifier to produce a usable signal level. The signal is then fed to a phase locked loop (PLL) tone decoder, and this activates a switch if the input signal is within a fairly narrow band of frequencies. A trigger circuit plus some simple filtering are used to give a clean switching action as the input tone commences and finishes, so that multiple operation of the circuit and unreliable results are avoided.

If the trigger circuit was to be used to directly drive a relay or relay driver stage the relay would only be switched on while the input tone was present and this would be of limited practical use. A flip-flop is therefore used between the trigger and relay driver circuits so that each time a burst of tone is received at the input the relay changes state (ie if it is on, it switches off; or if it is off, it switches on). A set of relay contacts are used to control the load.



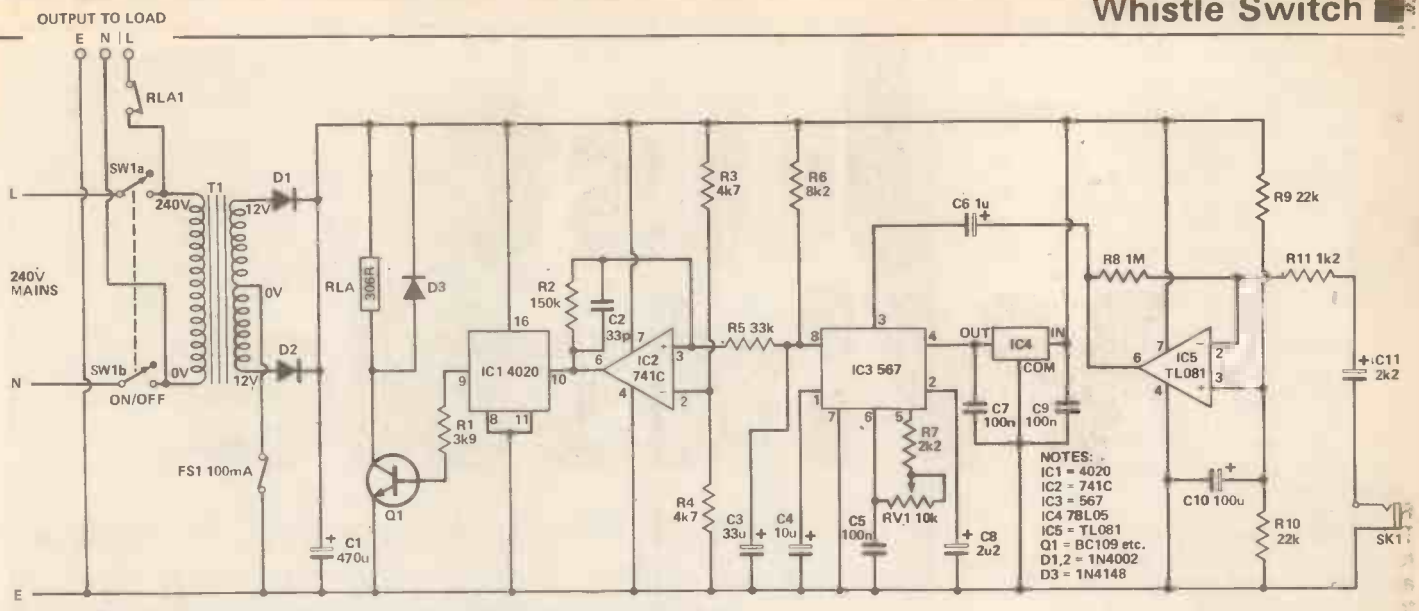


Figure 2. The circuit. SW1 disconnects the unit from the mains.

input signal is at a higher frequency than the CCO or leading it in phase, then the output voltage from the phase comparator increases slightly, and the amplified signal is fed to the CCO as an increased control current. This raises the operating frequency of the CCO so that it locks onto the frequency of the input signal and keeps in phase with it. Of course, this only happens if the input signal is reasonably close to the free running frequency of the CCO ie, within the locking range.

A similar thing happens if the input signal is at a slightly lower frequency than the CCO, but the output voltage from the phase comparator reduces as does the control current from the amplifier so that the operating frequency of the CCO reduces to match that of the input signal, and the CCO is locked in-phase with the input signal. The output from the phase comparator is actually a series of pulses, and the required control voltage for the amplifier is obtained by feeding these pulses to a lowpass filter which is comprised of R1 and C3. This simply gives an ouput voltage which is an average of the output potential from the phase comparator.

The CCO is used to operate an electronic switch, and it closes the switch on positive output half cycles and opens it on negative half cycles. The input signal is fed via this switch to a capacitor (C2), and if then the phase locked loop has achieved lock the input signal will only be connected to the capacitor during positive half cycles. This gives a strong positive charge on C2, producing a sufficiently large potential to activate the voltage comparator and switch on a transistor at the output of this circuit. If the input signal and CCO are not phased locked, the switch will sometimes conduct while the input is positive going, but it will conduct while the input is negative going as well, and just as often. This gives only a low charge on C2 since the positive and negative input signal tend to cancel out one another. The output transistor of the voltage comparator does not therefore switch on.

This may seem a rather complex way of doing things when compared to a filtering and level detection arrangement, which it is, but the complexity is in the NE567 integrated circuit and only four discrete components are needed (R1 is within the IC), R2 and the three capacitors are discrete components). Also, using conventional filtering it would be difficult to obtain a similar level of performance. This arrangement has good sensitivity to any signal within the locking range of the PLL, but signals outside the locking range cannot activate the circuit. This gives the circuit what is effectively an ideal frequency response for tone decoding applications, and provides virtually complete immunity against spurious operation.

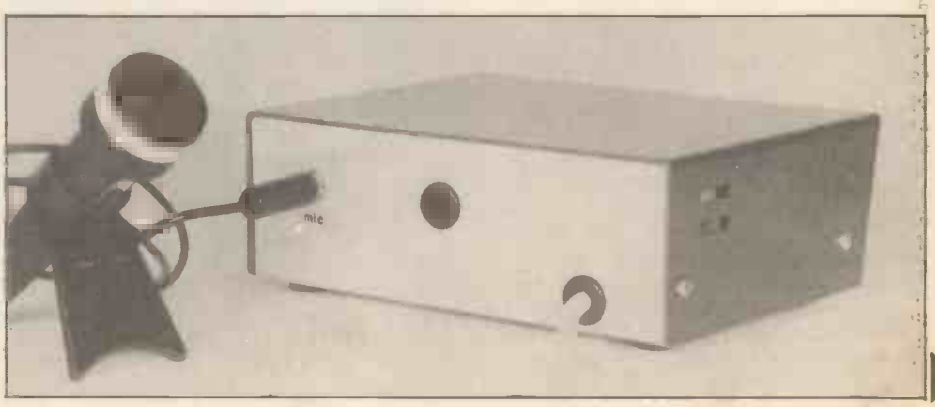
The Circuit

The full circuit diagram of the Whistle Switch appears in **Figure 2**. As the unit will be left running continuously and has a significant current consumption even when the relay is not switched on, it would be impractical to power the unit from batteries, and a simple unregulated mains power supply is therefore used. This uses push-pull fullwave rectification, and smoothing is provided by C1.

The preamplifier stage uses a BIFET operational amplifier, IC5, as a simple inverting amplifier having a voltage gain of nearly 60dB (1000 times). An output level of around 20 millivolts RMS is sufficient to drive the next stage of the circuit, and this obviously gives the unit a high degree of sensitivity. However, the preamplifier is designed for use with a low impedance dynamic (cassette type) microphone and the output level from one of these is usually no more than a few hundred microvolts even if the microphone is in quite close proximity to a loud sound. This high sensitivity is therefore essential in order to give the unit a good maximum operating range.

IC3 is the NE567 PLL tone decoder, and this is powered from the main supply lines via a 5 volt monolithic voltage regulator. This prevents the device from receiving an excessive supply voltage and also helps to avoid problems with the lock frequency range drifting. C5, R7, and RV1 control the centre frequency of the PLL, and using RV1 the centre frequency can be adjusted from about 700HZ to approximately 4kHZ. C8 is the lowpass filter capacitor and C4 is the charge storage capacitor in the output switching section of IC3.

Getting a system of this type to operate reliably is more difficult than it might at first appear, due to the fact that the input signal does not consist of perfectly gated tone bursts, and is likely to be contaminated with a



substantial amount of noise. The NE567 gives excellent noise immunity, and an R-C filter at the output (R6 plus C3) largely overcomes problems with the input signal starting and finishing less than instantly. IC2 is used as a trigger circuit having a substantial amount of hysteresis, and the 4020BE divide by two circuit also has a trigger circuit at its input. A combination of all these measures give the unit excellent reliability.

Q1 is the relay driver and this is fed from the output of the first binary counter stage of IC1 via current limiting resistor R1 (IC1 is a 14 stage binary counter, incidentally). A set of normally closed relay contacts are used to switch the "live" supply lead to the piece of (mains powered) controlled equipment. An on/off switch is included, and this can be used to disconnect both the Whistle Switch and the controlled equipment from both sides of the mains supply.

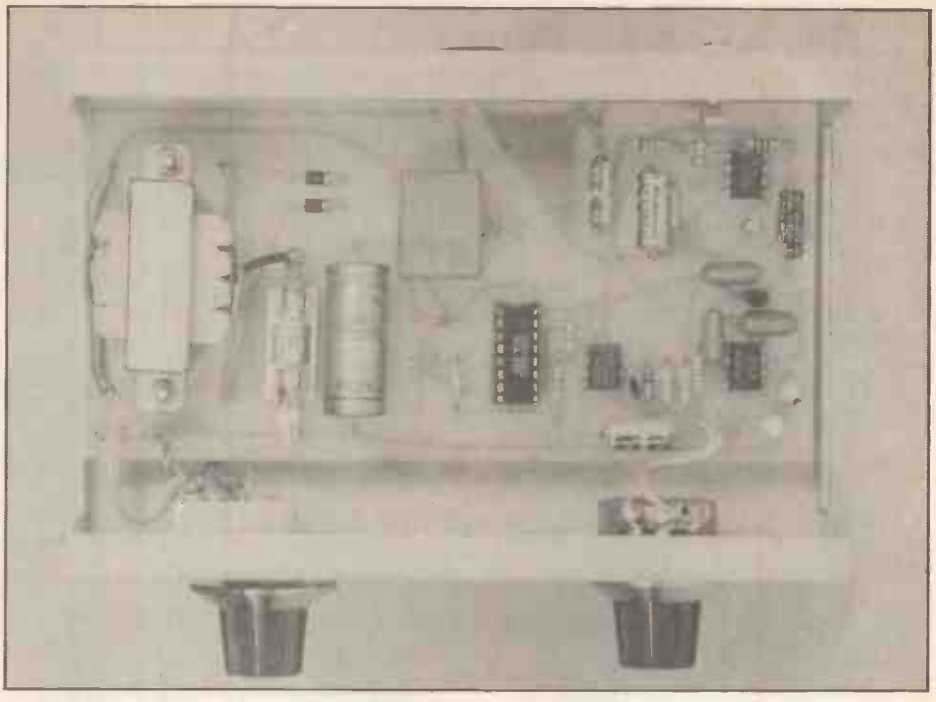
Construction

With the exception only of the controls and input sockets, the components are all mounted on a printed circuit board, as detailed in **Figure 3**. FS1 is mounted in a chassis mounting fuseholder which is bolted to the board. Similarly, T1 is not a printed circuit mounting component and must be bolted in place. It is advisable to use the specified relay since any other type would almost certainly necessitate a drastic redesign of the board before it could be used, and it might even be necessary to mount it off-board. Note that IC1 is a CMOS device and it should therefore be mounted in a (16 pin) DIL IC socket, and it should not be fitted into the socket until all the of the components have been mounted on the board. Handle this device as little as possible.

A case measuring about 150 by 100 by 50mm is suitable, but this represents about the smallest size that is capable of accomodating all the parts. SW1 and RV1 are mounted at opposite ends of the front panel (SW1 on the left — RV1 on the right), while SK1 is fitted at the left hand end of the rear panel (as viewed from the rear). The entrance hole for the mains lead is drilled low down at the opposite end of the rear panel and the exit hole for the mains ouput lead is drilled at roughly the centre of the panel. Both these holes should be fitted with grommets to protect the cables.

The printed circuit board is bolted to the base panel of the case and spacers about 12mm long are used so that the underside of the board is held well away from the metal casing. The final wiring-up is then completed. A short screened lead is used to connect SK1 to the printed circuit board. Be careful not to make an error when connecting the mains lead and SW1, and check this wiring carefully before switching on and testing the finished unit!

A low impedance dynamic



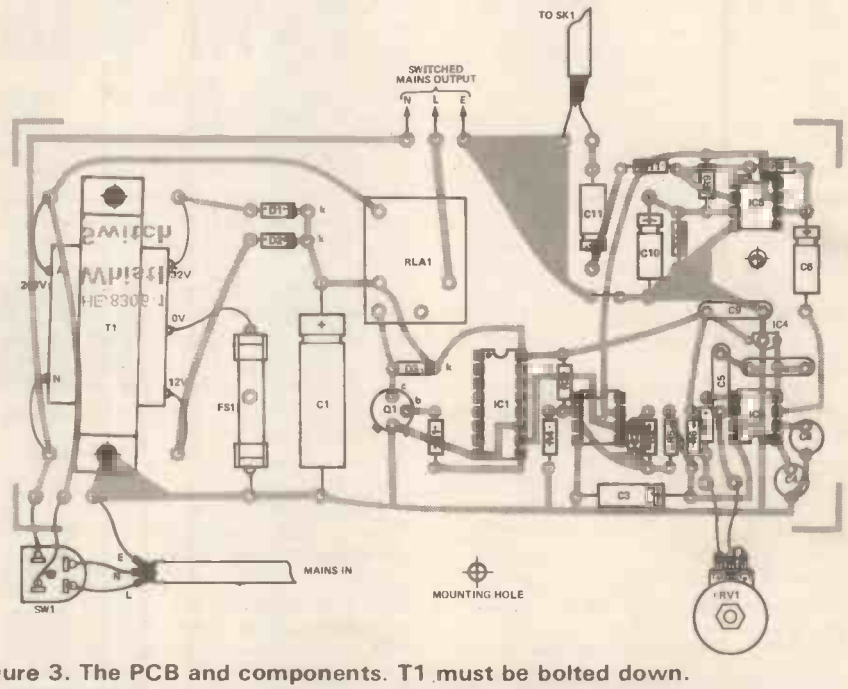
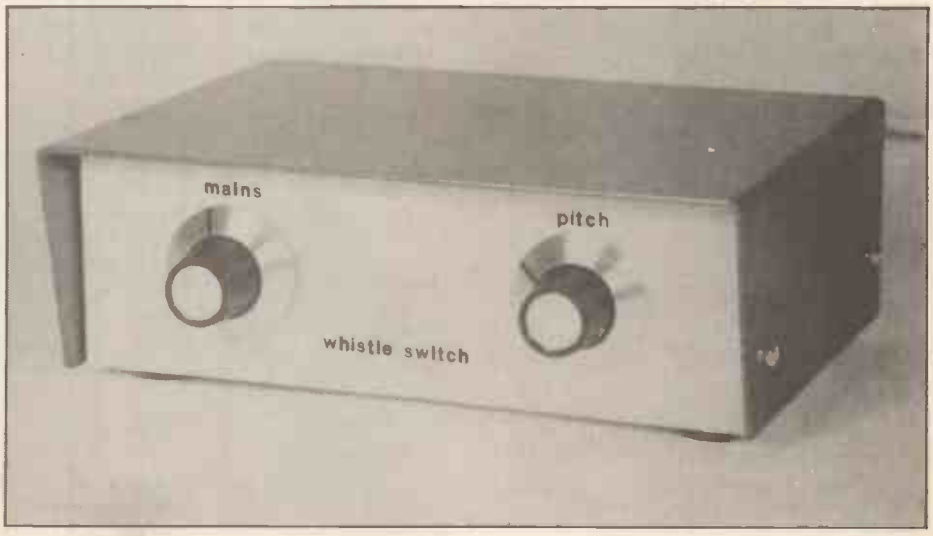


Figure 3. The PCB and components. T1 must be bolted down.



