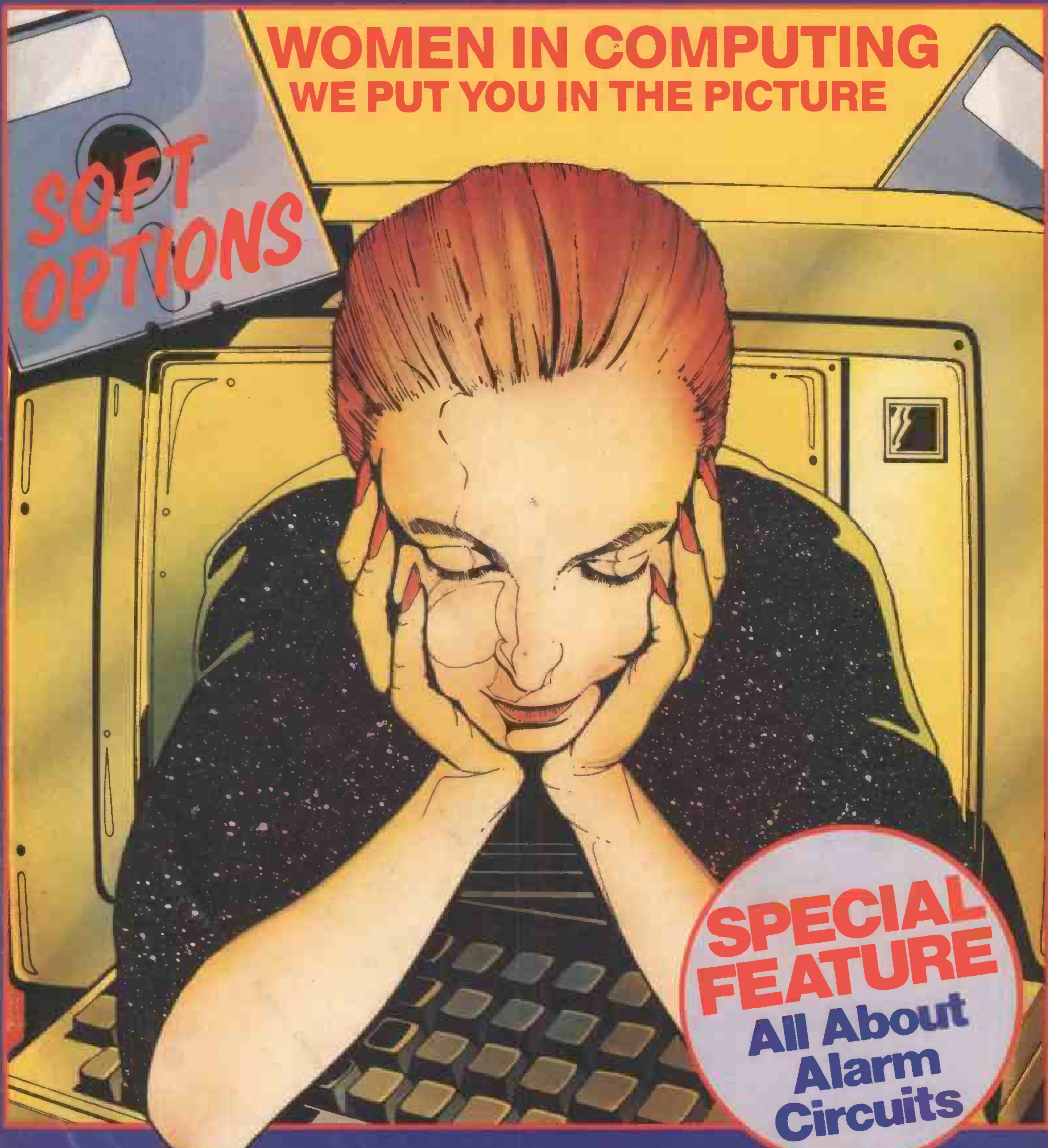
AN ARGUS SPECIALIST PUBLICATION
SEPTEMBER 1984

Hobby Electronics

Project Electronics For Everyone

95p



TELECINE . . . THE SECRETS OF FILM-TO-VIDEO TRANSFER

SEPTEMBER 1984
VOL. 6 No. 9

Hobby Electronics

PROJECTS

FEATURES

SPECIAL

REGULARS

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We are not normally able to deal with technical enquiries by 'phone, so please don't ring. Write to us with an SAE.

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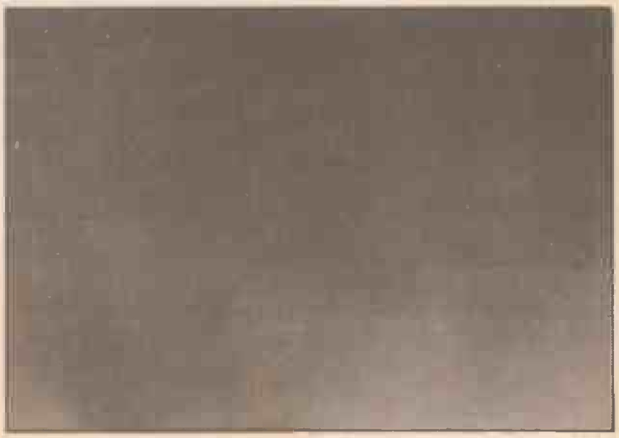
Light Dimmers — page 14



Ultrasonic Fire Alarm — page 19

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Digital & Micro ELECTRONICS

Aug/Sept 1984 NO

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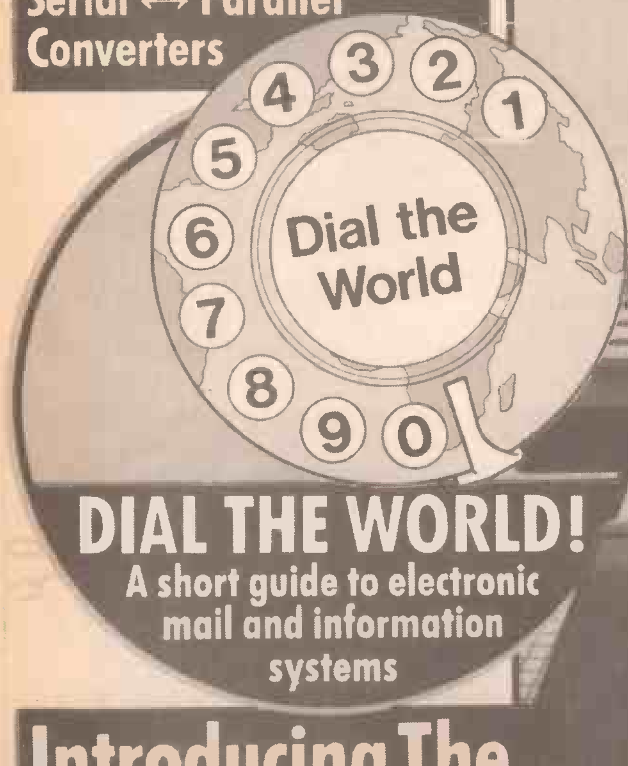
Interfacing Memotech's MTX Computers

Data Conversion Projects Serial ↔ Parallel Converters



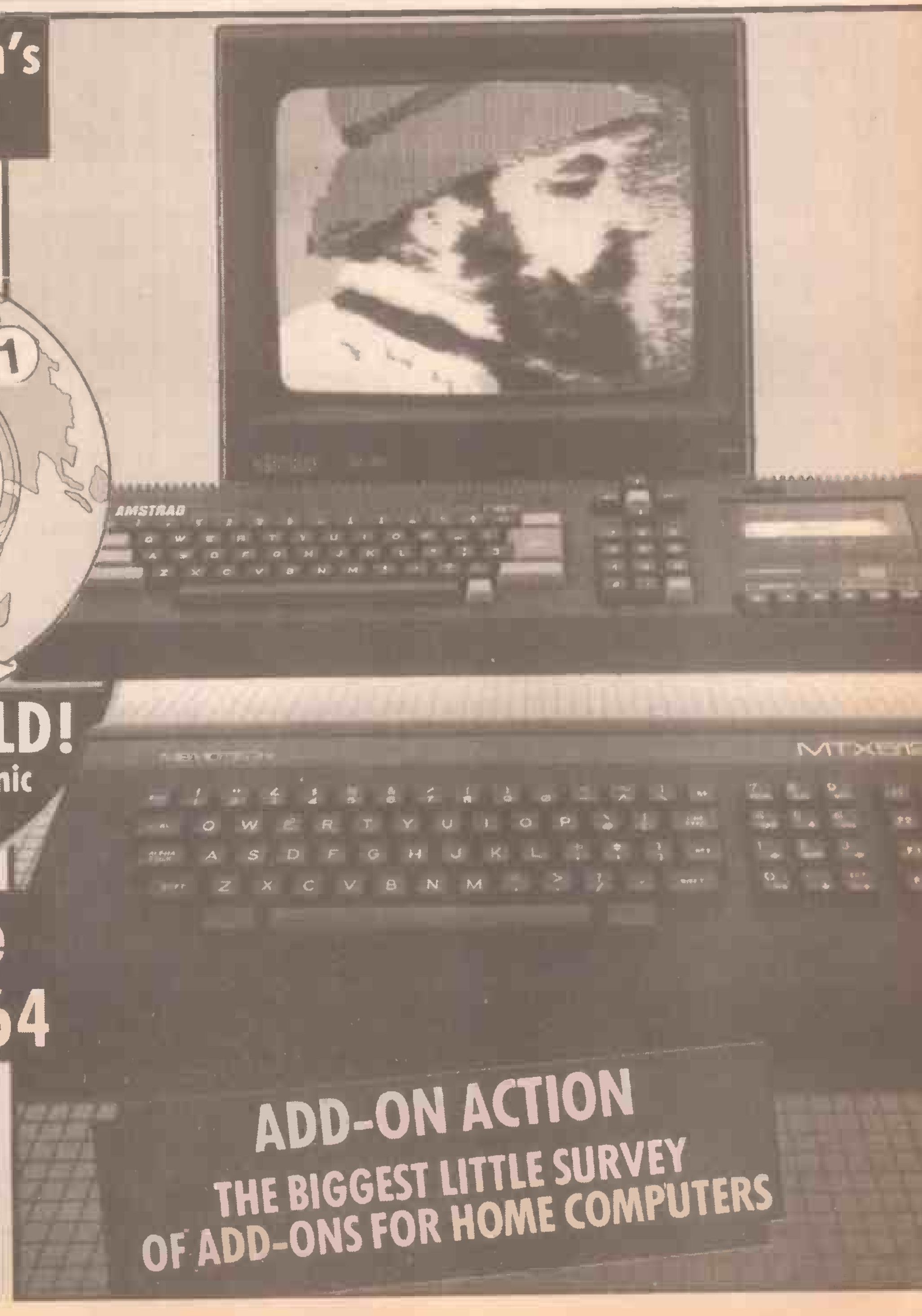
DIAL THE WORLD!

A short guide to electronic mail and information systems

Introducing The Amstrad CPC464

DIGITAL & MICRO PROJECTS

Datascope Logic Analyser
Frequency Meter Add-on
Enhanced Transistor Curve Tracer



ADD-ON ACTION

THE BIGGEST LITTLE SURVEY OF ADD-ONS FOR HOME COMPUTERS

HE PCB SERVICE

Ready made PCBs For Readers!

PRINTED CIRCUIT BOARDS (PCBs) for HE projects have often represented an obstacle for our readers. Some of you, no doubt, make your own but our PCB Service saves you the trouble.

NOW you can buy your PCBs direct from HE. All (non-copyright) PCBs will be available automatically from the HE PCB Service. Each board is produced from the same master as that used for the published design and so each will be a true copy, finished to a high standard.

Apart from the PCBs for this month's projects, we are making available some of the popular designs from earlier issues. See below for details. *Please note that only boards for projects listed below are available*: if it isn't listed we can't supply it.

July 82		
HE/8207/1	Tanover	£2.45
HE/8207/2	TVI Filter	£2.05
HE/8207/3	Computer PSU	£8.83
HE/8207/4	Solar Radio	£2.28
August 82		
HE/8208/1&2	Digital Millivoltmeter (Set of two)	£4.99
HE/8208/3&4	Audio-Analyser (Set of two)	£13.28
September 82		
HE/8209/1&2	Signal lights	
	Main Module	£2.25
	Junction Module	£1.96
HE/8209/3	ZX Interface	£3.84
HE/8209/4	Slot Car Controller	£2.28
October 82		
HE/8210/1	Flash Point Alarm	£2.45
HE/8210/2	Negative Voltage Generator	£1.71
HE/8210/3	Squelch Unit	£2.90
November 82		
HE/8211/1	Pedometer/Odometer	£2.45
December 82		
HE/B212/1	Phase Four	£3.25
HE/B212/2	Microlog	£4.58
HE/8212/3&4	Tape/Slide (Set of Two)	£6.05
HE/8212/5	TV Amp	£6.56
HE/8212/6	Lofty	£3.00
HE/B212/7	Noise Gate	£4.14
HE/8212/8	Low Cost Alarm	£2.65
January 83		
HE/8301/1	Chip Probe	£2.09
HE/8301/2	Switched Mode Regulator	£2.25
February 83		
HE/8302/1	Incremental Timer	£8.20
HE/8302/2	DigiTester PSU	£7.71
March 83		
HE/8303/1	Loudspeaker Protector	£2.89
HE/8303/2	Overvolt Cutout	£2.59
April 83		
HE/8304/1	6502 EPROMMER	£8.26
HE/8304/2&3	Ducker	
	Main Board	£4.09
	Preamp Board	£2.66
HE/8304/4	Power Down	£2.42
May 83		
HE/8203/1	BBC Interface	£5.54
HE/8305/3	Stall Thief	£2.88
HE/8305/4	Auto-Test	£2.88
June 83		
HE/8306/1	Sinclair Sound Board	£3.22
HE/8306/2	CB Rap Latch	£1.90
HE/8306/3	Bat Light (Car battery monitor)	£2.59
HE/8306/4	Traffic Light Toy	£2.94
July 83		
HE/8307/1	Soft Fuzz	£3.19
August 83		
HE/8308/1	Whistle Switch	£5.06
HE/8308/2	Ace Interface	£4.05
HE/8308/3	Enlarger Timer	£3.36
HE/8308/4	Auto-Winder	£3.43
September 83		
HE/8309/1	Tremoleko	£3.61
HE/8309/2	SPL Meter	£4.85
October 83		
HE/8310/1	Ultrasonic Alarm	£3.67
HE/8310/2	Audio Level Meter	£3.55
HE/8310/3	High Voltage Meter	£3.99
November 83		
HE/8311/1	Wiper Delay	£3.22
HE/8311/2	Light Delay	£3.21
December 83		
HE/8312/1	Damp Meter	£3.32
HE/8312/2	Continuity Tester	£1.39
HE/8312/3	Light Meter	£3.63
HE/8312/4	Bassman	£2.75
January 84		
HE/8401/1	Power Reducer	£3.69
HE/8401/2	Lap Counter	£7.00
HE/8401/3	Quizmaster	£3.23
February 84		
HE/8402/1	Audio PSU	£5.62
HE/8402/2	Field Memory	£3.23
HE/8402/3	Camera Remote	
	Transmitter	£2.67
	Receiver	£3.48
HE/8402/4	Timing Strobe	£3.61
March 84		
HE/8403/1	Offbeat Metronome	£3.46
HE/8403/2	Sinewave Generator	£3.31
HE/8403/3	Lightning Timer	£3.35
April 84		
HE/8404/1	Analogue Test Set	£4.31
HE/8404/2	Time Out	£3.54
May 84		
HE/8405/1	Spring Reverb	£3.70
HE/8405/2	Touch Switch	£3.11
HE/8405/3	Double sided touch plate	£5.49
June 84		
HE/8406/1	ZX81 Tape	£3.81
HE/8406/2	Mains Intercom	£3.78
HE/8406/3	Millivoltmeter	£3.33
July 84		
HE/8407/1	Audio Preamplifier	£7.20
HE/8407/2	Map Light Dimmer	£2.12
August 84		
HE/8408/1	Digitester	£3.59
September 84		
HE/8409/1	—	—
HE/8409/2	Headphone Amp	£3.17
HE/8409/3	Milliohm Meter	£3.67
HE/8409/4	Ultrasonic Fire Alarm	£4.74

PLACE an order for your PCBs using the form below (or a piece of plain paper if you prefer not to cut the magazine), then simply wait for your PCBs to drop through your letterbox, protected by a Jiffy bag.

HE PCB Service, Argus Specialist Publications Ltd., No. 1, Golden Square, London W1R 3AB.

I enclose a cheque/Postal Order made payable to ASP Ltd, for the amount shown below Price.

OR

I wish to pay by Barclaycard. Please charge my account number

. . . .

OR

I wish to pay by Access. Please charge to my account number

. . . .

SIGNATURE . . . .

NAME . . . .
(BLOCK CAPITALS)

ADDRESS . . . .
(BLOCK CAPITALS)

. . . .

. . . .

Please allow 21 days for delivery

Boards Required	Price
Add 45p p&p	0.45
Total Enclosed £	

MONITOR

Stick-On Keyboard

For Atari 400 owners who find the touchpad keyboard tiresome, a peel-off, **stick-on keypad** is being marketed by **Filesixty**, who have already produced a similar keypad for the ZX81.

The keyboard, which is stamped in highly resiliant, flexible silicon rubber is reinforced with a brushed-aluminium finish metallic panel. It is said to be "virtually indestructible", moisture and dust proof and colourfast, and tested for up to 3½ million impressions. It gives the keyboard the feel of a good quality calculator keyboard, which should make typing considerably easier and more accurate.

At present the keyboard is only available direct from **Filesixty** at **25 Chippenham Mews, London W9 2AN** price £19.95. Later, the keyboard will be sold through retailers.

What A DIN

A mini temperature control module from **Electronic Temperature Instruments** meets the demand for a DIN standard size 48x48mm **temperature control module** and an increase in control accuracy.

The controller is available as a panel mounting or a plug in module in the temperature ranges 0-250°C, 0-400°C or 0-800°C. 110V and 240VAC mains supplies are catered for, and thermocouple and resistance thermometer versions are available.

The units costs £28.50. Enquiries to **E. T. I., Highdown Works, Highdown Avenue, Worthing, W. Sussex BN13 1PU. Tel: (0903) 690750.**

Don't Flip

The **Opus Super 3 Microdrive** makes the claim that it is the UK's first truly double-sided disc-drive unit, providing access to both sides of a disc without turning it over.

The unit comes in single and dual drive formats compatible with most popular micros. The 200K single drive costs £229.95 (inc VAT) with all leads, a free disc cartridge, user manual and a year's guarantee. The 400K dual unit (which we can only assume comes with the same fittings, although this is not stated) costs £399 PLUS VAT.

Both versions have forty tracks, with a track to track as access time of 3mS. The single and double density models offer 125KB and 250KB per second rate of transfer respectively. The 3in units are fully compatible with 5¼in drives, and can be daisy chained to provide up to four drives in a row.

The advantage inherent in 3in drives is apparant here: at 95x155x45mm, it weighs half as much as a 5¼in unit, and is 75% smaller in volume, we are told. The drive's robustness make it particularly suitable for educational use, or just for use with young children about.

The units are available at high street stores, including W H Smith, Spectrum UK and Alders.

For further information contact **Opus Supplies Ltd., 158 Camberwell Rd., London SE5 0FE. Tel: 01 638 1698.**

Component Support

Ship Co., of Ireland have introduced a **component filing system** for storing and carrying a very wide range of components in smaller quantities.

The storage unit comprises a small drawer supporting a continuous strip of plastic foil formed into pockets, sixty in all. The strip is supported and can be labelled at the junction of each pocket — a mini hanging file, in other words.

The draws can be used separately, or as four- or six-drawer cabinets. The six-drawer unit is locked and portable with a pull-out handle.

The main advantage of the system is the number of different components which can be stored readily accessible in a small space, useful for anybody doing repairs, or servicing, or for hobbyists who do a lot of cannibalising and like to keep a good stock of general components.

The UK stockists for the system are **Circuit Chemicals, Unit 6a, Shilton Industrial Estate, Bulkington Rd., Shilton, Warwickshire. Tel: (0203) 610317**, who will doubtless be able to quote prices and further details.

Sir Clive Declares

The Office of Fair Trading tell us that "A company which sells computers — Sinclair Research Ltd., of Willis Road, Cambridge" has given a written assurance to the office that it will not advertise mail-order delivery periods which the company cannot keep to. In reality, this amounts to not "knowingly, recklessly or negligently making false statements" about the likely period of delivery.

Sinclair themselves (and Sir Clive himself) say that they regret delivery periods of twelve to sixteen weeks which occurred in 1982 owing, they say, to the difficulty in estimating the demand for a new product, and add that customers were given the option to cancel their orders for a refund. Very few did.

The Key To Success

A full-travel **QWERTY** (not "QUERTY" please!) **keyboard** for the Spectrum is being supplied by **Advanced Memory Systems**. The computer's wobbly rubber keys have proved something of a problem for anyone attempting to use typing skills on them, which has limited the use of the Spectrum for word processing, for instance (to say nothing of their occasional refusal to return to the 'up' position, or to operate at all if not hit dead on centre).

The LO PROFILE keyboard has a full length space bar and a dedicated numeric keypad, as well as increasing the number of keys from forty to fifty three.

The keyboard requires the innards of the Spectrum to be de-cased and placed within it. AMS say that the existing connections for TV, cassette, power and interfacing all use the ports at the rear of the case, and no alterations or adaptions are needed. If the LO PROFILE is as easy to use as AMS claim, it will make a considerable difference to the Spectrum's usefulness for those who do not shift the computer, hermit-crab like, into the new case, remembering that opening the Sinclair case for any reason will invalidate the manufacturer's guarantee, and so is not an ideal option for new Spectrum owners.

AMS has made their reputation by supplying 3in disc drives for the BBC Micro, which augers well for their other products. The LO PROFILE is available mail order for £49.50 plus £2.50 p&p from **Advanced Memory Systems, Green Lane, Appleton, Warrington, Cheshire WA4 5NG. Tel: (0925) 602690.**

Telephone Transgression

Micro User magazine has been soundly told off by **British Telecom** for encouraging its readers to build a DIY telephone link in their July edition. The modem project, by technical editor Mike Cook, is accompanied by a kit and is being rapped because it does not carry a warning that the unit has not been approved for connection to BT equipment (that is to say, the entire telephone system).

The Micro User article claimed that government type approval is both very expensive and very time-consuming; it also pointed out that type approval is aimed at preventing the electrocution of telephone engineers (or users, come to that — Ed.) by equipment which puts high voltages onto the telephone network.

British Telecom are quick to point out that type approval doesn't take that long, and that they have to abide by the Department of Industry's rules like everybody else.

There's nothing new about everybody screaming at BT to do things cheaper and faster, is there? Surely they don't have to start electrocuting them as well?

Trace The Dragon

Microtanic Computer Systems have produced "Dragon Ace Trace", machine code **monitor/disassembler**. It is written in position independent code and can reside anywhere in the Dragon's memory map from $0600 to $7FFF.

It enables the user to TRACE through RAM and ROM, simulating the 6809 in slow motion, displaying the CPU's every move as it happens. Also included is a powerful Monitor Dissassembler Line Editor standard 6809 Assembler supporting all Motorola mnemonics.

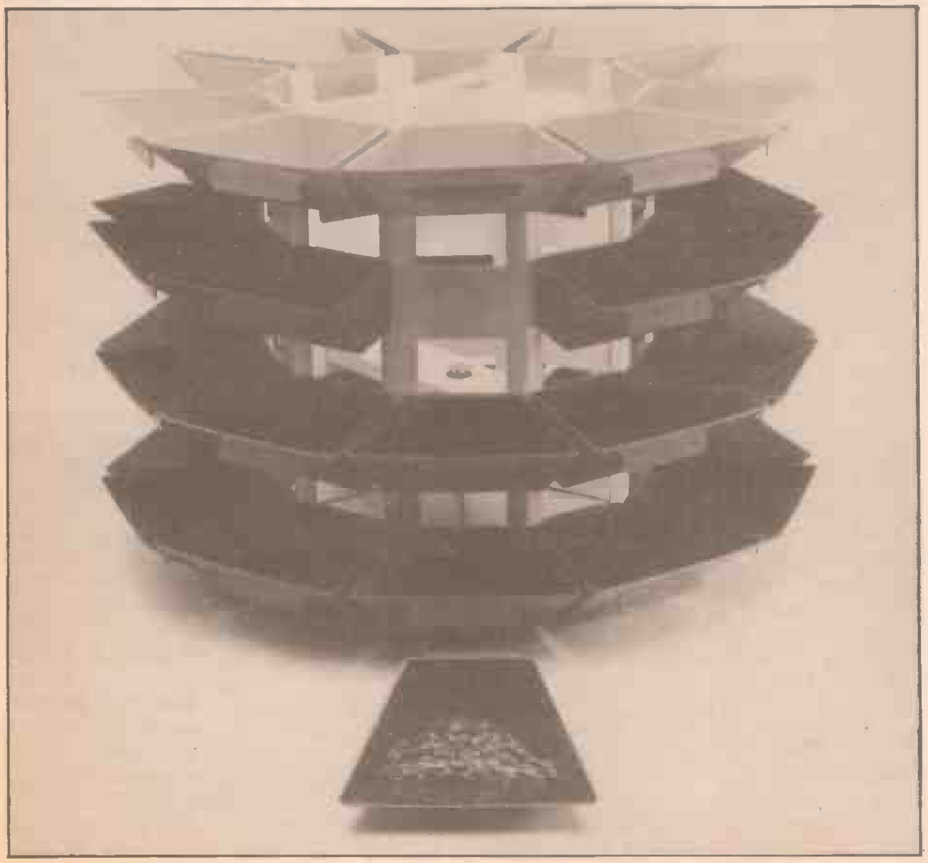
The EDITOR allows the insertion, deletion or alteration of any character or space, renumbering of lines of text, and insertion of blocks of text of any size within a file.

The ASSEMBLER allows ORG, EQU, FCB, FDB and FCC assembler directives and comments can be inserted in any line. All the Motorola addressing models are supported as well as the mnemonics.

The DISASSEMBLER can disassemble anywhere in the RAM or ROM Both code and mnemonics are displayed.

With the TRACE you can see all the instructions the micro is executing as they happen. The machine code, instructions and contents of all the registers of the 6809 will be displayed on the screen, so that the action of the program can be followed through in detail to trace any faults, around five hundred times more slowly than real time running. To speed up progress the register dump can be suppressed and recovered at any time, and the screen printout can also be suppressed and recovered.

Further information from **Microtanic Computer Systems Ltd., 16 Upland Rd., Dulwich, London SE22. Tel: 01 693 1137.**



All Change

Ambit International, Solent Component Supplies, Broxlea Ltd. and Projex Distribution — all parts of the electronics section of A.F. Bulgin & Co. PLC — have been collectively renamed **Cirkit**. Under the aegis of **Cirkit Holdings PLC**, the organisation aims to supply the industrial and amateur market with components, modules and kits, as well as a custom manufacturing and test facility, from one source. The Company will remain based at Broxbourne, Herts.

Cirkit attribute their present expansion to the establishment of their distribution company a few years ago. We hope that this means that the hobbyist will be served by the full weight of a major professional supplier. Their main offering to home constructors are their graded kits and modules which are right for rank beginners as well as experienced constructors.

And as an introduction to our own readers, three of the Cirkit designs are featured as projects in this month's Hobby.

Further enquiries to **Cirkit Holdings PLC, Park Lane, Broxbourne, Herts EN10 7NQ. Tel: (0992) 444111.**

Around And Around

OK Industries are providing industrial grade soldering irons for both 115VAC and 230VAC 50/60Hz. The SA-8-15 (371°C) and SA-8-20 (427°) heat up ready for use in less than two minutes, and can also be used with static-sensitive components without earthing.

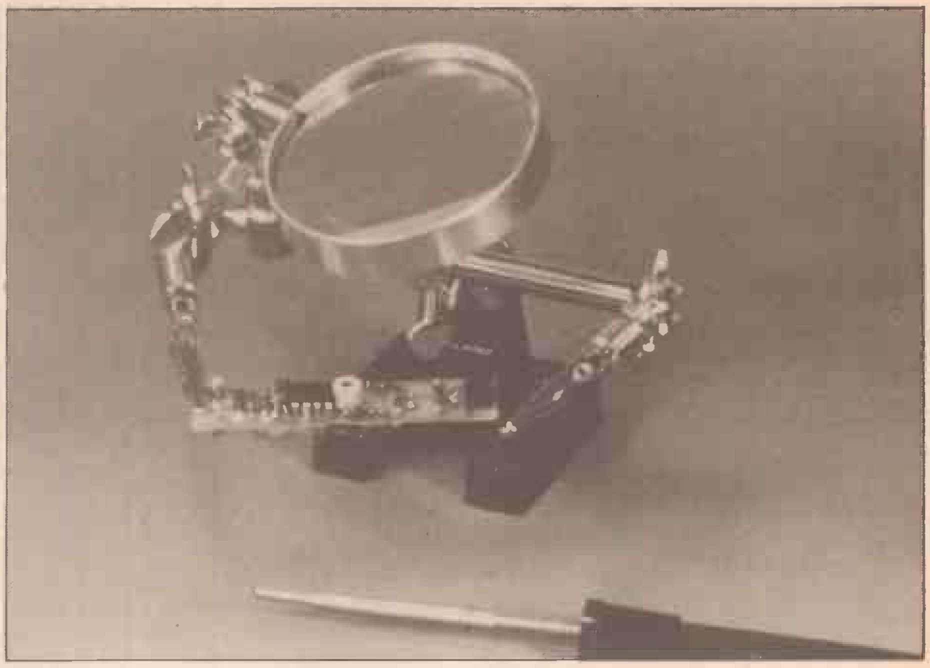
A four-tier, forty-bin component rack which rotates on precision bearings, has a carrying handle and dust cover, colour coded removable ABS bins is OK's latest contribution to benchtop component storage. The circular unit is 50cm in diameter and 32cm high.

Enquiries to **OK Industries UK Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA. Tel: (0703) 619841.**

Rising Chorus

The latest issue of **Electronic Organ Magazine** includes as usual a mass of circuit information on electronic keyboard music, including Staircasing With Chorus Effect (Part Three), a power supply circuit for the Maplin MES 53 and other organs, Standardization of Organ Consol for a Cinema or Theatre Organ, Yet Another Free Phase Organ Scheme (we quote) and much other sound advice (10p in the pun box there).

Interested parties should contact the **Electronic Organ Constructor's Society, the Hon. Sec., Pilgrim Cottage, Church St., Burham, Nr. Rochester, Kent.**



Hands Across The Board

"For those who often find themselves short-handed (and long-sighted) in the workshop", say **Light Soldering Developments,**" we have an essential little device called the Helping Hands."

The Helping Hands is a handy (ouch) little workstation, built on a solid, cast base, with 115mm support bar with two crocodile clips and a five dioptre glass lens. Bar, clips and lens are all mounted on adjustable ball-joints, and can be set to any position to hold components or PCBs for inspection, assembly, repair, etc. under a clear, magnified view.

The Helping Hands costs £7.45 all inclusive, which seems like very good value from a company with an established reputation. Orders and enquiries to **Litesold at Spencer Place, 97/99 Gloucester Rd., Croydon, Surrey CRO 2DN. Tel: 01 689 0574.**

More Meters

Beckman Instruments have added three new (or revised) series of multimeters to their lists.

The low-price T-series digital multimeters T100 and T110 have been replaced by the improved-format T100B and T110B, the T110B with a peak hold function.

The T100B gives seven functions and twenty eight ranges, including 200mV to 1000VDC (750VAC), 200uA to 10A (without shunt), and 200R to 20MR, and has a separate diode test range and a buzzer for indicating continuity. The T110B gives eight ranges and twenty nine functions, with the same measurement ranges. Basic accuracies are 0.5% for the T100B and 0.25% for the T110B.