Parts List

RESISTORS
(All ¼ watt 5% carbon)
R1 ..... 3k9
R2 ..... 150k
R3, 4 ..... 4k7
R5 ..... 33k
R6 ..... 8k2
R7 ..... 2k2
R8 ..... 1MR
R9, 10 ..... 22k
R11 ..... 1k2

POTENTIOMETERS
RV1 ..... 10k linear carbon

CAPACITORS
(All axial electrolytic except as noted)
C1 ..... 470u 25V
C2 ..... 33p ceramic plate
C3 ..... 33u 16V
C4 ..... 10u 25V radial electro
C5, 7, 9 ..... 100n polyester
C6 ..... 1u 63V
C8 ..... 2u2 63V radial electro
C10 ..... 100u 10V
C11 ..... 2u2 63V

SEMICONDUCTORS
IC1 ..... 4020BE 14-stage counter
IC2 ..... 741C op-amp
IC3 ..... NE567N tone decoder/PLL
IC4 ..... 78L05 5V regulator
IC5 ..... TL081 BIFET op-amp
Q1 ..... BC109 etc.
D1, 2 ..... 1N4002 rectifier diodes
D3 ..... 1n4148 signal diode

MISCELLANEOUS
T1 ..... 12-0-12 100mA secondary
FS1 ..... 20mm 100mA quick-blow
SW1 ..... two-pole rotary mains switch
RL1 ..... 12V/400R coil see Buylines
SK1 ..... 3.5mm socket
PCB; case, 150 x 100 x 50mm (see Buylines); 20mm chassis mount fuseholder; 2 x control knobs; 1 x 16-pin DIL socket; 6BA fixings, wire, solder etc.

BUYLINES ..... **page 34**

microphone is connected to SK1 (inexpensive microphones of this type are readily available as replacements for cassette recorders). These often have a remote control switch and a moulded twin 2.5 plus 3.5mm jack plug (the 2.5mm plug connecting to the remote control switch). In this case it will either be necessary to change the plug for an ordinary 3.5mm type, or a "dummy" 2.5mm socket must be fitted at a suitable position on the rear panel.

RV1 can be adjusted to give operation at any practical frequency desired, and the correct setting can be found simply by whistling the desired operating note and adjusting RV1 from maximum to minimum resistance, but stopping when the relay switches on or off (it can assume either state at switch-on). It takes the unit a fraction of a second to operate, and RV1 should therefore be adjusted reasonably slowly so that it is not taken beyond the correct setting before the relay is activated.

The locking range of the phase locked loop is only plus and minus about 7%, and this gives excellent immunity to spurious triggering by general noise and household sounds, but it is also necessary to hit the right note with reasonable accuracy in order to operate the unit. However, this should not be difficult for anyone with a reasonable sense of pitch.

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2 amp 100v 30p
2 amp 200v 35p
2 amp 400v 38p
6 amp 100v 45p
6 amp 200v 65p
6 amp 400v 75p
10 amp 50v 170p
10 amp 100v 180p
10 amp 200v 195p

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8 amp 400v 50p

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8 amp 400v 60p
25 amp 400v 168p

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Min. DP DT 70p
6 Min. SP ST 48p
6 Min. DP DT 62p

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BC108B 9p
BC109B 10p
BC140 25p
BC142 22p
BC160 35p
BCY70 18p
BCY71 18p
BC182 7p
BC212 7p
BC237 8p
BC337 8p
BD139 32p
BD139 33p
BD140 33p
BD149 32p
BF150 20p
BF178 25p
BF179 30p
BF257 30p
BF258 30p
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CLEVER DICK

Poor CD's in trouble, his brain all befuddled, Put him out of his muddle, by solving this puzzle.

Now here's a challenge for all crossword and puzzle fanatics. Let's have your answers then! All genuine and logical replies will be placed in a box and an answer selected by the fair hand of HE's editorial assistant. The reward? Oh, a binder . . . of course! The competition closes with the last entries received at the HE editorial office on 30th July 1983, and if no reasonable solution is submitted, the binder goes to the author, by default.

O Clever Dick!
My first belongs to us all, slave or free
My second concludes what is to be.
My third is initially placed by you second.
My fourth of all men is the end.
With my fifth may the answer be seen,
While my sixth lives and dies for its queen.
Solve this riddle and justice be done,
For my whole must be backed to be won.
Guy Inchbald,
Manchester.

PS Now at the last one further surprise:
I have no desire for your glittering prize!
A Spectrum cassette of the Hobbit would do,
But I doubt such a reward may be granted by you.

As for the Hobbit, you'd be amazed what the Wee Folk of the HE office can get up to. They'll be in touch.

Meanwhile, some people have strange ideas about what's witty and what's not . . .

Dear CD,
You wrote in the February issue of HE that you would award a Binder to the writer of the most witty letter: well, try this one.
I don't normally buy anything at Tandy (£1.19 for a 4011 IC is bad news), but I needed a piece of Veroboard like yesterday, so I risked it.
I went to the counter and asked if they had any Veroboard: "What board?" the man said, "I don't understand". So I pointed to a piece of perforated board and said "Like that but with copper strips across it". "Oh", he said, "If you can't see any we don't have any".
Tandy? Who needs them?
M. Bronze,
Corringham,
Essex.

OK. I tried it, but I don't see what's so funny. I can't believe you left the store in fits of laughter . . . did you? Prices like that are no joke!

It's not true, by the way, that I complain about hand-written letters. Of course I sometimes have to guess at words, which can be awkward!

Dear Clever Dick,
I think that it is appalling that a Hobby Electronics Binder costs £4.95. I'd rather the spend the money on components and I'm probably not the only one! (Hint, hint).
PS I'm only 13.
PPS Sorry about the spelling.
M. Myers,
Cheltenham,
Glos.
PPPS ACE mag.
PPPPS Please print this.

A request I cannot refuse (to print the letter that is — free binders are another matter entirely).
I agree that £4.95 is a lot of money, but if you only knew what it costs to produce them, the time and effort, the painstaking craftsmanship . . . oh alright, you win, you can have one. But if it doesn't arrive you can blame it on your handwriting!

Dear CD,
I have just made the Stall Thief project (May issue) but don't know how to connect it to the points in the car, which is a Renault 4. I have tried a few likely spots, with the engine running, on the outside of the distributor but only saw sparks and received a healthy shock. Please explain how and where they are connected.
Yours etc,
SC,
Hampstead.

First of all, I can't imagine why you bought a Renault — don't you know it's French? — and second, I find it difficult to believe that anyone would actually want to steal one. As for your problem (the Stall Thief, not the car) Figure 2 in the article shows that the device is connected across the distributor contact breaker. Not being a French Mechanic I can't do better than that. And since you regard a jolt from the ignition system as "healthy" you may as well continue to experiment with the engine running.
Personally, I prefer jogging.

In a recent issue, I referred a reader to HE's Book Service but apparently forgot to mention the price.

Dear Sirs,
In the May 1983 issue of Hobby Electronics magazine, in the Clever Dick feature, you make reference to a book on Long Distance Television Reception. Unfortunately no price was quoted.
I am interested in receiving two (2) copies of this book. Please advise price and delivery charge.
The most convenient way for me to make payment is by certified cheque in pesetas. I trust this is acceptable.
S. L. Watkins,
Malaga,
Spain.

Hmmmm. Long Distance Magazine Reception, eh? Not bad, not bad. My apologies to Mr. Watkins; the price is £1.95, and the order should refer to publication BP52. You should add £1 to the post and packaging charge and, if possible, make out the cheque in pounds, not pesetas.
As ever, I'm happy to try and answer any reasonable enquiry . . . but some questions simply leave me feeling blanque.

Dear Mr. Dicks,
I have only been interested in electronics for two months, now, so all this grovelling is quite new to me. Why do they do it? I would be inclined to send a cheque for £5 and ask for a binder.
P. Roberts,
Yeovil,
Somerset.
PS HE is the best mag out (I've only just realised what HE stands for).
PPS What are those cute cuddly looking balls that sometimes appear in your pages?

I'm inclined to agree — especially since my binders are being purveyed to the public (that's you) for only £4.25, including postage and packaging! I'll leave it to another reader to try to describe our 'Beastie' cartoon characters; words fail me!

HE

Extending the ACE

HE's Input/ Output board supplies the extra RAM the ACE needs to control HEBOT or similiar useful devices.

Mike Lord

If you are the proud owner of a Jupiter ACE then you will know that although it has 3K bytes of RAM fitted most of this is taken up by the screen and character set areas, leaving not a lot for your 'programs'. And you will probably know that FORTH was originally developed for control applications — like steering a telescope or guiding a robot — and may be interested in experimenting along these lines.

This project has been developed to help in both of these areas; by giving you an additional 2 or 4 bytes of RAM space, plus 8-bit input and output ports to control devices such as the HEBOT computer controlled robot.

Everything is on one printed circuit board which plugs onto the ACE's rear bus connector. If you don't want the I/O ports, then you can just build the RAM extension, or you could even leave out the RAM parts for the time being and just make the I/O ports.

The Credit

Figure 1 gives the complete circuit diagram of the add-on board. Looking at the RAM part first, this is provided by ICs 1, 2 and 3, ICs 1 and 2 are 6116 2K bytes CMOS static RAM chips, chosen because they are very easy to use — having no particular vices — and take very little power. These chips deal with a complete 8-bit byte at a time, the data being transferred into or out of the IC on the ACE's data bus lines D0-D7. Since each IC holds 2K (2048) bytes, eleven address inputs are needed to select a particular byte, and these come from the ACE's address bus lines A0-A10. To read data out of the chip, or to write new data in a 'low' pulse must be applied to the 'Output Enable' or 'Write Enable' inputs; these pulses are easily obtained from the ACE's

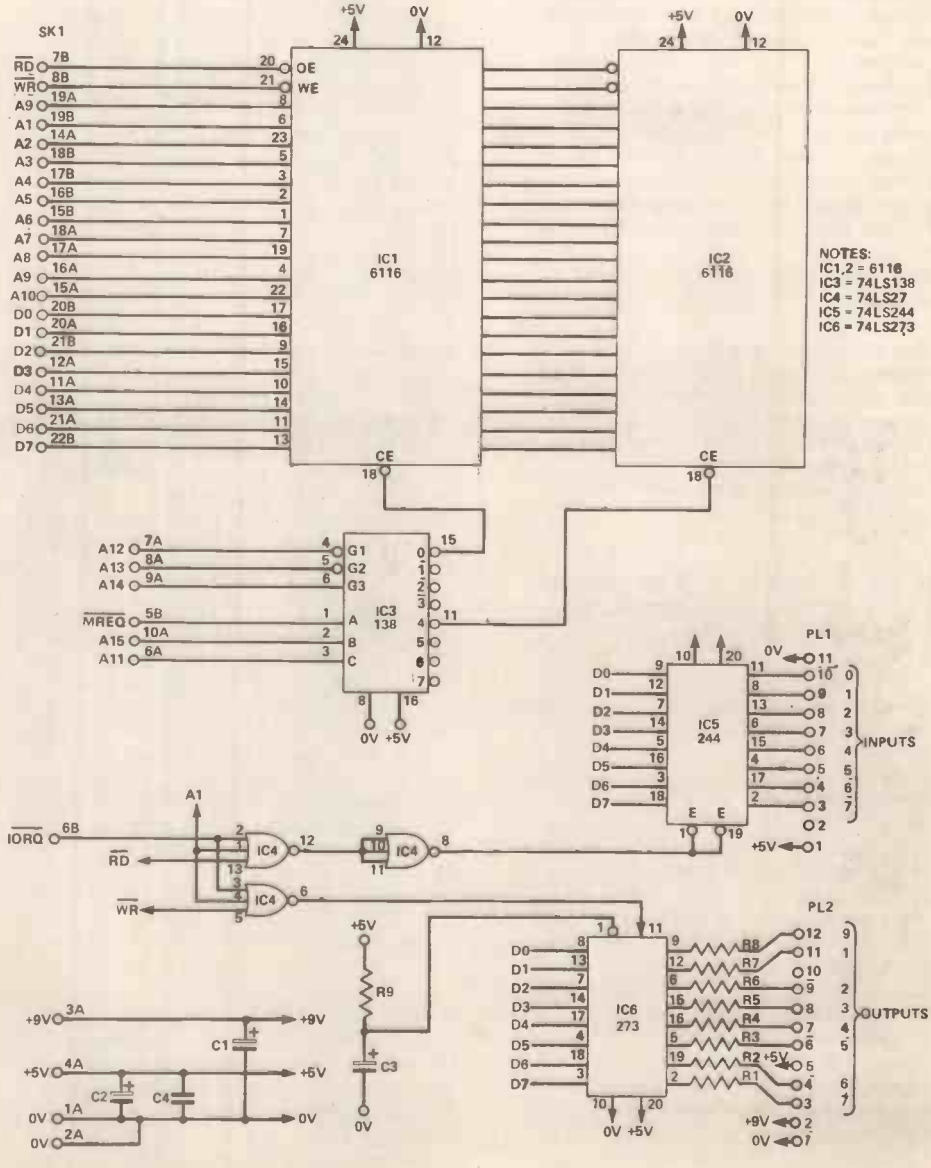


Figure 1. The complete circuit.

bus $\overline{RD}$ and $\overline{WR}$ lines. The other connections to the RAM chips are the OV and +5V supplies, and the $\overline{CE}$ (Chip Enable) input on pin 18, which must be low when data is being written to or read from the IC.

The $\overline{CE}$ inputs to the two RAM chips are provided by IC3, which ensures that ICs 1 and 2 are only enabled when the ACE wants to access memory at the appropriate addresses. IC3 is a 'one out of eight decoder' having eight outputs which normally give out a 'high' logic level. When the chip is enabled by low level signals on its G1 and G2 inputs and high level signal on its G3 input, then one of the eight outputs will go to a low level, which output depending on the signal applied to the chip's A, B & C select inputs.

These A, B, C and G inputs are connected to the five most significant address lines from the ACE and to the $\overline{MREQ}$ line, which goes low when the ACE wants to read from or write to a memory location (as opposed to an I/O location). The way they are connected results in IC1 being enabled whenever the address is in the range 4000-47FF (hex) and IC2 being enabled when the address is in the range 4800-4FFF. These addresses follow immediately after the addresses used by the RAM in the ACE itself, so that the new memory adds directly onto the existing directory and stack area.

The I/O ports are provided by ICs 4, 5 and 6. IC5 is a simple 8-bit tri-state buffer which, whenever it is enabled by a low level signal on pins 1 and 19, transfers whatever signals are present on PL1 directly to the system data bus lines D0-D7. At other times the outputs of IC5 are in a high impedance state, so as to not affect the data bus.

IC6 is an 8-bit latch which, when clocked by a pulse on pin 11, grabs whatever information is on the data bus lines at that time and holds it until the next time it is clocked. The eight outputs are fed though the protective resistors R1-R8 to the board output plug PL2. These resistors have been put in to prevent damage to IC6, in case any of the board outputs are accidentally connected together or to +5V, but they do limit the available output signals and so their values should really be chosen to give as much protection as possible depending on exactly what the board is driving. If it is driving TTL loads, then R1-R8 should be between 100 to 330 ohms each, but higher values (around 1kR) can be used when the board is driving light loads such as those presented by the HEBOT control circuitry.

R9 and C3 reset IC6 so that all of its outputs are at low level when power is switched on.

IC4 is a triple 'positive NOR' gate which is used here to provide the enable and clock pulses to ICs 5 and 6. It gives a low level 'enable' pulse to IC5 whenever the ACE reads from an I/O location with address line A1 to '0', and gives a clock pulse to IC6 whenever the ACE writes to an I/O location with address line A1 at '0'.

The I/O connectors PL1 and 2 carry +5V as well as the input/output signals; this comes from the regulator inside the ACE and not more than about 100mA should be drawn. PL2 carries the +9V unstabilised line from the ACE's mains adaptor; again, not more than about 100mA should be drawn. If you look at Figure 2, you will see that the two holes on the board are labelled 'OV' and '+9V'. These let you connect an external higher-powered unregulated '9V' supply if the devices you are controlling need more power than can be provided by the ACE's mains adaptor, but note that if you do connect such an external supply then it will also be powering the ACE, and so *the ACE's own mains adaptor should not then be connected.*

Parts List

RESISTORS
(All ¼ watt 5% carbon)
R1-8 ..... 1kR (see text)
R9 ..... 4k7

CAPACITOR
C1, 2, 3 ..... 4u7 25V radial electro
C4 ..... 100n ceramic

SEMICONDUCTORS
IC1, 2 ..... 6116 2K static RAM
IC3 ..... 74LS138 1-of-8 decoder
IC4 ..... 74LS27 triple 3-input NOR
IC5 ..... 75LS244 octal tri-state buffer
IC6 ..... 74LS273 octal latch

MISCELLANEOUS
SK1 ..... edge connector see Buylines
PL1, 2 ..... 12-way PCB plugs see Buylines
1 x 14-way, 1 x 16 way, 2 x 20 way, 2 x 24 way IC sockets; PCB; wire, sleeving, solder etc.

BUYLINES ..... page 34

Construction

The component layout is shown in Figure 2. A single sided printed circuit board has been used to keep the cost of the project down, but this has meant that 14 wire links have to be added, as shown, to complete all of the connections. These should be sleeved where there is a danger of accidental short circuits.

After fitting the links, the resistors R1-R9 should be soldered in place, followed by the IC sockets and then the capacitors. Note that the sockets used for ICs 3 and 4 *must* be low profile types.

The input and output connectors, PL1 and PL2, should be fitted so that their plastic mouldings are on the component side of the board with the short ends of the pins going though the board to be soldered on the track side. Two pins will have to be removed from PL1 and one from PL2, as only 10 and 11 holes respectively have been drilled in the board. The missing pins provide a polarising facility to reduce the chance of putting the mating sockets on wrongly.

The sockets to be used with the input/output plugs are purchased as empty 'shells', with loose contacts which are soldered onto the

connecting wires then pushed into the shell so that they latch home.

SK1 is a 25+25 way, 0.1in pitch double sided edge connector with wire-wrap pins. If you can't get exactly the right type then buy a longer one and cut it down to the correct length. The pins should be removed from the third position from one end and a polarising key fitted in their place (if you can't find a suitable key in the shops, then one can easily be cut from a piece of thick plastic). This polarising key is most important, as it is the only thing that will prevent you from plugging the board in wrongly, with possibly disasterous consequences. SK1 should be fitted so that it is square onto the PCB, and spaced so that the body of the connector is about ¼in from the PCB. PCB.

If you want to build up the RAM part of the board then ICs 4, 5, 6 and R1-9 and also C1 & C3 and PL1, 2 need not be fitted. If you are starting small, then IC2 can be left out, resulting in only 2K extra bytes of RAM. On the other hand, if you are are only interested in the I/O circuits then leave out ICs 1, 2 & 3.

Testing It

Before plugging the board into the ACE, check it very carefully to make sure that the right components have been fitted the right way round and — most important — that solder splashes or excess solder on joints have not caused any short circuits between adjacent tracks. The areas that this type of fault is most likely to have occurred are where tracks pass between the pins of ICs 1, 2, 5 & 6.

Once you are certain that it won't damage anything, you can then try the ACE with the new board plugged in. Remember to switch off the power before plugging anything in or out! It should behave exactly as before except that if you had added RAM then entering:

15384 @

should print 18432, if you have added 2K, or 20480 if you have added 4K bytes, and you will now be able to enter much longer dictionaries.

If you have equipped the board with the I/O circuits then you can test these with a voltmeter and a wire link. First, check that the outputs on pins 3, 4, 6-11 of PL2 are all at less than 0V4. Then set them all to the high level by:

255 253 OUT

and they should then be between 3 and 5 volts. To check the input circuits, use:

253 IN

which will print 255 if all of the inputs on pins 3-10 of PL1 are open, and lesser values if any or all of these pins are connected to OV.

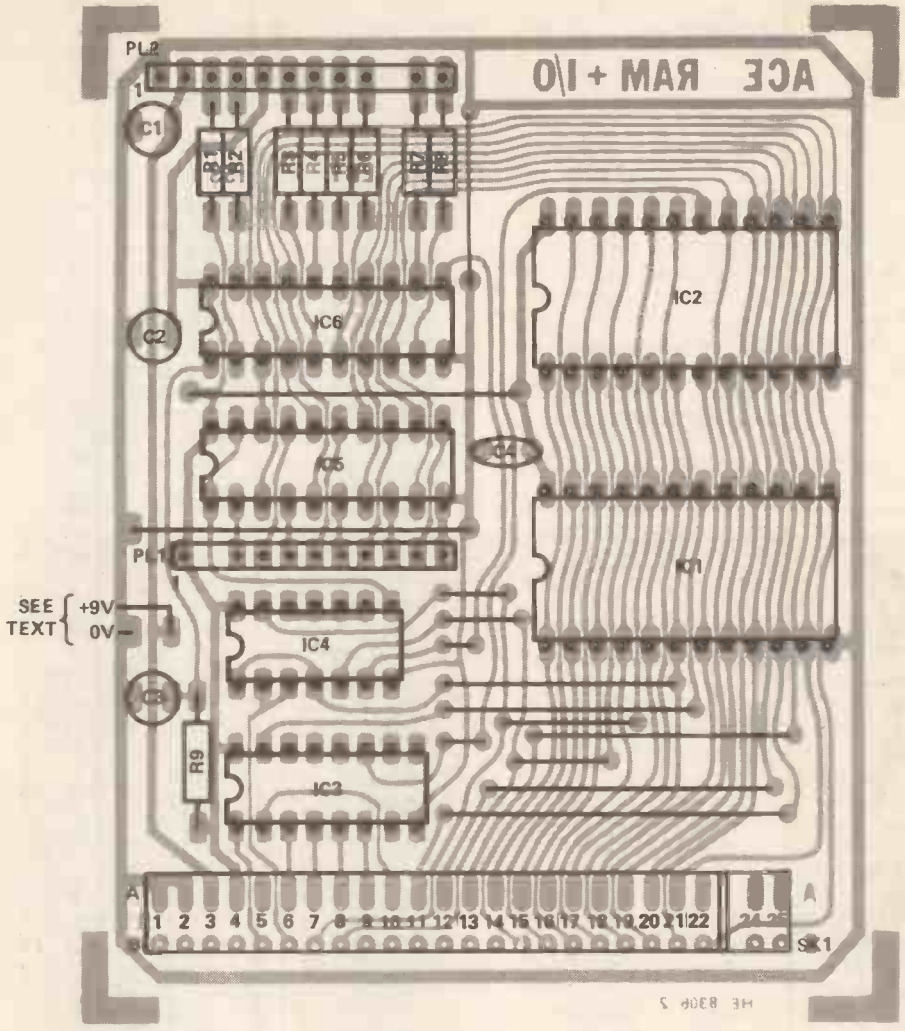


Figure 2. The PCB and components. Wire links are used to keep the board one-sided.

Using The I/O

Both the input and the output ports are at I/O address 253 (actually they will appear at many addresses because only address line A1 is looked at, but 253 is a convenient value to remember) and are accessed by using the ACE FORTH words IN and OUT. For example,

253 IN

will put on the stack a value corresponding to the logic levels on the eight input pins, while

253 OUT

will set the eight output pins according to the value on the top of the stack.

Both the input and the output are 8-bit binary values which you can translate to and from decimal with the aid of **Table 1**, so that — for example — to set bits 1 and 3 of the output port to the 'high' level (1) and the rest to 'low' (0) you could use:

10 253 OUT

It is worth noting that FORTH's OR word works on a bit by bit basis, so that we could have set output bits 1 and 3 to '1' by:

2 8 OR 253 OUT

And so does the AND word, which is very convenient when we want to examine the state of a particular input line;

253 IN 8 AND

leaves a value onto the stack which is zero only when input bit 3 is zero (bit 3 corresponding to decimal value 8).

TABLE 1

I/O Bit	Decimal Value
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128

Table 2

PL1		PL2	
1	+5V	1	0V
2	***	2	+9V
3	IP 7	3	OP 7
4	IP6	4	OP 6
5	IP 5	5	+5V
6	IP 4	6	OP 5
7	IP 3	7	OP 4
8	IP 2	8	OP 3
9	IP 1	9	OP 2
10	IP 0	10	***
11	OV	11	OP 1
12	***	12	OP 0

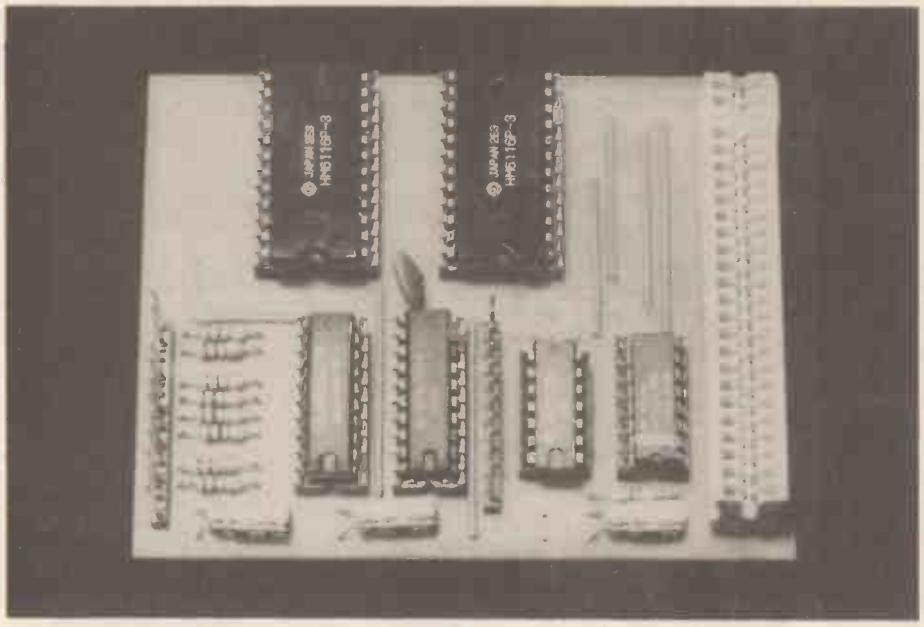
*** = pin removed for polarising

Table 3

HEBOT PCB	ACE I/O BOARD
RM1	PL2-11
RM2	PL2-10
RT	PL1-9
FT	PL1-8
LT	PL1-10
BT	PL1-7
P	PL2-6
OV	PL2-1
OV	PL1-11
+10V	PL2-2
H	PL2-4
T	PL2-3
LM2	PL2-8
LM1	PL2-9
L	PL2-7

Table 4

OUTPUT VALUE	CONTROL FUNCTION
0	HEBOT stopped, lights & beeper off.
5	Move forward.
6	Turn clockwise.
9	Turn anti-clockwise.
10	Move backwards.
16	Lamps on.
32	Pen solenoid on.
64	Low frequency beep.
192	High frequency beep.



Driving HEBOT

HEBOT (HE's computer controlled robot project published in the November 1982 issue) is an ideal vehicle for experimenting with the use of FORTH as a control language, using the input/output capabilities of this board.

Eight output lines are needed to control the motors, speakers, lights and pen of HEBOT, and four input lines are used to monitor the touch sensors. These can be connected to PL1 and 2 as shown in **Table 2**. The ACE's mains adaptor will give just about enough power to drive HEBOT, as well as the ACE, as long as you don't want to operate the pen solenoid and avoid switching instantaneously from full forward to full reverse. If you want to operate the pen or thrash about at high speed then a more powerful supply should be connected as described earlier.

Table 3 shows the decimal values to be output to get HEBOT to perform; as discussed earlier these can be combined by adding the values or by making use of the OR word. **Program 1** gives a simple program to make HEBOT move, beep and flash using keys W, E, S and 3 to control direction L to light the lamps and B OR H to beep. Pressing key Q will turn off HEBOT and end the program.

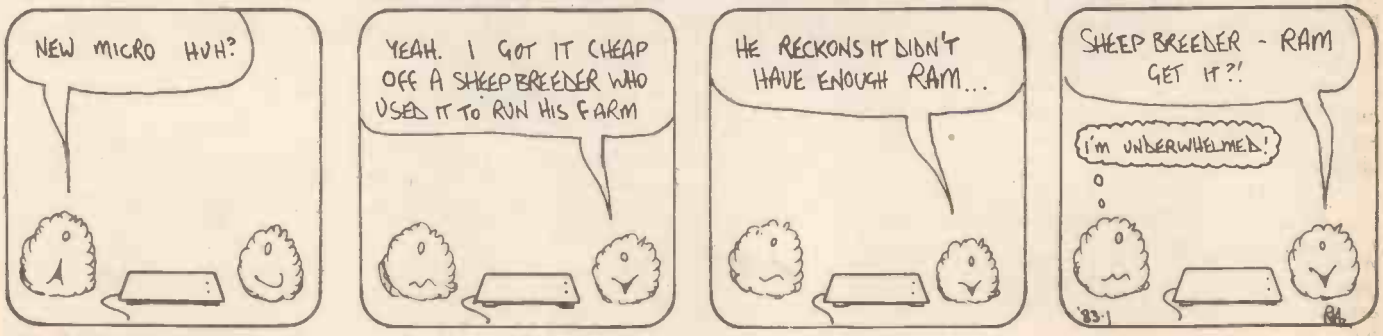
Program 1

```
: MATCH 3 PICK = IF
  ROT DROP SWAP
  ELSE DROP
  THEN;

: GO BEGIN
  0 INKEY
  6 ASCII E MATCH
  9 ASCII W MATCH
  10 ASCII S MATCH
  5 ASCII 3 MATCH
  16 ASCII L MATCH
  64 ASCII B MATCH
  192 ASCII H MATCH
SWAP 253 OUT
  ASCII 0 =
  UNTIL ;
```

HE

BEASTIES BY RH



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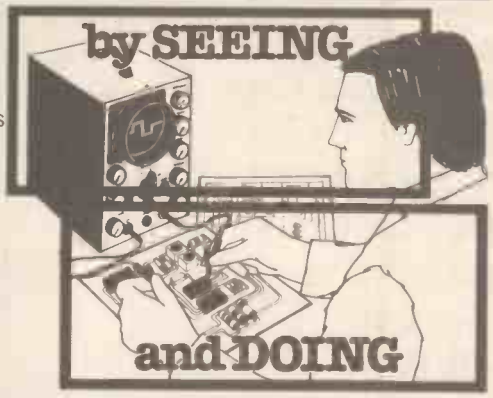

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Steady nerves, high standards of engineering achievement and no illusions about glamour are the basic requirements for getting into the broadcasting business.