The 200R range is high power for use with electrical circuits; other ohm ranges are low power; the T110B's peak hold function keeps the highest reading on the display after the test leads have been disconnected, and operates on all current and voltage ranges as well as positive AC and DC readings.

A true RMS model has been added to Beckman's list of heavy duty handheld DMMs. The HD130 provides seven functions and twenty-nine ranges, with the same measurement limits as the T series above. All AC voltage and current measurements are true RMS (AC and DC).

The meter is designed for outdoor and industrial service requirements, and will cope with sine waves distorted by interference from various sources.

A 4½-digit DMM, the 4410, gives seven functions and twenty-seven ranges, measurements as above. Accuracy is 0.05% +/- two digits on the lowest DC voltage range with a resolution of 10uV. Resolution is 10nA on the lowest current ranges and 0.1R on the lowest resistance range. All AC measurements are true RMS.

The package is basically the same as the Beckman 3½-digit meters but with superior accuracy and resolution owing to the extra decimal place, and true RMS readings.

For further details and prices, contact **Beckman Instruments Ltd., Electronic Components UK Sales and Marketing Organisation, Mylen House, 11 Wagon Lane, Sheldon, Birmingham B26 3DU. Tel: 021 742 7921.**

Bats On Board

Gould Micro Power Systems, who feature in these pages from time to time as purveyors of zinc air batteries, have announced that they have introduced a range of plastic battery holders which allow their zinc air batteries to be mounted directly onto a PCB. Gould recommend the batteries for microcomputer memory backup, or portable equipment applications.

The holders are made in a heat stable material, with a low-profile design and spacer feet to allow air flow.

Enquiries to **Gould Micro Power Products Division, 11 Ash Rd., Wrexham Industrial Estate Wrexham, Clwyd LL13 9UF. Tel: (0978) 61984.**

Control Computer

A company called **Radionic Micro-systems Ltd.** has developed a small microcomputer specifically for sensing and control. The machine known as the Radionic CNS, has been designed to run continuously for long periods (twenty eight days is quoted) while monitoring various household/control functions, including plant watering, home and office security, central heating, cooking, and feeding the goldfish, as well as ordinary number-crunching. It is also compatible with Tandy Basic Level II software (including games).

The machine has ten control and sensing sockets, expandable to twenty-two internally or 255 with an interface, and will operate simple robotics or timed functions.

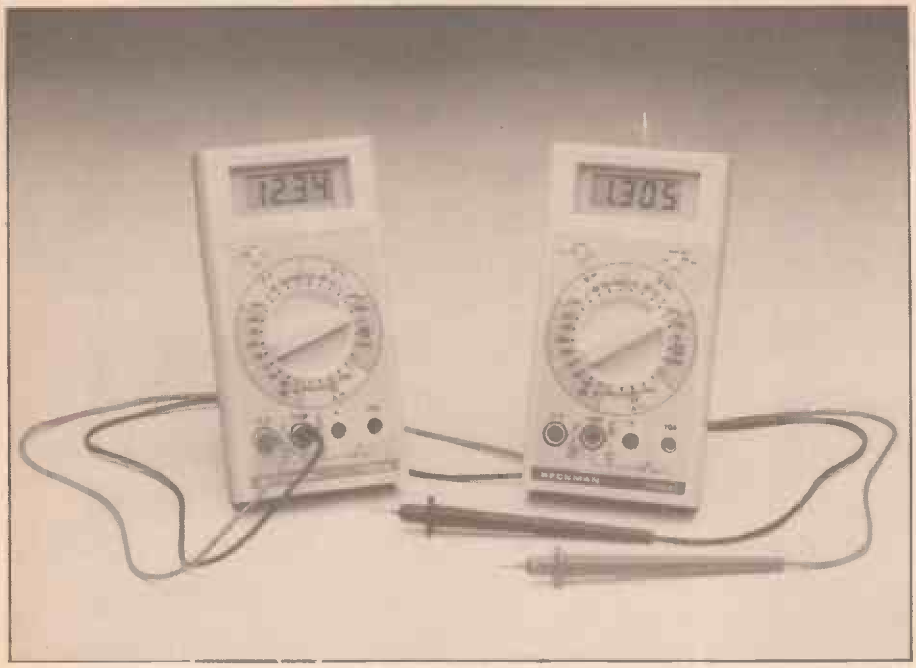
Small and low-powered, the CNS has a real keyboard and a real-time clock, and will run any Centronic interface printer without modification. It can be internally expanded to include a disc interface.

The computer itself costs £200, ex VAT but including P&P, and comes with a user manual and a project guide showing how to make the computer perform certain tasks.

Radionic claim that their micro is the only home computer marketed in this country with built-in sensing and control. There are also a matching monitor and cassette recorder.

To demonstrate the possibilities of the system, one of the developers of the computer, Mr. John Bowring, has wired up his country cottage with the control system.

Enquiries to **Radionic Micro-systems Ltd., Avondale Workshops, Woodland Way, Kingswood, Bristol BS15 1QH. Tel: (0272) 603871.**



New Catalogue

Stotron Ltd., purveyors of alarms, connectors, displays, LEDs, mains filers, indicators, switches, relays to name but a few, have issued a new product catalogue, which can be had free of charge from **Stotron Ltd., 72 Blackheath Rd., Greenwich, London SE10 8DA. Tel: 01 691 2031.**

Stotron add that they have no minimum order charge and that their prices are aimed at one off/small quantity orders as well as bulk orders.

Clean Up

STC are marketing a micro/printer/ word processor cleaning kit in a compact case. The kit includes Floppiclene diskette drive head cleaner, Foamclene anti-static foam cleaner, Microwipes lint-free absorbent wipes, Safeclene special cleaning fluid, Safebuds lint-free cotton bud sticks, Safeclens anti-static screen wipes, and Safetape cassette drive head cleaner. The kit comes in two versions, the standard version with anti-static cleaning cloth and a 5¼in floppy disc cleaner, and a version with a cassette transport cleaner.

Further information, as well as copies of their current free catalogue, can be had from **STC Electronic Services, Edinburgh Way, Harlow, Essex CM20 2DF. Tel: (0279) 26811.**

Low Power Electron

First Byte are launching their printer interface for the Electron at the Electron and BBC User Show in London. The interface will be different from others on the market in that it requires no software driver to be loaded from tape, but this has been achieved without the need of an EPROM, hence the low price of £34.95 (inc VAT).

The interface is housed in the same type of plastic case as their Joystick Interface and First Byte hope to achieve the same low (0.5%) failure rate as that interface.

An ultra low power design has been achieved, which means no compatibility problems with other peripheral interfaces, an important consideration with the relatively limited Electron power supply. The interface will be available in August from WH Smith and computer dealers already stocking the joystick interface.

Further enquiries to **FBC Systems Ltd., 10 Castlefields, Wain Centre, Derby DE1 2PE. Tel. (0332) 365280.**

Components On A Tray

A handy on-the-bench component storage system is provided by CNC Products Ltd. The storage trays are mounted, something like an old-fashioned cake stand, in a circle around a central stand. The trays are made from moulded high impact polystyrene and are curved throughout to make the components easy to get at and remove — no more resistors wedged into the corners. The standard version can be either freestanding, or anchored to the bench. The twelve trays are arranged in three independently revolving tiers of four trays each, with an overall diameter of only 10.75in.

The wall mounting version consists of four trays which revolve on a wall bracket. CNC can provide adaptations to this bracket to fit various positions.

Prices are £7.00 plus VAT for the bench mounting, and £3.75 plus VAT for the wall mounting version, from **CNC Products Ltd., 1 Keable Rd., Marks Tey, Colchester, Essex CO6 1XB.**

Switch Offer

From mid-June until the end of October **Superswitch** are making purchasers a money-back offer on all products as part of a summer promotion. This will be £1 if one item is bought, £3 on two.

The offer will be generally available wherever Superswitch products are sold, including electrical, DIY, hardware and lighting shops, and leading department stores. The products include dimmers, programmable lightswitches, low voltage outdoor lighting sets, immersion heater timers, smoke alarms and plug-in time-switches.

All the purchaser has to do is send off a product carton top together with a special sticker which will be on each carton. Superswitch will refund £1 (or £3 if two purchases are submitted at once) direct to the purchaser.

Further information from **Superswitch Electric Appliances Limited, 7 Station Trading Estate, Camberley, Surrey GU17 9AH. Telz; (0276) 34556.**

HE

Headphone Amplifier

Darn! It's 5.30 am. Only two hours of listening pleasure left. . .

Extend your listening hours into the depths of the night; bang your head without the neighbours banging on the wall. The HE Headphone Amp adds on to our Hifi Control Amp so that you can break the sound barrier in peace!

A. Armstrong

THIS IS intended as a companion unit to the hi-fi control amplifier (HE July '84 issue), and is the next building block in the preamplifier project. It is suitable for driving both high and low impedance headphones, and can deliver enough power for low level monitoring on a sensitive pair of loudspeakers.

The Circuit

This circuit is fairly straightforward, **Figure 1**. Both channels use the same circuitry so all references will be to just one channel (the left one).

The component numbering is the same as before, ie C1 is the left hand channel, and C101 is the same component but in the right hand channel.

The signal is fed via a DC blocking capacitor, C1 to the volume control, and from there to the non-inverting input of an op amp. A FET op-amp is used, so there is no significant bias current flowing in the volume control. This is a desirable situation because a crackling noise could occur when the control is turned. On the other hand, if the wire from the wiper of the volume control were to become disconnected, then static charges might build up on the FET input. This would cause an offset on the output which could damage the headphones. All this means is that the wiring needs to be securely soldered.

The op-amp in the circuit provides all the voltage gain, and the transistors on the output provide enough drive capability to use low impedence headphones.

The gain of the circuit is set by R7 and R8, and is calculated by:

(gain = R7 + R8 ÷ R8)

The gain can be set to any required value from unity to about ten by a suitable choice of R7. Gains in excess of ten should be avoided in order not to lower gain too much and allow distortion to occur.

The value of R8 should remain as 10k unless unity gain is required. In this case, R7 can be replaced with a wire link, and R8 and C2 can be omitted.

Offsets

The presence of C2 ensures that the DC gain is only every unity, so that a larger signal gain does not result in larger DC offsets. Output offset = DC gain × input offset of op-amp.

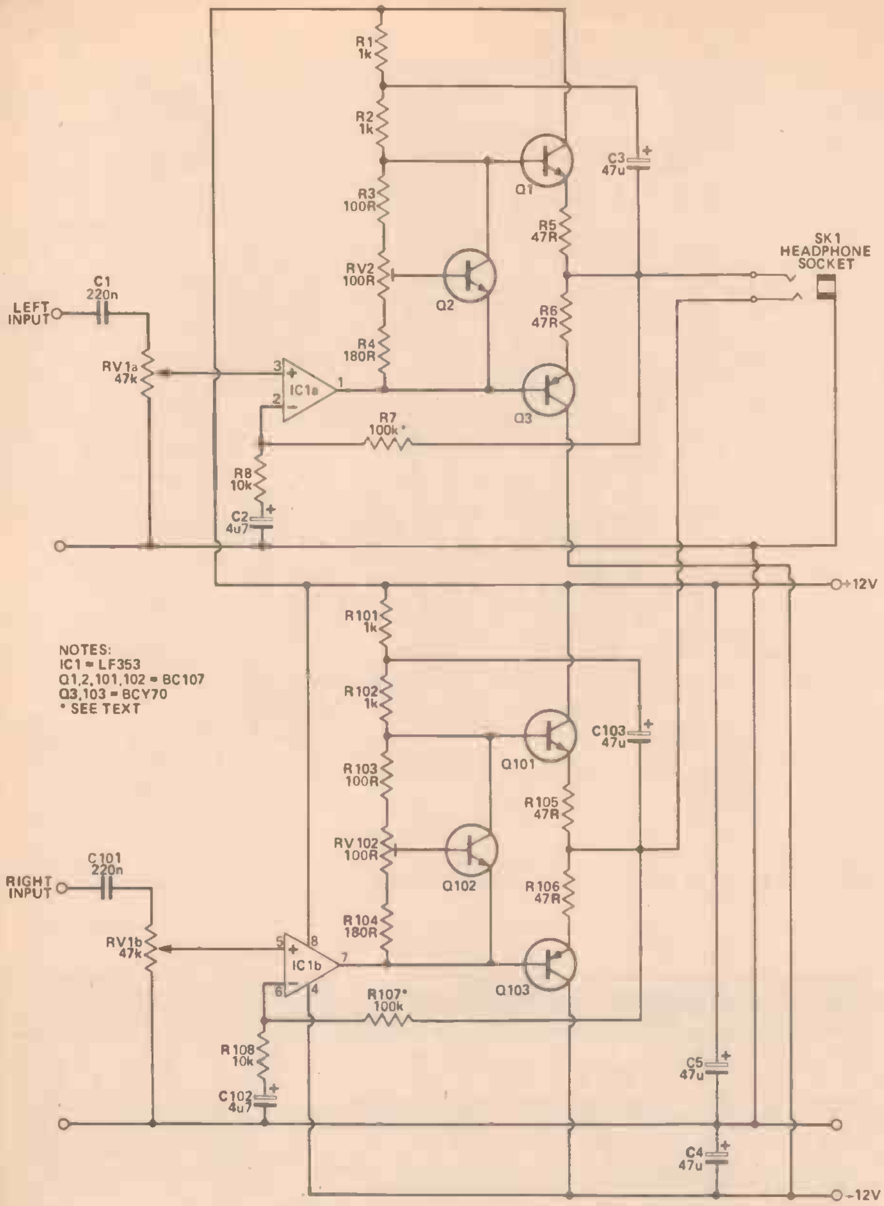
Capacitor, C2 is of a large enough value in that it comes nowhere near to affecting the audio frequency response of the circuit. It is a bead tantalum type because the offset of the circuit can be either positive or negative, and bead tantalums can function with a small reverse bias.

You Are Biased. . .

The output transistors are biased into class AB by Q2. This is connected in a configuration which multiplies its base-emitter voltage by the ratio of two resistances, R3 and R4 and the precise multiplication factor is set by RV2.

As long as the transistors remain at a similar temperature, the bias point will be similar over a wide range of ambient temperatures.

Resistors R5 and R6 are chosen so that the quiescent current does not rise destructively if the small output transistors should heat up due to a heavier load than anticipated. Their fairly high value also gives the advantage that the output level into low impedance headphones is limited, hopefully to safe levels.



Parts List

RESISTORS

(All ¼W 5% carbon)
R1,2,101,102 .... 1k
R3, 103 .... 100R
R4, 104 .... 180R
R5, 6, 105, 106 .... 47R
R7, 107 .... 100k
R8, 108 .... 10k

POTENTIOMETERS

RV1a, b .... 47k + 47k log dual gang potentiometer
RV2, 102 .... 100R horiz preset

CAPACITORS

C1, 101 .... 220n carbonate
C2, 102 .... 4u7 25V tantalum
C3, 103 .... 47u 16V radial electro
C4, 5 .... 47u 16V radial electro

SEMICONDUCTORS

Q1, 2, 101, 102 .... BC182B NPN silicon
Q3, 103 .... BC212 NPN silicon
IC1a, b .... LF353 dual op amp

MISCELLANEOUS

SK1 .... ¼ inch stereo jack socket
Printed circuit board; connecting wire; IC socket if required; solder etc.
Both channel components are included in the above parts list.

BUYLINES .... page 26

Figure 1. The circuit is straight-forward, but the construction needs care.

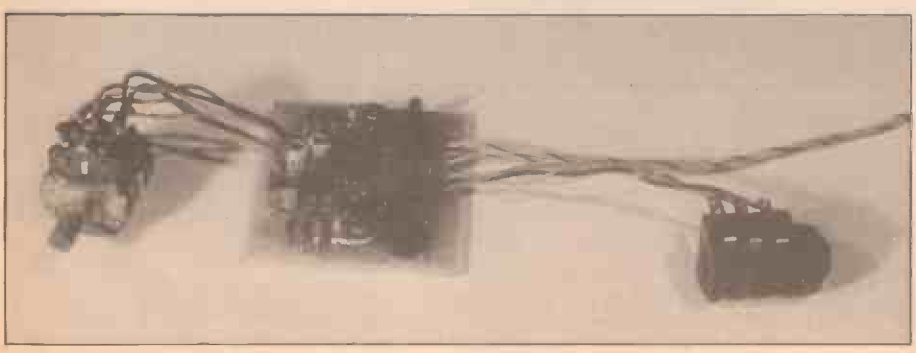
. . . By His Bootstraps

So as not to ask too much of the op amp, a constant current source is provided to feed current through the biasing chain. If this were not done, then the op amp would have trouble sinking the current during negative signal excursions, while the bias chain would be starved of current during positive swings. This would hardly be conducive to low distortion, even though the op amp would try hard to correct for the inevitable non-linearities.

The components responsible for this constant current are R1, R2, and C3. The negative end of C3 is connected to the low impedance signal output. Therefore its positive end follows the output signal waveform. Since the output stage has a gain of unity, or in fact very slightly less, the voltage across R2 remains constant. The current flowing down through R1 varies over the signal waveform, and on substantial positive peaks current can actually flow back in the other direction.

However, as long as the time constant of C3 and the parallel combination of R1 and R2 is long enough, voltage variations across C3 are small, and therefore the constant current source is very nearly constant.

This circuit technique, more widely known before the days of cheap op-amps, is called bootstrapping.



Construction And Testing

The unit is best built on a printed circuit, the layout of which is shown in Figure 2, though constructors wishing to do so should not have too much trouble with a Veroboard layout, as long as some attention is paid to the layout of the OV track.

It is intended to be powered by the hi-fi power supply (HE February '84), though if it is intended to be used with another project, any supply from ±9 to ±15 can be used.

Once the unit is built,connect up to the power source and switch on. Measure the DC offsets on the outputs, junction of R5/R6 (R105/R106). These should be less than about 25 millivolts — or too small to measure on most moving coil type meters.

Anything greater than this indicates a fault, and the power should be removed very quickly. First see if you can spot the short circuit or bad joint. If not, see if the appropriate op amp output is offset in the same direction or the opposite direction.

If offset in the same direction suspect the op amp, if in the opposite direction suspect the output stage.

Assuming the offsets are small, the only remaining job is to set the quiescent current of the output transistors. If you have a digital voltmeter which can read down to millivolts, then measure the voltage across the emitter resistors of the output transistors, Q1 and Q3.

Connect one lead to the emitter of Q1 and the other lead to the emitter of Q3, then adjust RV2 for a reading of 10mV. Do the same for the right hand channel, measuring the voltage across R105 and R106 and adjusting RV102 for the same 10mV reading. The output transistors seem to work best at a low currents, so do not adjust the presets for a reading appreciably greater than 10mV.

An alternative method is to temporarily disconnect one end of one the emitter resistors and connect a microammeter in series. Then adjust RV2 and RV102 for a current of 100u.

After the adjustments have been made, you can then put on the headphones and face the music!

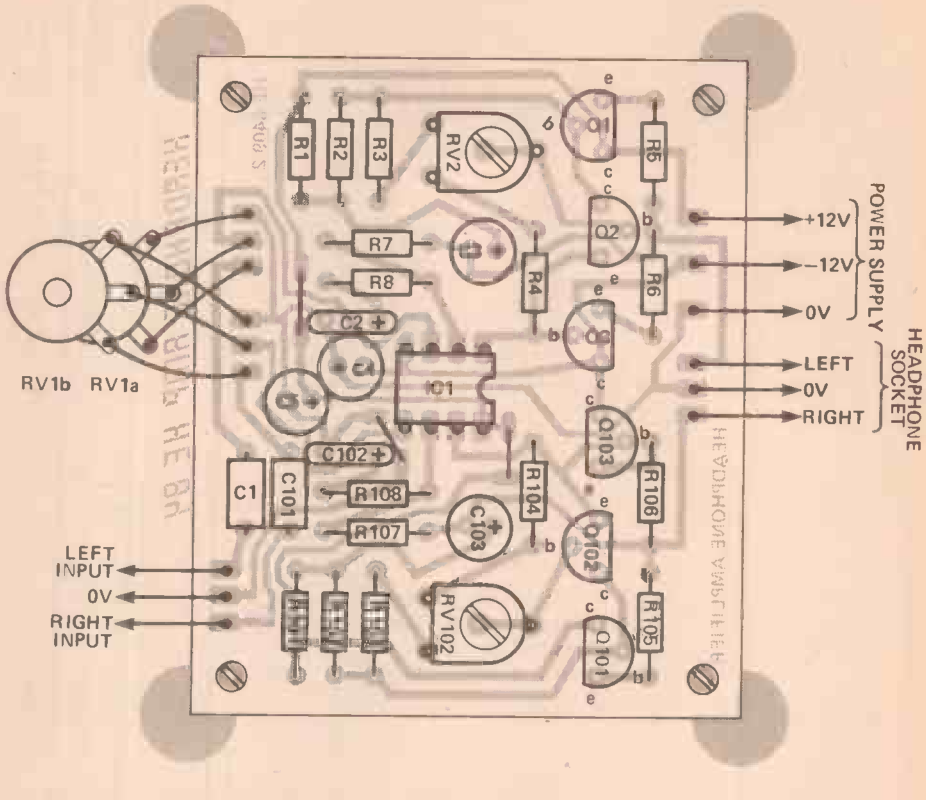


Figure 2. The PCB layout. Make sure that the pots are securely soldered.

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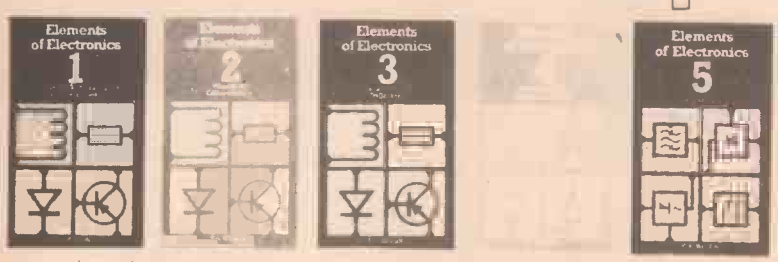

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A Look At Light Dimmers

In a combined project and feature, Robert Penfold looks at light dimming techniques including two simple but effective dimming circuits.

R. A. Penfold

LIGHT dimmers are not exactly the most complicated of electronic circuits, but they are not quite as straightforward as one might think, and they can prove troublesome for the unwary home constructor.

In this article we will throw some light on this subject, and show how using modern components a high quality light dimmer using just two components can be produced. A simple automatic dimmer circuit will also be described.

Switching Control

The obvious way of controlling the power fed to a lamp is to simply place a variable resistance in series with it. With the variable resistor set at minimum, full power is fed to the lamp, but as it is adjusted for higher resistance less power flows in the circuit, and an increasing proportion of the power that does flow is dissipated in the potentiometer rather than in the lamp.

This is not a very good way of doing things in practice as the potentiometer has to dissipate quite a high power — as much as 25 watts when controlling a 100 watt bulb, so that a very bulky component is needed and a substantial amount of heat is produced. Also, the heat generated in the potentiometer represents wasted electricity.

This system was in fact quite common at one time, and large potentiometers, known as rheostats could be obtained at a price. These days it is far more practical to use a semiconductor switching device as the power control element, and the principle of operation is then quite different.

A switching device can be used in two similar ways in a power controller application, with the more complicated system the device switches on for a certain number of mains half cycles, then switches off for a certain number of mains half cycles, and so on. If it conducts for, say one half cycle, and cuts off for two half cycles, only one cycle in three will reach the load, which thus consequently runs at one third power. As the switching device is either switched hard on, or switched off, it dissipates and wastes very little power.

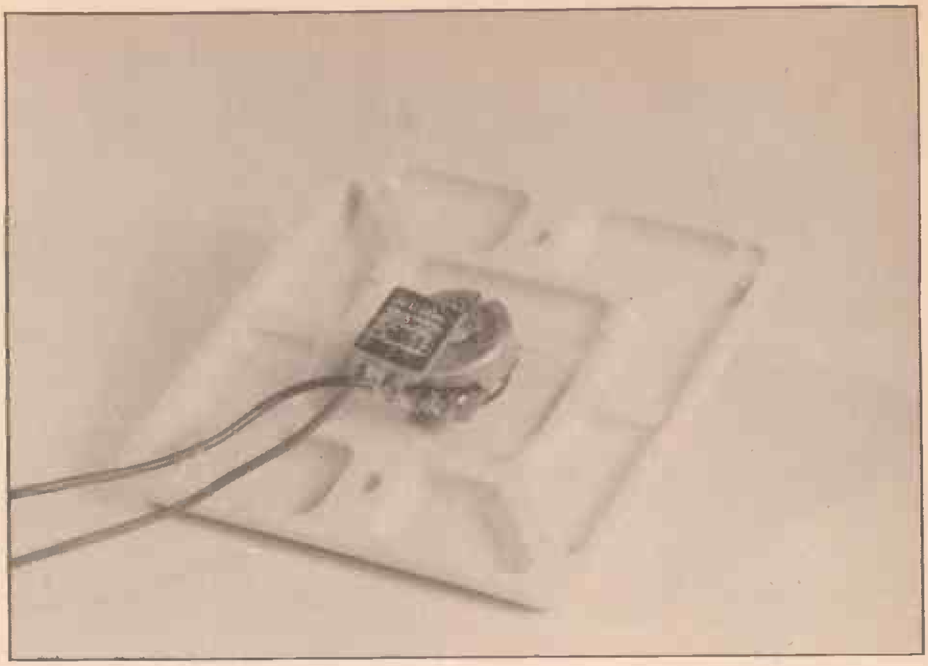
With most semiconductor switching devices there is a voltage drop of about a volt or so across the device when it is switched on, and some power is dissipated in the device, but in a lamp dimmer application the power dissipated by device is normally inadequate to merit the fitting of even a small heatsink.

The trouble with these creatures is, they shed hair everywhere, they're always asking for food, they won't settle down when you want them to.

Cycles And Half Cycles

The second method of power control differs from the one just described only in that the mains signal is not "chopped up" on a whole cycle basis, but instead each half cycle is cut down in order to regulate the power fed to the load. The waveform diagrams of **Figure 1** help to illustrate this point.

In **Figure 1**a the mains signal is allowed to pass through to the load with only the initial part of each half cycle removed by the switching action. This gives practically full power in the load, and in practice there would almost certainly be no apparent loss of power whatever.



In **Figure 1b** the switching device is not activated until about half way through each half cycle. This results in only about half power being fed to the load.

In the waveform of **Figure 1c** only the final part of each half cycle is fed to the load, giving only a very low power output to the load. Using this system or the one described above, any desired power level from zero to maximum can be fed to the load with minimal heat generation in the switching device.

Zero Switching

There is an advantage to the system which switches on for whole mains half cycles in that the switching always occurs when the mains voltage is at zero volts. This type of controller is often termed a "zero switching" controller. The importance of this is that no significant radio frequency interference is generated. The situation is very different with the type that chops up each half cycle.

Maximum interference is generated when the unit is set for half power, as

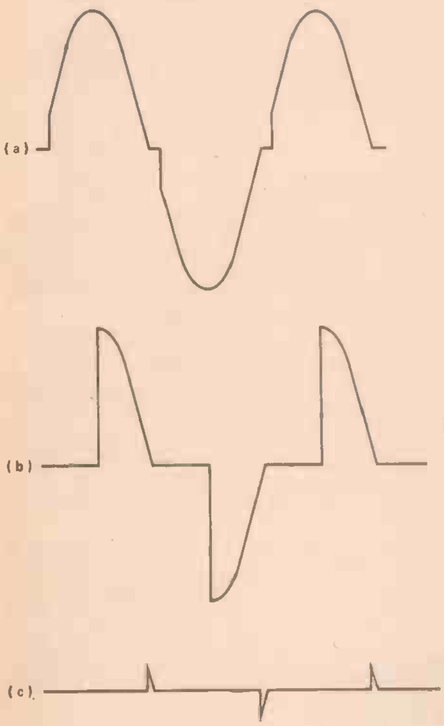


Figure 1. Waveforms illustrating how part of each mains half-cycle is reduced in order to reduce the power to the light.

the switching device then cuts in when the mains supply is at its peak potential of around 340 volts. This high voltage together with the fast switching speed of the control device results in quite strong radio interference being generated at the low frequency end of the radio spectrum.

Suppression components can be fitted of course, but these are often ineffective, and can even radiate strong interference themselves. If a dimmer is fitted into an ordinary wall mounted switch box there is not really sufficient space for really effective suppression components, and there may even be inadequate space for ineffective ones.

Zero Crossing

Despite this problem with the type of controller that acts on each half cycle, this is the system that is most often used in lamp dimmer applications. One reason for this is that although this might appear to be a more complicated method, it is actually very much easier to implement in practice than the zero crossing type of control.

Also, with the zero crossing type the removal of some mains half cycles effectively reduces the mains frequency. This is not of any consequence in many power controller applications, but with a lamp dimmer it can result in noticeable flickering of the lamp. Therefore, most lamp dimmers use a chopping circuit, and the user just has to put up with any radio frequency interference that result.

In practice this interference only tends to give problems with longwave reception, and probably accounts for the BBC Radio 4 longwave transmission being practically unusable in many built-up areas. Of course, if you have a lamp dimmer which causes interference to other people you could be ordered by the authorities to fit effective suppression components or cease using the equipment, but in most cases the interference is verly localised and this type of problem does not occur.

Dimmer Circuit

Lamp dimmer circuits do vary slightly from one design to another, but they are essentially the same, and all use the same operating principle.

The circuit diagram of **Figure 2** shows a "standard" lamp dimmer circuit.

Components, C1 and L1 are the token suppression components which help to reduce the amount of radio interference radiated from the mains wiring. These do not reduce the level of interference radiated from the wiring to the lamp.

The switching device used to control the flow of power to the lamp is a triac. This can be triggered into conduction by a gate current which needs to be typically 2 to 10 milliamps, and can be of either polarity.

Once triggered into conduction it will continue to conduct for as long as a reasonable current flows between

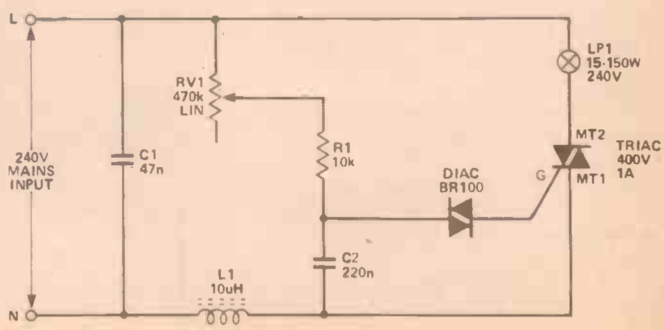


Figure 2. A sample light dimmer circuit of a commonly used type. Problems are often caused by unsuitable switching devices.

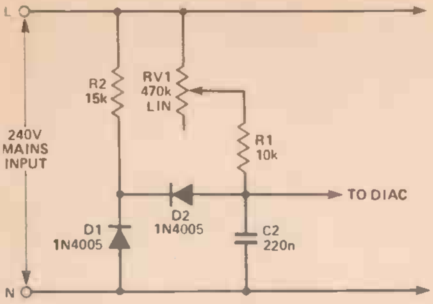


Figure 3. A circuit which improves on the low power handling of the circuit in Figure 2.

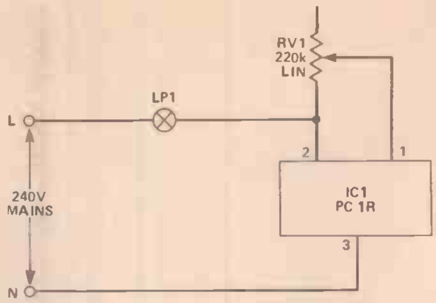


Figure 4. The circuit of our two-component dimmer, using the PC 1R power controller.

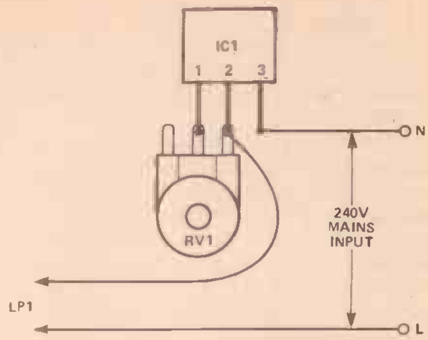


Figure 5. The wiring diagram for the two component light dimmer. The control knob and spindle should be of a plastic type.

the MT1 and MT2 terminals. The hold on current is usually about 10 to 30 milliamps. The trigger device used in this circuit is a diac, and this normally has a very high resistance with a voltage of either polarity applied to the device. However, if the voltage exceeds a certain level, about 30 volts its resistance drops to a very low level, and remains at this level until the current flow through the device falls to a low level.

Circuit Operation

The operation of the circuit is quite straightforward. If we assume RV1 is set at minimum resistance, C2 will charge very rapidly through the relatively low resistance of R1. The voltage on C2 therefore lags only slightly behind the mains input voltage. When the voltage on C2 reaches about 30 volts, which will happen early in each mains half cycle, the diac is triggered into conduction, and a pulse of current flows into the gate of the triac as C2 discharges through the diac into the triac. This triggers the triac into conduction and power is applied to the lamp.

Although the trigger current soon subsides and the diac switches off, the triac continues to conduct until almost the end of the mains half cycle when the current through the triac falls below the hold on level. This gives a waveform of the type show in **Figure 1a**, and thus full power to the lamp.

The circuit operates in the same basic manner if RV1 is adjusted for higher resistance. Capacitor C2 charges more slowly though, so that the triac is not triggered until later in each half cycle. With RV1 at maximum resistance the triac fails to be triggered at all, and zero power is fed to the lamp. The circuit therefore provides any output power from zero to virtually maximum.

Note that some triacs have a built-in diac, and that with this type of component the external diac must not be included. Also, this component must be a triac and *not* a thyristor, which is only intended for DC applications.

It is very easy to get into difficulties with this type of circuit, and the usual cause is the use of an unsuitable switching device.

Improved Performance

Although, on the face of it, the circuit of **Figure 2** performs perfectly, in practice it does not give very good performance at low power levels. In particular, it does not operate very well if RV1 is adjusted for zero output, and is then gradually advanced.

Rather than the lamp gradually and steadily increasing in intensity, what actually tends to happen is that the lamp remains off until RV1 is well advanced, and then it suddenly switches on at something approaching half brightness.

The cause of this is the residual charge on C2 if the triac is not triggered. The circuit is handling an AC signal, and if the potential on C2 fails to reach the trigger threshold level, the charge potential that is achieved remains when the next half cycle commences.

On the next half cycle the charge potential fed to C2 is of the opposite polarity to the charge left over from the previous half cycle, and it is this that produces the reluctance for the triac to trigger.

Low Power Modification

It is not too difficult to overcome this problem, and there is more than one way of doing it. What is probably the most simple way is to use a couple of diodes to discharge C2 at the end of one set of half cycles if the triac has failed to fire.

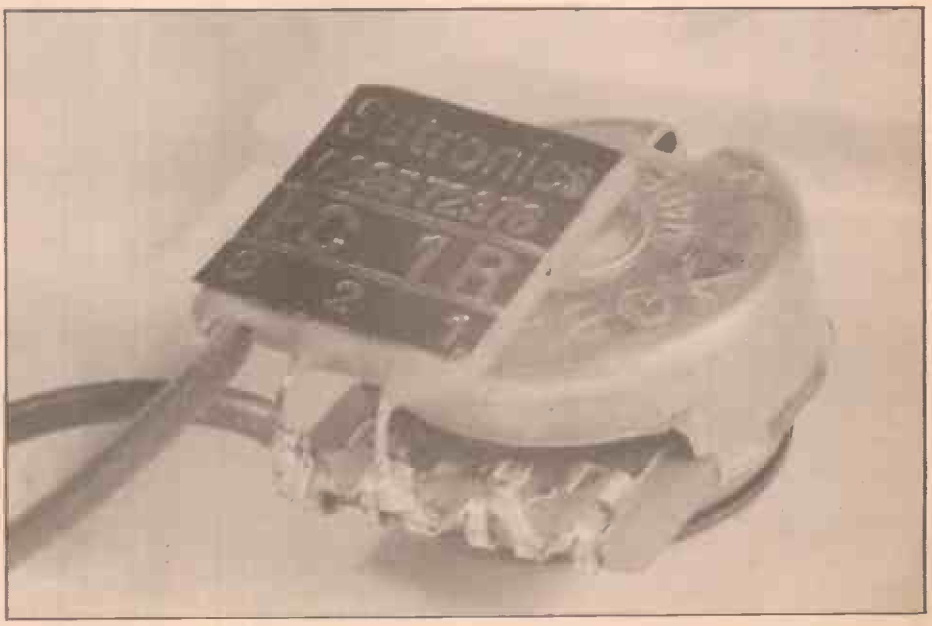
It is not necessary to have a discharge circuit that operates on both negative and positive half cycles, as it is only necessary to get the triac to fire once in order to get the circuit under way and operating properly.

The circuit of **Figure 3** shows the modifications needed to achieve this.

The Circuit

When the mains "L" lead is negative of the "N" lead, the additional components have no real effect. A bias current flows through R2 and D1, and a potential of about 0V65 is developed across D1, but as there is a voltage drop of about 0V65 through D2 no significant charge can flow into C2 via this route.

It is on the opposite half cycles, when the "L" lead is positive of the "N" lead that the circuit is operational. On the main part of the



half cycle the circuit operates in the normal way. It is towards the end of the half cycle that things are different.

Assuming the triac does not fire, as the mains potential drops towards zero the voltage on C2 is greater than the mains voltage. Capacitor C2 therefore discharges by way of D2 and R2 into the mains supply, and no significant residual charge remains on C2 as the next mains cycle commences.

The triac will trigger on this cycle if RV1 has a low enough resistance, and the circuit is able to function properly at low power settings with RV1 advanced from zero.

Two Component Dimmer

These days a high quality lamp dimmer having good low power performance can be constructed using just two components, one of which is the power control potentiometer. The other is not, as one might have expected, an integrated circuit, but is an integrated thick film hybrid circuit.

It is presumably not possible to produce a lamp dimmer in true integrated circuit form as a fairly high value timing capacitor is required, and it is not practical to form these on an integrated circuit. The hybrid approach therefore has to be adopted.

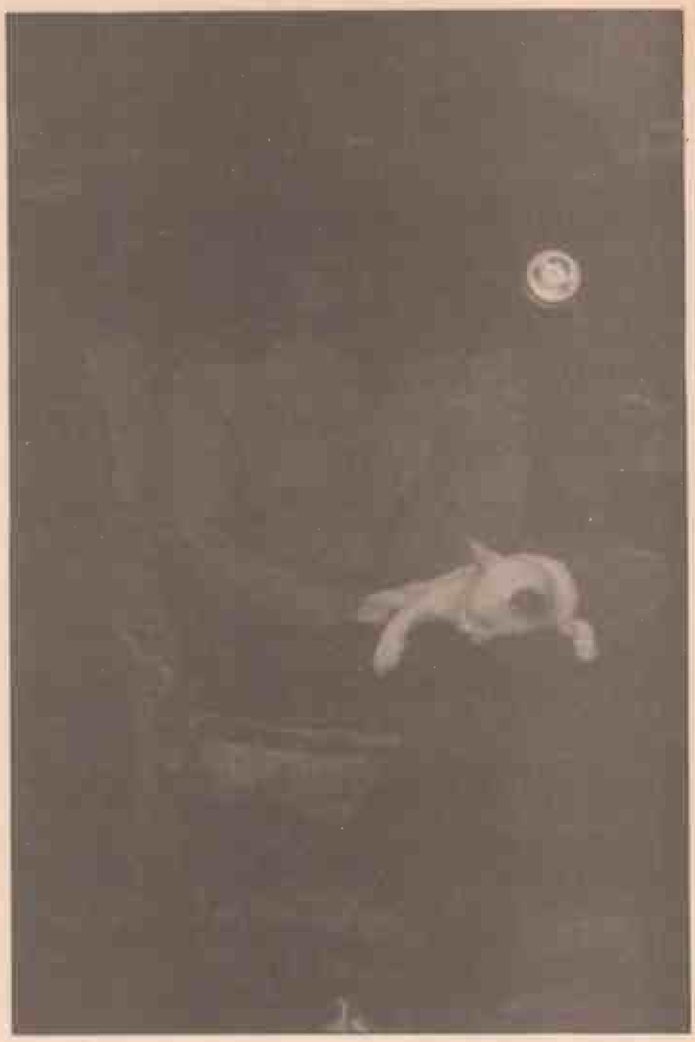
Figure 4 shows the circuit diagram of a lamp dimmer using the PC 1R power controller device, and **Figure 5** gives the wiring diagram for this circuit.

Provided a modern miniature potentiometer is used, there should be no difficulty in fitting the unit into a wall mounting switch box, although it could, of course, be constructed as a normally cased project for use with a table lamp if preferred.

In either case due care must be taken as this project is connected direct to the dangerous mains supply, and due to the way in which it operates it is impractical to provide isolation from the mains supply. Despite the extreme simplicity of this project it is one that is not really suitable for complete beginners at electronics construction.

With any project of this type a potentiometer having a plastic spindle should be used, and the control knob should also be a plastic type. The maximum current the PC 1R can handle is 1A1 which corresponds to a maximum power of 264 watts with the 240V mains supply.

In all these circuits the mains earth lead has been ignored, and this is simply because the earth lead is unused in most lamp dimmer applications. However, if an earth lead is present on the equipment fed from the output of the unit then the mains earth lead should be fed straight through to this.



. . .At last! The brute has dimmed the light and settled down. Now perhaps a girl can get some sleep, thanks to the HE Two Component Light Dimmer.

Parts List

RV1	220k Line potentiometer
IC1	PC 1R Power controller
Plain plateswitch; connecting wire etc.	

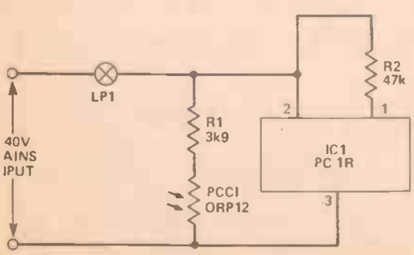


Figure 6. The circuit of a dimmer using the PC 1R, which fades the light as the ambient light level increases.

Simple Auto-Dimmer

Figure 6 shows the circuit diagram of a simple automatic lamp dimmer based on the PC 1R.

With this type of circuit the lamp is automatically "faded" down as the ambient light level rises, and faded up again as the ambient light level falls. If we ignore R1 and PCC1 for the moment, we have a straight forward lamp dimmer with the value of R2 setting the lamp brightness at a fairly high level, although admittedly not quite at full power.

Under fairly dark conditions PCC1 exhibits a resistance of a few hundred kilohms or more, and it has no significant effect on the circuit. However, as the light level on PCC1 increases, its resistance decreases, and it tends to tap off some of the charge current for the timing capacitor. This causes IC1 to trigger later in each mains half cycle, and lamp's brightness is reduced.

If PCC1 is subjected to reasonably bright conditions it will divert so much charge current that IC1 will not trigger at all, and the lamp will be switched off.

For such a simple circuit quite good results are obtained in practice. The low power performance of the circuit is less good than when the PC 1R is used in an ordinary dimmer circuit, but this is not likely to be of any practical importance in this application.

Two important points to bear in mind are that all the components in the circuit (including PCC1) must be well insulated so that there is no risk of anyone obtaining an electric shock from the unit, and PCC1 must not be mounted too close to the lamp or feedback will result in the circuit having only a low maximum output power.

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R.A. Penfold

ELECTRONIC fire detectors use a multitude of different systems to detect the presence of a fire, and vary greatly in their level of sophistication.

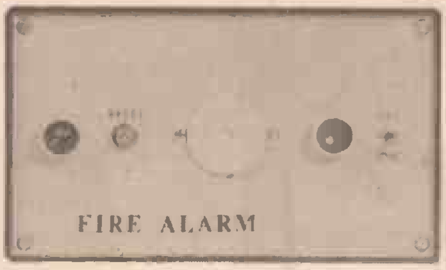
The most simple types use a temperature sensor of some kind to detect the abnormally high temperature caused by a fire. The sensor is not necessarily an electronic component such as a thermistor or a semiconductor temperature sensor, but can be a special low temperature fusable link or a bimetal temperature switch. Alarms of this type can be very simple, but may fail to operate until a fire has taken hold.

There are several more sophisticated types of alarm, such as smoke detectors which use a special semiconductor component to detect the presence of smoke or any combustible gas or vapour. Another type uses an opto-electric system to detect smoke, which is opaque, and interrupts a light beam. A simple detector of this type was described in a recent issue of Hobby Electronics incidentally.

We've saved everything important. Wonder how the editor's getting on?

The fire alarm featured in this article uses what, as far as I am aware, is a new method of fire detection using ultrasonic sound. The unit uses the same principle as the popular Doppler Shift ultrasonic intruder alarms. This type of alarm tends to be very sensitive to turbulence in the air, and not just to the movement of solid objects. False alarms are easily caused by the turbulence caused by something like the heat from an electric fire.

Alarms of this type would therefore seem to be ideal as fire alarms, and work as such whether or not the people who use them realise it.



Discriminating Sound

A problem with using a Doppler Shift intruder alarm as a fire alarm is the large detection area that a device of this type provides. In a way this is an advantage in that it helps to provide rapid detection no matter where in the room the fire starts.

However, in most fire alarm applications it is necessary for the alarm to detect fires but ignore people moving around the room, so that it can be set running and then left ignored unless it is activated.

A normal ultrasonic Doppler Shift alarm does not make this distinction between people and turbulence. For fire detection it is more practical to have a circuit which has a relatively small area of operation. The unit can then be positioned where it will not be triggered by people moving around the room, but it will still detect the turbulence caused by a fire fairly rapidly.

Editor: "Don't worry! I've thrown a bucket of sand over my pipe!"

System Operation

An ultrasonic alarm consists of two circuits that are independent apart from a common power source. The more simple of the two is the transmitter which simply sends out a constant ultrasonic sound, and the more complex section is the receiver.

Figure 1 shows the block diagram for the alarm.

As explained above, the transmitter simply has to act as a source of ultrasonic sound, and it therefore consists of nothing more than an oscillator operating at an ultrasonic frequency and feeding into a loudspeaker which converts the electrical signal into a sound one. Of course, the sound is not audible as its pitch is too high to be detected by human hearing.

Ordinary loudspeakers do not operate efficiently at ultrasonic frequencies, and the transmitting transducer is actually a special Piezoelectric type. An output level control is included so that the sensitivity of the circuit can be adjusted, and set to a suitable level.

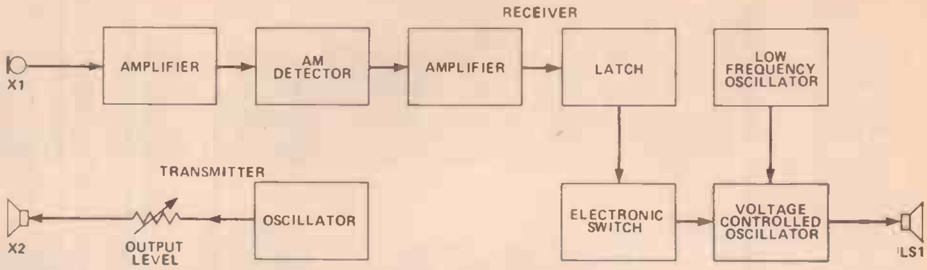


Figure 1. The block diagram. Only a single amplifier stage is needed, as the unit operates on a much lower sensitivity than an ordinary intruder alarm.

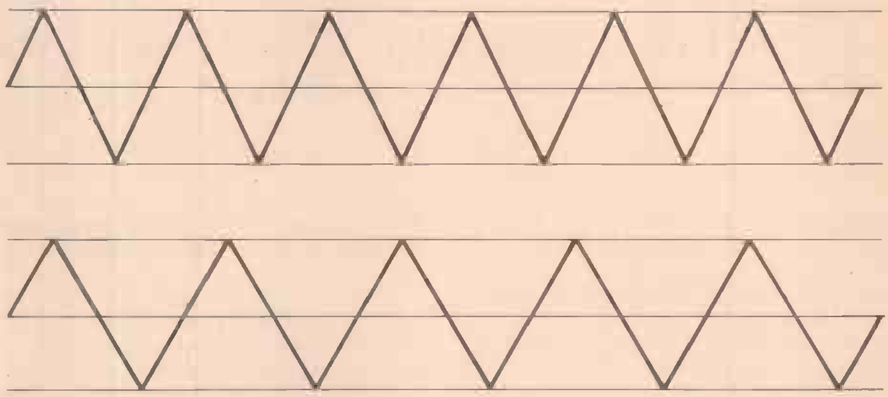


Figure 2. Waveforms of the 40kHz signal and the frequency shifted signal.

Receiver

The signal from the transmitter is picked up by a microphone at the receiver which converts the soundwaves back to an electrical signal. Again, a special Piezoelectric transducer is used for the microphone as ordinary types are only intended for audio frequency use and do not operate efficiently at ultrasonic frequencies.

Although the loudspeaker and the microphone are mounted more or less side by side, the highly directional nature of ultrasonic sound results in very little direct pick up between the microphone and the loudspeaker. Most of the received signal is obtained via reflections from walls, or objects in the room. The output from the microphone is not likely to be very large, being perhaps something in the region of one millivolt RMS at best. An amplifier is therefore used to boost the signal to a usable level.

In an ultrasonic intruder alarm at least two high gain stages of amplification would be used, but as much lower sensitivity is needed in this application a single stage of amplification is sufficient.

Detector

The next stage of the circuit is an amplitude modulation detector. Under normal operating conditions the received signal is just the straightforward 40kHz output signal from the transmitter. This signal is received via a variety of routes, and the signals are randomly phased. However, the phase relationships of the signals remain unaltered, as does the amplitude of the signal. This gives no output from the amplitude detector under stand-by conditions.

Things are different if an object moves in front of the detector, or if there is turbulence in the air. The well known Doppler Shift effect then produces a frequency shift on any signals that are reflected from the moving object or affected by the moving air. Some of the transmitted signal is still received either directly or by way of stationary objects through air that is not affected by the turbulence.

There are then two or more frequencies fed to the amplitude demodulator. With signals at differing frequencies their phase relationship can no longer be fixed.

Waveforms

Consider the waveform diagram of Figure 2, and imagine that the top waveform is the ordinary 40kHz signal, and that the lower one is the frequency shifted signal.

The signals start off in-phase. In other words they rise and fall in amplitude more or less in unison, and they are of the same polarity. In-phase signals add together at the demodulator to give a large output signal. Later in the waveform

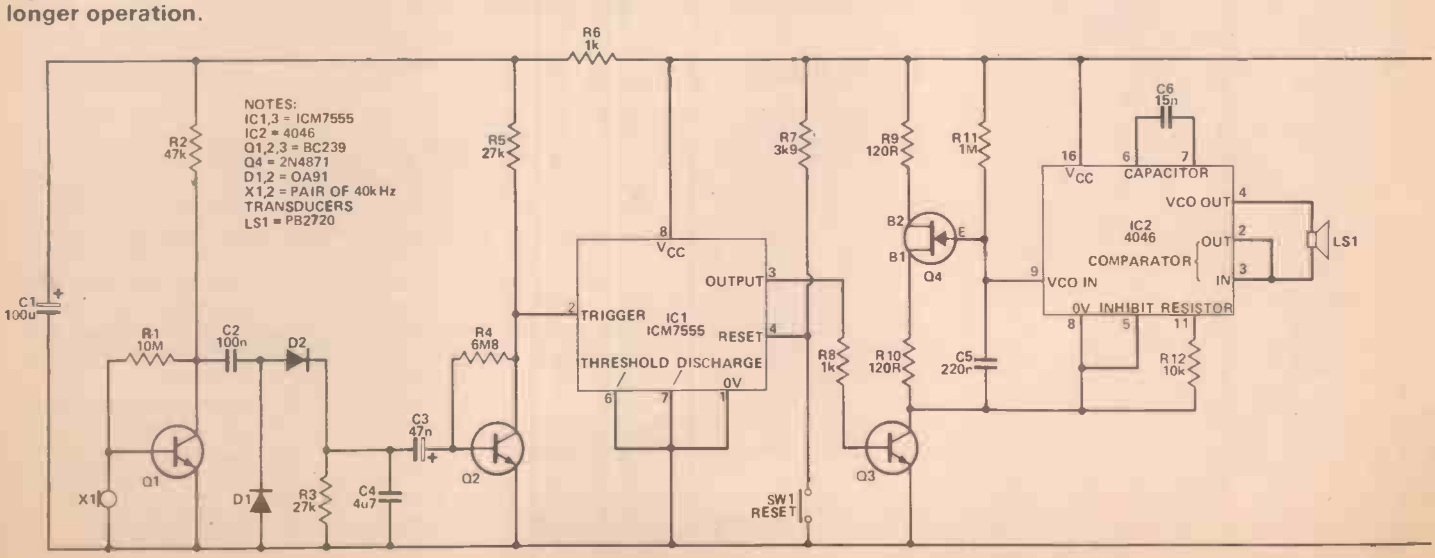


Figure 3. The circuit of the Ultrasonic Fire Alarm. A CMOS 7555 timer is used, to keep current consumption down for longer operation.

Parts List

RESISTORS
All ¼W 5% carbon

R1	10M
R2, 13	47k
R3, 5	27k
R4	6M8
R6, 8	1k
R7	3k9
R9, 10	120R
R11	1M
R12	10k

POTENTIOMETERS

RV1	100k horiz preset
RV2	22k horiz preset

CAPACITORS

C1	100u 16V radial electro
C2	100n polyester
C3	47n polyester
C4	4u7 63V radial electro
C5	220n polyester
C6	15n polyester
C7	220p ceramic plate
C8	220u 16V radial electro

SEMICONDUCTORS

Q1, 2, 3	BC239 npn silicon
Q4	2N4871 unijunction
IC1, 3	ICM7555 CMOS timer
IC2	4046 CMOS phase locked loop
D1, 2	OA91 germanium diode

MISCELLANEOUS

SW1	Push to make release to break
SW2	SPST min toggle
B1	9 to 12 volt
LS1	PB2720 ceramic resonator
X1, 2	Pair of 40kHz ultrasonic transducers

Plastic or aluminium case 161 x 96 x 59mm; printed circuit board; battery connector; 16 pin DIL IC socket; two 8 pin DIL IC sockets; wire; solder; etc.

BUYLINES ....page 26

sequence they go into anti-phase. That is, they still rise and fall in amplitude more or less together, but are opposite in polarity. This gives a weak output signal from the demodulator with the two signals having a cancelling effect on one another. Towards the end, the signals slip back in-phase once again, and give a strong output from the demodulator.

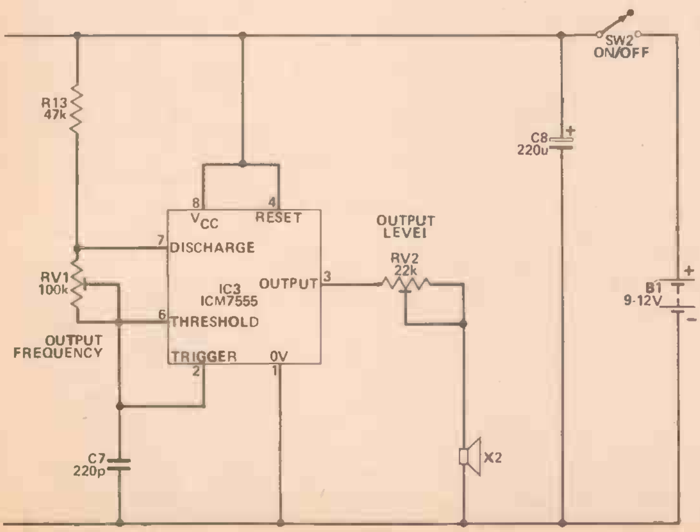
When the unit is activated there is thus a varying output level from the demodulator. The frequency of the output signal is equal to the frequency difference between the two input signals, and in practice this is normally only a low audio frequency or even a sub-audio one. Nevertheless, this signal is easily detected once it has been boosted by a high gain amplifier.

Alarm Generator

This amplified signal is used to operate a simple latch circuit, so that once triggered the alarm continues to sound until the unit is reset. The latch connects power to the alarm generator circuit by way of a switching transistor.

The alarm generator consists of a voltage controlled oscillator (VCO) modulated by a low frequency oscillator. The latter produces a ramp waveform, and this gives an output from the VCO that is steadily swept upwards in frequency until it reaches its peak pitch, after which it is switched back to the minimum pitch again, steadily swept upwards, and so on.

This gives a very effective alarm signal.



Circuit Description

Figure 3 shows the full circuit diagram of the ultrasonic fire alarm.

Starting with the transmitter, this is based on IC1 which is a 7555 timer device. This is the CMOS, low power version of the popular and well known 555 timer. In this application the 7555 is preferable to the standard 555 since it enables the overall current consumption of the circuit to be kept down to only about one milliamp or less, so that economic battery operation is possible. The IC is used in the standard astable mode, and the values of timing components R13, RV1, and C7 have been chosen to give an operating frequency in the region of 40kHz. The preset is adjusted to produce the output frequency that gives optimum efficiency from the transmitting and receiving transducers.

Preset, RV2 is the output level control.

Receiver

In the receiver circuit X1 is the receiving transducer, and its output is directly coupled to the input of a common emitter amplifier which is built around Q1.

This stage is run at a low collector current of only 100 microamps in order to keep the overall current consumption of the unit down to a low level. This results in less gain than one would normally expect from an amplifier of this type, but it is still more than adequate in this respect for the present application.

Capacitor, C2 couples the amplified output from Q1 to a conventional AM demodulator using D1, D2, R3, and C3. The resultant low frequency signal is then amplified by a second common emitter amplifier which is based on Q2.

A second timer, IC1 is used as the latch. However, it is not utilized in a conventional fashion in this case. It is effectively used in the monostable mode, and it provides a positive output pulse if pin two is taken below one third of the supply potential.

Normally the length of the output pulse would be controlled by a timing resistor and capacitor, but these are omitted in this circuit and pins six and seven of IC1 are connected to the negative supply rail. Once triggered, the output of IC1 goes high and remains in that state indefinitely, giving the required latching action.

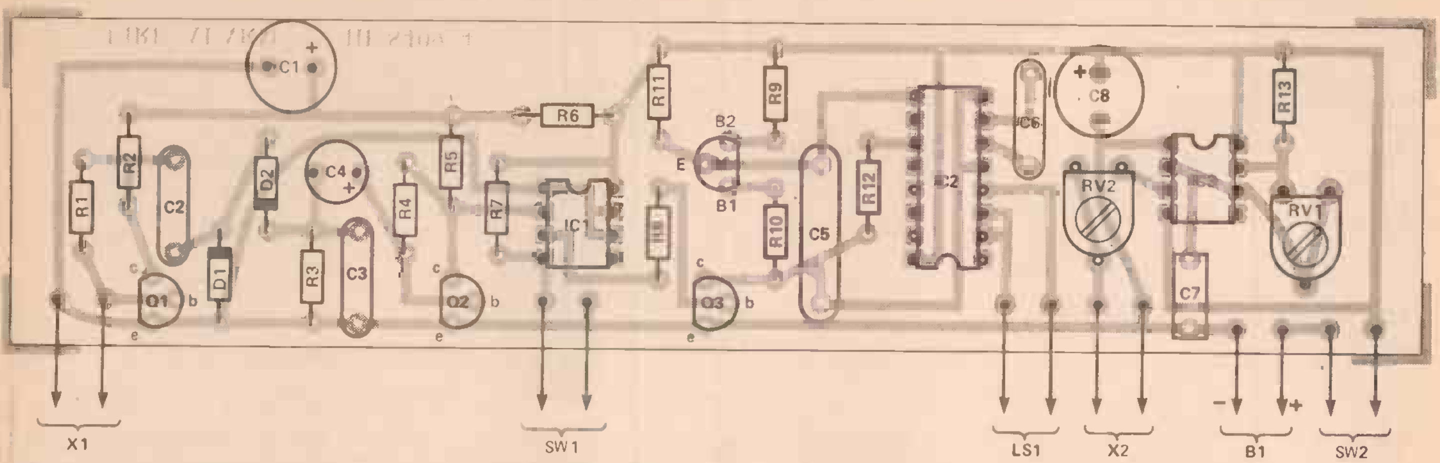
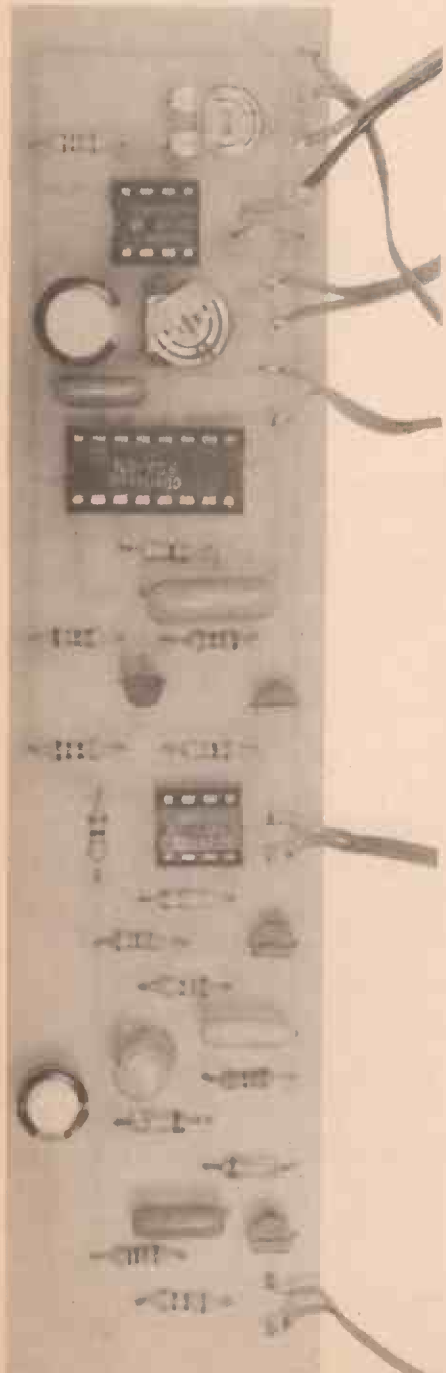


Figure 4. The PCB overlay. Solder D1 and D2 carefully as they are prone to heat damage, and treat IC2 with full CMOS precautions.



Pin two of IC1 is fed from the collector of Q2, and this is biased to about half the supply potential. Therefore, under quiescent conditions IC1 is not triggered. When the unit is activated the collector voltage of Q2 fluctuates, and on negative half cycles goes below the trigger threshold potential. The circuit can be reset by operating SW1 and taking the reset input of IC1 to the OV supply potential.

Transistor, Q3 is the switching transistor which is used to supply power to the alarm circuit when the output of IC1 goes high, and R8 is a current limiting resistor.

Alarm Signal

The final IC, IC2 is a CMOS 4046BE phase locked loop, but in this circuit it is only the VCO section that is required. In actual fact one of the phase comparators is also put to good use, but it is merely used as an inverter in this circuit. It inverts the output of the VCO to give a two-phase output so that ceramic resonator LS1 is fed with a peak to peak voltage that is virtually double the supply voltage.