Helen Armstrong

MANY CAREERS in electronics make highly specialised, even rarified, demands on the engineer, enabling him or her to work safely within a narrow field. In the world of broadcasting, this is far less likely to be true. Broadcasting is one of the most competitive of all industries. On the one hand, it feeds the constant public demand for new ideas and entertainment, calling for continual experimentation, even innovation, with new effects and equipment and, on the other hand, the media is enormously self-publicising by its very existence, attracting talent from many fields from all over the country. So competition to get in is fierce. To compensate for this possibly discouraging picture, broadcasting companies are less likely to be looking for the brilliant theoretician who cannot wire up a plug, and more likely to take the self-motivated enthusiast with reasonable qualifications and a proven personal interest in a relevant activity: amateur radio, sound recording or film-making, to take some obvious examples. The vivid — and possibly apocryphal — description of the ideal trainee engineer: "A third class degree who can get an outside broadcast truck out of a bog" may not tell the whole story, but it illustrates the kind of practical problem which a broadcast engineer may be faced with.

With the expansion of the telecommunications industry during the past decade, the need for a supply of able engineers and technicians has grown in fits and starts. The arrival of the video boom and new television companies like Channel 4 is currently opening up, by direct and indirect means, more opportunities in broadcasting in general than for some time, providing some of the most varied careers in engineering.

IBA And BBC

There are, as you might expect, a number of categories of technician and engineer employed in the industry. The two big transmitting organisations in the UK, the BBC (British Broadcasting Corporation) and the IBA (Independent Broadcasting Authority) have very similiar structures where engineers are concerned, except that with the BBC the studio and transmitter operations are contained in the same organisation, whereas with independent TV and radio, the IBA operates the transmission networks, while various private companies operate the studios.

In this month's issue, we are going to by-pass the studio side — which would partially tend to attract engineers perhaps with more creative yearnings, who want to work with cameras, sound and video equipment — and look at the engineering jobs on the transmission networks in the two broadcasting companies.

It is worth noting that the IBA, having a smaller number of jobs on offer, advertises its posts less widely than the BBC. While the BBC may advertise in specialist magazines, and also (naturally) in The Listener, as well as advertising for trainees through college and local authority careers offices, the IBA restricts its advertising, which therefore reaches the press more rarely.

Part of the IBA's Harman Engineering Training College, in Seaton, Devon, the centre of operations for their training programme.

In both cases however, if you know what sort of a job you are looking for, or would like to train for, and what kind of qualifications you have or hope to have, it can be helpful to send an application to the relevant part of the organisation. Don't rely on this, however — keep an eye open for specific jobs and courses and apply for these as well.

When the IBA needs trainees they circulate schools and technical colleges on the "Milk Round", interviewing prospective candidates on the spot. When they do advertise, amateur electronics magazines and the local press are two media they choose.

Getting In Training

The BBC puts its trainee engineers through a course which starts with a twelve week stint at their Engineering Training Centre at Wood Norton in Worcestershire and then continues on the job, depending on their specialisation. Training includes further stints at the training centre and, particularly in transmitter work, trainees will be moved round the country to some extent. Their specialist training for engineers is registered with the IEE and counts towards the qualification of Chartered Engineer and membership of the IEE. Trainees work towards attaining Engineer status within three years.

The IBA recruits one group of trainees every year, and to fill jobs as needed. Their training programme begins in June and takes in four stages over eighteen months. This begins with a nine-week induction course at the Harman Engineering Training College in Devon, and concentrates on broadcast engineering, especially the systems used by Independent television and radio. This is followed by a stay at one of their transmitting stations, and after that a full-time two-term polytechnic course. The last six months concentrates on Transmission Technology, again at the Harman college. The course concludes, if successful, with your appointment as a Broadcast Engineer.

Non-qualified engineers beginning at the BBC are known as Technical Assistants. Young people — this effectively includes anyone from college leaver age up to about thirty — can begin a career as a broadcast engineer by acting as assistants to the qualified engineers, and training on the job. They work chiefly at setting up, aligning and maintaining broadcast equipment, both in London and at various sites around the country. This of course can include work in the studio as well as the transmission equipment, but the emphasis is on the maintaining and developing of equipment, rather than operating it.

The basic requirements for a Technical Assistant are GCE 'O' levels, grade A, B or C, or CSE grade 1s, in English, Maths and Physics, as well as "A" level study (or the equivalent) in Maths and Physics. English, plus a TEC Certificate or Diploma, or a City and Guilds Part 1 in Telecommunications, or an ONC/OND in Electrical or Electronic Engineering can be considered. As well as this, a keen amateur interest in and knowledge of an electronic-based subject is effectively vital. The minimum age for appointment is 18, and normal hearing and colour vision are essential. For the Transmitter Department, especially, a driving license is an asset.

Taking test measurements on a transmitter during on-the-job training.

Qualified Opportunities

The BBC also takes on qualified engineers for a wide range of jobs. Transmitter Engineers are needed for the maintenance and operation of complete transmission stations around the country, including SHF link equipment, receivers, RF standards converters, stereo encoders, digital equipment for synchonisations and pulse code modulation signals, low and high voltage switching gear, generators, aerials, cooling systems, test equipment and the transmitters

An important factor in all broadcast work is learning to work as a team, as well as using individual initiative.

Constant monitoring of signals is the basis of transmission work.

themselves. There are opportunities to work on both analogue and digital, valve and transistor equipment. The work is usually based at transmitting stations often in isolated areas around the country and needs a fair amount of mobility from day to day.

There is a Research Department where new techniques and systems are developed for use by the whole organisation. The Radio Frequency Group deals with the business of transmitting from the stations to home receivers. The Transmission Group deals with long-distance transmission and signal coding of all sorts. In the Design Department the Transmission Group designs new equipment for transmitting, monitoring and controlling, and the Transmitter Capital Projects Department commissions and sets up new transmission links.

Communications engineers based in London or other main regional centres maintain the radio and TV links between studio and transmitters, and also international links, including satellite links at short notice — very demanding work.

As a qualified engineer, you will need to have at least a degree, an HND or HNC in electronics or electrical engineering, or physics or a City and Guilds Full Tech Certificate in Telecommunications or a TEC Higher Certificate or Diploma in Electronics or Telecommunications. For work on R&D or Capital Projects a first or good second class degree is needed.

One field of transmission engineering is experimental work with satellite transmissions. This is an outside broadcast transmitter/receiver.

An Expanding Business

The IBA's requirements for both trainees and engineers are very similar. They specify City and Guilds Full Tech, HNC or HTC or CNAA degree in Electrical or Electronic engineering as basic qualifications for trainee Broadcast Engineers, and recruit qualified engineers on an ad hoc basis.

Broadcast Engineers operate and maintain the IBA's 750-and-growing transmission stations; some are based at their four Regional Operations Centres, and are concerned with monitoring and operating transmission. The majority of Broadcast Engineers are based at one of the twenty-two maintenance bases and work as part of a Mobile Maintenance Team, visiting transmitters within a certain range. As well as signal measuring, repairs, maintenance and trouble-shooting, Broadcast Engineers are involved in setting up new transmitters at the rate of about one a week, countrywide; and the expansions brought about by Channel 4 and increasing local radio stations are both widening the scope of the services provided and bringing in new engineering techniques.

The central planning and control centre is at the Engineering Headquarters, Crawley Court, Winchester, where there are also sections dealing with new developments and experimental electronics, including digital work.

Getting In Touch

If you are interested in a career in broadcasting, then the first step is to write to the Personnel Officer of the organisation (or organisations!) that you would like to work for, stating your qualifications (or potential qualifications, if studying) and interests. The demand for engineers of the right calibre is high at the moment, and likely to remain so for a long while, so now is a good time to be planning towards a broadcasting career. All the broadcast companies, both those we have looked at here, and the television companies and independent video companies, can afford to choose candidates of the highest calibre and posts are usually filled by people holding more then the basic qualifications are kept to a level which any bright student of engineering can fulfil, to encourage enthusiastic people to apply, since the broadcasting organisations are looking for the right people, rather than for a sheaf of paper qualifications.

Both the BBC and the IBA produce booklets laying out the requirements — and rewards — for engineers which you should look at before making a speculative application, or if planning a course of study. The two addresses you need to know are:

Inside IBA's Television Transmission Laboratory, students learn how to operate equipment used at the transmitting stations.

The Personnel Officer,
The IBA,
Crawley Court,
Winchester,
Hants.

The Engineering Recruitment Officer,
BBC,
Broadcasting House,
London W1A 1AA

You can also look in the engineering and audio press, and consult your college careers office and local Education Authority careers office, where vacancies will be on file.

Our thanks to the BBC, IBA and Central London Careers Office for assistance with this feature. Pictures reproduced by kind permission of the BBC and IBA.

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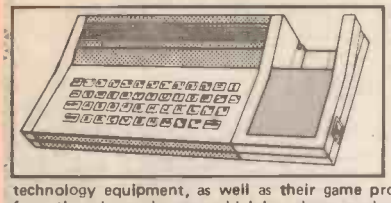
HOME COMPUTERS

AQUARIUS



AQUARIUS: The brand new Aquarius Personal Computer is part of Mattel Electronics latest developments in advanced technology and offers full home computing facilities, as well as extensive game play, using a very wide range of plug in cartridges. Since Aquarius is a Mattel Electronics product, it benefits by the company's wide experience of producing high technology equipment, as well as their game programming expertise which is evident from the advanced games which have been produced for the Intellivision. Aquarius costs £79 and comes with microsoft basic built in. It is so simple to use that you'll be writing your first programs within minutes of taking the machine out of its box. You can even record the programs on your own cassette recorder at home, so you can use them again at a later date. Most available domestic tape recorders are compatible with the Aquarius.

A POWERFUL MACHINE: For all its simplicity, it is also very sophisticated. It has a Z80A processor and 8K of built in ROM as well as 4K of RAM, which is user expandable to 52K. It has a display of 40x 24 characters, and a graphic resolution of 320x192 with a total character set of 256 (including the complete ASCII set with upper and lower case letters, numbers and additional graphic symbols). The keyboard has 49 full stroke moving keys, unlike some of the cheaper machines which have membrane keyboards. The size of the machine (excluding any of the additional peripherals), is 13"x6"x2".

PERIPHERALS: It is very easy to increase the capabilities of your Aquarius as all the peripherals plug straight into one another. You can add a Printer, a Modem, a Data Recorder, Mini Expander and other items. All of the peripherals are very easy to install and what is more, they're easy to use. But the best news of all is, they're easy to afford.

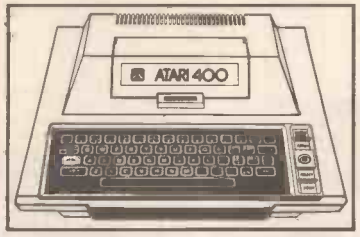
CPM OPERATING CAPABILITY: The Aquarius is capable of being expanded to 52K RAM and later in 1983 a disk drive will be available for it, with the commercial CPM business operating system. This will allow you access to one of the largest software libraries in the world, with literally hundreds of programs available for you to use.

CARTRIDGES: Various sophisticated programs will be launched on plug in cartridges such as a Visicalc type spreadsheet and a word processor. In addition there will be dozens of games and utilities and alternative languages such as Logo, which combined with the built in microsoft basic gives an unbeatable combination of high quality programming ability.

MATTEL AQUARIUS – £68.70 + VAT = £79

£79

ATARI 400/800



NEW LOW PRICES

ATARI 400/800: With the Atari Personal Computers, you can play the ultimate in T.V. games, teach yourself new subjects or skills, balance budgets, and even write your own computer programs in Basic.

SPECIFICATIONS: Both the Atari 400 and 800 can display in up to 16 colours, each with 16 intensities. They have four independent sound synthesizers for music tunes/game sounds, giving four octaves with variable volume and tone control on your T.V.'s speaker. The display graphics are of amazing quality, having a detailed resolution of 320 x192, comprising 24 lines of 40 characters. Atari personal computers have a standard 10K ROM operating system. In addition the standard Atari 400 (£149) comes with 16K of RAM, and the expanded version with 48K (£198). The Atari 800 (£299) comes with 48K as standard. Both the 400 and 800 are now supplied with a FREE £40 Basic Programming Kit, which includes the Basic Programming Cartridge, as well as a 120 page Basic Reference Manual and the 184 page Self Teaching Manual by Bill Carris called 'Inside Atari Basic', so you can begin programming straight away, without buying any 'extras'. Even a mains plug is supplied!

OVER 500 PROGRAMS AVAILABLE: The Atari computers are supported by well over 500 programs available for your use, a larger selection than you will find on any other television game or home computer! The wide selection puts Atari way ahead of the competition. Just fill in the coupon and we will be pleased to send you a full price list which gives details of our range of software available for entertainment, home education, programming and home office use. We think you'll agree when we say it's quite impressive.

100 FREE PROGRAMS FROM SILICA SHOP: If you buy your Atari Home Computer from Silica Shop, you will recieve a FREE presentation pack of 6 cassettes, containing 100 programs including games, utilities and demonstrations. A 16 page booklet giving full details of all of these programs is available on request. If you have already purchased your computer elsewhere you can buy the set of 6 cassettes for £30. What's more, Silica Shop offer a two year guarantee on all computers as well as a FREE joystick. This adds up to a great offer that we believe can't be beaten or matched by any of our competitors.

ATARI 400 16K – £129.57+VAT=£149
ATARI 400 48K – £172.17+VAT=£198
ATARI 800 48K – £260.00+VAT=£299

£149

VIDEO GAMES

COLECOVISION

THE SYSTEM: The CBS Colecovision offers new standards in video game play. The excellent graphics are well implemented with arcade titles such as Zaxxon, Lady Bug, Gorf, Wizard of Wor, Carnival, Mouse Trap and the lovable Smurfs. The console comes supplied with a three screen arcade quality version of DONKEY KONG. Parker and other companies have also announced ranges of cartridges for Colecovision, to further enhance the wide range of quality titles available for this new television games machine.

THE CONSOLE: The CBS Colecovision video games system has advanced technology which produces superlative graphics resolution and excellent sound effects. The styling of the console and hand controllers has been carefully researched; the console is designed to complement modern hi-tech equipment, and has clear features for easy operation. The hand controllers allow fingertip control via the 8 direction joystick, and feature 2 independent fire buttons. The push button keyboard is used for game selection and for game control with some cartridges. The hand controllers are detachable and are connected to six feet of telephone coil cable, storing neatly away in the console when not in use.

ATARI EXPANSION MODULE: The Atari converter module allows Atari VCS software cartridges to be played on the Colecovision console, allowing owners the freedom to purchase from the extensive range of Atari compatible cartridges. It also means that existing Atari owners can buy the CBS Colecovision games system without discarding their software library. Silica Shop offer part exchange facilities if you wish to upgrade.