This gives quite a loud and penetrating alarm signal, but the output from pin four of IC2 could obviously be amplified and used to drive an ordinary loudspeaker if preferred. Capacitor, C6 and R12 are the timing components for the VCO. These give an output frequency range centred at around 2kHz, where the ceramic resonator achieves peak efficiency.

The modulation signal is generated by the simple unijunction relaxation oscillator based on Q4. This provides a non-linear ramp waveform at a frequency of around 4kHz.

Power Supply

Power is obtained from a nine volt battery, such as six HP7 cells. With a current consumption of only one milliamp this gives something over one months continuous operation from each set of batteries, but in the long term it would probably be more economic to use something like a PP3 size nickel cadmium rechargeable battery.

A mains power supply could of course, be used, but it is better for units of this type to be self contained. When using a mains power supply there is also the problem of false alarms caused by noise on the mains supply to contend with.

Construction

The unit will fit comfortably into a plastic case having an aluminium front panel and approximate outside dimensions of 161 x 96 x 59mm.

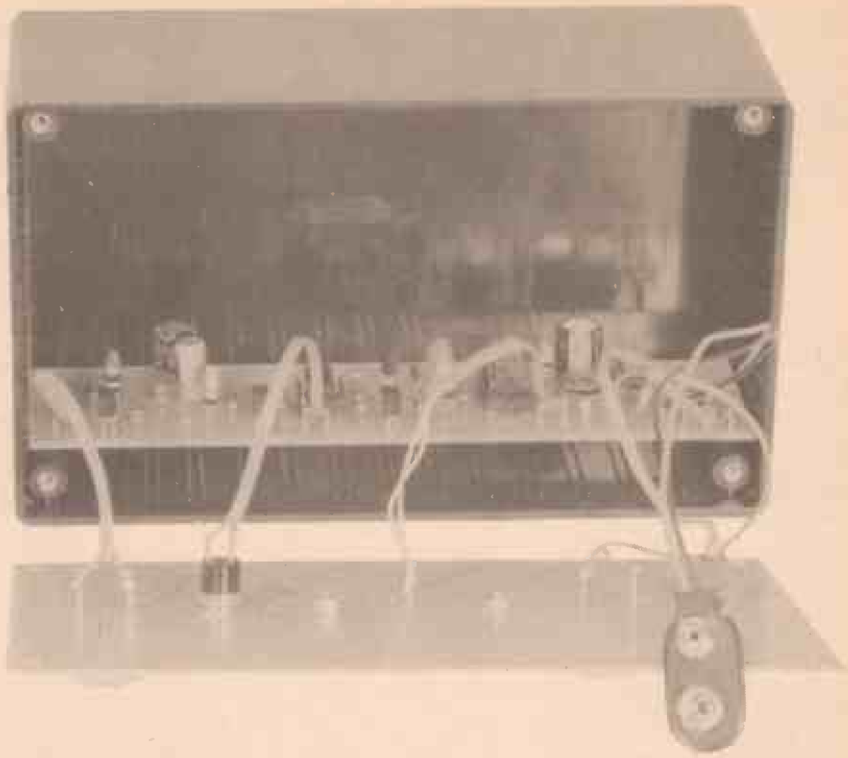
Construction will be more straightforward if this type of case is used, as the printed circuit board is designed to slot into guide rails moulded into the case. If a different type is used it will be necessary to bolt the board in place, and there are ample blank areas of the board to accomodate mounting bolts.

The switches and transducers are mounted on the metal front panel, as can be seen from the photographs. Ultrasonic transducers are usually sold in matched pairs, and often the transmitting and receiving transducers are the same.

This is not invariably the case though, and if there are transducers specifically for transmitting and receiving, make sure that each one is used in the appropriate role. Consult the retailers literature if necessary. The transmitting transducer is mounted on the right hand side of the panel, and the receiving one is fitted on the left hand section of the panel. Ultrasonic transducers rarely have provision for panel mounting, but they can be firmly fixed in place by first drilling a couple of holes for the pins at the rear of each component, and then simply gluing them in place using a good quality gap-filling adhesive.

The ceramic resonator is mounted using two short 8BA screws plus fixing nuts. An additional small hole must be drilled in the panel to allow the two leadout wires to pass through to the interior of the case. The leadout wires will probably prove to be slightly too short and will need to be fitted with extension wires about 50mm long.

Cover the soldered connections with PVC sleeving to avoid accidental short circuits.



Printed Circuit Board

Details of the printed circuit board and component overlay appear in **Figure 4**.

Diodes, D1 and D2 are germanium diodes, and these are more easily damaged by overheating than silicon semiconductors. When soldering them in place do not keep the bit of the iron on each joint for any longer than is absolutely necessary. All three integrated circuits are CMOS types, but only IC2 requires anti-static handling precautions as the 7555 has effective anti-static protection circuits.

Fit IC2 in a 16 pin DIL IC socket, but do not fit it in place until the board and wiring have been completed. Do not handle IC2 any more than is really necessary once it has been removed from its protective packaging, and leave it in this packaging until it is to be fitted onto the board. Note that IC2 has the opposite orientation to the other two integrated circuits.

Once the board has been completed it is wired to the off-board components using ordinary multistrand connecting wire. If X1 is a type that has one pin connected to its metal case, make sure that this is the pin which connects to the negative supply rail on the printed circuit board. When the wiring has been completed the printed circuit board is slotted into the lowest set of horizontal mounting rails in the case.

If the unit is to be powered from six HP7 cells these are fitted into a plastic battery holder, and this connects to the printed circuit board via a standard PP3 type battery connector.

Setting Up

Start with RV1 at a roughly midway setting and RV2 set for maximum output — fully anticlockwise. If a multimeter is available, set this to its lowest DC voltage range and connect it across R3 with the negative test prod connected to the negative supply rail.

Switch the unit on and aim the transducers at a wall or other large, flat surface, and place the unit only about 100 to 200 millimetres away from that surface. By adjusting RV1 it should be possible to obtain a deflection of the meter, and RV1 is then adjusted for the highest obtainable reading. It is advisable to place a shorting lead across SW1 while making this adjustment, so that the alarm generator is muted and its output can not influence readins.

If a multimeter is not available RV1 can be adjusted using trial and error to find a setting that gives correct operation of the unit.

Even with RV2 well backed off it should be found that the unit is quite sensitive. Careful thought should be given to the best position for the unit. The prototype is installed above the author's workbench, which is obviously a possible starting point for a fire with the presence of a lot of electrics in general, and soldering irons in particular.

It is best to position the unit quite high up because hot air rises, and it is also then relatively easy to find a location where triggering due to people moving around the room is not a proble. A little experimentation should soon find a position for the unit that gives good sensitivity without the problem of false alarms. A soldering iron held beneath and in front of the unit should provide sufficient air turbulence to trigger the alarm. The circuit will often trigger at switch on, but it can be immediately reset using SW1.

The unit does not have a switch-on delay, but provided you are behind it when operating SW1 there should be no problem with activating it as you take your hand away.

POINTS OF VIEW

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

Equipment Hire

Dear Sir,
Is it possible to hire electronic equipment such as oscilloscopes, meters, signal generators, frequency meters and the like from electronic stores, just as one can hire power tools from many hire shops like HSO? I would like to know since I am unemployed. I have to make good use of the money I get every fortnight to make whatever projects I can but with some projects you need an oscilloscope, and probably a signal generator for testing and setting up, and I don't have the money to obtain even a simple scope!

And as I am a first-time electronics constructor, how does one make a speaker grille on a project case like most of your projects with speakers?
D.E. Jones,
Hackney,
London.
PS About the Quick Project: the Simple Stylus Organ (HE Nov '81), is the value of the volume control resistor 220R or 220k, since it is quite difficult to get a 220R pot.

Value for money this guy wants! And value he shall have. Various companies hire out electronic equipment. Check under *Electronic Equipment Hire* in your yellow pages phone book. One major firm with some regional offices which does so is Livingston Hire Ltd., who do all kinds of electronic gear including meters, oscilloscopes from £10 to £295 per week, right up to spectrum analysers. All their terms are weekly or over. £10 for a basic oscilloscope for a week sounds very reasonable. All enquiries should go to **Livingston Hire Ltd., The Rental Centre, 99, Waldgrave Rd., Teddington, Middlesex TW11 8LL. Tel: 01 977 8866**, even if you are not local. They can refer overseas enquiries to their nearest branch as well.

Speaker grilles: the simplest way is to mark a matrix of dots (say, with the point of a sharp pencil through a sheet of graph paper) on the surface of the case, mark the dots with a compass point or punch, and then drill through each dot. This gives a rough grille which will often do a good job.

Alternatively, you can buy speaker grille fabric from many DIY/Hobby shops, which can be tacked or glued over a suitably-sized cut-out in the case. Cutting can be done with a hobbyists knife (which requires care so as not to damage yourself or the case) or a fine coping saw.

As for the **Stylus Organ**, no, the pot should be 220R, but 220R or 250R will do. For errata on this project, see this month's **Forward Bias** page.

Hunting Diana

Dear Sir,
Request for Oops/Errata update
I wish to start by thanking the HE PCB Service dept. for re-routing my enquiry to the relevant manufacturer.

I wish to build the HE "Diana" Metal Detector. I have obtained copies of the article, HE September 1981, and the Diana VCO HE November 1982.

Please advise me whether there have been any Oops/Errata corrections/component value changes/modifications etc. that have appeared in HE.

I realise this may require some photocopies of references, I therefore enclose a cheque to attempt to cover for such.

I look forward to hearing from you at your earliest convenience. Please find the enclosed SAE.
Yours faithfully,
N. Traherne,
Southminster,
Essex.

You will be glad to hear that the only Oop associated with the Diana and its VCO is that, in the original article, R11 should have been listed as 2k2. Also, R12 has been omitted from the Parts List, but is shown on the Circuit. We will pass your thanks to Julie up the corridor for the PCB Service, and meanwhile pass your cheque back to you — as we don't charge our readers for our mistakes. Good hunting.

More Metal

Dear Sirs,
Re: What A Melter (HE July '84)
This is one of the CERRO alloys. Approximately: bismuth, tin, lead and cadmium in specific proportions, melting point about 73°C or 164°F. The CERRO alloys are produced by the Mining & Chemical Products Ltd., and I believe they are at Alperton, Wembley. These alloys are used extensively in industry, eg (thermal fuses, dies and moulds in the plastics industry, work supporting weak sections during machining operations).

Melting points can vary from 20° to 292°C, but there are other alloys for special applications.
Yours sincerely,
L R Ellard
Porthtowan,
Cornwall.

PS Try CERROBEND, melting temp. 70°C, tensile strength 300lb/m², Coeff. of thermal expansion, same as aluminium 0.000022/°C.

We tracked down Mining & Chemical Products Ltd., who are indeed in Wembley. They say that they made Woods Metal, or rather, the modern equivalent, which they call MCP 70 (because, as Mr. Ellard says, it melts at 70°C). The smallest batch they do, unfortunately, is one kilo at about £14, but they say they welcome enquiries. They are: **Mining & Chemical Products Ltd., Station Wharf, Alperton, Wembley, Middx. HAO 4PE. Tel: 01 902 1191.**

In the meantime, I am using the blob of Low Melt Solder sent to me by Mr. Woodman last month as a stabiliser on the bottom of my personal sugar supply bowl, and I haven't had a spillage all month.

Overseas Problems

Dear Editor,
I decided to direct all my complaints to you after a long time of going though your magazine and not being able to construct a single project. My problem is not being able to get the semiconductors out here. I always obtained your magazine locally from "superstores" and big hotels. I am very much worried by the non-availability of most of (if not all of) the semiconductor material included in most of the projects found in your magazine.

I started reading your magazine in the year 1980, up to the present date, but have been unable to construct the projects. Lack of currency exchange is one of the serious problems I am facing.

I am therefore writing this to you asking you to help me with the equivalents of some of the

semiconductors to enable me to build at least three projects. These are:
2N3819, BC650, LM3909, BC109C, 244B, ZN414, ULN2283B, BB212, TR1400-8, BC184L, IN1400.
All these parts listed above are unavailable in our local electronics shops. The inconvenience which this letter puts you to is highly regretted.
Yours faithfully,
Abdul Rashid Buharilawal,
Dept. of Engineering,
Kaduna,
Nigeria.

IC semiconductors do not really have direct equivalents. The prefixes may differ — for instance, LM3907, uA3907, and MC3907 are all the same, apart from the manufacturer's code letters at the beginning, which simply tell you where they come from.

For most semiconductors, the only way to trace the nearest equivalent is to check data books for their parameters and then look through various catalogues for a device with similar characteristics, or else with a higher rating. For instance, the CSRI-3 is probably a 300V 1A device, so any similar device will do the same job in most circumstances, eg. a C106D. Note that the casings of the two devices may be different, even very different, in shape and size.

Special transistors, such as the 2N3819, do not really have direct equivalents, so here it is better to obtain the exact device.

Others, such as the BC109C, have countless equivalents, such as the BC549 and the BC182L, the list is lengthy.

It is probably better to compare data when looking for equivalents, as many equivalents may be better than the original specified. *Hobby Electronics* usually specifies transistors which are widely known and easy to obtain, unless a more obscure device is nessary, but the supply situation is doubtless different out there in Nigeria, and other places which may be supplied from different sources.

Sent Packing

Dear Sir,
Old cigarette packets, instead of just being thown away, can be made into very useful component storage units.
You need a wooden holder, or something similar, in which you can stack the packets one on top of the other so that the lids flip open downwards and can be opened and closed. They will hold resistors, capacitors etc. safely. I have made one, and they work very well.
Yours faithfully,
Jeremy Haile,
Berkhamstead,
Herts.

True to the motto "HE Readers Do It with Less", reader J. Haile starts us all on the trail of empty cigarette packs. Will HE readers now be seen, sifting through skips, hoppers and public WPBs for discarded packs? A health warning: it's cheaper to fork out for component draws than it is to take up smoking.

That apart, good idea, if you can find a way of preventing all your components from smelling delicately of tobacco. If you don't feel like contriving a wooden 'support' for the boxes, you could always just glue them together in columns — a bit less versatile for getting that last resistor out of the back of the box, but quite serviceable nonetheless.

Loss Of Control

Dear Sir,
Please help!
Infra Red Remote Control (HE February '84)
I have constructed a large number of projects from Hobby Electronics and ETI, mostly successful, but this one beats me! I've checked and replaced every component, checked the board, etc., but no way can I get a response from the indicator LED – ie, the thing just does not work.
Your assistance would be appreciated. Many thanks.
Yours faithfully,
D. Keen,
North Shields,
Tyne & Wear.

The standing errata for this one state that "IC2 should be IC1 and IC3 should be IC2" — ie, there is a case of mis-labelling here.

Try this, and if it does not cure the problem, write to us with the results of your on-board testing(you say that you've checked the components and the board, but don't make it clear whether you have followed the constructed circuit round with a meter) and we'll try and work it out.

Tune In, Turn On, Bomb Out

Dear Sir,
I have a 12in B&W portable TV, and when I bought it I was amazed to see that the same model with sonic remote channel changing was £30 more expensive.
It occurs to me that a simple wire-controlled channel changer that could be plugged into the aerial socket of the TV would be far cheaper and within the scope of an electronics amateur to make. Is there any chance of such a project being included in HE in the future.
Yours sincerely,
Roderick Graham,
Felixstowe,
Suffolk.

I hope not. It took us a year to get the technical enquiries under control. We don't want to triple them again overnight. TV remote control systems don't plug into the aerial socket . . .

Seriously, we have looked into the possibility of doing, for instance, a project to convert wire-controlled remote systems to UV or ultrasonic, but found that there is such a variety of control systems used (they vary from model to model, let alone between brands) that it was impractical. Also, a remote control system for the sort of model you describe would require the redesign of a large part of the TV circuit. Rewriting Mr. Sony's manuals is beyond our brief, unfortunately.

Mind you, if someone was to pay us £30 a unit, we might consider it. We might consider *anything*.

Musical Feet

Dear Editor,
I am used to DIY of most kinds, but am very much a beginner as far as electronics is concerned, and should therefore be very grateful for help and advice with the following project.
Recently I acquired a full-sized church organ pedal board and wish to use it in conjunction with our piano at home for practice in co-ordinating feet and hands. My aim is to buy or build a set of sound generators with amplification, corresponding to the range of notes on the pedal board. This has thirty-two notes in all, covering the range bottom C to treble G.
The resulting sound quality is not too important. What matters is that a) I should be able to tune each note to the pitch of its corresponding piano note and that b) the over-all output volume should be controllable and adequate to balance with the sound of the piano. If possible I should like to mount the sound generator part of the system as a fixture in the space between the pedals and the floor, which would mean a maximum depth of about 2in only.
Many thanks in advance.
Yours sincerely,
Brian J S Bull,
Beckenham
Kent.

We could refer you to our own pedalboard organ project of HE December '81, which used a sound-generator chip to give a thirteen-note range. However, if you are not used to electronics you may not find it very informative (a note for other Pedalboard Organ constructors: the ready-made PCB, and the kit, for this project, are no longer available). Attempting to modify electronic circuits is a minefield for the inexperienced constructor.

However, if you were to contact the **Electronic Organ Constructors Society, at c/o the Hon. Secretary, Pilgrim Cottage, Church St., Burham, Nr. Rochester, Kent,** they should be able to help you. **HE**

BUYLINES

Headphone Amplifier

No problems here as all the components are easily available. The printed circuit is fairly small, so its advisable to obtain miniature components. Remember that the Headphone Amplifier forms part of a larger pre-amplifier system, so some constructors might like to wait until the final episode before actually constructing the project.

If you do not want to wait, then the unit can be used on its own perhaps fitted into a small ali or plastic box.

Estimated cost is £6 which excludes the PCB and any case you might use. The printed circuit board is available from our PCB service.

Ultrasonic Fire Alarm

The only slightly difficult component may be the 2N4871 unijunction. For this component, you could try **Cricklewood Electronics**. All other components are easy to get, and you could try **Rapid** for most of the parts.

Estimated cost is £10 excluding the case and PCB. Our PCB Service will provide the printed circuit board.

Alarm Circuits

Not strictly a constructional article this! As the author has suggested in the article, all the circuits have at one time or another been published — but in many instances only once. All are very popular tried and tested circuits and each one could be valuable in protecting the home.

Note, we cannot provide any constructional information for these circuits although they are all fairly easy to construct and should present no real problems for the practiced constructor.

Because of the lack of constructional data, we do not recommend these to be attempted by the complete beginner, for the simple reason we cannot guarantee your constructional abilities.

There are a few components which require a brief mention as they might be difficult to obtain. For the following components try **Rapid Electronics**; PB2720, TIL100, TIL38 and the pair of 40kHz transducers. For the following try **Cricklewood**; LM1830 and 2N4871. All the other components are pretty standard and should be widely available.

We give no cost for the projects as a lot depends on how you construct them, and whether you dig into your junk box!

Milliohm Meter

We estimate the cost for this project to be about £16 excluding the case and printed circuit board, which is of course available from our PCB Service.

No buying problems, but do shop around for the panel meter. You could even try a "surplus" type, bought from a second hand shop or similar. Obviously the meter type will determine the size of the case so do make sure you buy the meter first.

The author mentions copper wire for connecting to the output sockets. To save the expense of buying a reel of copper wire, you could try the solid conductor from 1.5mm Twin & Earth house wiring cable.

The ceramic resonator is the uncased version which needs fairly delicate soldering. Some constructors may prefer to use the cased version, the PB2720, available from **Rapid**. Note that the cased version gives louder output than the uncased version.

As a point of interest, you could in fact try **Rapid** for most of the components used in this project.

Light Dimmer

With this project we can confidently say that there are no buying problems! Well be honest, with only two components in the parts list there can't really be any problems can there! There can? Well if in doubt try **Maplin** for the power controller, PC1R.

The plain plateswitch can be bought at most electrical and DIY shops. We estimate the cost to be approximately £5.

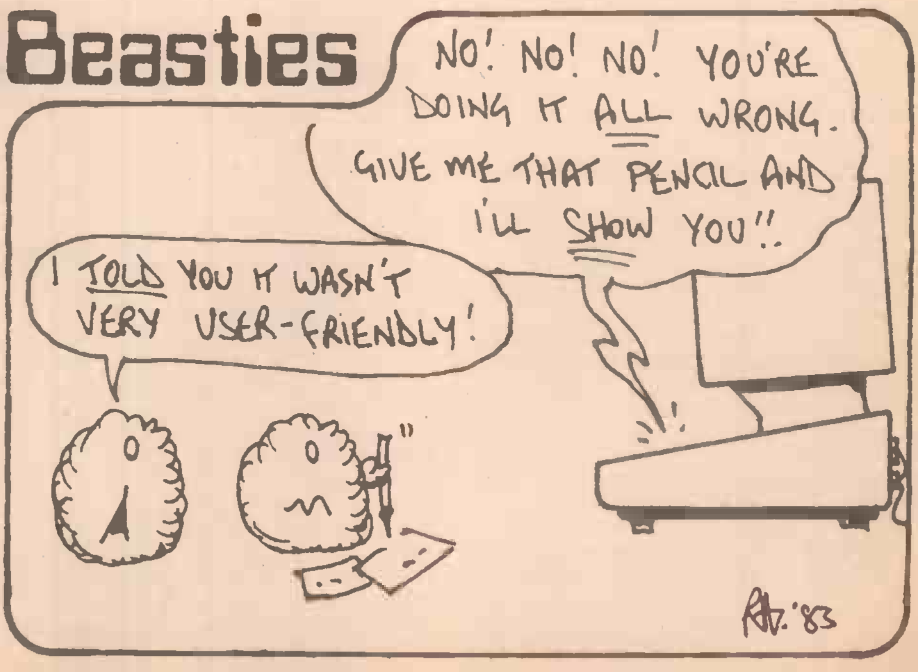
Short Circuits

We are always on the look out for suitable short circuits to be published under our occasional series of Short Circuits.

The circuits may be on any aspect of electronics but should always be of a practical nature. No constructional information is required and will not be published anyway! Keep your ideas shortish but do include a substantial circuit description otherwise we shall not consider your idea too seriously.

Keep all diagrams separate from the text and do make sure that everything is clear and readable.

Any circuit that we publish will be suitably rewarded!



SOFT OPTIONS

Editor: *Ron Keeley*
Associate Editor: *Mary Sargent BA*
News Editor: *Helen P. Armstrong BA*

Editorial

This is a conservation edition of Soft Options.

It came to the attention of certain of the staff that there was a little known species of creature haunting the streets and byways of Britain, whose existence was not only threatened, but actually believed in some quarters to be mythical.

We refer, not to some urbanised relative of the Yeti, but to a life form similarly ignored by the World Wildlife Fund, the R.S.P.C.A. and the Cats' Protection League: Computerate Woman.

Little is known about the habitat, mannerisms and characteristics of this animal, due to the fact that it is retiring, nearly mute and extraordinarily good at camouflage, especially in the presence of the more flamboyant male of the species whose numbers are many times greater.

This is not to say that the female is not competent to survive: indeed, the indications are that, since there are fewer of them, Computerate Women are arguably better at functioning than many of the males, who sometimes eject, squid-like, black clouds of jargon designed to confuse and deter possible threats. Such as Computerate Woman.

Having heard a rumour about a sighting in Finchley, the Seek-and-Find squad was despatched hastily from the nerve centre of the Soft Options Bunker, and battled its way fearlessly through traffic wardens, tube systems etc, etc, to discover a small settlement, huddled away from civilisation etc, etc...

Actually, it was very easy. There were a lot of them about. And they're highly articulate, which is more than can be said for a lot of the men who work with micros.

And since no-one else has bothered to do it, we thought we'd invite a few of them out of their habitual obscurity and introduce them to you.

We think you'll find what they have to say interesting.

SOFT OPTION

Equally Well-Informed

1984 has been designated WISE year by the **Equal Opportunities Commission**. Working in conjunction with the Engineering Council, the EOC has launched a publicity initiative, called *Women Into Science And Engineering*, to try to offset the traditional prejudicies which mean that far fewer women than men take up careers in these fields.

Information packs are being made available to all schools and education centres in the country, in an attempt to encourage girls to regard mathematical, scientific and technical subjects as natural subjects for study, rather than as matters which are best left to the masculine mind to tackle.

In January, the first of these packages, which dealt with Information Technology, was sent to every secondary school in the country. Since microcomputing is a new subject in the curriculum, it was a logical target, and particularly important when it looks set to become yet another "boy's subject". Recent statistics released by the Department of Education and Science show that already, four times as many boys as girls take Computer Science to 'A' level.

The EOC handouts included a handbook for teachers, setting out guidelines on how to motivate girls to learn about computers, and hopefully, to see the new technology as a feasible area in which to seek work after leaving school. Also in the pack was a booklet on careers in Information Technology, and demand for that exceeded supply very quickly.

Reaction to the initiative has been good, insofar as the Equal Opportunities Commission has received a number of calls from both teachers and parents, but unfortunately lack of money means that there are no plans at present to reprint the books, leaflets and posters in the Information Technology pack. However, there are still some available from the EOC, and further information can be obtained from **The Equal Opportunities Commission, 1 Bedford St., London WC2E 9HD Tel: 01 379 6323.** You can also write to **EOC, Overseas House, Quay Street, Manchester, M3 3HN.**

Additional Effort In Sheffield

A women's group in Sheffield (Sheffield, you will remember, is known both to its supporters and its detractors as The People's Republic Of Sheffield, because of the council's extreme willingness to direct public money to community projects), funded partly by the City Council and partly by the EEC Social Fund, has set up a course in computer microelectronics specifically for women who have found it difficult to obtain the necessary education

Programmer Kate Nelson of the **Women's Technology Training Workshop** told us that the course, which runs for forty-eight weeks at around fifteen hours a week, is aimed at 'disadvantaged' women over twenty-five: single parents, ethnic minorities, women with several small children, and child care is provided.

The training on the course covers programming in high level languages such as BASIC and Pascal, familiarity with program packages like word processors and sales ledger, problem solving, electronic project building and testing, mathematics for electronics, as well as information on job hunting, finding further education, and women's rights.

"We didn't intend to set them homework" they told us, "But their enthusiasm has been so great that they've been asking for it, especially the maths, which is difficult. They are very grateful for the opportunity, and many of them want to find further education."

Why does the combination of "mathematics" and "enthusiasm" all fall into place when the WTTW mentions "ethnic minorities"? Because it's exactly these ladies, and others whose circumstances have so far prevented them from studying for a serious career, who grasp their opportunities. More is the pity that so many girls, with opportunities for learning theirs in return for a little serious effort, pass them by completely.

A Dream Of A Program?

For the many teachers and parents who have long suspected that the microcomputer offers hitherto neglected opportunities for learning programs, there is very good news. **Widgit Software** have produced two tapes which are possibly the best argument in favour of Computer Assisted Learning (CAL) yet devised.

Adventure Playground is designed for primary pupils, from the earliest readers up to about nine year-olds, and is loosely based on an idea sent to Widgit by a fourteen year-old, Carl Jones. His suggestion was for an adventure game set in Toyland, which prompted Mike and Tina Detheridge to design nursery rhyme locations in which characters such as Old King Cole must be persuaded to clear the route to the Queen of Hearts' Palace with gifts suitable to the characters' needs. Carl was asked to help with the programming, members of the Detheridge family designed the graphics and the overall structure, and Gordon Askew, a headmaster responsible for other Widgit work, completed the tape with a logic and strategy game called *Crooked Adventure*.

The result is a primary school program which will delight those who feared that educational software would never come of age.

The second tape, *Castle of Dreams*, is Widgit's first venture into programming for secondary age groups. This too is an adventure with a difference, the difference

being that there is a lot of attractive graphic work, and the tools needed to complete the adventure can only be achieved by solving problems incorporated in games within the main game.

Tina Detheridge says that Widgit have wanted for some time to expand their range of programs into the secondary market but, "We didn't want to get involved in the revision style programs. We wanted to wait for the right idea". The right idea calls for strategy, planning, logic, mapping and imagination, both from the user's point of view, and the programmer's. *Castle of Dreams* and *Adventure Playground* cost £7.95 each and are available from **Widgit Software, 48 Durham Rd., East Finchley, London N2 9DT. Tel: 01 444 5285,** or from major software outlets.

Soft Options

HARD NEWS

Micros On The March

Sponsored by four of the larger computer magazines, one of an increasing number of Computer Fairs took place at Earl's Court Exhibition Halls between 14th and 17th June.

If there are many magazines and many shows, there are apparently even more home microcomputers. An estimated four million by the beginning of 1985, in fact: and to meet the needs of all these owners, any number of companies, of which about one hundred were exhibiting at Earl's Court.

Representatives of both hard and software for business, leisure and educational applications were there, together with Spiderman, the Incredible Hulk, Mr. Floppy and some Roman Legionnaires, presumably to underline the march of progress.

Sinclair Research were displaying the Q-L- to public gaze. This time, you could actually touch the beast, and a very handsome animal it is, too, as far as appearances go.

The machine popularly supposed to be most likely to interfere with its progress, the Amstrad, was curiously absent. So, too, was the Enterprise, which made its debut at Olympia last autumn, but has since been curiously inconspicuous.

The March Of Progress — the Lost Legion look at the latest and reflect that it was just like this when they invented the stylus, too.

Memotech, however, were much in evidence, with both the MTX computers and an impressive image-grabber, which can be added to the modular MTX system. Called the HRX, the high resolution graphics machine attracted a lot of attention on a day reserved for members of the Computer Industry.

On the software side, there was good news for those familiar with the educational programs put out by Widgit Software, who also write for Mirrorsoft. Widgit were using the show to launch their latest programs.

The presence at the Fair of Longmans and Addion-Wesley underlined the interest being shown in the software market by the traditional publishing houses, and the Encyclopedia Britannica also had a stand there. Why? "Why not?" was the reaction.

After all, one shouldn't get the micro-revolution out of proportion. It would take an enormous number of Spectrums to store all the information to be found in the new thirty-volume edition, which took fifteen years to compile. By a quirk of the layout of the catalogue, the entry on the Britannica is side by side with the phrase, "an ideal match for the QL."

"We'll go along with that!"

Realistic Software?

Thorn EMI Computer Software Distributors have signed a distribution agreement with the American software company **Human Engineering Software** (they are based in California) on their complete line of home software, marketed under the **HesWare** brand name.

The HesWare product comprises mostly games and educational software for the Commodore 64 and VIC 20 micros. HesWare's own contention is that UK software distribution is "chaotic" and pricing is "unrealistic", in view of the drastic price cutting proposed by some software companies recently.

Drastic price cutting is not on Thorn EMI's mind, nor on HesWare's. EMI's Henry Kitchen told us that Thorn's intention was to set up a reliable distribution network, with technical support for all customers from the buyer who doesn't know how to load the program through to business support, in the UK and parts of Europe.

HesWare is being promoted as high quality product at a reasonable price. Thorn's 'reasonable price', quite reasonably, is one sufficient to finance their distribution, promotion and support operations, and their contention is that the customer would rather pay a little more to have a reliable product and service, than pay less and have neither. Another very reasonable contention, which has been shown to stand up when (and only when) the product and service are genuinely of a high and supportive quality.

An attractive innovation which HesWare are introducing is the Turbo program cassette, which loads much faster than a conventional cassette, in many cases in uder a minute.

Thorn's commitment to the Turbo cassette is such that they have priced their equivalent cartridges at between £19.95 and £28.95 while the Turbo cassettes are not exactly cheap at a minimum of £9.95.

Of the four initial releases, three were games programs of the 'maze', 'cavern' and 'adventure' genre respectively, and the fourth was a worthy but dull letter-and shape-recognition program for 3-9 year olds, *Kids On Keys*, which certainly seemed to be somewhat overpriced at £14.95. Only time will tell whether Thorn's pricing and customer service policy will justify itself. Cetainly increased organisation and service can only benefit the customer, but by how much?