TURBO EXPANSION MODULE: The Turbo Driver Expansion Module allows you to actually drive the vehicle that appears on your T.V. screen. The module consists of a steering wheel, dashboard and accelerator pedal. One hand controller is mounted on the dashboard to provide a gear change unit. The module comes complete with a Turbo Driver cartridge, the first of several cartridges to make use of the module, which provides all the action of sitting in the driving seat. This facility is unique to CBS Colecovision.

HOME COMPUTER EXPANSION MODULE: The Home Computer Module scheduled for late 1983, allows conversion of the games unit into a sophisticated Home Computer. This flexibility of design is an important feature of the CBS Colecovision System.

COLECOVISION - £127.82 + VAT = £147

£147

VECTREX

THE SYSTEM: Vectrex is a totally unique Home Arcade System, which has been exclusively designed and engineered to duplicate real arcade game play. Complete with its own monitor display, Vectrex won't cause any arguments over the use of the family's television because it has its own built in screen.

THE SCREEN: Vectrex does not use ordinary display techniques, instead it uses vector scanning to control the images on the screen. With this scanning method, the gun only updates the area of the screen that has changed, whereas a normal T.V. re-transmits the ENTIRE screen 50 times a minute. It is this that gives Vectrex its speed, and means that very little computer power is required for screen control, and the results provide very fast responding and clear images. These 'Vector Graphics' are used in several arcade games such as Asteroids and Battlezone, to give you incredibly high resolution and quality. Vectrex brings all of this from the arcade right into your living room. The Vectrex screen is capable of displaying 80 columns by 40 lines, which is significant to the extensive developments planned for the system.

EXCITING SOUNDS AND ELECTRONICS: Vectrex has an advanced microprocessor with more speed and power and exciting effects than many home video games systems.

REAL ARCADE CONTROLS: Vectrex has a unique control panel, similar to those used in many real arcade games, with 4 concave action buttons and a full 360° self centering joystick. This control panel has a 4 foot detachable cord for maximum player freedom.

REAL ARCADE GRAPHICS: Vectrex has its own 9 inch vertical screen and unlike a conventional T.V. screen, uses advanced display technology to achieve brilliant, high resolution imagery and superb game play never before possible. The Vectrex display provides special effects too, such as 3-D rotation and zooming in and out, which a regular T.V. cannot match. Using a black and white monitor, each Vectrex game comes supplied with its own coloured plastic screen overlay to add to the excitement of game play. The range of Vectrex cartridges (£21.95 each), gives a good selection of arcade games such as Berzerk, Scramble, Rip-Off and Bomber Attack. Vectrex comes complete with a fast paced 'Minestorm' game built into memory.

VECTREX: Vectrex has an advanced state-of-the-art microprocessor with more speed than other T.V. games.

VECTREX – £129.57 + VAT = £149.00

£149

WHO ARE SILICA SHOP?

Silica Shop are one of the leading specialist suppliers of Video Games & Personal Computers. We consider that our service, to those who already own or to those who are interested in any products in our range, cannot be matched by any other supplier. Just look at what we have to offer:

- **SHOP DEMONSTRATION FACILITIES** - we provide full demonstration facilities at our shop in Sidcup, so that you can get 'hands on' experience of our range.
- **SHOP OPENING HOURS** - we are open from Monday to Saturday 9 am - 5.30 pm, but close at 1 pm on Thursday's and 8pm on Friday's.
- **MAIL ORDER** - we are a specialist mail order company and are able to supply goods direct to your door at no extra cost.
- **FREE FIRST CLASS DELIVERY** - all orders are sent Post and Packing FREE, most of them being despatched by FIRST CLASS POST within 24 hours of us receiving your order details. If you require overnight delivery, this can be arranged at a charge of £3 for items under £80, or alternatively £5 for items over £80.
- **MONEY BACK UNDERTAKING** - if you are totally dissatisfied with your purchase, you may return it to us (in good condition) within 15 days for a full refund.
- **PART EXCHANGE** - we will offer you up to one third of our current selling price in part exchange on your old Mattel Intellivision or Atari console (and related cartridges), if you decide to buy a new video game or personal computer from us.
- **SECONDHAND GOODS** - we sell secondhand Mattel & Atari consoles/cartridges (with a full 1 year guarantee), at two thirds of our normal retail prices.
- **COMPETITIVE PRICES** - both our prices and service are very competitive. We are never knowingly undersold and will normally match any bona fide price quoted by our competitors, providing they actually have the goods in stock. We will also send the order to you post and packing free!
- **HELPFUL ADVICE** - our specialist sales staff are always available to give you advice on the suitability of various computers or T.V. games.
- **SERVICE/REPAIRS** - are available on all machines in our range, often utilising our in house service facilities. We will support your machine long after you buy it.
- **ATARI SERVICE CENTRE** - we are now an authorised Atari service centre and can therefore accept repairs on all Atari equipment (TV Games and Computers) even if you did not originally purchase it from Silica Shop. All repairs during the manufacturers 1st year warranty period will be completed FREE OF CHARGE.
- **2 YEAR GUARANTEE** - we offer a 1 year extension on some manufacturers 12 month guarantee, including Atari Personal Computers.
- **VIDEO GAMES AND COMPUTER CLUBS** - we offer a full information service on all video games and computers in our range. Advanced information on many new developments is often included, so you are always kept informed. We now issue regular newsletters on software releases, so make sure that you join our club.
- **OVERSEAS ORDERS** - we regularly send goods overseas and use various despatch services. Please let us know your requirements and we will give you a quotation.
- **PAYMENT** - we accept Access/Barclaycard/Visa/American Express/Diners Club credit cards, as well as cash, cheques, postal orders, COD or Post Office Transcash.
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Space Cavern
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ATARI
3-D tic tac toe
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Backgammon
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Basketball
Basketball (r/s)
Berzerk
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Brain Games
Breakout
Casino
Centipede
Checkers
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Codebreaker
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Outlaw
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Pinball
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Raiders of L/A
Sky Diver
Slot Racers
Soccer
Space Invaders
Space War
Star Raiders
Street Racer
Superman

ATARI

ATARI VCS (2600) – THE NO 1 BRAND LEADER IN THE U.K.

ATARI: The Atari Video Computer System known as the Atari VCS or the 2600 has now become the T.V. game brand leader. In the U.K. there are over 700,000 owners of the VCS with access to a range of over 200 different plug in cartridges, each having a multitude of different variations and difficulty levels. Every system comes complete with the main console, two individual joystick controllers, a pair of paddle controllers, aerial splitter, mains adaptor and a 27 game Combat cartridge. It gives you bright crisp graphics, realistic sound effects and even specially designed circuits for the protection of your Television Set.

SECONDHAND GAMES: We currently have several secondhand Atari VCS units in stock which we are selling for only £49 (inc VAT). This price includes the Console, with Combat Cartridge and all the accessories, as well as a 12 month guarantee. We also have stocks of several secondhand cartridges many at half price (all with 12 months guarantee). We will normally buy back secondhand units and cartridges at one third of our standard price.

£49

EXTENSIVE CARTRIDGE RANGE: The Atari VCS is so popular that in addition to Atari's own cartridges, there are over 150 compatible cartridges, produced by at least a dozen different third party manufacturers. Silica Shop has one of the largest cartridge selections available in the U.K. Our range of over 200 titles (printed either side of this column), includes items in stock now, as well as many of the new releases for later in 1983.

SILICA ATARI CLUB: Silica Shop has over 20,000 Atari VCS club members registered on our computer. As a specialist company we are able to obtain advance information about new developments and send detailed catalogues to all of our club members, enabling them to evaluate new products before they buy. This is a totally FREE service, to receive your copies complete the coupon below.

SERVICE CENTRE: Atari International (UK) Inc has recently appointed Silica Shop as an authorised Atari Service Centre. This means that we can now service your Atari VCS or 400/800 (under guarantee if applicable), whether or not you purchased it from us.

VCS COMPUTER KEYBOARD: A keyboard will soon be launched to convert the VCS into a fully programmable home computer. For further details, join our club by completing the coupon below. We will then let you know when further information is available.

STARPATH SUPERCHARGER: The supercharger plugs into the cartridge socket of your VCS and expands its RAM almost 50 fold, from 128 to 6,272 bytes. This increased memory adds vivid high resolution graphics capabilities and significantly lengthens the game playing time. Supercharger has a range of multi-load games (at £19.45 each), these offer the facility to play a game in several distinct parts (great for adventures), the next section being loaded when you have completed the previous one, thus enhancing the game play. For further information please complete the coupon below.

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ATARI VCS CONSOLE- With Combat Cart & Accessories £68.70+VAT = £79.00

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Swordquest E
Swordquest F
Tennis (rtapt)
Vanguard
Volleyball (r/s)
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Yars Revenge

BOMB
Assault
Great Escape
Splendour
Well Defender
Z-Tack

CBS (Coleco)
Blue Print
Carnival
Donkey Kong
Gorf
Mousetrap
Smurf
Solar Fox
Turbo
Venture
Wings
Wizard of Wor
Zaxxon

IMAGIC
Atlantis
Cosmic Ark
Demon Attack
Dem. Attack II
Dragonfire
Fire Fighter
No Escape
Riddle of Sph
Scuba
Starstorm
Star Voyager
Trick Shot
Zone

M-NETWORK
Advs of Tron
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Jedi Arena
Lord of Rings
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Rtn of Jedi 1
Rtn of Jedi 2
Sky Skipper
Spiderman
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Tutankham

SPCTRVSION
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Marauder
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Polaris
River Patrol
Threshold

ZIMAG
Cosmic Corridor
Disaster
Immies & Apps
I want my Mom
Pizza Chef
Quest for Gold
Telly Ho
Tanks no Tanks

ACCESSORIES

We stock a wide range of accessories for the Atari VCS and 400/800 personal computers. The same accessories can be used on the Commodore VIC range of computers. The Wico range can also be used with the Texas Instruments computers on purchasing a special adaptor. To give you an idea of the range available, just take a look at the following list:

Trackball by Wico

LE STICK: A mercury filled joystick specially made for one handed operation, with thumb fire button.

QUICK - SHOT: This joystick features a contoured handle grip, thumb trigger and optional base fire button. It is supplied with 4 sure foot suction grips.

STARFIGHTER: Neat and compact with a small direction stick. Metal interior for added strength.

VIDEO COMMAND: With a tapered handle, this joystick is for one handed use. It has a directional control which is similar to a jet fighter joystick.

WICO RED-BALL: An arcade type joystick with a red ball handle, it features 2 fire button locations, one at the base and one on the stick. It comes supplied with 4 grip pads for easier table top use.

Wico Straight Stick with Stick Fire Button

WICO STRAIGHT - STICK: The main feature of this joystick is its arcade style, bat handle grip. It also has 2 fire buttons. Four grip pads included for table top use.

WICO TRACKBALL: A true arcade style trackball for use with your Atari or Commodore VIC. This product is designed to give arcade control in your living room.

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FREE LITERATURE

Alexander Graham Bell

Ian Sinclair

Dooby Doo Doo Wop! Time to ring off with the most Famous Name of them all . . .

YES, of course you've heard of *him,* Bell of telephone fame and founder of the Bell Telephone Co., "Ma Bell" to millions of US citizens who take for granted a standard of telephone service that makes us as sick as a Buzby to think about. But did you know that the decibel is named after him, or that he invented the telephone as a deaf aid? Read on, and discover more about the life of this remarkable poineer.

Alexander Graham Bell was born in Edinburgh in 1847, to a family who had dedicated their lives to the service of the deaf and dumb — his father was the inventor of the hand signals which are still used to this day. His parents were established authorities in elocution and speech correction (what would they have made of CB?), and they did not send Alexander to school, preferring to draw on the considerable talents of the family for his education. The success of this education, unhindered by local authorities or social workers (not yet invented), gained Alexander his first job in 1864, as resident master at Weston House Academy, a small boarding school in Elgin, a cold grey town in the Highlands.

Devoted To The Deaf

In 1870, however, the whole Bell family decided to emigrate, like so many Scots before and since, in search of a better living in Canada, and they moved to Brentford, Ontario. Alexander found nothing to his taste there, and shifted again to Boston, Mass. in the USA, to open a small school, in 1872, for training teachers of the deaf, a topic in which he took a passionate interest.

He had very considerable success, and in a remarkably short time established a nationwide reputation for his methods of training teachers, particularly in the "hand alphabet" which his father had devised. This, incidentally, is a subject of controversy at the moment because it is no longer being taught, and the change is bitterly resented by many deaf people who feel that a valuable method of communication may be lost to future generations.

As a result of Bell's success, he was asked to incorporate his school into Boston University, and he became Boston's first Professor of Vocal Physiology in 1873. It was as a result of this achievement that he was able to find time for research, with all the facilities of a University now available to him.

Telegraphy Progress

He was fascinated by the development of Telegraphy, because it was a method of communication which was open to people with severe hearing or speech defects — in fact many deaf people were trained as telegraph operators in those days, just as the tradition of training blind people as piano tuners grew up, Bell's interest in the electric telegraph led to the invention, along with his excellent but lesser known assistant Thomas Watson, of many improvements in telegraph design, and to Bell's increasing involvement in, and knowledge of, electrical circuits. Gradually he conceived a system which would convert the sound waves of speech into electrical signals, and back again, with the purpose of allowing the deaf to hear what was being said some distance away. Curiously enough, another emigré, David Hughes, was working in Virginia along similar lines.

Bell's telephone system, after a few false starts, took the simple form of a carbon microphone, a battery, and an earpiece. The carbon microphone was until very recently still being used in telephones, particularly in this country; it is now being replaced by the electret microphone, the only device sufficiently sensitive, and with a large enough signal output, to take its place.

The carbon microphone principle (which is attributed to Hughes) goes thus: a thin flexible membrane or diaphragm of metal is held in an insulating cylinder which has a metal backplate, and the space between the diaphragm and the backplate is packed with granules of carbon. Carbon is a resistive material, and the resistance depends very much on how tightly the carbon particles are packed together. With this arrangement, pressing the diaphragm inwards considerably reduces the resistance between the diaphragm and the backplate; pulling the diaphragm outwards considerably increases the resistance. With a battery connected, the device becomes a variable current generator, with the amount of current depending on the movement of the diagphragm.

A Toast To Carbon

When a sound wave hits the diaphragm, it causes the diaphragm to vibrate at the same frequency as the sound wave, and with an amplitude (amount of movement) which depends on the loudness of the sound. In this way, sound waves hitting the diaphragm cause waves of electric current in the circuit connected to the carbon microphone. The useful and remarkable thing about the carbon microphone is the size of the electrical signal that it generates, putting several volts across a load with several milliamps flowing. Until the development of electrets there was nothing that came anywhere near such an output, and the defects of the carbon microphone, such as its narrow bandwidth and the resonances which

it caused, were not of great significance in telephone use.

Bell's receiver was electromagnetic, using the arrangement which, once again, has survived more than a hundred years. This uses a magnetised metal diaphragm held close to an electromagnet, usually of horseshoe shape. The varying currents transmitted by the microphone are sent through the electromagnet of the earpiece, and they cause the diaphragm to be magnetically attracted to an extent that depends on the amount of current. In this way, the current waves that flow in the circuit when someone speaks into the microphone are converted back to a sound by the action of the earpiece.