Softly, Softly, Softly . . .

Helen Reidy, program designer for the Memotech computer, graphically describes the graft involved in learning the soft way.

Married to a computer software company, I could not help but be pulled — albeit unwillingly — into the world of the micro.

A few floundering months later, I found that I was unconciously absorbing such alien terms as RAMS, ROMS, video chips and the like, and was actually becoming conversant with the jargon which had once been about as comprehensible as a Balinese mantra.

A little later still, however, my newfound confidence was severely shaken by a request from Memotech that I should design a range of educational software for young children, aged from three to seven, and my initial reaction, I must admit, was total disbelief, quickly followed by hysterical laughter.

When I actually started to consider it as a credible proposition, I remembered the software that I'd seen at exhibitions and fairs, aimed at parents and teachers and being promoted under the grand banner of Education.

The vast mass of it, with a few notable exceptions, seemed either to be written by computer experts who had little, if any, clue as to what goes on behind the gates of a school, or else was created by teachers with an interest in computing, and as such was more theoretically sound, but was often poorly written and easily crashed by a little careless button pressing.

Memotech dangled before me the carrot of a resident, in-house programmer at my disposal and I realised that my own knowledge of teaching, together with programming expertise, could produce programs competent both in theory and presentation. I began to take it all a bit more seriously.

I started by looking at the capabilities of the machine I was to work on, the Memotech MTX, a new micro with which I had been sharing my home and my husband for some few months past.

I was extremely impressed with what it could do, and it then became a matter of trying to write down all my ideas before they gave way to something else, equally exciting, inside my head. The possibilities, it seemed were endless.

I took to carrying pens and paper in my handbags: after days spent etching ideas on the backs of cigarette packets and the corners of shopping lists, it seemed the most sensible thing to do.

After a week or so of frantic scribbling, I managed to calm down enough to look at all these brainwaves and to think them through to see if they were worth following up.

I decided finally on a range of software which would include some of the more popularly recognised educational themes such as letter recognition and word matching, together with a number of problem solving, logic testing programs which could be used successfully, I felt, with younger children.

For my own benefit, I sat down and wrote short notes on the aims and purposes of the various ideas, together with a picture of the screen displays as I envisaged them.

This included the structure of the programs themselves. Much of the available software seemed very poorly documented, so I wanted a large amount of teacher/parent information made available, as well as the facility to choose and alter the presentation of any given program.

My teaching experience came in useful here, with the realisation that a great number of children apparently learning the words are in fact merely making associations, as for example, that the word "cat" always goes in the phrase "the dog and the. . ." in their reading books.

If the sequence of the words is changed, many of these children are completely lost.

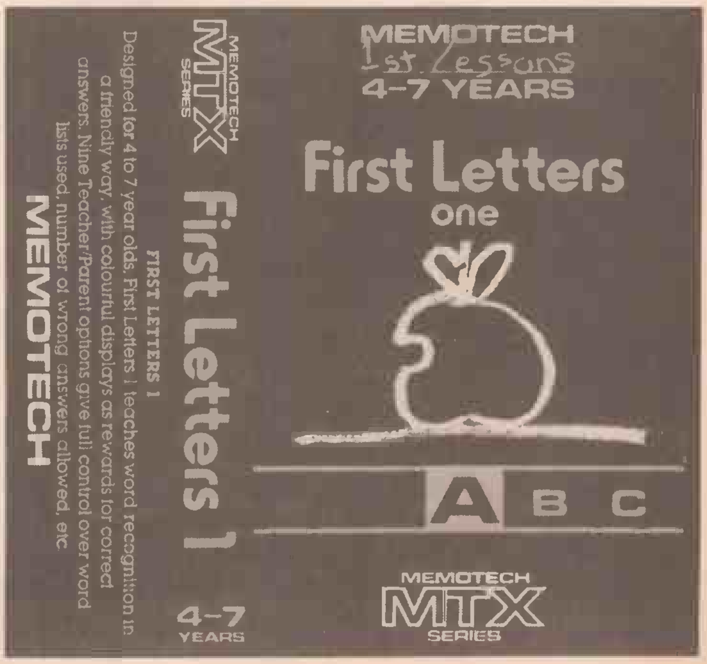
Visual presentation had to be stimulating. Too many of the programs I had seen went to one extreme or the other. They seemed either to be very dull, or they spent so long being entertaining that they lost sight of their purpose.

I tried to aim for the middle road, with designs interesting to look at but not so attractive that the child didn't learn anything.

Then there was the vexed question of the reward scheme. There are a number of programs in which the penalty for making a mistake is infinitely more interesting to watch than the reward for giving the correct answer.

Most children would prefer to see the pretty graphics than bother with an answer for which the reward was, by comparison, boring.

This, I felt strongly, had to be avoided. I did not want to punish wrong answers, but I was determined that only the right answers would give the child anything interesting to watch.



Now began the hard work. Fast coming to the realisation that a number of the future programs could all rely on a similar library of words and pictures, I began to write an A to Z of possible vocabulary, always trying to bear in mind, with this as well as all the other aspects of the project, what I would like to see in a program, as a teacher and therefore potential user.

More scraps of paper began to materialise, this time covered with pictures of elephants, kings, telephones and the like, and I finished up with a collection of which the quantity, if not the quality, would have made a fair-sized display at an exhibition.

It was at this point that my programmer and I got together for the first time. I somehow discerned by his blanched features and strained smile that he had started to think of the man-hours involved in turning my set of pictures into computer graphics, and was not entirely thrilled with the prospect.

Fortunately for the relationship, however, physical space in the computer's memory dictated a paring down of my optimistic mountain of drawings to a hill of more manageable size.
After much casting aside and simplification, I finally had a set of pictures with which to form a library and the basis of my start programs: those concerned with first letters, and word and picture matching.

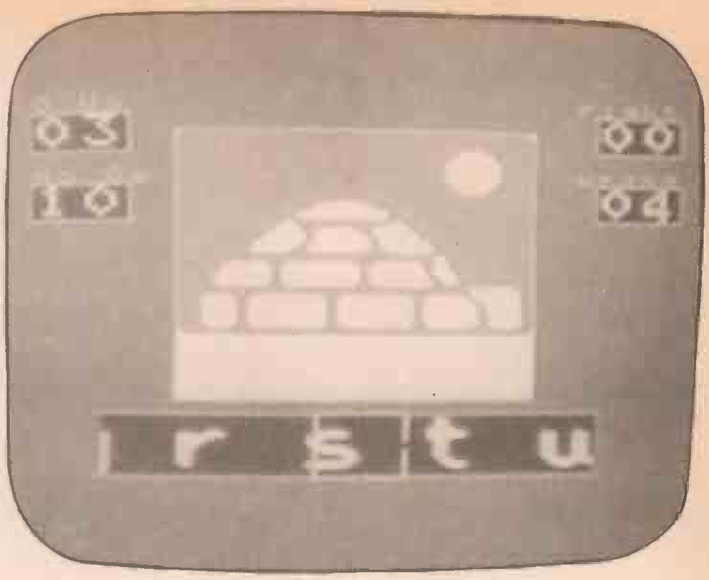
My teaching experience had in some ways made it more difficult, in that I was aware of the need to limit the vocabulary to objects easily recognisable onscreeen, both as pictures, and as words whose spelling and appearance was suited to young children.

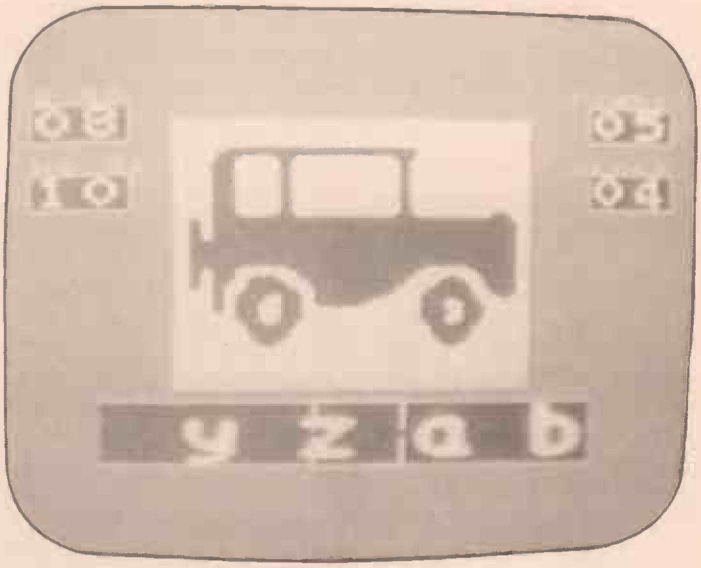
This was something not commonly taken into account by other designers, judging by the unlikely array of words that I had seen, including things like "hat" and "bat" in the same program. These words look very similar to the eyes of a child just beginning to read.

Next, I tackled the problems of the reward scheme. Having seen the possibilities for animation of the MTX, I was confident that we could produce something fairly sophisticated, but what?

It had to be good to look at and it had to be something with which the child could identify.

Aware, too, that teachers and parents could well have differing views on rewards, I included the facility to opt for different numbers of correct answers qualifying for reward, together with a variable number of stages to each reward.





As before, I drew a set of pictures to show the different stages of the reward, along with short descriptions of the sounds to accompany them.

Fortunately, the programmer's mind worked more or less in concert with mine on this point, and he was able to transform requests like, "whooshing noise here" and "something roaring" into the sounds I had imagined.

Then came the laborious task of setting out on paper exactly what I wanted to appear on the screen. I set to and began to write out precise instructions, following through the programs step by step, indicating what should occur at any given point.

I had to think of, and cover, all eventualities, including what was to happen if the child pressed the right key, the wrong key or even no key at all.

All this not only had to be written out in neat longhand — a sufficiently daunting chore in itself — but it also had to be intelligible to a complete stranger, so that someone whose ability to know what I was thinking should not have to be put to the test.

This completed, my part in the project was almost at an end.
I say almost. I now had to don a new cap: that of artistic adviser.

After having attempted the creation of a few pictures and letters using computer graphics, I knew they all had to be made up from small squares. This is no mean feat, when you are trying to make a stubbornly square orange appear circular!

The library of pictureswas growing nicely by this time, so I took a train to Oxford, and thence to Memotech in Witney, to see how my original sketches looked on the screen, and to put the first draft of the starter program through its paces.

Suprisingly few alterations later (all credit to the programmer!) I was back on the train to London. I had done it! There was something concrete to show for it all at last.

I sat back in the compartment with a whole set of mixed feelings: pride that this was my brainchild, relief that it was now almost complete, anxiety over how it would be received in a world of critics, both amateur and professional, and a growing sense that, if asked, I'd secretly rather enjoy going through the whole fraught experience all over again!

The first two programs designed by Helen Reidy, **First Letters** *and* **Words And Pctures** *are currently available for the MTX computers. Issued by Continental Software, they can be bought from Memotech dealers and cost £9.95 each.*

Soft Talk

This month's reviews have been written by primary and secondary teachers, and by parents with children of the ages catered for by the particular programs on test.

Goldilocks I Can Read Sentences

Learning Box Software for Kids

Arrow

48k Spectrum

For ages up to 6

£9.95

Reviewed by **Phillipa Money**

The program comes in a smart plastic box and consists of a double sided tape, side A having on it the story of Goldilocks read by Toni Arthur, and side B being the computer program.

The box also contains an illustrated story book introducing the characters and words used in the program, a parents' guide to the activities and a double sided cardboard overlay intended to simplify use of the keyboard.

Learning box is a series of tapes to help develop basic reading and number skills.

The parent guide states that the Goldilocks program is "designed to teach your child a wide range of skills. This program introduces your child to lots of words, provides practice in reading in a sentence from left to right, develops an understanding of how words form sentences, introduces your child to punctuation marks and improves your child's hand and eye co-ordination."

The importance of reading the guide carefully and studying the activities thoroughly before introducing the child to them is emphasised, and step by step instructions for using both the program and the computer are given.

Having read the checklist of things which might go wrong, I wondered if the authors might be prescient, since I found the program extremely difficult to load, and on several occasions it took so long that the children lost interest and wandered off.

When I did finally load successfully, I was offered a choice of two stories, Goldilocks or Red Riding Hood, and five activities for each story.

These were *Words To Pictures Snap, Find The word Stage 1, Word Snap Stage 1, Find The Word Stage 2* and *Word Snap Stage 2.*

What all this amounted to was two variations on the game of snap, and a game to replace a picture with a word in a sentence.

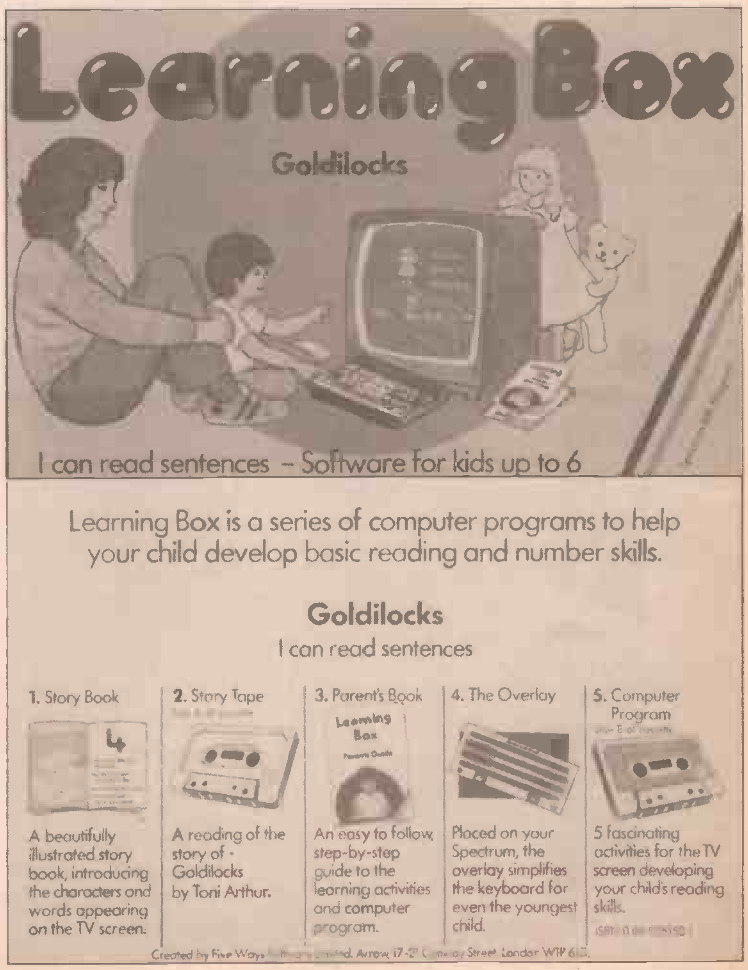
Although the graphics were attractive and were accompanied by sound (which could be switched off) I nevertheless felt that it would be possible, if less gimmicky, to play the games with paper and pencil. It would certainly be a lot cheaper.

However, given that a lot of children respond to the novelty of using a computer, it was generally a useful supplement to the sort of activities undertaken in schools, albeit with a fairly restricted vocabulary.

I had a few specific criticisms and some ideas on possible improvements.

In the first place, the programs included two stories, but all the documentation referred only to the Goldilocks tale, which made a nonsense of trying to link the games in with the booklet.

Perhaps this may have something to do with the fact



that there is available in the same series a tape called *Red Riding Hood*, which also features Goldilocks. . . .

In any event, the children using the *Goldilocks* program found it frustrating to be unable to use a booklet with Red Riding Hood in it, and so did not reap the full benefit from the tape.

In the Word/Picture snap game, the notes state that the speed at which the words and pictures changed could be adjusted to suit the user, but even at its slowest it was too quick for younger children, and confused them.

There is a pause facility, but this can only obtained by pressing three keys at one, a procedure which was too awkward to use to slow the game down.

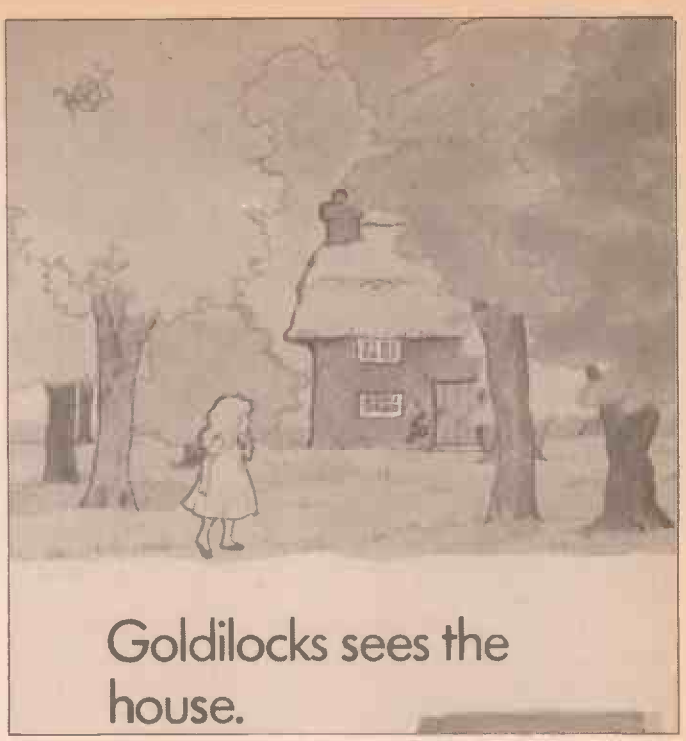
The reason for this complicated method made sense in so far as it is intended to prevent accidental pausing, but I feel that the scope of the program would be much increased if it were possible to slow the game to help younger children.

Word Snap suffered the same problem, but was easier to play.

The reward system in the games is visual. It seemed to me that it might have maintained the children's interest longer if correct answers had been applauded with a tune played by the computer, as well as the little jig performed by the winning character, be it Wolf, Bear or little girl.

Finally, one minor point concerning the overlay for the keyboard. This is an excellent idea, designed to simplify the use of the computer by dividing the keyboard into right and left hand control panels and thus obviating the need to use highly specific keys.

Unfortunately, though, because it was made of thin cardboard and was folded in the box, it was very difficult to keep over the keyboard and actually hindered efforts to press the keys. It would have been very useful had it been made of thin plastic!



There was no doubt that the children enjoyed playing with the program and listening to the story tape. The package is carefully thought out and the documentation is clear and useful.

However, bearing in mind the wealth of learning material there is available for this age group, and the price of this package, it must be a matter for careful parental consideration as to whether the same good results could not be achieved by other methods.

Learning Box software is available at most High Street stores.

Glider

(Sinclair/Macmillan)

For Spectrum 48K

Ages: From 8

£9.95

Reviewed by
Margaret Saxon

As a user of this program, one of the Science Horizon series put out by the book publishers, Macmillan, you will find yourself in the pilot seat of a glider, launched at 300 metres to explore an island from the air.

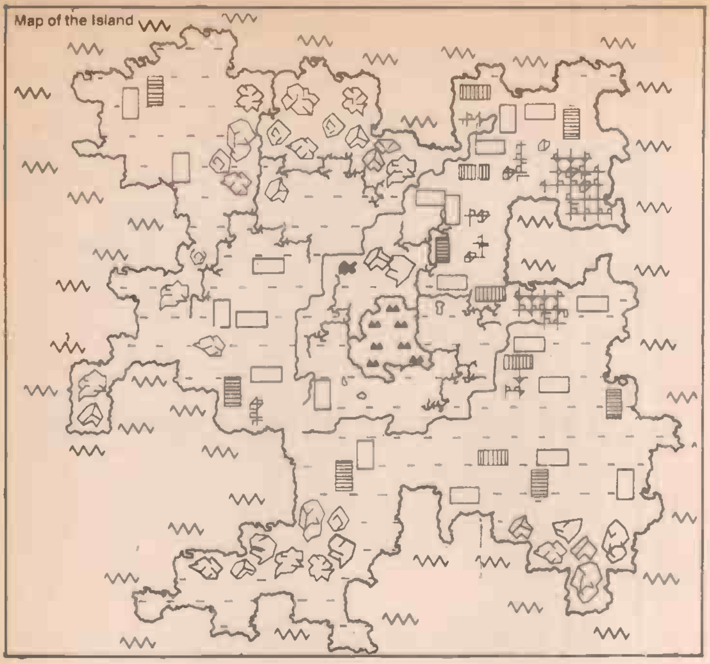
In order to gain height and maintain flight, you must steer the glider towards thermal currents which will bear you upwards until such time as you decide to return to base.

If you fail to find enough thermals to support you at least 50 metres above ground, you will either crash, if you are over the sea, the road or buildings, or suffer an enforced landing if you are over grass.

The game is great fun. The score is calculated on the distance flown and the time the flight lasted, together with a safe landing, and the challenge of bettering the highest score is compulsive.

Both the adults and children who used this tape made repeated efforts to improve both their flying skills and their scores, and the enjoyment of the children, boys aged 10 and 12, was obvious.

Part of the program's objective is to teach the principles of gliding, not as a sport but as a science, and in this it succeeds by steady progression.



The user will need to practise selecting suitable weather conditions and the time of day, as well as locating likely places for thermal currents. He will also have to be able to time the key presses on the keyboard competently.

Basic map-reading and the use of a compass are also taught in this program, and it is best used by individuals or pairs, but not by a large group.

Unlike many programs for the Spectrum, this one can be used on a black and white TV without particular handicap.

The graphics are excellent, and the ground recedes as the glider gains height and vice versa, which is most effective.

My one quibble is that I should have liked the coastline to be marked in such a way as to distinguish it from, for example, a river, so that I would have known instantly when I had strayed over the sea.

However, there is a pause device, which is invaluable since it allows time to consult the map when in doubt!

Glider is a thoroughly entertaining program, which is recreational in its appeal, so that children enjoy using it, and educational in its effect, so that parents can also feel some satisfaction!

Cargo

(Sinclair/Macmillan Science Horizons)

48K Spectrum

For ages 8 upwards.

£9.95

Reviewed **Margaret Saxon.**

In ***Cargo*** the user is required to undertake responsibility for loading a cargo ship repeatedly as it sails between two of a selected number of ports, seven being the maximum.

The object is to sail with the largest cargo consistent with the safety of the ship and her crew, thereby making as few journeys as possible.

Various factors have to be taken into account, such as the varying mass and weight of cargoes and the need for the ship to be evenly loaded.

The Plimsoll line is displayed onscreen to help prevent overloading, and it is explained that this line takes account of the kind of waters the ship will be sailing through.

It is also necessary to consider the time of year, the route chosen and the likelihood of bad weather before making final decisions.

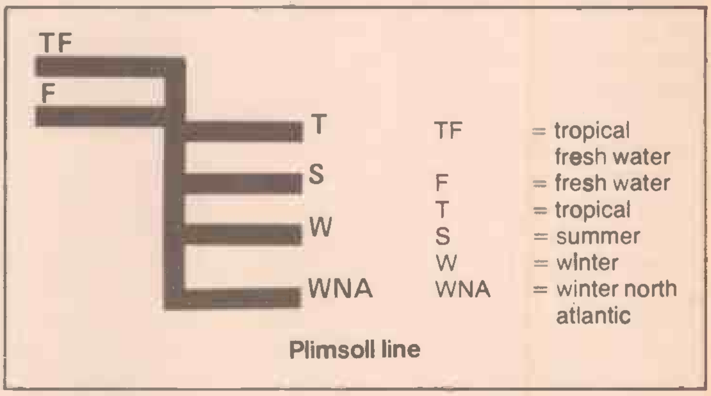
The game can go on for some time. It is probably better to select three or four ports, at the most, for the first few attempts until the instructions and strategy of the task are fully understood.

The instructions are clearly set out in the accompanying booklet, but there is a lot to think about. Not the least of the challenge is to reduce the number of necessary trips by taking onboard goods destined for ports other than the one you are bound for.

My twelve year old son did not realise what transit goods routes to them, and will emphatically appreciate the significance of the Panama Canal. Weather patterns in certain areas will also become familiar.

The program should encourage the ability to think more than one move ahead, as the player attempts to increase the score and win promotion at the end of the game as a reward for the effectiveness of the decisions made.

The graphics are good, the booklet is well presented and both the program and the booklet could stimulate



were, and needed extra help.

My feeling is that the age range of this program is underestimated by two or three years.

The user will certainly learn the geographical whereabouts of the seven ports and the sea plenty of follow up work.

In my opinion, this is a good educational program both for individual and classroom use.

Sinclair/Macmillan tapes are widely available at good soft-ware outlets.

Learn to Read 1 to 5

(Sinclair/Macmillan)

For Spectrum 48K

For Ages 4 to 7

£9.95 for each tape.

Reviewed by **Audrey Verdin**

Learn to read 1-5 is a series of prgrams based on the "Gay Way"reading scheme, using the animal characters found there — Deb the rat, Meg the hen, Jip the cat, Sam the fox, Ben the dog and Fat pig.

The booklet which accompanies each of the tapes is useful and is aimed primarily at parents, who will, however, find the tapes an expensive alternative to books.

Each tape is made up of several parts which are loaded together, and individual games are chosen from a menu.

A moving outline box appears over each item in turn and when the required game is outlined, any key can be pressed to select it. The format of each of the tapes is similar.

Learn to Read tapes 1-3 contain, mostly, versions of learning games at different levels.

Copy is unique to *Learn to Read 1*, and is described as a first introduction to spelling.

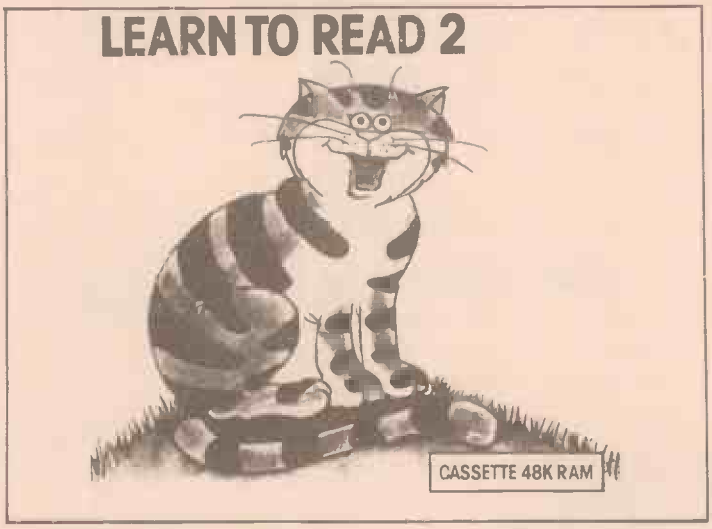
Pictures of all the animals appear and one is highlighted. The idea is that the child matches the name of the animal letter to letter by typing, but since the Spectrum keyboard shows upper case letter, and the letters on screen are lower case, it's a non-starter.

If children can accept upper and lower case letters as equivalent, they are past the stage of needing matching exercises.

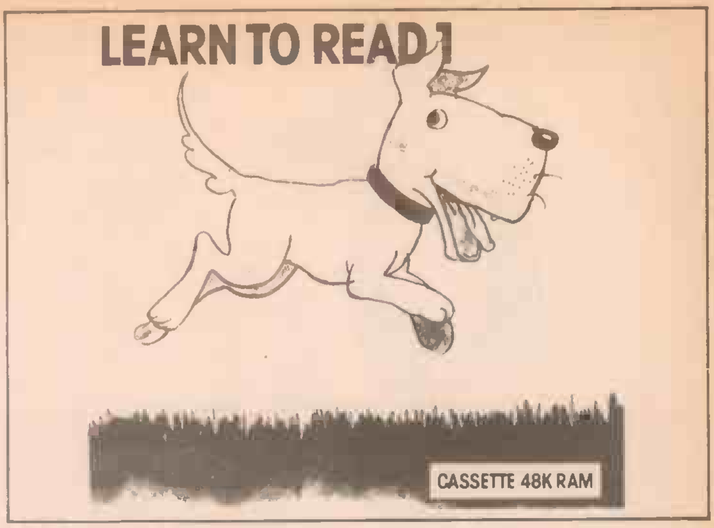
Name is a game for teaching nouns. In *Learn to Read 1* the names of all the characters are displayed with their pictures and any key starts the game.

One animal is shown with all the names and the user selects the right name when it is outlined.

In *Learn to Read 2* a similar game introduces vehicles and their names. A sentence such as "Deb the rat has a car" appears, and the car's picture is chosen by a key press when it is outlined.



Learn to Read 3 introduces more nouns such as cake and banana, and again the right word must be chosen to fit the picture.



An example is "Ben the dog has a cake" and when the selection is correct, the sentence is lengthened to "Ben the dog has a cake and a banana".

My main criticism of this activity is that the sentences tend to be silly, but since the characters are not believable anyway, the children seem to accept them for the nonsense they are.

Kim is designed to help with memory and deductive skills. On Tape 1 all the animals are displayed with their names and then one disappears. The child must remember or work out who is missing and type in the name.

On Tape 2, the game is played with the vehicles and in *Learn to Read 3*, the method of playing is actually easier, since the player selects the correct answer from a list on the screen by simply typing in its number.

Spell reinforces the nouns already introduced in *Names*. The version of the game in Tape 1 highlights a word which then disappears, leaving the child to remember and spell it.

Tape 2 introduces colours and in Tape 3, the correct word must be chosen from a list of phonically similar words.

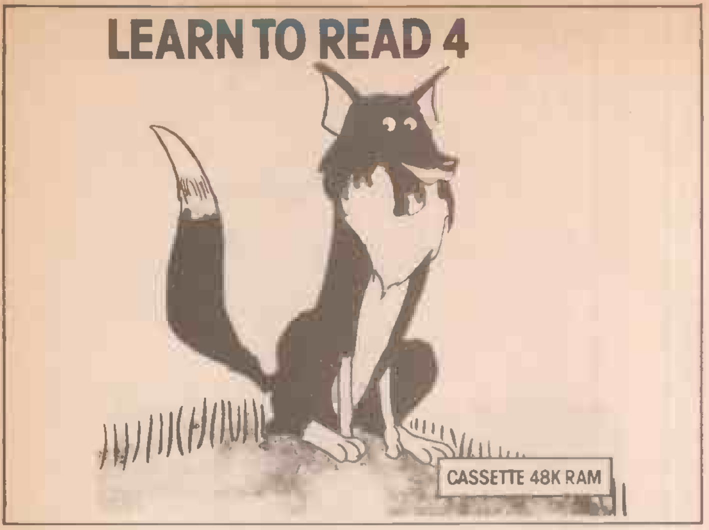
Cards is a computer version of pelmanism. *Learn to Read 1* displays eight playing cards, numbered.

A card is chosen to be turned over to reveal a picture, which the player then attempts to match by selecting a second card.

In Tape 2, a picture must be paired with a word and Tape 3 shows twelve cards whose pictures are matched with an initital letter only. The player does not have to indicate when he considers a match has been achieved, so only if an adult is present can you be sure that the child is doing anything except pressing number keys at random.

Learn to Read 4 moves on to teaching alphabetical order. The program is in three parts.

Next displays the alphabet for reference, and then shows any three letters in alphabetical order. A picture clue to the fourth letter of the series is given and the child must type it in.



Middle uses the same technique, but this time pictures and initial letters appear. The middle picture has no letter and the player provides it.