According to the notes that Bell made at the time, the first words spoken over a telephone circuit were "Come here, Watson, I want you . . . ". The fact that Watson heard them and rushed through to Bell's room was the start of something big. They took out a patent on their telephone system in 1876, and the invention was recognised by the confederation of the Volta Medal on Bell in 1880 by the French Government. By this time, the Bell Corporation was being set up to exploit the invention which in a few years was to change the habits of the whole world.

Enter The Decibel

Bell, at this stage, could have simply retired from active life, content to amass a fortune as President of one of the most important and rapidly-growing corporations in the US. It is typical of him that he did not, preferring to devote more time to research and to the twin ideals of developing his invention and of helping the deaf. His work on sound transmission soon highlighted a shortcoming of measurement, that there was no scale of comparative loudness of sound.

From a large number of careful measurements, Bell found that the apparent loudness of a fixed frequency from a telephone receiver was proportional not to the electrical power but to the *logarithm* of the power, and so he proposed a unit for comparative loudness, the logarithm of the power ratio of two signals. This was widely adopted, and named the Bel in his honour, dropping the final "l" to avoid any confusion between unit and name.

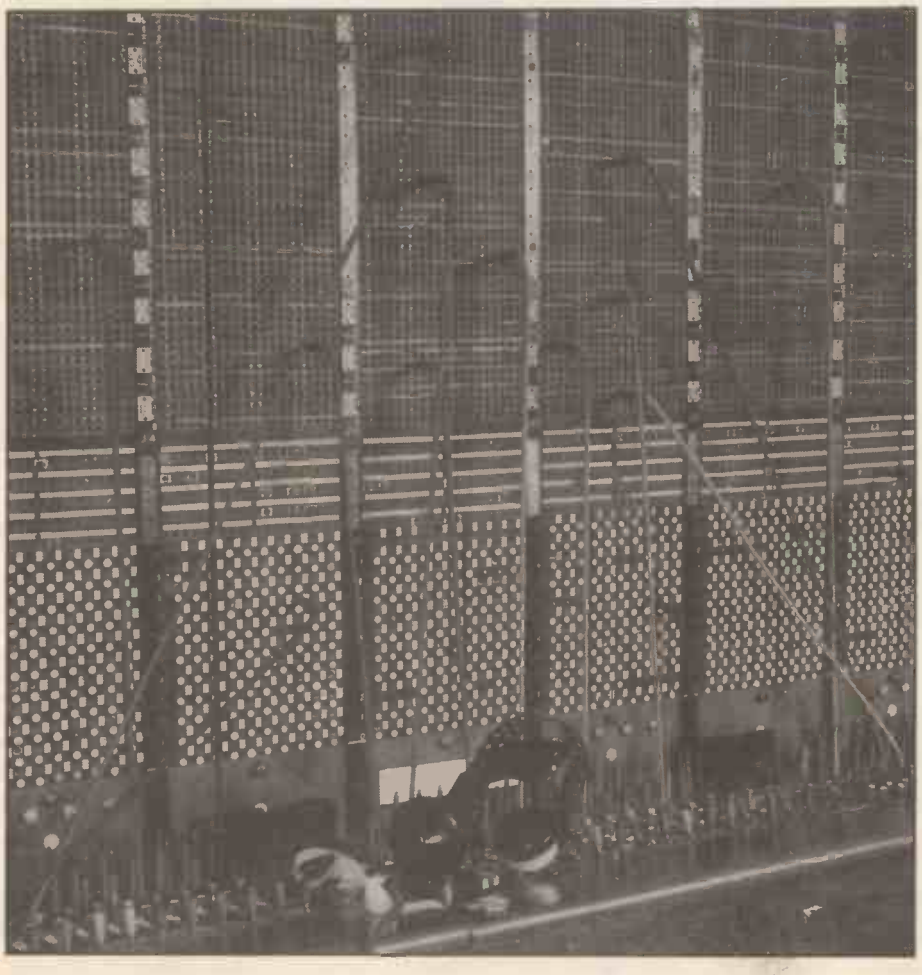
The Bel, however, is a larger unit, and just as we use microfarads instead of farads for measuring capacitance, it's more convenient to use tenths of a Bel, or "decibels", in place of Bels. Unfortunately the decibel is the most abused and least understood of all the units encountered in electronics.

Photos On The Phone . . .

Bell also worked on developments of the telephone system, as always, with a view to helping the deaf to communicate. One notable development, well ahead of its time, was the Photophone of 1880. This was a device to transmit photographic images over a telephone, a forerunner in many ways of the Photofax process and of slow-scan TV.

The principle was simple and ingenious. A transparency is fastened to a glass cylinder so that a light can be shone through transparency and glass on to a photocell (using selenium), which is inside the hollow cylinder. The cylinder is spun round, and the photocell is slowly moved from one end to the other, so that varying currents are generated in a circuit connected to the cell as varying amounts of light reach it through the transparency.

These currents could be transmitted over telephone lines, and at the receiver a photographic method was used to recreate the image. A piece of moist sensitised paper (the original sensitising chemical was potassium iodide) was then wrapped round a metal drum, which was the earth connection of the receiver. The signals from the transmitter were connected to a brush contact, which touched the moist paper as it revolved with the drum. The current flowing through the paper caused the chemcial to decompose, leaving a stain (iodine, when potassium iodide is used), and the amount of staining depends on the amount of current. Provided that the receiver drum is sychronised with the transmitter drum, the received image is a reasonably good reproduction of the transmitted one. An incidental advantage is that the picture size can be scaled up or down by making the receiving drum a different size from the transmitting drum.



. . . Letters Down The Line

The Photophone principle was developed into Photofax, and its descendents are still used. Bell followed it up with the Graphophone of 1887, designed to allow writing to be transmitted along telephone lines — and a large part of his receiver principle for this device can now be seen in the form of XY plotters for computers.

Bell died in 1922, the Grand Old Man of the telephone, and to the end a benefactor of the deaf, to whom he left much of the vast fortune he had accumulated. His other monument was the founding of the American Association to Promote Teaching of Speech to the Deaf, now known as the Alexander Graham Bell Association for the Deaf. This institute sponsors a great deal of research, much of it nowadays into electronics, resulting in a constantly improving service to the deaf. In many ways, I think that Bell would be more interested in this than in the whole telephone service if he could return to see it all.

Many, many thanks to Ian Sinclair for our longest-running series, and we hope our readers have enjoyed reading Famous Names as much as we have enjoyed running it. HE

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74LS40	12p	74LS193	38p
74LS42	30p	74LS194	35p
74LS47	36p	74LS195	35p
74LS48	45p	74LS196	45p
74LS51	14p	74LS197	45p
74LS54	14p	74LS221	50p
74LS55	14p	74LS240	55p
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14	10p	35p
16	10p	40p
20	22p	50p
24	24p	65p
40	30p	100p

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(Axial & Radial) Values in uf
63V: 1, 2.2, 3.3, 4.7, 6.8, 10 8p; 15, 22, 33 8p
40V: 330, 470 45p; 1000 48p; 2200 70p
25V: 47, 100 8p; 220, 330 12p; 470 26p; 680 1000 34p; 2200 50p; 4700 82p
16V: 470 14p; 1000 20p
10V: 1000 15p; 2200 25p

POLYESTER CAPACITORS (Radial) 250V
10n, 15n, 22n, 33n, 47n 8p; 68n, 100n 8p; 150n, 220n, 330n 10p; 470n 15p; 680n 20p, 1000n 25p

MYLAR FILM CAPACITORS (Radial) 100V
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CERAMIC CAPACITORS 50V Radial Lead
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0A90	9p
0A91	9p
0A200	9p
0A202	9p
1N914	4p
1N916	7p
1N4148	4p
1N4001	5p
1N4004	6p
4007	7p

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Carbon track, 0.25W log & linear

5K-2M single gang	30p
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5K-2M dual gang stereo	88p

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E12 values

0.25W 1R-5MI	1p
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SWITCHES
Slide 1A

DPDT	1Ap
DPDT c/off	15p
Sub-min Toggle	
SPST on/off	54p
SP c/over	80p
DPDT	75p
DPDT c/off	88p
Push Button	
Push to Make	15p
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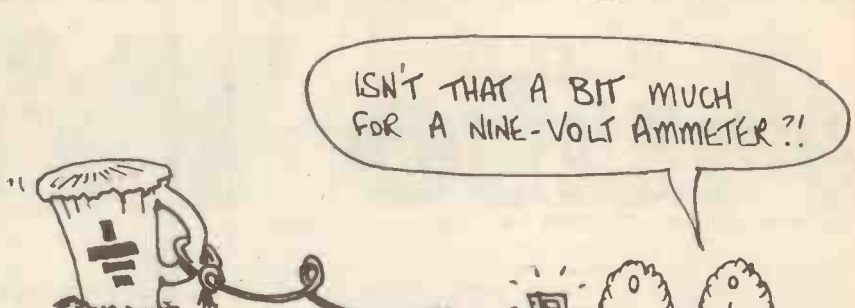
READERS' SERVICES

Feeling stumped? Looking for the right connection? It must be time to reach for HOBBY ELECTRONICS! Here's how . . .



Letters

While we are always happy to receive correspondence from readers, it is simply not possible for the editorial staff to reply to every letter. Because of staff limitations and the fact that producing the monthly editions of HE must take precedence, *we cannot even guarantee to answer letters accompanied by an SAE.* Hopefully this situation will prove temporary and we can shortly resume a full service to readers.

In the meantime, to reduce the amount of mail to which we attempt a reply, certain guidelines have had to be imposed:

● Letters from readers who have been unable to successfully build a Hobby project will receive first claim on our attention. But we urge readers to first make sure they understand the problem, and to read all parts of the article thoroughly: it is wasting our time (which is better spent ensuring that current projects are error free) to reply (to pick a common case) that the supplier of certain components is given in Buylines, on page 34.

● Many enquiries are concerned with drafting errors in circuit diagrams or component overlays; corrections for most errors have been published in subsequent issues, so please check your back numbers before writing to us — the information may already be in your hands.

● Where there is a definite problem, we ask that readers first try to solve the problem themselves: again, reading the article carefully will often resolve what appears to be a contradiction between, say a Veroboard layout and the circuit diagram.

● If it is necessary to write, please try to supply useful information: it is impossible to give constructive advice to the reader who says "My project doesn't work. Can you help?". The short answer, and the only one possible, is *no*!

● We would like to hear from any reader who has had difficulty with a Hobby project and who has come up with a solution, but we cannot advise when a project has been modified and fails to work: if you decide to make changes you will have to live with the consequences. Similarly, we are pleased to take readers suggestions for projects they would like to see in the magazine, or for modifications to improve a published project, but we cannot design circuits on request or re-design a project to suit the requirements of a single reader.

● We will try to answer any readers' questions on electronics in general, to suggest sources for components for old projects or to offer whatever advice we can when circumstances permit; however, we cannot advise on the purchase, use or modification of commercial equipment.

● We are unable to advise on the purchase of components in foreign countries; overseas readers are advised to read carefully the advertisements placed in HE by mail-order component suppliers and to write to them directly (this advice also applies to many UK readers wishing to obtain components for projects!).

● Unless specifically requested to the contrary, any letter to Hobby Electronics may be selected for publication in the magazine, including letters with an SAE if they are sufficiently interesting; in such a case a copy of the editorial comment will be returned to the reader prior to publication.

● Letters not accompanied by a stamped, self-addressed envelope may be selected for publication but will not receive a personal reply. We will attempt to reply to all enquiries backed by an SAE (if writing from outside the UK please include the correct number of International Reply Coupons, available from Post Offices) but we cannot guarantee a reply, nor can the publishers, Argus Specialist Publications, be held legally responsible for the accuracy of the information supplied.

Writing For HE

● Hobby Electronics' editor is continually looking for good projects, ideas for projects and designers to develop an idea into working project.

However unless you are already a seasoned contributor, it is unlikely that your first effort will reach the standard required for publication in the magazine. So if you have an idea or a design and you personally think it would be suitable as a Hobby project, write and tell us about it — and please include a telephone number (night or day, we're open all hours here) where you can be contacted.

Similarly if you are a designer, perhaps with time to develop someone else's ideas, please write or phone the editor!

Any Old Rope?

We will also undertake to publish any suitable but undeveloped ideas as experimental "Reader's Projects". The article will generally fill one page when published and should include a circuit diagram and description, parts list, component overlay (the projects should generally be on Veroboard) and some brief suggestions as to how the device might be constructed by the adventurous reader! A working prototype will not be needed, and the flat rate for Reader's Projects will be £20.

Simple circuits are also needed for publication as "Short Circuits"; no constructional information is needed, and contributors of "Shorts" will be rewarded with £10 per idea.

The Back-Log

The above guidelines for writing to Hobby Electronics have had to be drawn up in response to the growing pile of yet un-answered letters from readers.

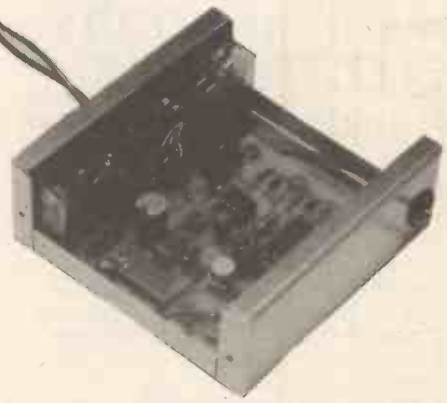
We apologise to all those still awaiting a reply; we are doing everything possible to clear the jam, but to enable us to do so in reasonable time we are retrospectively imposing the above restrictions on the type of enquiry with which we will deal. Therefore, any letter or question not relating to a Hobby Electronics project or a general electronics enquiry will be returned, with the SAE, to the reader.

HE

The Automatic Car Wash has just eaten your Car Radio Aerial for the third time in six months. It's time you got wise to the

Barry Foster

Auto Winder



LIKE MOST THINGS, car aerials are not intended to last forever. Far from it, you'd be lucky if one stayed in its appointed place for 12 months, because as well as the perils of rust and accidental damage, car aerials seem to provide an irresistable attraction for some . . . people. So, a car aerial that can be wound up and down by an electric motor is worth those few extra pounds — unless you like the battered chic of the coat-hanger look, of course.

The problem with motorised aerials, though, is that you have to remember to wind the thing down when you leave the car. No problem, you'd say — but the one time you forget will be the night you'll lose it, won't you! The solution to all these problems, then, is to install an automatic car aerial motor, one that winds the aerial up when you turn the radio on and winds it down when the radio is switched off. You can buy such an item outright, of course, but why spend more than you have to? The HE Auto-Winder will do the trick, and impress your friends as well!