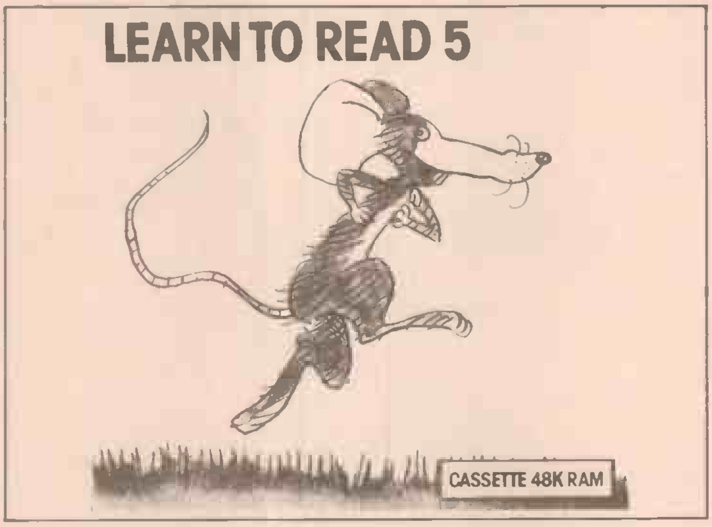
Find can be played at two speeds. Pictures with initial letters move across the screen, starting with a and ending with z.

At random intervals, a letter is missed and the player must fill it in, however, since the greatest number missed is only six, there is not a great deal for the child to do.

Learn to Read 5 is entirely devoted to positional words, such as 'on', 'over' and 'behind'.

Look simply demonstrates the meaning of the words with pictures, as in "Meg the hen is outside the house".

Snap can be played at three speeds. A picture shows the position of one of the animals in relation to another object and two words denoting position are then given at the bottom of the screen.
A choice between the words is made by pressing 'L' to select the lefthand word, or '0' for the righthand word.

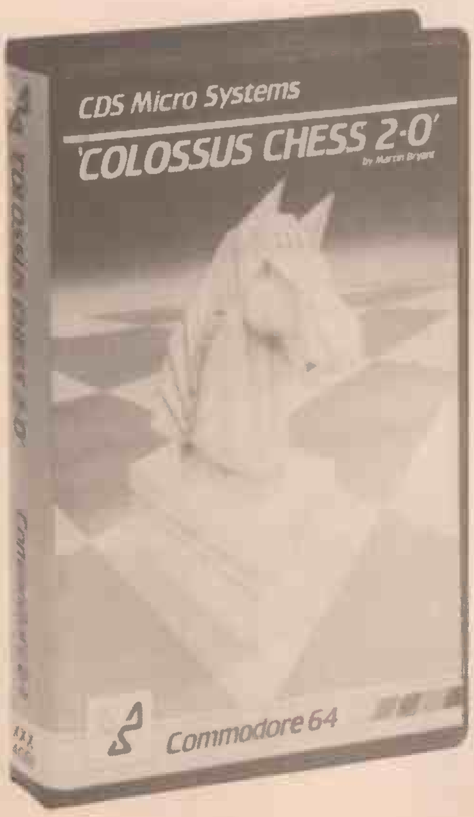


Spell reinforces understanding of the words introduced in the previous two games. A picture of an animal appears, together with a sentence which omits the position word. The child chooses the relevant word from a list of eight and types it in correctly.

The series of programs includes some attractive and potentially useful material which is helpful to children who have just started to read. **However,** it is optimistic to expect parents to achieve great success with pre-school learners, a scepticism based on the fact that the Spectrum keyboard is a confusing tool for very young children who are unskilled in the matter of fine visual discrimination.

There is also the point that all five programs, which although they can be used separately, do inter-link as a scheme as well, will cost very nearly fifty pounds.

Learn to Read 1 - 5 tapes are stocked by most software retailers.



Colossus Chess 2.0

(CDS Micro Systems)
For Commodore 64
Age Range: General
£9.95 tape, £12.95 disc.
Reviewed by **Jane and Ann Wilkinson.**

The program comes in a large video-tape style package, with a 32-page instruction booklet and is written in a mixture of machine code and BASIC.

Control is from the keyboard and the game is for one player only, since your opponent is always the computer.

The game has two screen displays, the first of which shows the chess board. On to this screen you type in the move you wish to make by moving the cursor to the relevant square. All squares are marked with a number and a letter.

If you attempt a move which is against the rules the word "illegal" is printed onscreen, and you have to try again.

Since the program understands all the chess moves, there is no way of cheating!

During the game, you can change you mind and your move, backwards or forwards, and can also select any one of six modes of play. These modes include:
1) Tournament mode
2) Average mode, which is similar to 1), but easier
3) All the moves mode, when the game is played in a limited time
4) Equality mode, when you are playing to your own standard
5) Infinite mode, the object of which is to solve Chess puzzles of the "you are here, which is

the best move you can make?" variety, and finally

6) Problem mode, which sets you the task of checkmating your opponent, and also offers self-mate problems if you want them!

The second screen displays the last seven moves made by each player and also shows lapsed time clocks which record how much time has been taken by each player in the course of the game.

Games are won when one side has check-mated the other, obviously, but there is a facility for drawn games, which occur after each side has made fifty moves.

In addition to these choices, the game can be made to play by itself, or you can watch your own efforts on action replay. You can also save an uncompleted game in its current state.

The screens are attractively presented. The game is loaded in black and white, but the borders, ink and paper can be changed to any one of sixteen available colours, with the only restriction that the ink and paper must be differently coloured.

Colossus Chess 2.0 is a very good example of such a game. It is capable of teaching users to play better chess, whilst ensuring that the rules are learnt.

The very wide range of modes means that you can undertake puzzles which will help you develop your own particular style of play, and once you are really confident, you can even play "blindfold"!

In this mode the chess pieces become invisible, and only the cursor can be seen, although your previous moves are still displayed on the second screen to help you keep track.

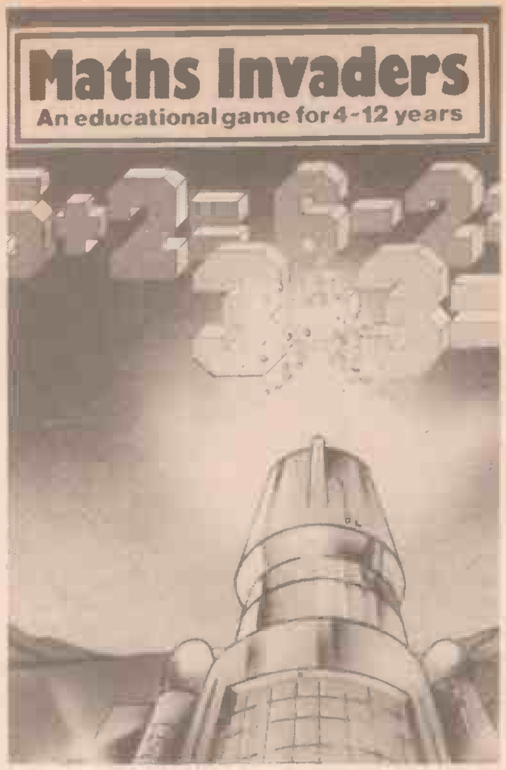
For any budding Grand Masters who wish to play against a computer, this program can be recommended.

Colossus Chess 2.0 can be bought at Boots and most major High St. stores.

Soft Options

Maths Invaders

(Stell Software)
16/48k Spectrum; CBM 64; BBC/B; Electron; Atari 800
Price £6.95 for Spectrum tape, all others £7.95
For ages 4-12
Reviewed by **Phillipa Money**



The ***Maths Invader*** program comes in a large cardboard box containing the cassette, an instruction sheet and a free badge, which was immediately appropriated by my three year old, who thereafter took no interest in the program at all!

The instruction sheet informs the interested that "*Maths Invaders* is an entertaining, educational game for children of 4-12 years old. It makes learning to add, subtract, multiply and divide great fun. Six skill levels allow the child to play at their (sic) own standard — but they'll soon be playing at higher levels."

My suspicions were immediately aroused by the claim of catering for such a wide age range.

It seemed unlikely that a single program could interest, entertain or, more importantly, educate children who were not yet at primary school, as well as those who might already have graduated to secondary school!

The program is a variation on the old arcade space invaders game. You are asked to select what type of question you want, whether addition, subtraction, multiplication, division or any combination of the four, and at what level you want to play.

When you have made your selection, rows of invaders appear, moving down a yellow screen, making an unpleasant ticking noise.

When you have answered the question correctly, a gun appears and you are invited to press any letter key to fire at an invader, the object being to annihilate them all before they land.

If you manage to evaporate all the aliens. however, the game does not end but presents yet more invaders advancing from the top of the screen.

It was possible, thank goodness, to stop the game by pressing BREAK, but although I tried, I could not turn off the sound and all attempts to use the program were accompanied by sound effects which the younger children in the age range found threatening and very distracting.

In its favour, I must say that the program loaded faultlessly every time and the instruction sheet was clear, although there was no attempt to provide detailed information about the aims of the program. As far as making use of the program was concerned, the younger children could not cope with even the simplest level.

There is no pause facility and the invaders move too quickly for children who are beginning arithmetic to work out the sums and still have time to fire at the invaders before they landed.

So far as I could see, the invaders moved at the same speed regardless of the skill level used.

I feel the program is totally unsuitable for children at the lower end of the age range, since their continual failure to answer the questions quickly enough could discourage and frustrate even the most able of them.

At the other end of the scale, 12 year olds of reasonable ability found the questions far too easy, and had no problem at all in operating at the highest level. .

If the program has any use at all, it may be more for the 7 to 10 year olds, particularly those who would rather use a computer than a pencil and paper to practise mental arithmetic.

I am not convinced that annihilating aliens is a particularly appropriate way to reward juvenile efforts in problem solving, and it was not improved by the need to be able to aim and fire fast as well as answering the sums.

On the whole, I found this an unimaginative and uninspiring creation, and one which I would certainly not myself buy for my children.

***Maths Invaders** is available from larger branches of Boots. (Stell Software)*

COULD TRY HARDER

A teacher's report on boys, girls and computers in the 80s.

Computer Education is arriving in force in schools in many different forms, from the general use of computers in classrooms, teaching a range of subjects, to the specialist computer education courses which have been around for longer, but which have increased in number dramatically since the introduction of the micro.

These same micros have also been arriving in great numbers in homes, usually where there are children, and whilst the changes that are taking place are educationally welcome, they are also worrying.

Why, as a general rule, do the boys make a beeline for the machines, while the girls make only shy and tentative approaches, if indeed they make any approach at all?

When computers in homes and schools were rare, the problem was limited and largely invisible; now the number of machines available is large enough to have made it not merely visible, but alarming in scale.

The problem is highlighted in four specific areas, which are: the subject options chosen by pupils in schools; attendance at school computer clubs; computing in single sex schools; and micros bought as presents for children by parents.

Most secondary schools offer some variety in the subjects available for study.

From the age of 14, pupils select options which they usually follow to public examination level. At 0-level, one girl is entered for Computer Studies for every three boys.

For the courses taken after 16, which are more specialised, for example A-level Computing Science, the numbers drop to one girl for every four boys.

The same picture emerges in Computer Clubs. Schools have no difficulty in attracting pupils to use computers outside lesson time, but it is rare to find clubs where the boys do not predominate.

Most pupils are taught in mixed comprehensive schools so single sex schools may seem a minor issue. Nevertheless, it is interesting to look at the attitudes to computer education prevailing in establishments which cater for the education of girls only or of boys only.

The information available is far from complete, and there are some notable exceptions, but the overall impression is that boys' schools have for some years been more likely than girls' schools to take computing seriously.

My own research into A-level Computing Science revealed that boys' schools were among the first to offer the subject to their pupils. A study in Croydon last year included a look at a girls' school where, despite successful fund raising to buy a computer for the school, the Computer Studies course collapsed when the teacher of the subject left.

On the matter of micros bought as presents for home-use, I must again draw on my own experience rather than complete information, since this has simply not been gathered.

I would guess that the number of computers bought for boys is at least six times as great as the number bought for girls.

It would be interesting to know the facts. Are the girls I meet whose brothers "let me use his computer" typical? Is it true, as it seems to me, that girls without brothers are more likely to get computers of their own, but smaller and cheaper ones than those bought for boys incorresponding situations?

And while I'm asking, what about the software — do all the "Zap the Alien" games appeal equally to boys and girls? Are there any games equivalent to *Donkey Kong* with a heroine who does difficult and dangerous things in order to rescue the boy.

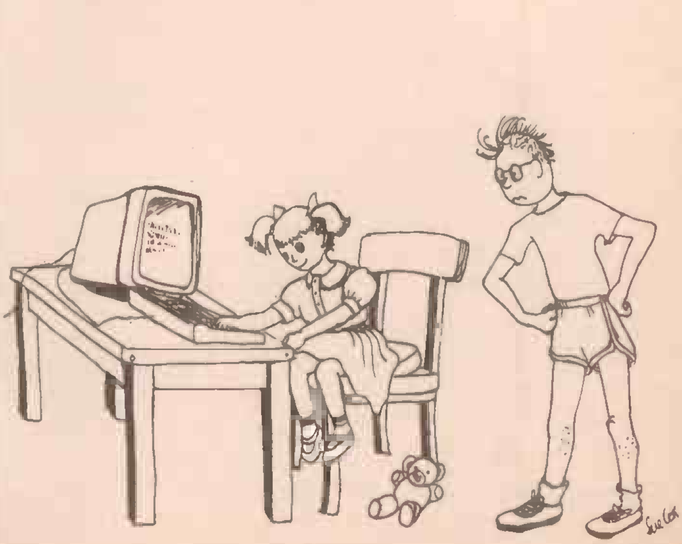
If you ask the software houses, will they say they are just responding to market forces, since their consumers are largely male?

So we come to the all-important question. Why doe
xxxxxxx
important question. Why does the gap between boys' and girls' attitudes exist?

The particular problem of divergent reactions to the new technology is as new as the technology itself. The underlying differences in the education of boys and girls is as old as education.

Comparing examination entries and option choices

"MY BROTHER LETS ME USE HIS COMPUTER"



across all schools would reveal the same pattern in disciplines like Physics. Craft subjects show even greater divisions, with Needlework for girls and Metalwork for boys.

It may be that the sexes have different aptitudes, but the nature and extent of these is far from clear, and research into the intellectual differences has identified many of yesterday's conclusions as superstitious. There is no proof of any major differences in ability, and the small discrepancies there are, are too insignificant to explain the very different choices made by children.

By the age of 14, the majority of girls and boys demonstrably have separate interests, ambitions and expectations for themselves and their lives. They are not alone in viewing the world as a place which changes according to gender.

Boys are encouraged to tinker with, and understand things mechanical. Boys receive more attention in schools, particularly in Maths and Science, and if when they sit at a keyboard, they do so with more will to experiment and greater confidence that they will master the machine than girls do, it is because they are responding to this handling.

How many girls who have difficulty with Maths have been told by some helpful woman, "Never mind, dear, I could never do this either"? This is no exaggeration.

The Croydon study, like others based in the classroom, showed that, even when teachers try their hardest to be impartial, boys and girls are treated differently.

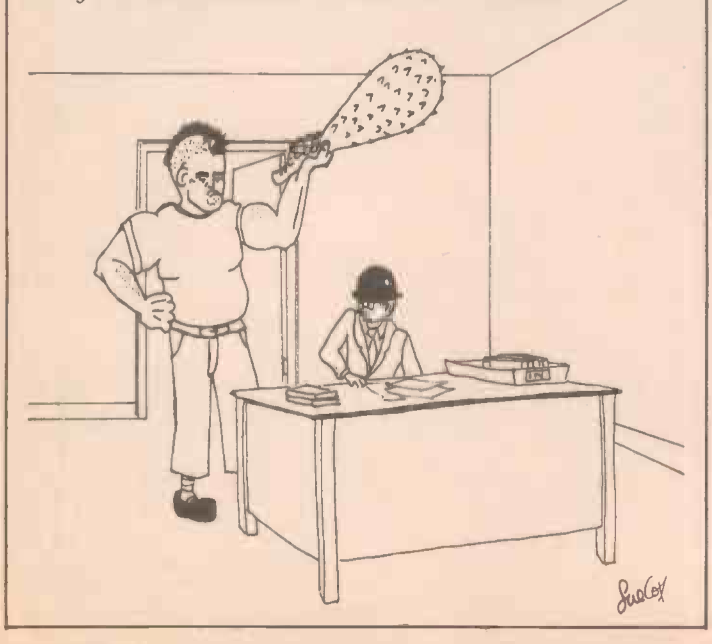
However, there are also signs that most teachers are now trying very hard indeed to redress the balance.

Outside schools, the image of computing being a man's career is greatly strengthened. The importance of the technology and the fascination of it mean that increasing numbers of men are desirous of competing for the money and status this field offers.

The programmes made by the BBC to promote computer literacy have shown men and computers in almost every context you can think of: men and computers, computers and men, more men and more computers, but *no women* — or have I missed something?

The history of computing is not without its heroines, but there seem to be fewer of them in proportion to men these days, and their existence is not on the whole promoted except by the Equal Opportunities Commission, and their work does not seem to extend much further than schools.

. . . JUST RESPONDING TO MARKET FORCES. . . .



MEN AND COMPUTERS: COMPUTERS AND MEN, MORE MEN AND MORE COMPUTERS. BUT NO WOMEN - OR HAVE I MISSED SOMETHING?. . . .

Are women losing out because Computing and Information Technology has become too much of a good thing, and is thus seen as the natural preserve of ment?

So what is to be done to improve matters? There is no easy answer to this, but it is important that we do not merely close our eyes and hope, or pretend that it is not really significant.

Girls represent an enormous source of talent. Women who have made it are valued throughout the computer industry for their contribution, and it is worth the effort to increase female education in this field to give girls a real chance to choose a career in computing.

Positive discrimination in favour of recruiting women on the part of some companies is arguably too little, and comes late in the day.

Because the bias is presently against them, girls will need teachers' time and patient encouragement when they start computing. The teaching profession can and must continue to be aware of how pupils are treated and to be sensitive to individual needs.

Girls must be taught that the technology has many uses, some of which will be important to them, and they should be encouraged to discuss their feelings and attitudes.

It is necessary that girls recognise the way in which they may be restricting their own choice in future careers by a passive acceptance of images of men at computer keyboards, or with soldering iron in hand.

Parents should consider that their daughters, given the slightest encouragement, have many of the same requirements as their sons, when it comes to personal micros.

It is a small start to the fundamental change which is needed. The **truth** is that the girls are there, but the picture of themselves that society has created in their heads must be redrawn.

Elizabeth Lee is Head of Computer Studies in a sixth form college, and a one-time Regional representative of M.U.S.E. (Micro Users in Secondary Education). She is currently Chairman of the Oxfordshire Computer Group and Branch Educational Liason Officer of the British Computer Society. The research to which she refers in her article was undertaken whilst she was studying for an M.Sc. from the Dept. of Education, Oxford University.

Profile

At a time when there is growing concern about the image of computing as a male preserve, Soft Options talks to two women who have been involved with computers since before Sir Clive Sinclair made his first million.

Norma Martin graduated with a B.Sc. in Mathematics and "came into computing really by accident." This was in 1966, a period when, for most of us, computers were either a myth or the subject of cartoons in Punch showing shockheaded professors confronting an entire roomful of machinery.

The company she joined specialised in business applications, and Norma found herself using her maths degree and the mainframe computer to work on accounts. It was less than enthralling, and she left fairly quickly.

She encountered no male chauvinism, merely boredom and a general dislike of the specific company set-up, but she had experienced computers for the first time.

She went to Culham, part of the Government Research establishment, and stayed for four years, using mainframe computers, before teaching maths in a secondary modern school for a year.

Then came children and no paid work for three and a half years, after which she felt the need to expand her horizons beyond the washing line and the nappy bucket.

As a result of a casual acquaintance with an employee of I.C.L., the nearest equivalent to the American I.B.M. Corporation that this country has, Norma approached them for possible part-time work, and was introduced to the company's homeworkers scheme.

Set up in 1970 as Contract Programming Services, this is a scheme designed to use people, mainly but not exclusively women, who prefer to work from home, but have valuable expertise which should not go to waste.

It embraces Software support programmers, teams engaged in development work and specific enhancements of existing programs, and technical writers. Although the work was originally given out on a contract basis, it proved so successful an idea that the majority of the people involved are now employed directly by I.C.L.

Norma now works, as she has done for the last seven years, as a part-time software support programmer, sorting out bugs in particular products.

This she does from home, with the company supplying the hardware, the necessary manuals and the problems.

From time to time she goes into the office of her section, which mitigates to some small extent the one problem of homeworking — isolation.

This is a factor which Margaret Curtis, too, has found difficult to come to terms with.

After a traditional education at a girl's grammar school, Margaret went to London to read Theoretical Physics, and met up with her first mainframe computer, the Atlas system.

After taking a Ph.D., she went to Oxford on a Research Fellowship. As part of her work she found herself commuting to the Rutherford Laboratory at Chilton two days a week, to the Atlas centre, where she began programming in earnest.

After a time, she realised that she was enjoying the programming and computer work more than she was enjoying the theoretical physics, and after two years, she made a few decisions.

In the first place she decided to marry, which meant an immediate restriction on her choice of location.

Since she had now to find a job, the Research fellowship being ended, this was a factor in her plans.

Her husband was employed at A.E.R.E. Harwell, which meant that they would live in Oxfordshire, and there were more opportunities for work with computers than in the field of Theoretical Physics.

Margaret also felt that, if she

Margaret Curtis at home.

wanted a family at any point, then working in computing afforded more scope for part-time work than research. There was also the fact that she liked computers!

Having written off to various suitable places, she found the most interesting job on offer was at the Rutherford Laboratory, working as a systems analyst on a project run by the Research Council, and in 1968 she joined the team.

The first hurdle she had to overcome was the discovery that there were many more computer languages than the one she was familiar with, which was ALGOL, but she found that she enjoyed the work as much as she had hoped to, and stayed until she decided to have a baby.

At this point, her employers asked her to consider working part-time from home, which she did, and when her son, Mark, started school last year, she was able to increase her workload.

She now runs part of the Systems programming department at the Rutherford, using equipment from the Laboratory at home and with her staff reporting to her often by phone.

Like Norma, she makes regular forays into the office, and says that she misses the stimulation of working constantly with other people, sharing the pleasure of problem solving and reaping the sympathy over recalcitrant bugs which foul up the best of systems.

Both Dr. Curtis and Mrs. Martin work at a sophisticated level within the industry, and represent the proportion of women who are likely to succeed in their chosen field, no matter what the problems or obstacles they encounter.

In that sense, they could be said to have little relevance to the sorts of statistics which prompted the Equal Opportunities Commission to launch its initiative to encourage girls to learn about information technology in January this year.

Those figures revealed that only one in four of pupils studying A-Level Computer Science were girls which indicates that, even if the subject is new, the fact of male-dominance in certain academic areas has not changed much since Margaret first studied Physics, and Norma Mathematics.

But if their qualifications are impressive, their opinions are realistic.

As Norma Martin says, "What do most girls want to do after leaving school? Get married and have a family."

"Then we should be showing them that working with computers is something you can do at home, that it is in their own interests to learn about micros."

"You can combine children and part-time computing more easily than many other types of work, and it doesn't have to be in a high-powered way."

Margaret Curtis agrees. The education of girls in computer technology is important because, "It's there and it's going to remain. Learning to use a computer is part of knowing how to manipulate one's environment."

"It's like driving a car — it becomes progressively more accepted that it is part of everyday life. Life becomes geared to the fact that everyone can drive, and so life becomes that much more difficult for non-drivers."

And, as Norma says, "It may not be something you want to do every day of your life, but it's jolly useful to know how."

It's also something that women can become very good at. A talent for lateral thinking is sometimes postulated as a feminine trait, and Margaret believes "women are potentially better organised" and both are qualities which "are very, very useful" when dealing with computers.

Of course discussion of male and female characteristics is entirely within the realm of speculation, but since the men-only image of micro-technology is based on just such speculation, it is at least valid to suggest that there can be prejudices in favour of women having an in-built flair for computing.

Margaret sees part of that flair being developed as a direct result of the sort of fragmentation of their daily lives many women experience.

When you have to function as Wife, Mother, Chief Cook and Bottlewasher, as well as Contributer to the Family's Finances, you cultivate an "ability to think of several things at once."

"You have to do a lot of things simultaneously — writing the shopping list, whilst washing up, whilst playing with your child, and so on."

Special qualifications are not needed for secretarial work.

Margaret Curtis at work. . .at home.

"Having that ability is very valuable, especially when you're working part-time."

For example, when your children are small, you may have an hour and a half to do some work, while a child has a morning sleep. Now you *know* you only have an hour and a half, and so you do something that will fit into that time."

That ability to organise and think logically stays with a woman after the pressure of having young children around has passed, and becomes a definite plus factor when using computers.

"My husband's attitude is to carry on with what he was doing, without considering whether the time he has is a useful length of time to pursue that particular activity. If you point it out to him, he can see the logic of organising, but it doesn't come naturally."

Norma agrees, but sees one way in which computing as a field for women may be rather more difficult than other spheres. The gap in their working lives which many experience, as a result of raising children, can cause problems.

"You need to keep in touch, you shouldn't have a big gap. The technology develops so fast, you need to be aware of the changes. Trying to struggle with a new system is anything but easy, especially when you're working from home. If you're in an office, it's not so bad, you can ask someone, but when you're at home and the wretched thing is linked up to the telephone, you can't even ring up for help!"

On the positive side is the fact that computing has so many different aspects, that there are many more jobs that can be done from home than would appear from the propaganda.

Although the work highlighted in the Equal Opportunities package and the work done by Norma and Margaret comes across as requiring heavy qualifications and expertise, this is not a prerequisite of the computing world generally.

Word-processing and data-storage functions open up opportunities for routine office work to be performed from home by girls trained as typists, filing clerks, record clerks and even secretaries.

Telephone modems have made possible the fast and efficient transfer of up-dated files and freshly typed letters, and the hardware involved is becoming cheaper all the time.

It is therefore a nonsense, in the view of both Norma Martin and Margaret Curtis, for girls to be deterred from learning how to exploit information technology because they are intellectually intimidated.

There are many ways in which computers can be useful to women in the home, and such uses do not include the keeping of cookery records and the ordering of groceries, so prominent a feature of the ad-men's sales pitch.

What of the future? Since one of the major problems of the micro-computer is that the software available is dramatically inferior to the hardware development, is there hope that the flexibility and manipulation involved in creating mainframe applications will ever be available to the home-user? Norma Martin thinks there is.

"People see a commercial program and accept that it does only what they can see. They don't say, ah, but can I make it do this or that instead?"

"But, with mainframe computers already on the way out and being replaced in many instances with micros, knowledge will spread. The work done in Universities and Science institutions will have the effect of gradually building up a core of knowledge from which, eventually, home-users will benefit."

Margaret is less optimistic. "The problem at the moment is that many people who use a computer don't realise the potential that is there," and so perhaps will never go looking for more information.

She feels that so far as flexible micro-systems are concerned, "It's a matter of the demand being there, and somebody perceiving that it is worth their while in money terms to meet it."

"It hasn't happened yet."

Computer literacy starts with hands-on experience.

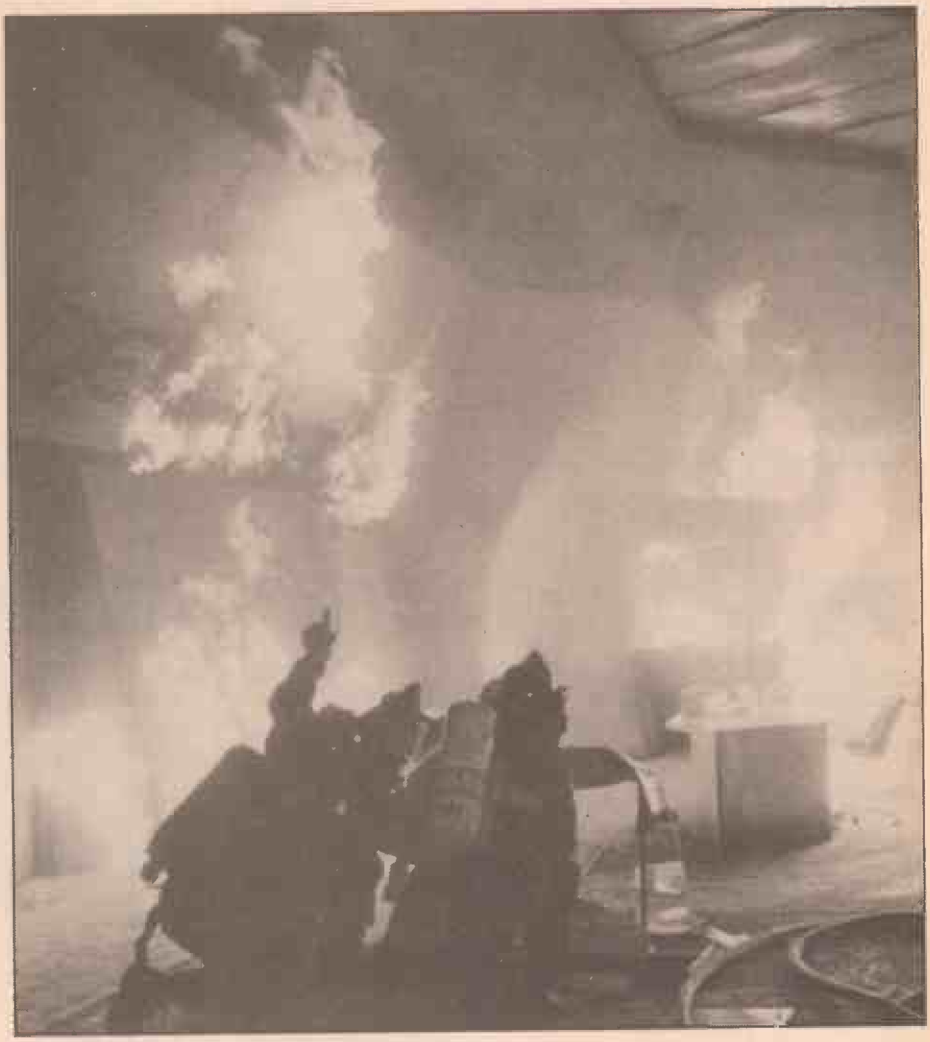
SPREADING ALARMS

Alarm circuits are more popular than ever. HE looks at some of the alternative circuits, including some neglected varieties.

R. A. Penfold

ONE of the most common uses of electronics these days is in alarm circuits of one kind or another, including such things as home security systems and various types of alarms for cars and other vehicles. Despite the fact that there is no shortage of published alarm circuits, some quite interesting and useful types of alarm seem to receive little or no attention.

This article features some alarm designs which use techniques that put them in this neglected but not unique catagory, and practical circuits including type numbers and values are provided. Anyone wishing to try out any of the circuits in practice should therefore be able to do so with very little difficulty.



"If you read your Hobby Electronics more carefully, this sort of thing wouldn't happen." "That's all very well, then we'd be out of a job wouldn't we?"

Mains Hum Sensor

The first circuit uses pick up of "mains hum" to detect when someone is touching a metal object. The sensor could be the door of a drawer containing valuables, or the doorhandle of a room. Although the circuit described here is for a stand-alone unit, it would not be difficult to modify it for inclusion in a large alarm system. The block diagram of **Figure 1** helps to explain the way in which the unit functions.

In any building where mains wiring is present, (which includes practically all UK dwellings) "mains hum" is picked up by any object which is made of a material that conducts reasonably well. This includes the human body which tends to pick up quite a strong signal due to its large size .

The metal sensor used at the input of the circuit must be relatively small, and must be connected to the rest of the unit either via a quite short cable, no more than 300 to 500mm or a screened lead must be used.

The sensor feeds into a gain control, and this is a simple volume control type variable attenuator which is adjusted so that the normal background signal from the sensor is not quite adequate to activate the alarm. When someone touches the sensor the comparitively large signal picked up by their body is coupled into

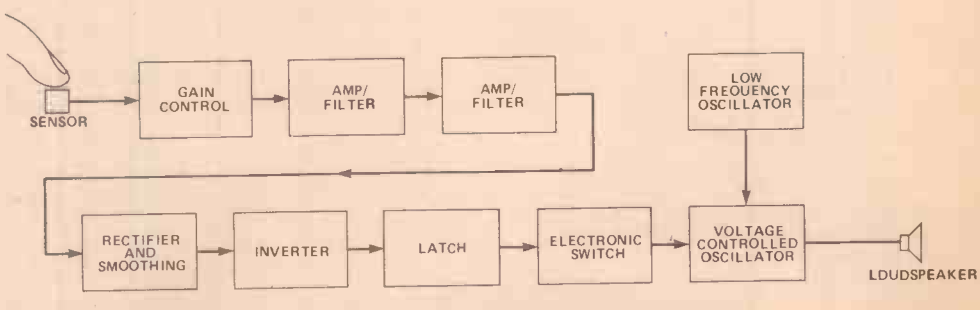


Figure 1. The block diagram of a Mains Hum Sensor alarm.

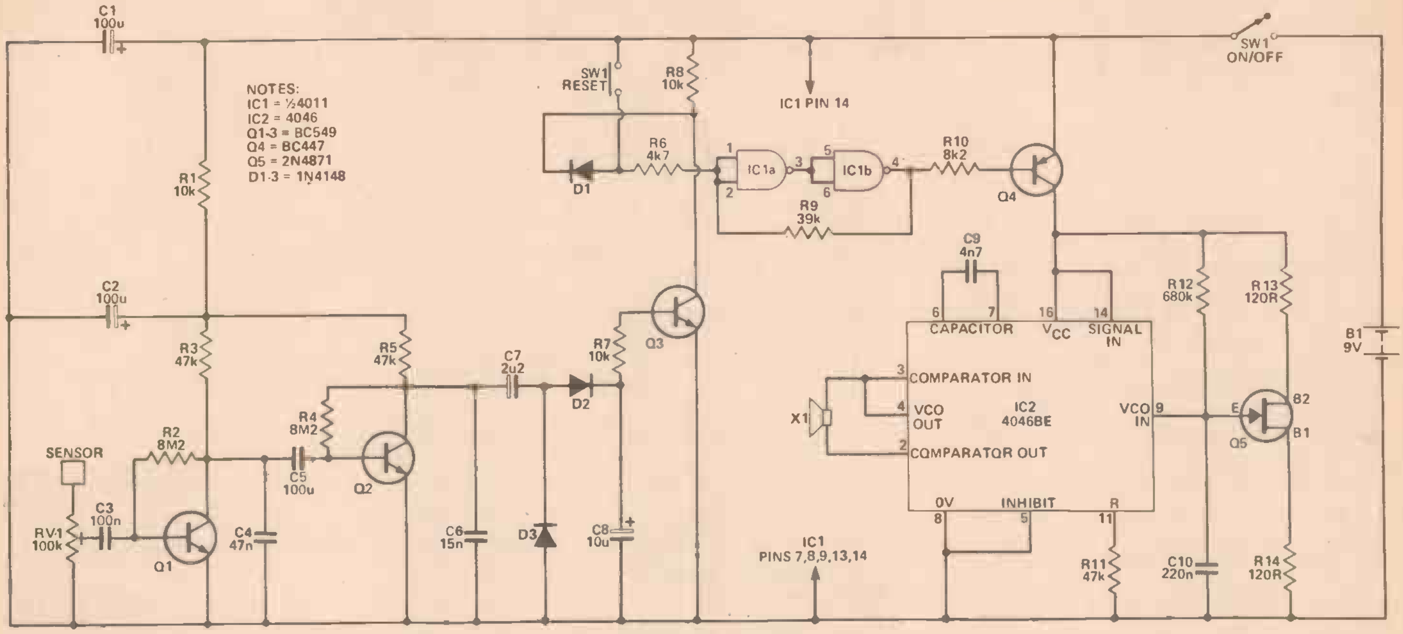


Figure 2. The circuit of the Mains Hum Sensor alarm, which detects mains hum "received" by a human body, which acts as an aerial for the signals given off by house wiring. The unit amplifies the signal and triggers the alarm.

the sensor, and gives a sufficiently strong input signal to activate the unit.

Amplification

Two stages of amplification follow the sensor, and a fairly high level of gain is needed, as the input signal level when the unit is activated, will vary considerably depending on the circumstances under which the unit is used. The signal level will not invariably be high. Each amplifier incorporates a capacitor which gives a lowpass filter action. A good high frequency response is not needed as the input signal is the fundamental mains frequency of 50Hz plus harmonics up to a few hundred Hertz.

Attenuating higher frequencies reduces the risk of spurious triggering due to pick up of radio frequency signals.

Rectifier — Latch

The next stage rectifies and smoothes the amplified signal to give a positive DC voltage. Under stand-by conditions this signal is very low, and due to the forward voltage drop across the diodes in the rectifier circuit, may well be non-existant. However, when the unit is activated a much stronger output signal is produced, and the DC output voltage rises to a few volts.

This signal is then used to drive an inverter stage which also gives some amplification so that a lower impedance output signal of greater amplitude is produced. This signal drives the input of a latch circuit, which in turn activates an electronic switch. The latter connects power to an audio alarm generator circuit which utilizes a voltage controlled oscillator (VCO) to drive a loudspeaker, and a low frequency oscillator to frequency modulate the VCO.

The low frequency oscillator produces a sawtooth output signal, and this gives modulation of the type where the pitch of the output sweeps upwards until the peak level is reached, whereupon it jumps back to minimum pitch, starts to sweep upwards again, and so on. This gives a very effective alarm signal.

Of course, with the latch included in the unit the alarm continues to sound even when the unit is no longer activated via the sensor.

Hum Circuit

Figure 2 shows the full circuit diagram of the Mains Hum Sensor Alarm.

The sensor feeds into preset gain control RV1, and the signal is then processed by two common emitter amplifiers which are built around Q1 and Q2. Filtering is done by capacitors C4 and C6.

Coupling capacitors C3 and C5 may seem to be rather low in value considering the low frequencies involved in this application, but as Q1 and Q2 are operated at very low collector currents they have higher input impedances than normal common emitter amplifiers, and the coupling capacitors are perfectly adequate in practice.

The output of Q2 is rectified and smoothed by D2, D3, and C8, and if a suitably large voltage is generated it biases Q3 into conduction so that its collector goes low.

The latch circuit uses two NAND gates, IC1a and IC1b of a CMOS 4011BE quad 2-input NAND device, but the two gates are connected to act as simple inverters, and are connected in series. The positive feedback to give the latching action is provided by R9, and D1 ensures that Q3 can pull the input of the latch low, but cannot force it to the high state. However, this can be achieved using reset switch SW1 which is connected to the other side of D1.

When the output of the latch is triggered to the low state it switches on Q4 which then supplies power to the alarm generator circuit. This is based on IC2 which is a CMOS 4046BE phase locked loop, but in this application only the VCO section and one phase comparator is utilized. In fact the phase comparator is only used as an inverter stage which gives a two-phase output signal.

This output signal drives X1 which is a ceramic resonator rather than an ordinary moving coil loudpeaker. This gives quite a piercing output from the low drive current available from IC2, and is probably a lot louder than you would expect. If preferred though, the output from pin two of IC2 could be amplified and fed to a normal loudspeaker.

The sawtooth modulation signal is provided by a conventional unijunction relaxation oscillator based on Q5.

Adjustment

Setting up the circuit is quite straightforward. Start with RV1 adjusted for minimum sensitivity, and then slowly advance it until the alarm is activated. Then back it off slightly from this setting, and reset the alarm. If the alarm then operates again, back RV1 off a little further and then reset the unit once more using SW1.

Touching the sensor should then activate the unit. If RV1 is advanced all the way to full sensitivity without the unit triggering, then simply leave it set for maximum sensitivity.

Uses

In most cases there should be no difficulty in successfully installing the alarm, but it may sometimes be found that if the unit is, say connected to a door handle there is a very large amount of background hum which prevents the unit from functioning properly. This is presumably where there is a high moisture content in the door (or whatever) so that it acts as a large pick-up, and the unit can not be made to function properly.

Something like a metal door would also act as a very efficient pick-up and prevent the unit from operating properly. In most circumstances though, the unit was found to operate reliably with no installation difficulties.

The stand-by current consumption of the circuit is quite low at about 150 microamps, and battery operation of the circuit is perfectly feasable.

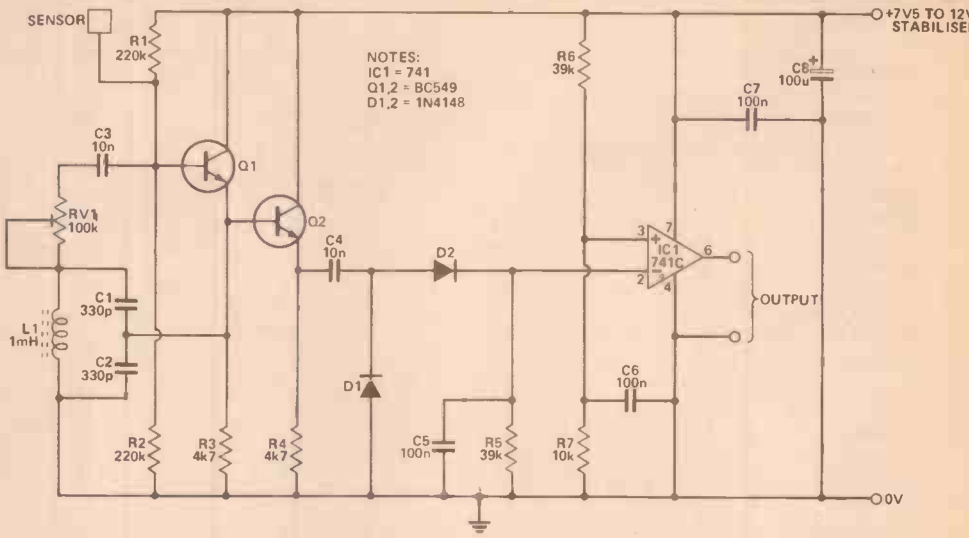


Figure 3. The circuit of a promimity detector, which undergoes a change of capacitiance when a body comes near to it.

Proximity Detector

"Proximity detector" is a term which could accurately be applied to any circuit which detects the presence of someone in its vicinity. However, this term is generally accepted as refering to a type of circuit which detects the presence of someone within, typically 300 to 500mm of the sensor using the "hand capacity" effect, or the "body capacity" as it would more aptly be called in this application.

This effect is where the earth, together with a sensor, a metal plate or wire for example acts as a capacitor. When standing on the ground, or even on the floor of a building ones body is effectively earthed, and this gives an increase in capacitance when someone goes close to the sensor.

This is an effect which can be troublesome with radio circuits as it can result in tuning shifts as the operator's hand is moved towards or away from the tuning control. In this application it can be used to good effect with the change in capacitance triggering the alarm circuit.

The Circuit

Circuits of this type can be quite simple, and **Figure 3** shows a conventional proximity detector based on an RF oscillator. The coil, L1 in parallel with the series capacitance of C1 and C2 form the tuned circuit which sets the frequency of operation at a few hundred kilohertz (the precise frequency is unimportant).

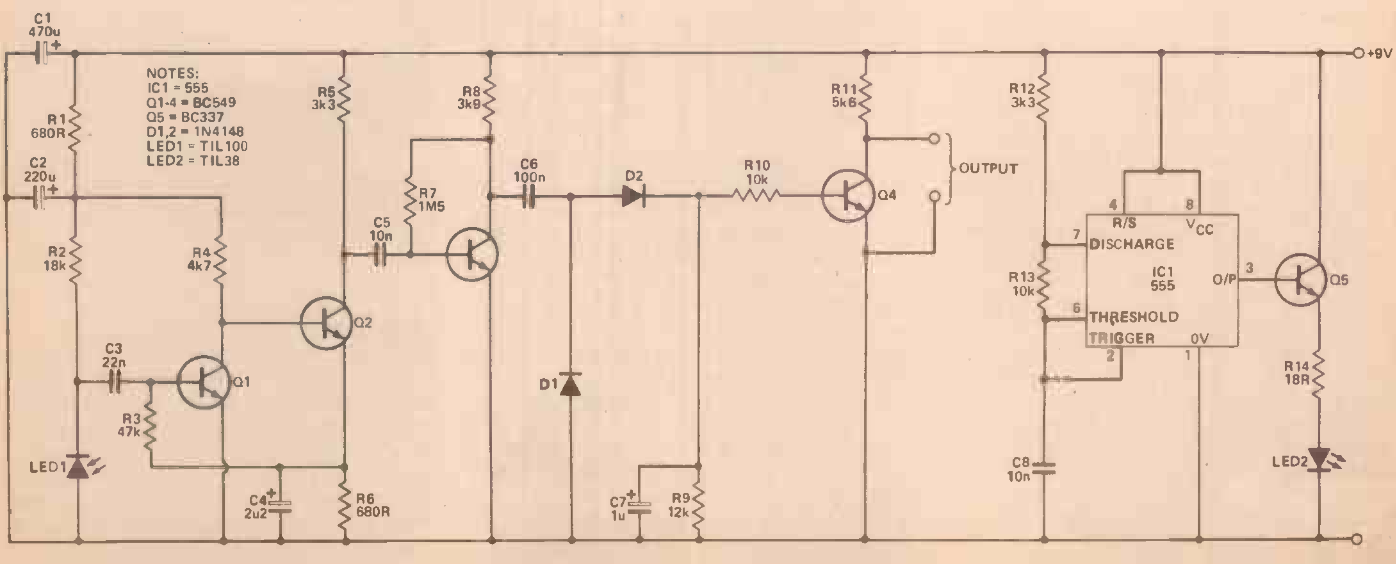
Transistor, Q1 is used as an emitter follower with the tuned circuit providing positive feedback and a voltage step-up to provide sufficient feedback to maintain oscillation. Preset, RV1 is used to control the amount of feedback, and it is adjusted to give only just sufficient feedback to maintain oscillation.

The second transistor, Q2 is an emitter follower buffer stage which prevents the rectifier and smoothing circuit, D1, D2, C5, and R5 from significantly loading the output of the oscillator. The voltage fed to the inverting input of IC1 depends on the amplitude of the oscillations generated by Q1, and in practice this voltage is slightly higher than the reference voltage generated by R6 plus R7 and fed to the non-inverting input of IC1.

The IC is an operational amplifier, but it is used here as a voltage comparator, and under quiescent conditions its output goes low.

If someone goes close to the sensor, this gives an increased capacitance from the base of Q1 to earth. In most proximity detectors the sensor connects to the non-earthed

Figure 4. The circuit of an infra red detector, a circuit of a type which transmits its own signal and responds to any disturbances in the transmitted signal.



end of the tuned circuit, and the increased capacitance across this circuit damps it sufficiently to cause oscillation to cease.

A slightly different arrangement is used in this circuit, and the increased capacitance does have some damping effect on the tuned circuit via RV1. There is also a lowpass filter action across RV1 which causes increased losses and blocks oscillation. This arrangement seems to give much better sensitivity than connecting the sensor direct to L1, which actually gives very poor sensitivity indeed.

The result of Q1 failing to oscillate, or even of a significant reduction in the amplitude of the oscillations, is to cause the voltage fed to pin two of IC1 to drop below the voltage fed to pin three. The output ot the IC then goes high, and this signal can be used to operate an alarm generator or some other circuit.

Ideally the sensor should consist of something like a sheet of metal about 1m by 300mm. Quite good results can be obtained using nothing more than a piece of connecting wire about half a metre to one metre long. As the supply needs to be well stabilised and the negative supply rail must be earthed if the unit is to function properly, it is probably best to use a mains power supply with the mains earth being used to earth the negative supply.

With RV1 set at maximum resistance the output of IC1 should go high. Adjust RV1 slowly for reduced resistance until the output of IC1 triggers to the high state. The unit should then give good results, but due to the nature of this device it might be necessary to use trial and error to peak RV1 for optimum results.

Infra Red Detector

The proximity detector just described is a passive type, and an alternative approach is to transmit a signal of some kind and then detect a change in the signal caused by an object in its path.

This circuit Figure 4 is for a detector of this type, and it provides a similar operating range to the circuit described previously. However, it can be used in an alternative set-up where much greater range is provided.

The unit transmits an infra red beam, and if an object passes into this beam it reflects some of the infra red back towards the unit. The circuit operates by detecting this reflected infra red radiation.

The Circuit

The circuit really breaks down into two sections which are independent apart from a common power source. The right hand section is the more simple of the two, and this is the transmitter which is based on IC1. This is the familiar 555 timer device used in the standard astable (oscillator) configuration. This operates at a frequency of around 5kHz, and the squarewave output drives the infra red LED, LED2 by way of emitter follower buffer stage Q5 and current limiting resistor R14. The LED current is about 100 milliamps, but as LED2 is switched off for about 50 per cent of the time the average LED current is in the region of 50 milliamps.

The point of using a pulsed output is that this gives a signal which is more readily detected than a continuous output which could easily be swamped by background infra red radiation.

The receiver is basically a very high gain amplifier which boosts the signal from the infra red detector diode LED1. The pulses of reflected infra red give a pulsed output signal from LED1 but the amplitude of this signal is likely to be very low at typically well under a millivolt,

Capacitor, C3 couples this signal to a high gain two stage common emitter amplifier which uses Q1 and Q2. The signal is then fed to a third high gain common emitter amplifier based on Q3. Coupling capacitors C3 and C5 have been given quite low values so that they do not provide an efficient coupling at 100Hz, and this highpass filtering reduces the risk of infra red signals from mains powered lighting from blocking operation of the circuit.

The output of Q3 is rectified and smoothed by D1, D2, C7, and R9. In the absence of a reflected signal the positive bias produced across C7 will be inadequate to switch on Q4, and the output of the unit will be high. If a suitably strong reflected signal is present the bias voltage will be around one volt or more, Q4 will be biased into conduction, and the output will go low.

Diode LED2 has a built-in lens which makes it quite directional, and results in the unit being sensitive over a quite small area, which could possibly be of advantage in some applications. LED1 does not have a built-in lens and alignment of this with LED2 is therefore not critical. The two diodes are mounted anything from a few millimetres to about 150mm apart, and if necessary LED2 should be shielded against the direct ouput of LED2.

The unit can be used as a broken beam type alarm, with the transmitter and receiver built as separate units and situated up to about 9m apart. With this system the output of LED2 is aimed at the sensitive surface of LED1, and as LED1 is normally subjected to the signal from LED2 the output of the receiver is normally low. If the beam is broken and the signal ceases the output of the receiver switches to the high state.

"You know why we're doing overtime here tonight, don't you? Someone nipped in the back way and nicked all the fire extinguishers yesterday. No burglar alarms fitted, see. . ."

Ultrasonic Beam

Most alarms which use ultrasonic sound seem to use the Doppler Shift method of detection. As an alarm of this type was featured in the October 1983 issue of Hobby Electronics we will not consider this type of alarm here. Instead, an alternative type of ultrasonic alarm, the broken beam type, will be described. This is the ultrasonic equivalent of the infra red broken beam alarm outlined above.

The idea of a narrow beam of sound may seem a little unrealistic, but sound at frequencies in the ultrasonic range does in fact tend to naturally

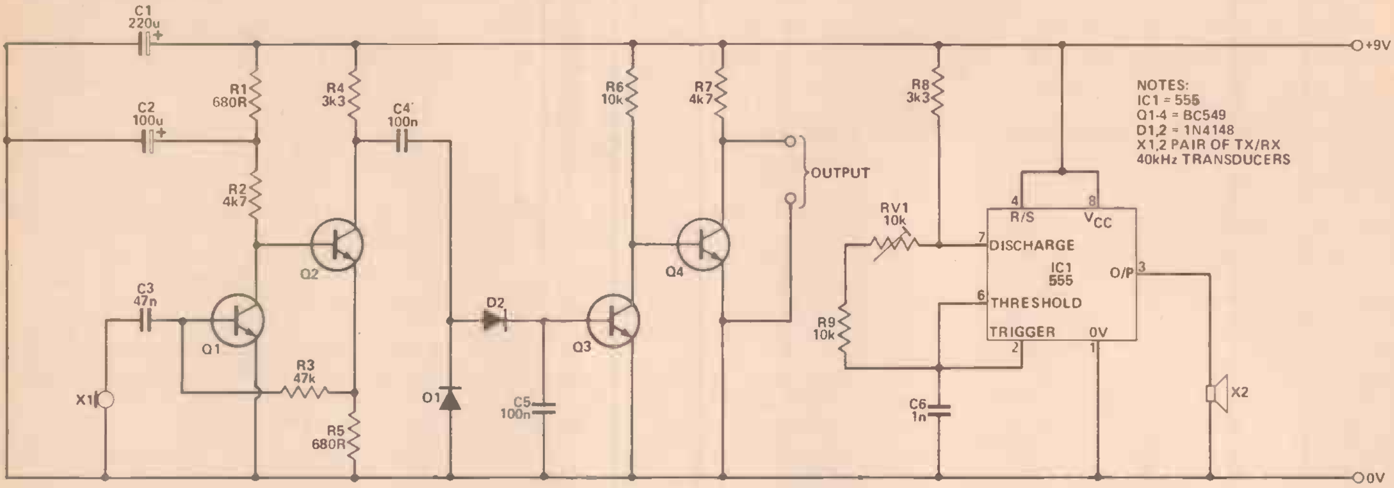


Figure 5. The circuit of an ultrasonic alarm, which transmits an inaudible tone. The use of transducers means that the output frequency of the unit must be carefully adjusted to get the best results from the circuit.

have the necessary highly directional properties, and there is no difficulty in producing an alarm of this type using ordinary ultrasonic transducers.

Figure 5 shows the circuit diagram of the ultrasonic broken beam alarm, and this is another type of alarm which consists of two separate sections — the transmitter and receiver.

Taking the transmitter first, this is little more than a 555 astable circuit which has an operating frequency of about 40kHz. With the infra red alarm the precise operating frequency is unimportant, but this is not the case with an ultrasonic type.

X2 is an ultrasonic transducer (which is a form of Piezo Electric device) and it only operates efficiently over a narrow band of frequencies. The preset, RV1 must therefore be adjusted to bring the output frequency to one which gives good results from X2 and X1.

Transducers

The receiver has a two stage common emitter amplifier based on Q1 and Q2 to amplify the signal provided by X1. The amplifier is a fairly low gain type, and in this application high sensitivity is not normally required, and can actually prevent the system from operating properly. This occurs when the unit is used indoors, and what happens is that signals reflected from walls etc provide a path between the transmitting and receiving transducers even if there is an object between the two. This circuit gives good results when used indoors with the transducers up to about seven metres apart. The range can be boosted somewhat by adding a 1u decoupling capacitor across R5, or for a substantially greater range the three stage amplifier of the infra red circuit could be used in place of this two stage circuit. This would give a maximum range of something approaching 15m, although the exact range obtained is heavily dependent on the efficiency of the particular transducers used in the unit.

The output of the amplifier is rectified and smoothed by D1, D2, and C5, and if the beam is not broken the resultant positive DC signal is strong enough to switch on Q3 and pull its collector low.

Transistor Q4 is therefore cut off and its collector, and the output of the unit are high. When the beam is broken the DC bias quickly subsides so that Q3 switches off, Q4 switches on, and the output goes low.

Ideally an AC millivoltmeter is required when adjusting RV1. This can be used to measure the output signal level from the receiveing transducer with the transmitter switched on and its output directed towards X2. The preset is then simply adjusted for maximum reading on the millivoltmeter.

In the absence of suitable test equipment, it is really just a matter of using trial and error to find a setting for RV1 that gives adequate range with good reliability.

Opto Smoke Alarm

The most common forms of fire detector for the home constructor are the types which use a sophisticated semiconductor detector to detect smoke, or practically any combustible gas or vapour, and circuits which detect abnormally high temperatures. A less well known but effective type of smoke detector uses a simple optodetector circuit, and it is a detector of this type which will be described here.

Block Diagram

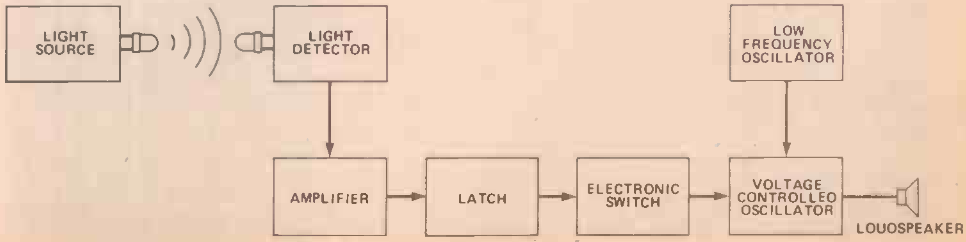
There are two basic types of opto smoke detector, but as far as the circuit is concerned they are the same. The difference is that one type is a localised smoke detector, whereas the other can detect smoke over a large area.

Figure 6 shows the block diagram for the opto smoke detector, and this helps to explain the way in which both forms of alarm operate.

The light source has its output directed towards a light detector circuit, and the light source can be a LED in close proximity to the photocell if the unit is to act as a localised smoke detector. For a type which must monitor a large area the light source would need to be much more powerful, and at the very least would need to be one of the higher wattage torch bulbs.

A lens or reflector system is then needed to focus the light output of the torch bulb into a narrow beam of light which is then directed towards the photocell (which is mounted on the opposite side of the room to the light source). Ideally a second lens or reflector should be used to concentrate the beam of light onto the photocell. This is not just to give a

Figure 6. The block diagram of a opto smoke detector, which works by detecting the changes in the light reaching a photocell, caused by smoke or even turbulent air.



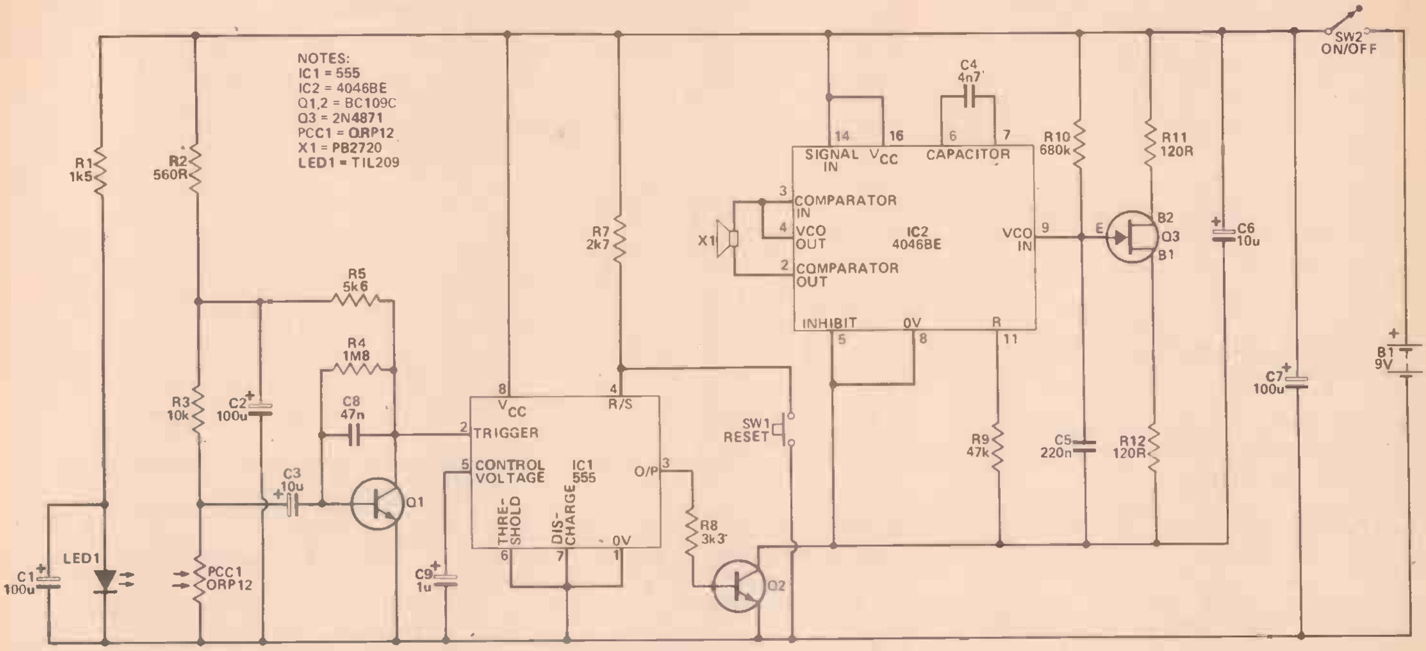


Figure 7. **The full circuit diagram for the opto smoke alarm.**

stronger light level on the photocell, but is also to reduce the amount of ambient light received by the photocell.

A large amount of ambient light reaching the photocell would be unacceptable as it would almost certainly result in frequent spurious triggering of the unit. A couple of plano-convex lenses (one at each end of the system) are all that is required, and lenses having a fairly short focal distance are the most convenient in use.

Ambient light can also be a problem if the unit is utilized as a localised sensor, and it is generally necessary to use a tube or other housing to shield the photocell from ambient light, but without blocking the output from the light source or preventing smoke from entering and getting between the light source and the photocell.

Under normal conditions the light level received by the photocell will be constant, but if smoke or even hot, turbulent air comes between the light source and the photocell, the received light level will fluctuate at least slightly. The low frequency output signal from the photocell circuit is amplified and then used to drive a large circuit. This in turn operates an electronic switch and a frequency modulated alarm generator circuit.

The Circuit

Figure 7 shows the full circuit diagram of the Opto Smoke Alarm. Here it is assumed that a light emitting diode LED1 is used to provide the light source, but this can of course be replaced with a different light source if necessary. If LED1 is used as the light source it must be positioned about 20 to 25mm away from the photocell, PCC1, and it must be accurately aligned so that PCC1 receives the maximum possible light level.

The photocell is an ORP12 cadmium sulphide photoresistor, and together with R3/R2 it forms a potential divider circuit so that a varying output voltage is produced if the light level received by PCC1 (and hence its resistance) should vary.

Transistor Q1 is used as a high gain common emitter amplifier which boosts the signal level, and C8 gives this amplifier a very restricted bandwidth. This is quite acceptable since the photocell circuit produces only low output frequencies when activated, and it has the advantage of reducing the risk of spurious triggering caused by sources of electrical interference.

Integrated circuit, IC1 is a 555 timer device, but it is used here as the latch.

It is effectively in the monostable mode, but the timing resistance is absent. Thus, once triggered the output goes high indefinitely and the required latching action is obtained. To trigger IC1, pin two must be taken below one third of the supply voltage. This pin is fed from the collector of Q1, and the latter is normally biased so that its collector is at a higher voltage than one third supply voltage threshold level.

However, when the unit is activated the collector voltage of Q1 fluctuates, and on the first negative half cycle of adequate amplitude IC1 is triggered. Switching transistor Q2 is then switched on, connecting power through to the alarm generator circuit.IC1 can be reset using SW1.

Dryness Detector

Most readers are probably familiar with rain alarm and similar circuits which are activated when a simple sensor detects the presence of water or some other conductive fluid.

The sensor is no more than two pieces of metal placed close together and insulated from one another. This gives a very high resistance between the two metal electrodes under dry conditions, but if water bridges the gap between the electrodes it causes a substantial drop in the resistance, to typically only a few kilohms or less.

Pure water is actually quite a good insulator, but tap water etc contains impurities which result in the water becoming a reasonable good conductor of electricity.

This type of alarm is very simple and works well in practice, but it does not function properly in applications where the sensor is normally in water, or other fluid, and the alarm must operate when an absence of the fluid is detected (automatic plant watering systems for example). What goes wrong in this type of application is that the DC signal across the sensor tends to produce an electolytic action which results in such things as corrosion or erosion of the electrodes, and could even result in damage to other metal objects in contact with the fluid. These problems can be avoided by using an AC signal across the sensor, and there is an integrated circuit which is specifically designed for this application.