Up And Down Circuits

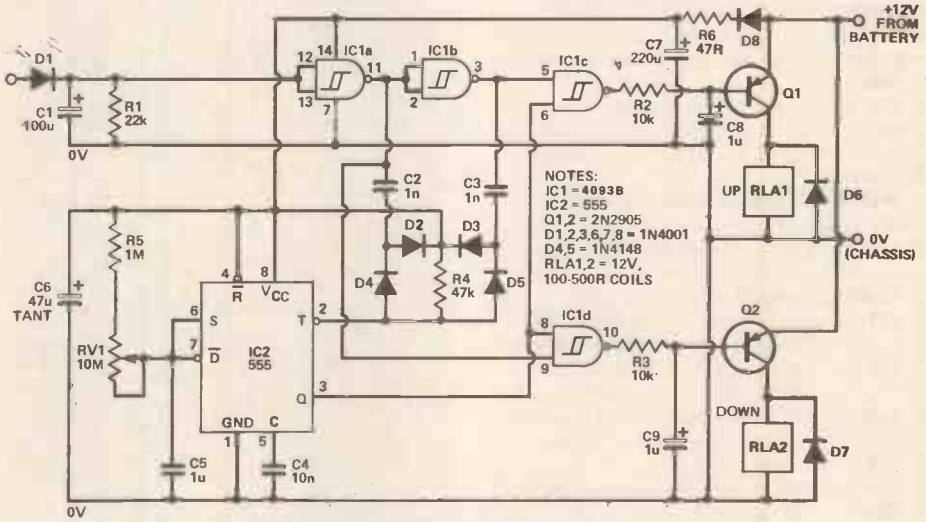
Since the Auto-Winder has to automatically wind the aerial either up or down, it has to respond to two different conditions in different ways. First, when the radio is switched on, it must wind the aerial up; then when the radio is turned off the aerial has to be retracted. All this is accomplished by a circuit which controls two relays to drive the motor in one direction or the other; a gating network turns on the appropriate relay while an adjustable timer sets the period for which the motor is driven.

The Auto-Winder circuit is permanently connected to the car's battery (the current consumption of the control circuitry is a matter of around eight milliamps and is hardly significant, especially when compared to the current drawn from the battery by the starter motor, say) and therefore will instantly respond when the radio is turned on or off.

The control input is taken from the on/off switch of the radio; when power is applied capacitor C1 rapidly charges up through the isolating diode D1, and when the voltage reaches the Schmitt trigger threshold of IC1a, its pin 11 will go low. Now C2 begins to charge through R4 and D4, pulling the trigger input of IC2 (a 555 timer) below 1/3 supply voltage and thus starting the timing period. C2 charges fairly rapidly, producing a low-going pulse approximately 120 microseconds wide, after which is charges up to the supply voltage; this leaves the trigger input at V+ so that it can respond to another low-going pulse.

IC2 is connected in a standard monostable configuration. Initially the Q output is low and the Discharge input, pin 7, is in a low impedance state,

Figure 1. The circuit, using a 555 timer and 4093B Schmitt trigger.



How It Works

The input to the unit comes from the car radio power supply, which provides a positive voltage on the input gate when the radio is switched on. The gate output is a negative pulse to the trigger generator; this produces trigger pulses to start the timer in two different situations: first, when the radio is switched on and then when the radio is switched off.

The timer sets the period for which the aerial motor is on, so that the aerial may be either completely extended or totally retracted.

The timer output is gated to either the Up or Down relay by another output from the trigger generator.

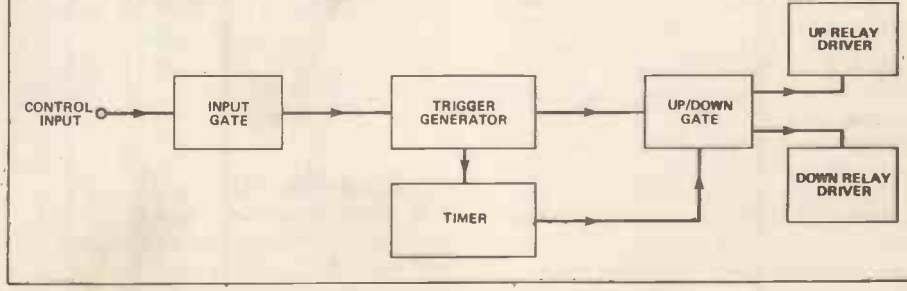
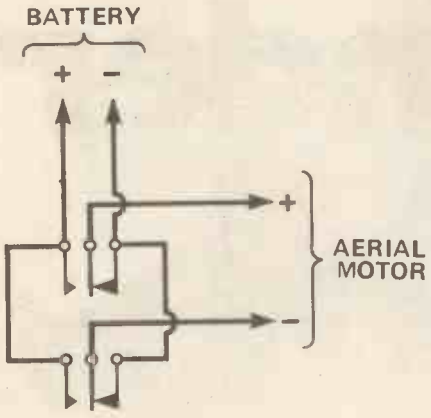
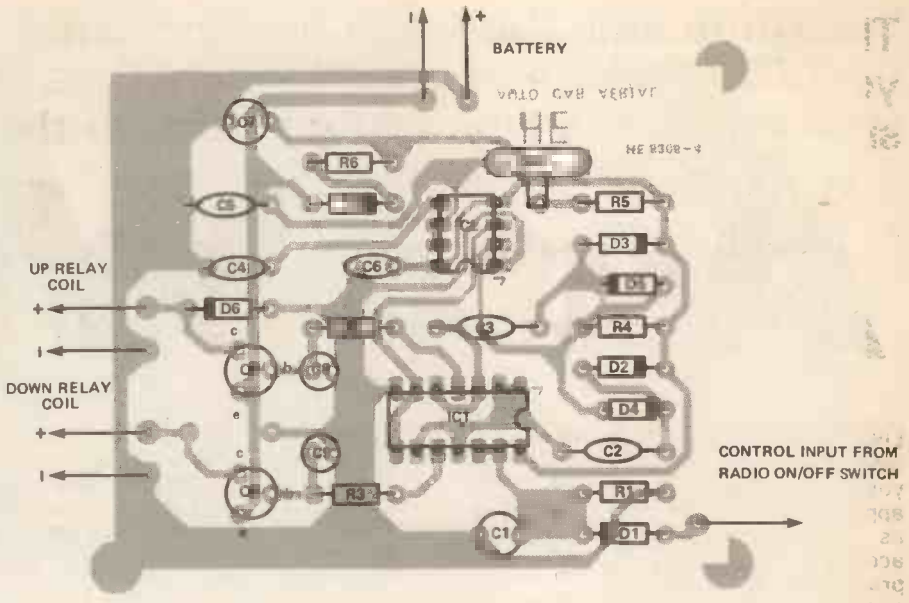


Figure 2. The PCB and components. Note that the relays are designed to be mounted away from the board.

Figure 3. Wiring for the relays. See over the page for suggestions on how to install the relay with the Auto Winder.





Parts List

RESISTORS
(All ¼ watt 5% carbon)

R1	22k
R2,3	10k
R4	47k
R5	1MR
R6	47R

POTENTIOMETERS

RV1	10M vert. preset

CAPACITORS

C1	100u 16V radial electro
C2,3	1n polyester
C4	10n metallised polyester
C5	1u metallised polyester
C6	47u 16V tantalum bead
C7	220u 16V radial electro
C8,9	1u 16V radial electro

SEMICONDUCTORS

IC1	4093B quad 2-in Schmitt trigger NAND
IC2	555 timer
Q1,2	2N2905 PNP transistors
D1,2,3,6,7,8	1N4001
D4,5	1N4148

MISCELLANEOUS

RLA1,2	see Buylines

Case (see buylines); PCB; wire, solder, nuts and bolts etc.

BUYLINES ..... **page 34**

shorting out the timing capacitor C5. When the IC is triggered, Q goes high and pin 7 goes to a high impedance state. C5 then begins to charge via R5 and RV1 until the voltage on it reaches 2/3 of the supply; this is detected by the Sample or 'threshold' input, pin 6, and the output promptly changes to low. At the same time pin 7 switches to low impedance and C5 discharges to ground through the IC, in readiness for the next timing period. The charge rate of C5, and hence the monostable on-time, can be varied by adjusting RV1.

The Q output of IC1 is applied to gates IC1c and d; since the output from IC1a is low when the radio is switched on, the pin 9 output of IC1d is low, and so its output is high. However C9 was charged to near the supply voltage through the emitter-base junction of Q2 when the unit was first connected to the battery, so this high just ensures that the charge on C9 is maintained, keeping Q2 turned off.

However with a low on pin 11 of IC1a, the output of IC1b will be high, thus both inputs to IC1c are high and its output will go low. Now C8 will discharge into pin 4 and as soon as the voltage on the base drops to more than OV7 below the battery voltage, Q1 will turn on, activating RLA1 and driving the motor to wind the aerial up. The sequence of events when the radio is switched off is similar; the unit will not operate immediately however, because C1 will take some time to discharge through R1, thus maintaining a high on IC1a's inputs for about two seconds. This is to prevent the aerial shuttling up and down if it takes two or three attempts to start the motor! Eventually, though, C1 will discharge below the threshold voltage of the Schmitt trigger and the output of IC1a will go high, IC1b output goes low and IC1c output goes high. However C2 was previously charged through R4, D4, so now the voltage at the junction of C2, D2 and D4 goes rapidly to 2V+ but then discharges via D2 and R4.

Meanwhile C3 is charging up through R4 and D5, pulling the trigger input of IC1 below 1/3 V+ and so commencing another timing period. This time, though, IC1c has a low input and so its output is high, keeping Q1 and the up relay turned off. But IC1d has both inputs high, and therefore a low output, so C9 will now discharge into pin 10 of IC1d; when the voltage on the base drops more than OV7 below the battery voltage Q2 turns on RLA2, driving the aerial motor to wind the stick down.

Construction

The Auto-Winder is easily built on a single-sided PCB (see PCB Service page for a ready-made board or build your own using the pattern printed on page 64), following the overlay diagram Figure 2. No special precautions are needed beyond the usual handling restrictions applicable to CMOS integrated circuits and the correct orientation of polarised components such as electrolytic capacitors.

When the PCB has been assembled, temporarily connect the relays to the points indicated on the component overlay. The relays have not been mounted on the PCB to allow a wider selection of relay types and to allow more flexibility when it comes to installing the unit in the car. However, the relay contacts should be rated at at least 5A, preferably 10A, since the aerial motor will draw quite a lot of current when it starts up. Then connect a lead to the control input on the PCB and temporarily connect the power supply lines to a 12V battery or power supply (do not connect the aerial motor, yet) and test the unit by touching the control input lead to the positive terminal of the supply. Hold it there, and the Up relay should click on for a moment, then turn off. Remove the control lead from the positive terminal and after a short delay the Down relay should turn on, then release. You can now adjust RV1 to hold the relays on for

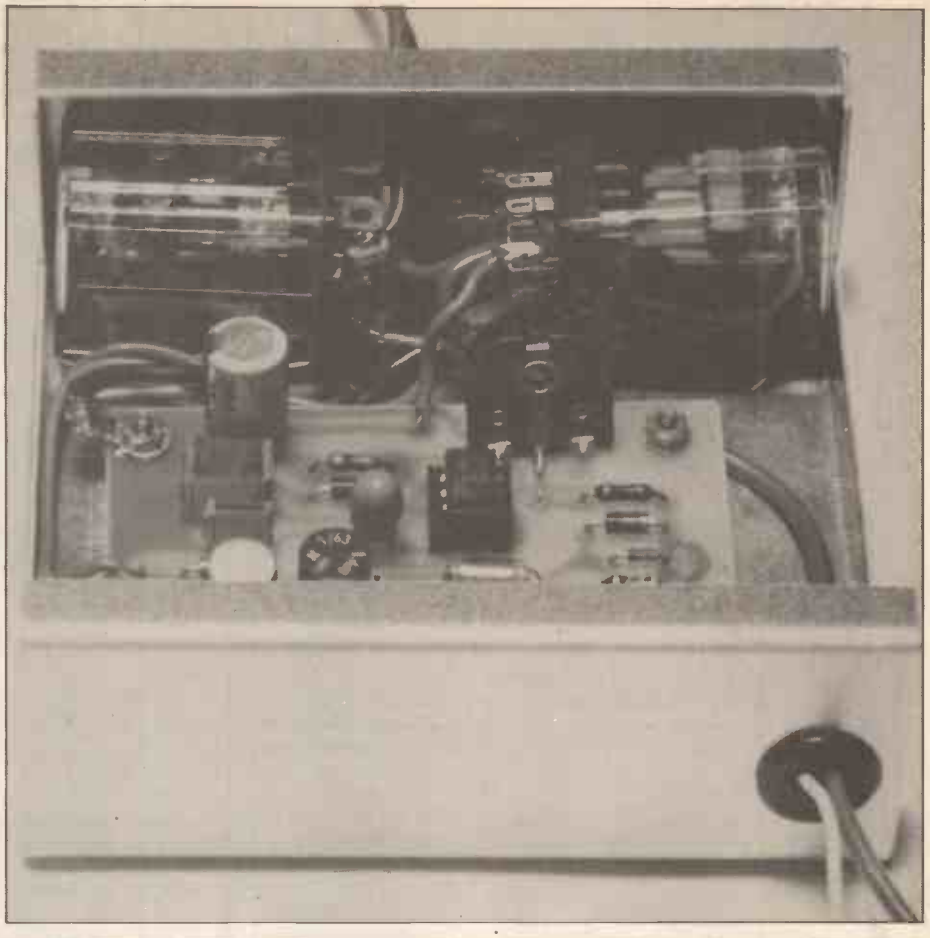
a time approximately equal to that required to wind the aerial up and down to its end-stops

Installation

Where and how you mount the Auto-Winder in the car is going to depend on the space available. The obvious spots are either under the dash or in the engine compartment; the preferred location is under the dash, away from the hot and oily engine.

The relays could be mounted with the PCB inside a metal case, as with the prototype, or separated from the control board; for example the PCB could be installed under the dash, close to the radio, with long leads to the relay coils and short leads again to the aerial motor. However if the relays are mounted with the PCB, be sure to wire them as shown in **Figure 3** before securing them inside the case with strips of double-sided tape.

Once the unit has been installed, all that remains is to make the final adjustment to RV1 so that the motor fully extends and retracts the aerial; then all you have to do is to remember to turn on the radiol



Our prototype was built in a no-frills, open-topped metal case for mounting in an inconspicuous place under the dashboard. The relays were mounted in the case with the PCB.

HE

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6810	120p
6821	160p
68B21	215p
6840	390p
68B40	580p
6844	1295p
6845	795p
6850	140p
6852	250p
6854	680p
6875	490p
6126A	120p
6128	120p
8T95	90p
8T96	90p
8T97	90p
8T98	90p
8035L	340p
8039L	290p
8080A	360p
8085A	450p
8155	450p
8212	155p
8216	100p
8224	180p
8226	195p
8228	250p
8251	300p
8254	450p
8255	280p
8257	450p
8259	450p
8279	450p
75107	90p
7510B	90p
75110	85p
75112	160p
75182	95p
75450	85p
75451	50p
75452	50p
75453	72p
75461	40p
75491	70p
75492	70p
AY-3-1015D	300p
AY-5-1013A	300p
MC1408	285p
MC1488	85p
MC1489	85p
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3.6864MHz	240p
4.0000MHz	150p
4.1943MHz	190p
5.0688MHz	240p
6.0000MHz	180p
6.8800MHz	240p
8.0000MHz	180p
10.0000MHz	170p
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48.0000MHz	170p

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READER'S PROJECT

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Enlarger Timer

A. Clegg

THIS CIRCUIT differs from most of those published in recent years inasmuch as neither a transformer nor a relay are employed. The preference here is for a lighter, more compact mains switching device — one that can be built for a fifth of the price asked in photographic shops — with an acceptable degree of accuracy and repeatability of the timing period.

The Circuit

The unit is powered from the mains, via a 13A plug fused at 3A, with the mains rectified directly by BR1; thyristor SCR1 provides the load switching and both these components can easily accommodate a 100W bulb.

The remainder of the circuit is powered from a 10V rail provided by dropping resistor R1, Zener diode ZD1 and smoothing capacitor C1. The dropping resistor should be rated at at least 3W for the value shown; it can be reduced, but to no lower than 10k, in which case it should be a 5W type, and the values of R3 and R6 should be decreased to 1kR.

The timing is provided by IC1, a 555. The timing period commences when SW2, a push-to-make momentary action switch, is operated. Then, pin 3 goes high and feeds the potential divider formed by R4, R5; the voltage from the divider switches on the SCR and thus the load. C4 and R7 are included as a precaution against self-latching of the SCR when a high wattage bulb is used but they may be omitted for a normal 60W bulb.

When pin 3 goes high at the start of the timing period, it also drives LED 2 to indicate 'time on', and commences to charge C2 via RV1, which therefore sets the timing period. When C2 charges up to 2/3 of the supply voltage, the timer pin 3 output will go low, causing the SCR to switch off and extinguish LED 2. C2 now discharges into pin 7 of IC1 and the green LED 1 comes on to indicate the timer is in the standby condition. The indicator LEDs are arranged to switch alternately to maintain a reasonably constant current through R1.

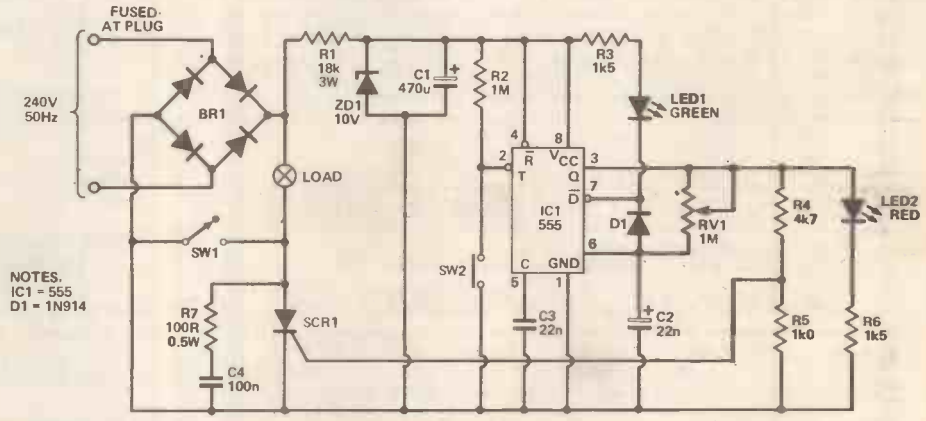


Figure 1. The circuit.

Parts List

RESISTORS
(All ¼ 5% carbon except as noted)
R1 ..... 18k 3W (see text)
R2 ..... 1MR
R3, 6 ..... 1k5
R4 ..... 4k7
R5 ..... 1kR
R7 ..... 100R 0W5

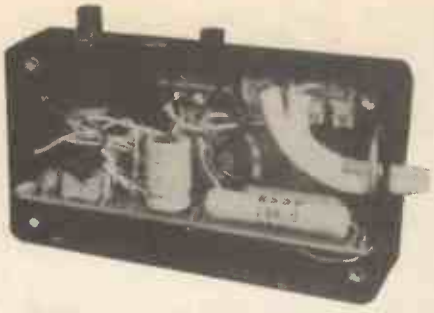
POTENTIOMETERS
RV1 ..... 1MR 0W5 linear

CAPACITORS
C1 ..... 470u 16V radial electro
C2 ..... 22u 16V tantalum
C3 ..... 22n radial polyester
C4 ..... 100n 400V axial polyester

SEMICONDUCTORS
IC1 555
SCR1 ..... C106 400V/4A SCR
BR1 ..... WO-04 400V/1A diode
ZD1 ..... BZX61C10V 10V 1W3 Zener
D1 ..... 1N914
LED1 ..... 0.2" green
LED2 ..... 0.2" red

MISCELLANEOUS
SW1 ..... 240V/1A mains rated slide or toggle
SWS2 ..... push-to-make momentary action
Case (see text); PCB; mains flex or 'Figure 8'; control knob, wire solder etc.

BUYLINES ..... page 34



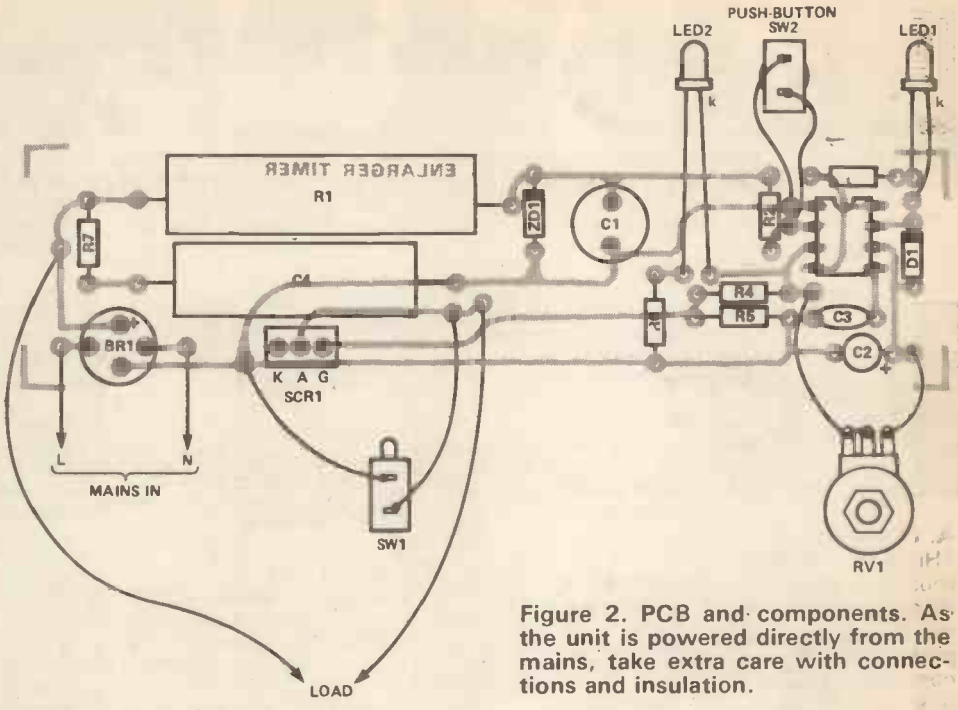


Figure 2. PCB and components. As the unit is powered directly from the mains, take extra care with connections and insulation.

Construction

The circuit can be build on a PCB and housed in an ABS plastic case measuring 112 x 62 x 31mm. As the circuit is powered directly from the mains, without the isolation afforded by a transformer, *every care should be taken with all connections*, soldered or otherwise; a plastic enclosure should be used and the timing capacitor RV1 should have a plastic shaft and a plastic covered control knob. The input and output leads should be securely clamped inside the box to prevent the connections from being pulled apart. If light 'Figure 8' flex is used, tie a knot in the cables inside the box, beside the outlet holes.

An over-ride switch, SW1, is included for setting up the enlarger and a graduated scale can be drawn around the timing control knob. First sketch out the timing positions (0 to 30 seconds) on white card, then use rub-down lettering to mark the positions for 0, 10, 20 and 30 seconds. Finally, cover the card with a piece of thin clear plastic and secure it under the potentiometer with the hex locking nut.

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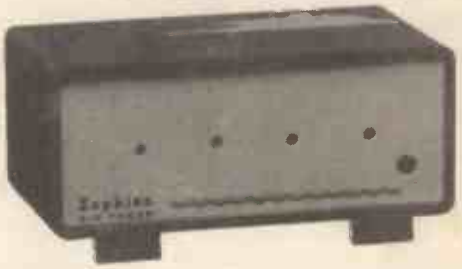

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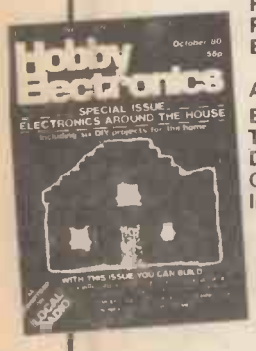

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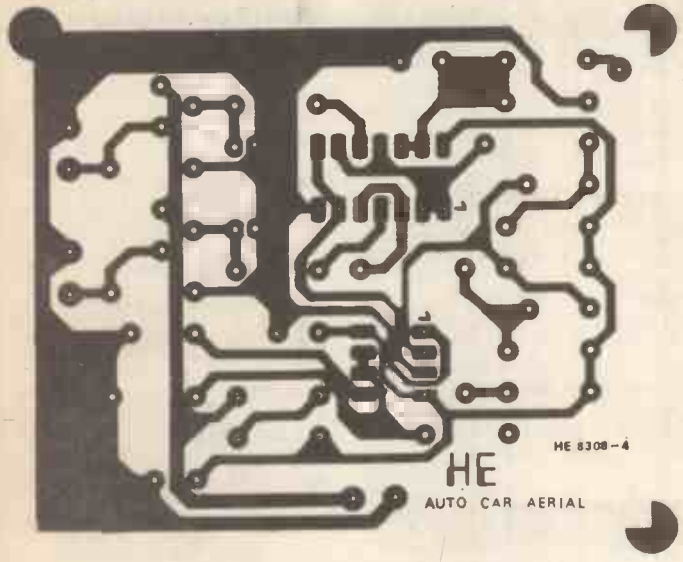
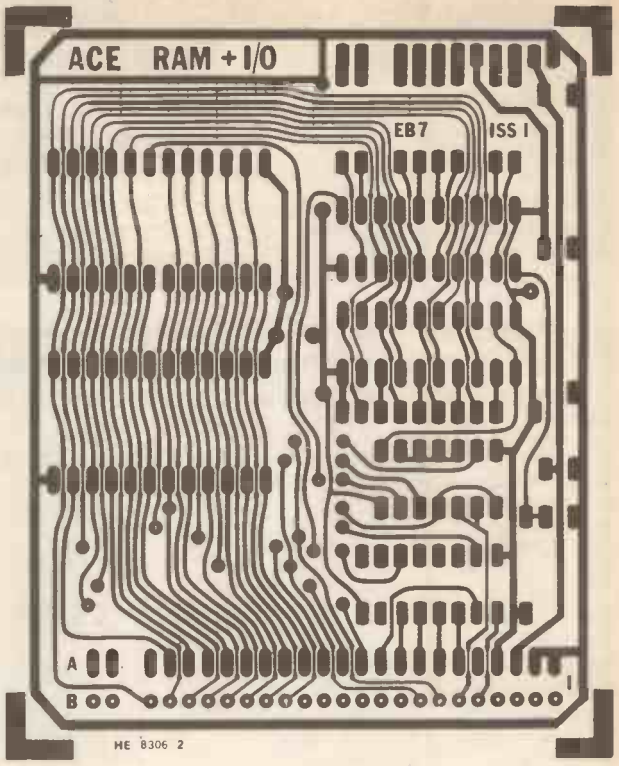
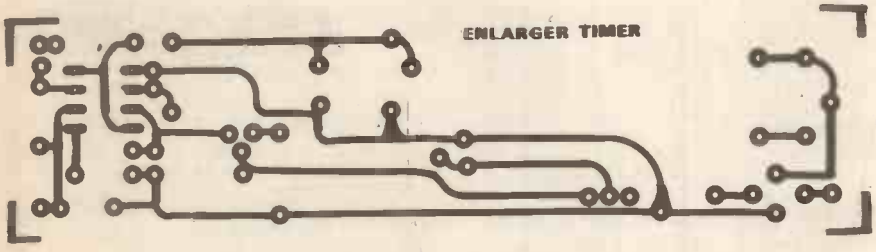


Above. The Auto Winder PCB foil.

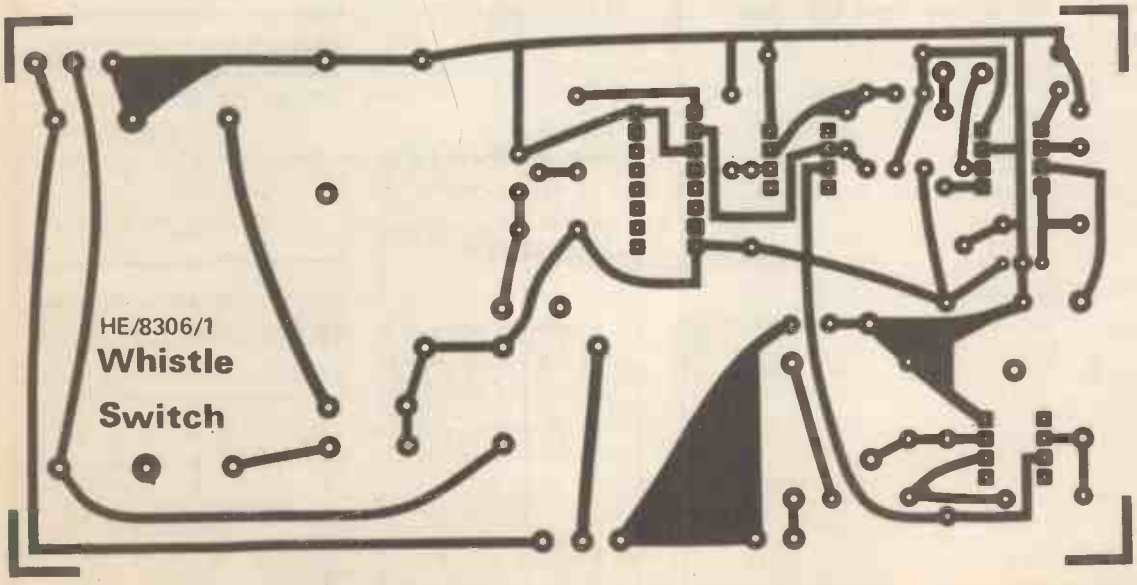


Above.
The ACE I/O board. Take care, before soldering in components, that the fine tracks have not fused together at any point, and that you have drilled out all the connection pads.

Below. The Photographic Enlarger/Timer PCB.



Below. The HE Whistle Switch.



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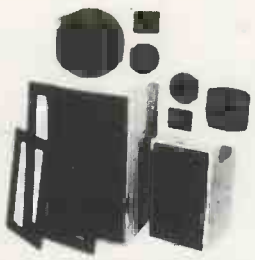
MULLARD SPEAKER KITS



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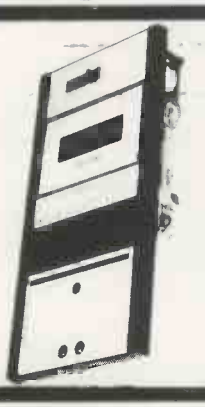
STEREO CASSETTE TAPE DECK MODULE



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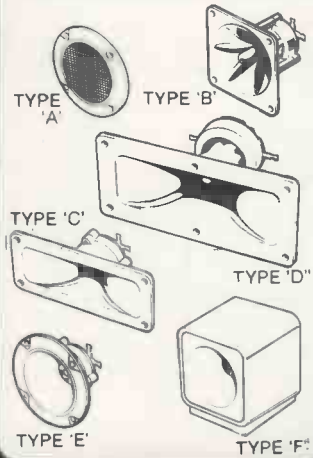

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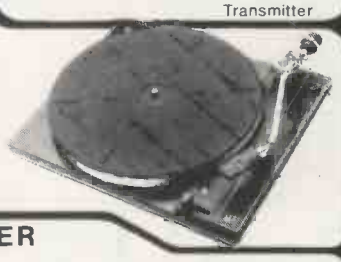

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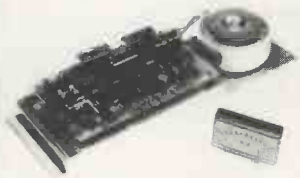

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