The device in question is the LM1830, and **Figure 8** is the block diagram for this device. **Figure 9** shows the circuit of a dryness alarm based on the LM1830.

The Circuit

An oscillator is used to generate a pulsing DC signal, and the only discrete component this requires is timing capacitor C3.

With the specified value an operating frequency of about 6kHz is obtained, but the precise operating frequency is not important. The output ▶

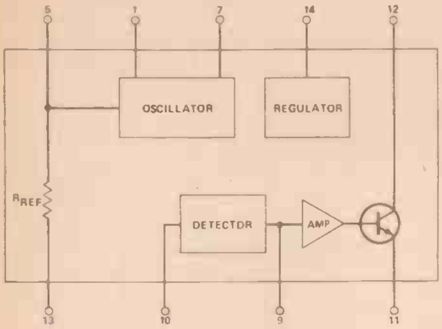


Figure 8. The block diagram for a dryness detector.

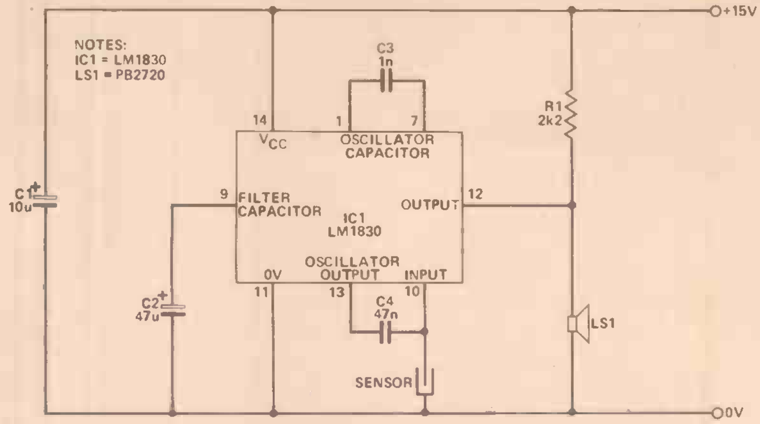


Figure 9. The circuit of a dryness alarm based on the special LM1830 chip.

of the oscillator is taken via an internal reference resistor, and is then coupled to the sensor via C4. Although the oscillator generates a pulsing DC signal, the output from C4 is a true AC signal.

The signal across the sensor is fed to a detector circuit, and if the sensor has a low impedance the voltage drop through the reference resistor is large, and there is little signal fed to the detector. The switching transistor at the output of the unit therefore remains switched off. On the other hand, if there is no liquid bridging the sensor's electrodes it has a very high impedance, and virtually the full output of the oscillator is fed to the detector. This results in the output transistor being pulsed on and off at the operating frequency of the oscillator.

Resistor R1 is the collector load for the output transistor, and X1 is a ceramic resonator which produces an audio alarm signal from the output pulses.

Alternatively, C2 can be included and X1 can be omitted. Capacitor, C2 is a filter capacitor which smoothes the pulses from the detector circuit so that the output transistor switches on continuously when the unit is activated. The maximum sink current for the output transistor is just 20 milliamps, and if a relay or other high current device is to be driven from the circuit a discrete output stage will be required.

The circuit requires a minimum supply potential of eight volts (24 volts maximum), and the supply current is typically 5.5 to 10 milliamps. The sensor must provide a resistance of significantly less than 13k when wet, and reasonably in excess of this figure when dry. This is suitable for use with most sensors, but if necessary the sensitivity of the circuit can be altered by using a discrete resistor in place of the internal reference component. This is achieved by disconnecting C4 from pin 13 of IC1 and instead connecting it to pin five via the discrete resistor.

The latter should have a value in the range 1k to 100k.

FORWARD BIAS

COLLECTED BOOBS

Continuing excerpts from the Hobby Electronics Errata Box

Guitar Tremelo *(HE April '81)*

In **Figure 2**, two R11s are shown on the component layout. The lower component (position 019 to L19) is correct. The upper component (position D31 to C31) should be labelled R12. On the track diagram, the connection at 029 (for the C10 negative lead) has been omitted.

Electronic Organ *(HE May and August '81)*

In **Figure 2**, C9 is shown as 220n, but should be 220u as in the **Parts List**. C12 can be 22n, C13 can be 10n. Neither value is critical. C32 should be reversed, with the +ve to the op-amp input.

In **Figure 3**, C28, C32 and C34 should each be reversed, with the +ve to the right.

The errata printed in HE August '81, page 44, were incorrect. Correct errata appear in **Your Letters**, HE March '82.

Quick Project — Metronome *(HE July '81)*

On page 55, a track break is required at G21, otherwise the base and collector of Q3 are shorted.

Ultrasound Alarm *(HE July ' 81)*

If the 4093 gates don't trigger, wire a potential divider of 4k7 and 22k from V+ to 0V, disconnect the cathode (band end) of D3 and connect it to the middle of the divider. Reduction of R17 to 22k may also be required.

The transmitting frequency is 40kHz.

RPM Meter *(HE August '81)*

On page 62, the PCB **foil pattern** is shown from the components side instead of the tracks side; a transfer taken from it will need to be reversed.

Reaction Tester Game *(HE September '81)*

In **Figure 1** on page 58, IC1 is not a 4017, but a 555, and IC2 is not a 555, but a 4017.

Diana Metal Detector *(HE September '81)*

On pages 11 and 12, R11 should be given the value 2k2. R12 is missing from the **Parts List**, but is correct in the circuit.

Low Power Pilot Light *(HE September '81)*

In **Figures 1** and **2**, the connections to LED1 are reversed: C should be labelled A, and vice versa. In **Figure 2**, C1 should go to point D8, no C8.

If Q2 réfuses to switch off, reduce the value of R3 by stages until the required result is obtained.

SW Radio *(HE September '81)*

In **Figure 2**, track cuts should be made at F17 and G17, and a link added between F12 and G12.

On the diode D1, the anode should go to E7 and the cathode to F7.

Doorphone *(HE October '81)*

In the **Circuit Diagram**, interchange the position of R6 and LED1.

In **Figure 2**, C5 has been omitted. It should be inserted between B10 (+ve) and B12. A wire should be connected between D1 and the top right hand corner of SW1 in **Figure 3**.

Baby Alarm *(HE October '81)*

The six track breaks referred to in the text are erroneous, and should be A22, B22, C22 and H22, I22, J22. The mounting holes should then come beyond the breaks at the far end of the board.

Telephone Bell Repeater *(HE October '81)*

In the **Parts LIst**, the 4001 referred to is a quad NOR, not a quad NAND. However, either type will work in the circuit.

The IC symbols i **Figure 1** should of course, figure NAND gates and not AND gates as they do. R1 should be 47R. There should be no link between C1 and R1.

In **Figure 2**, R9 goes between L18 and S18, and C1 between V3 and T3. The socket controlling LS1 connects across V2 and W2 (chassis or earth tag).

All the socket pins for IC1 should be soldered — some solder blobs are missing on the diagram.

Metronome *(HE November '81)*

On **page 61**, we have enough errata to keep the technical department going for a week or two. Fortunately, they are well documented.

RV1 is a pot with a switch — but the battery leads should be swapped over. The leads are also wrong to **Q1**: e and c should be swapped over. There should be track breaks at U27, T27, S27 and R27. Two more lead swaps at J2 and L2. C3 should be connected to M33 and I33, and C1 should be connected to R24 and S24 (+ve). The link between T29 and V29 should not be there. R1 should be labelled R2 and mounted between V33 and T33, while R2 should be labelled R1. The wiper of RV1 should go to S36.

Simple Stylus Organ *(HE November '81)*

In **Figure 1**, RV3 should have an arrow printed across it to indicate a variable resistor.

In **Figure 2**, a link is needed between D23 and A23. The link from I15 to F15 should not connect to H15 as well. R5, which is not labelled on the diagram, but stands next to R1, should go to B14 and not to A14 as shown. The lead from RV2 wiper should go to F4 and not to F11, and should not be linked on the circuit diagram to pin 6 of IC1, but RV2 should go to pin 3 of IC1. The underside should show connection points at J14, J16.

Direct Reading Frequency Meter *(HE November '81 – Circuit Supplement)*

On the **PCB Overlay**, positions of R7 and R2 should be swapped, as should R7 and ZD1, and C5 and C4. The original ZD1 should be relabelled R17, and the original R6 to R16.

Pedalboard Organ *(HE December '81)*

In **Figure 2**, IC2 is shown the wrong way round: pin 1 should be nearest to C1.

Drum Synthesiser *(HE December '81)*

There should be a 100u 16V electro capacitor across the supply rails to improve the signal to noise ratio.

Intruder Confuser *(HE January '81)*

In **Figure 1**, IC1 is inverted — pin 1 should be in line with C1.

On the **Overlay**, a track cut is missing between the ends of C1.

HE

From Cine To Telly

Andrew Armstrong

. . . is not as simple as it looks. Moving pictures have a habit of moving at the wrong moment, or at the wrong speed. Our author explains how movies are captured and converted into video, by the technique called "telecine".

Picture courtesy of Marconi Communication Systems

AUTHOR'S HEALTH WARNING: Certain parts of this article may tend to damage your appreciation of television movies, as you begin to notice all the irritating little imperfections sustained in the transfer from film to video. Beware! If you develop the habit of pointing these out to your friends and family, *you* may sustain some imperfections, as well.

Such is the price of wisdom, so pull your self together and read on.

Do you ever wonder how the celluloid feature film which you saw at the cinema last year can now be shown on television (apart, that is, from paying the makers of the film enormous sums of money?) Have you ever considered how it is that you can hire pre-recorded videocassettes of movies which were originally made on film, rather than having to hire a film print and a projector?

Have you noticed how, on some television feature films, the opening credits perform a little circular dance on the screen, which is not a normal characteristic of opening credits?

The key to these mysteries which most people take more or less for granted is the technique known as "telecine". All, I hope, will now be revealed about this fascinating achievement of modern technology, which behind the scenes has been known to reduce strong men to grivelling wrecks by its complications.

Where commercial movies and public television are concerned, telecine

Our lead picture shows a Marconi Line Array Telecine machine in use. This machine uses a Charge Coupled Device (CCD) array principle, and incorporates microprocessor control for such things as pre-programming control settings to compensate for different scenes, and fault diagnostics. The screen on the right shows the computer readout, while the TV screen shows the video conversion as it happens.

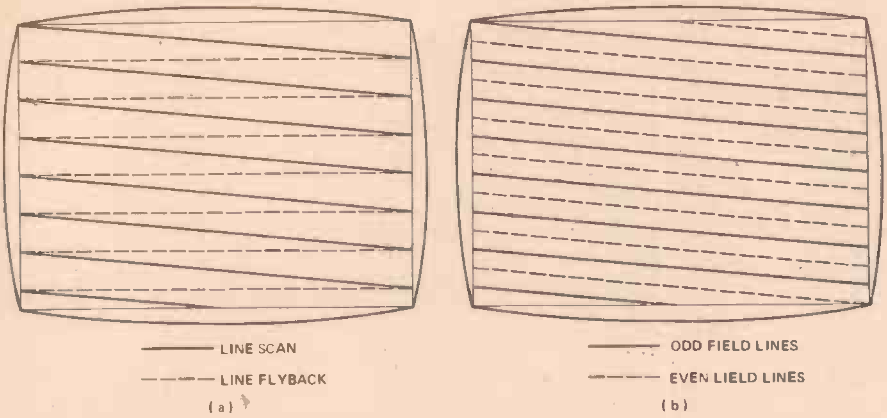


Figure 1a shows one field (the odd field) of a single frame of video as scanned by a TV camera; Figure 1b shows the odd and even fields combined to make up the complete frame, or 'interlaced raster'.

machines are used mainly to transfer film prints to magnetic video tape (sometimes directly to cassette for public sale), or to generate a video signal from a film print, which can be broadcast directly onto the air for immediate viewing or for recording and storing elsewhere — particularly useful for news gathered on a conventional cine-type camera rather than an ENG (electronic news gathering) video camera.

The answer is, on the face of it, simple enough: take a good TV camera, and a good-quality screen and projector. Indeed, some telecine has been done in this way. But it won't do, because the two systems are incompatible.

Persistence

Both of these systems rely on the persistence of vision to produce the appearance of a complete, continuous picture. To the eye there is little difference. However the methods of producing this illusion do not easily fit together.

In projecting a film, the projector pulls the next frame into position with a claw that engages with the sprocket holes, then uncovers the light source which shines through the film, and displays an enlarged image on the screen. When the eye has had a chance to register this, the projector covers the light source with a shutter and proceeds to pull the next film frame into position. This process is typically carried out at a rate of twenty four frames per second (fps). (Home cine equipment works at the slower speed of eighteen fps).

Raster

A television picture, on the other hand, is built up by scanning in lines to build up a raster, which is continually being rescanned. The UK television system uses a field of 625 lines, built up from two interlaced rasters each of 312½ lines. This is illustrated in **Figure 1**. There are twenty five blank lines in and around the flyback period. Thus the television camera would be scanning the image focussed by its lens for over 90% of the time.

This is a much greater proportion of the time than that for which the projector is displaying the picture on the screen, so for part of the time the television camera would be looking at a blank screen.

To add to this particular incompatibility, the frame rate of the UK television is 50Hz. There are fifty interlaced rasters (ie twenty five complete frames) each second.

More Persistence

This simplified view of things would suggest that black bands would move down the picture, moving from top to bottom over about a second. Things are not so black and white as this, however. The light sensitive coatings on the television camera tubes continue to respond for a brief period after the light is interrupted, so that darker bands rather than black ones are generated.

This persistence effect is greater on most home video cameras, so the so called telecine adaptors available for home video have a chance of working, albeit with limited quality.

'In that case' I hear you ask, 'why are the professional cameras so short on "persistence of vision." ?' The price to be paid for this longer persistence is streaking, which you must have noticed if you have ever used a home video camera. In fact, to use a long enough persistence to completely avoid the dark bands would result in any moving object leaving visible trails. (I have heard tell that this technique has been used, and maybe still is, in some very small local TV stations in the America. This is not necessarily a particular recommendation .)

It must by now be quite obvious (cease beating donkey with stick) that a special machine designed for the job will produce much better pictures from your average film than will the obvious techniques.

Square Wheel

Most of the successful telecine machines made have used a technique whereby the film is moved steadily through the machine, and it is optically or electronically scanned as it goes past.

One company did toy, briefly, with the idea of a so called "intermittent motion telecine," in which the attempt was made to grab the film with the claw in the sprocket hole, move it onto the next frame, and stop it in the right position, all during the television frame blanking period. This employed an almost square cam to operate the claw, and unsurprisingly it made an awful clatter.

The machine was intended to play cassettes of super 8 film, and was about the size of a videocassette machine. It was intended for a comparable sort of domestic use.

The idea was abandoned when a mechanical engineer called to look at it was able to show that even with the fairly light super 8 film, any practical method of pulling the new frame into view fast enough would perforce tear the film.

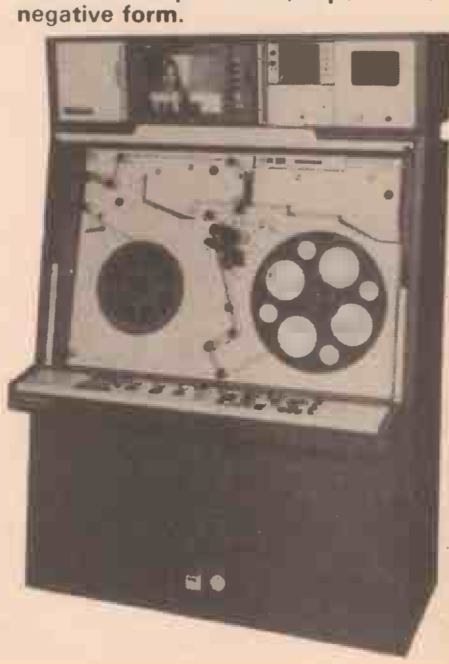
Workable Methods

Many methods of producing a continuous motion telecine have been tried, though most of them, when examined closely, are variations on relatively few themes. These are:

1. Flying spot scanner type, with or without "hopping patch". In this type of machine, the film is scannedby the image of a raster generated on a cathode ray tube (CRT) and focussed onto the film. The light from the raster passes through the film and is then converted to an electrical (video) signal by light sensitive cells.

Below: The Marconi B3410 Line Array Telecine. Compare the film lacing layout of this machine, which is different from that of the Flying Spot Scanner type show over the page, due to the very different techniques used. The film motion is still from the left to the right reel, with the sound pickup below the video pickup.

This machine, in common with most other types, can handle 35mm, 16mm and super 8 film, in positive or negative form.



Picture courtesy of Marconi Communication Systems

2. Camera chain. As its name implies, a television camera forms part of this system, and the passage of the film and the scanning in the camera are modified to get around the problems found when using an ordinary projector and screen with a camera looking at it. The film is projected straight into the camera tube, and the scanning techniques are very similar to the flying spot technique. This kind of telecine is not widely used.
3. Charge coupled device type with a frame store. This uses a relatively new technology, a charge coupled line imaging device, with a frame store to enable a picture to be sent out in the conventional interlaced fields though it is read in from the top line by line.

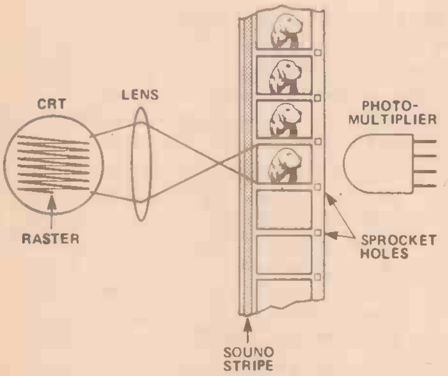


Figure 2. In a Flying Spot Scanner, the photomultiplier receives the light only from the Flying Spot as it travels along its scanning path, building up the complete raster.

Flying Spot

It is most fruitful first to consider the flying spot telecine, since probably the majority of machines in use in broadcast today fall into this category, although a number of new machines on the market use CCD techniques. The adoption of CCD seems slow, however.

The flying spot scanner has been around a long time, and back in the days of the youth of the author one of the uses of this principle was in amateur television. Before home video cameras were so readily available, many of those interested in amateur television found the flying spot scanner an economical way of generating video. Slides could be displayed, showing, for example, a picture of the flying spot scanner or the TV transmitter. . .

Back in them days of course it were all black and white.

Figure 2 shows the principle of televising a slide using a flying spot scanner to produce a black and white picture. Though the raster looks like a rectangular area of light, the light is emitted primarily from the position of the scanning spot as it traces out the raster. Thus the photomultiplier receives, at any particular moment, the light passing through one small spot on the film.

The usual law of things being more difficult applies here as generally in engineering. The light emission from the phosphor does not stop the instant the electron beam scans past. It decays with (depending on the phosphor) one or more superimposed exponential laws. In order that the picture shall not be significantly affected, this must be electronically compensated for as far as possible, by a circuit known as the afterglow corrector. I shall not go into all the technical details of this or many of the other fudges and tweaks which have to be applied — to do so would require a book.

Dichroic

With the use of some sort of filtering to separate the colours, and three photomultipliers rather than one. RGB (red green and blue) signals can be generated, which can be suitably encoded to PAL or whatever standard is required. The details of this would be more relevant to an article on colour television, if enough people are interested and say to the editor then one will be forthcoming.

To separate the colours without dimming the light too much, dichroic filters are used. These bear the same relationship to a piece of coloured glass or plastic as do the circuits of **Figure 3** and **3b** to each other. **Figure 4** shows the principle of transmission or cancellation of light of certain colours as used in dichroic filters. This diagram shows the effect of one coating on a piece of glass, the coating having a very different refractive index from the glass. This is the equivalent of one tuned circuit, whereas the filter used in a telecine machine (or a television camera) bears comparison with a multi element low or high pass filter.

Figure 5 shows the method of employing dichroic filters to separate the colours.

. . .On The Grounds of Mutual Incompatibility

It should come as no surprise that there are problems of mismatch with the two

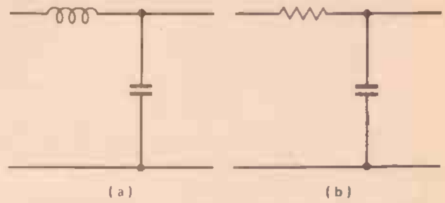


Figure 3. Circuit 3a either reflects the signal or allows it to pass, according to frequency, like a dicroic filter; circuit 3b either absorbs the signal or allows it to pass, like a plain glass filter.

different types of system here. The colours of the dyes used in colour film do not match with the colour bands used to split the light before the photomultipliers. Why? Well, changing these bands would result in a mismatch between the dichroic filters and the phosphors of the television sets on which the picture is shown. Just to keep people on their toes, there are several different sets of film dye colours.

Normally joysticks are used to adjust the tint of black and of white, and the gamma curves for the three colours. The precise adjustment needed can change from scene to scene, since in effect the joysticks are used to adjust something which is wrong to *look* right.

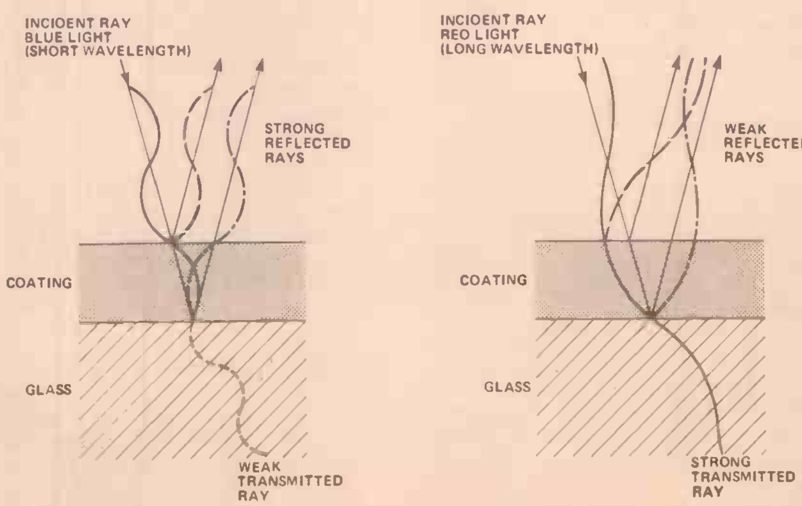
To understand why, imagine that the green colour on the film has a small effect on the red television signal. If the compensation has been adjusted to make the colours look right with a certain green content, then a different content in a different scene will cause unnatural looking colours.

Have you noticed on television films how, sometimes, the colours change for a second or so just after a scene change? This may well be the result of someone quickly stirring the joysticks up to correct the colours again.

Gamma

Ignoring the actual colour for a moment, there is yet another correction which

Figure 4. The principle of a dichronic filter: when short wave light strikes this filter, it is weakly transmitted and strongly reflected; long-wave light however is weakly reflected and stongly transmitted. In this way, a full-colour picture can be split into several component colours (usually three) without any of the colours being lost in absorption (as with an ordinary tinted glass or plastic filter).



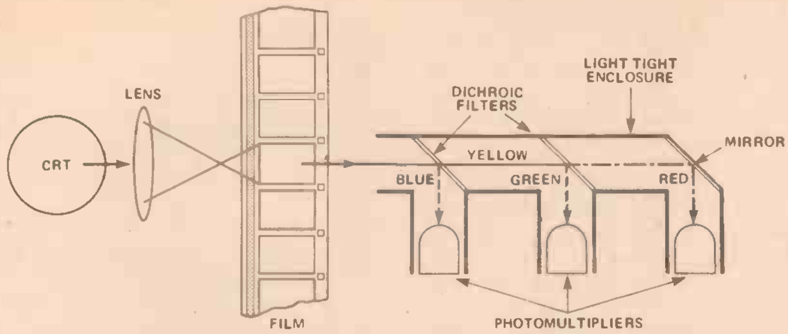


Figure 5. The light projected from a colour film is directed through a series of dichroic filters, which direct one component of the coloured light to the appropriate photo-multiplier, while allowing the rest to pass through to be split down again by a further filter.

would need to be made even on a black and white film.

The eye can cope with very wide ranges of light level, and very dim objects can be distinguished in the same scene as very bright objects. The film can handle only a lesser range of light intensities, and it does not respond in direct proportion to the light received. Thus the dynamic range is reduced. This characteristic of non-linearity and compression is known as the gamma curve of the film.

The television system is only able to handle an even lower contrast range. The compression curve normally needed is also somewhat different, so an adjustable gamma compensation is required. Due to the mismatches mentioned earlier, this curve may be different for the different colours. Different films of course need a different balance between the gammas of the colours.

Tracking With Closeups

So far all we have considered is how to produce a stationary picture from a film frame, but the really difficult problem is how to produce a clean moving picture.

Tackling the problem by easy stages, imagine the film, which is being displayed by the flying spot scanner, moving slowly past. So long as the raster did not reach the edge of the CRT, it would be possible to follow the movement of the frame and keep it in view by progressively moving the raster, by adding a DC offset to the scanning waveform.

Eventually, of course, the raster would run out of CRT. At this point, if the film kept moving, it would be reasonable to jump the raster to the position of the next frame coming past, so as to continue to have a framed picture. If carried out repetitively at a steady rate of film movement, this would result in a slow sawtooth waveform being added to the vertical scanning.

If this waveform were generated at a rate to match the film movement, then at first sight it would seem that any rate of film movement could be accommodated. This ain't *exactly* so but it is a good starting point.

Synchronicity

The first step is to cheat slightly on the film speed, and run the film at 25fps. This means that each film frame should be scanned for exactly two interlaced fields as it trundles past.

In order to prevent the film slowly drifting out of sync with the TV timebase, the timebase signal is often used as a reference to control the film movement.

From this point there are two obvious ways of making sure the film stays in frame. The first is to generate the scanning waveforms as if the film were moving past exactly in synchronism with the TV timebase, and then to control the film movement by means of servos accurately, so that it does.

The second is to control the speed of the film accurately enough for good sound, and to measure the position of the film by electronic means and adjust the scanning to take account of its actual position.

Facts and Figures

In order to understand the effects of these two methods, some more information is needed. For the sake of an example, assume that 16mm film is used.

The distance between sprocket holes is 0.3 inches. Therefore one television line corresponds to about 0.3÷625= 0.00048 inches (approximately half a thou).

The direction of movement of the film is upwards relative to the image ie in the reverse direction to the raster scan.

Picture courtesy of Rank Cintel

Right: A Rank Cintel ADSI CCD line array machine. Two film transport mechanisms are shown, but the electronics can handle up to three, alleviating the problems of reel changing. The frame store uses 64K RAM chips, and among the features of this advanced machine are a dirt concealment circuit, which uses infra-red sensing to locate dirt and scratches, and an automatic colour correction circuit.

Hopping Patch

In either case, the scanning pattern looks as shown in **Figure 6**. Scanning alternates between the two scanning areas, hence the name hopping patch for this type of system.

The patches are half the height they would be to scan a stationary frame, since the film comes half a frame up in the time taken to scan one field (312½). The main difference between the two systems is that one has to measure the film position accurately in order to control the scanning accurately, the other has to measure the film position accurately and use this information to control the *film* accurately.

It may seem obvious which is easier, particularly with modern digital and micro electronics, but don't forget that the film has to be controlled fairly accurately anyway in order to get good sound without wow and flutter. At least one successful machine used the technique of having a very accurate servo (made I believe by Rank Cintel).

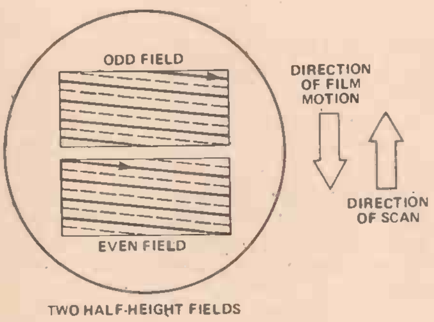


Figure 6. The "hopping patch" system: the odd field is scanned first. The scanning area then moves physically downwards to scan the even field as the film travels past. The scanning areas are compressed in size to accomodate the moving film.

Equally I am sure I recall seeing a patent, possibly by Kodak, showing the use of a film tracking system. At the time of this particular patent, the only type of circuitry suitable for the job was analogue and rather drift-prone.

I have seen a prototype digital film tracking system, with a DAC (digital to analogue converter) on its output, working from freezer spray temperature to hairdryer temperature without visible drift. As far as I know no machine using this principle is on the market.

Reverse Gear

There is an operational advantage to the use of a film tracking system, which is probably why several patents on the subjects have been taken out. The accurate servo control method can only show a clean picture at synchronous speeds. The film tracking system method can show pictures from stationary to in excess of synchronous speeds, and can even show a good picture in reverse.

Using this means it is easy to find one specific film frame, for example in order to start the broadcast at the exact right point. An example of a film lacing diagram is shown in **Figure 7**. The position of the film is measured by shaft encoders attached to the sprocket wheel and the capstan.

Film Tracking Principles

Figure 8 shows the principles of a film tracking system using this information. An important point to consider here is that the change from scanning one frame to the next should only be carried out during the frame blanking interval, in order that the deflection circuitry of the scanning CRT has time to settle to an accurate position.

If, as is likely, the deflection is carried out magnetically, then in order to move the electron beam from one frame to the next during the line blanking interval would require enormous voltage, while an attempt to move it fast enough not to produce a disturbance in the middle of a picture line would be thoroughly destructive.

What would happen in practice if the change from film frame to film frame were not synchronised with the television system is that the vertical deflection system would be unable to keep up, and several picture lines would contain rubbish while the scanning position settled. For this reason, the vertical sync pulse is fed to the control circuitry of the film tracking system.

Eccentric

It is clear that any inaccuracy or eccentricity in either the capstan or the sprocket wheel will result in an error in the measured position of the piece of film being televised.

If there is an error which displaces the film by half a thou from its measured position, then the picture will show a movement of one television line each revolution of the eccentric wheel. This is just enough to be noticed, but judging by the vertical bounce sometimes seen on televised films, particularly easy to notice on the credits, it would seem that bigger errors do occur.

On machines which use accurate servo control as the sole means of ensuring correct scanning, the problem is worse. Only a small amount of servo hunting or disturbance will produce noticeable picture movement.

Picture courtesy of Rank Cintel

Not Mission Control Houston, but a remote control desk for use with the Rank Cintel Mk III Telecine. Note the colour correction joysticks in prominent view.

Weave

As those who own cassette recorders may have discovered, a build up of dirt on a driving capstan can cause the tape to list to one side. This can become so severe in some cases that the machine chews up the tape and spits it out.

Dirt build up or tiny irregularities can occur on the film driving capstan as well, and only small sideways movements of the film (weave) are needed to make the viewer feel faintly seasick.

If the same layer of dirt picked up from the film is responsible for vertical movement and weave, then the two movements will be at the same frequency but phase shifted.

This will tend to produce an eliptical motion on the picture.

Another cause of side to side movement of the picture comes from the use of cinemascope films. These have a markedly different aspect ratio (ratio of picture width to height) from the television system. The picture on the film frame is compressed widthways at the time of filming, so that everything looks tall and narrow. At the time of

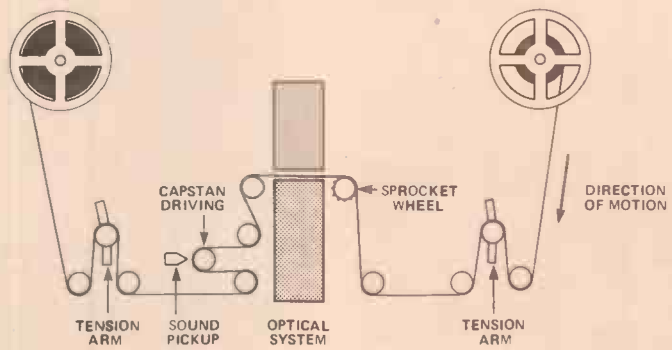
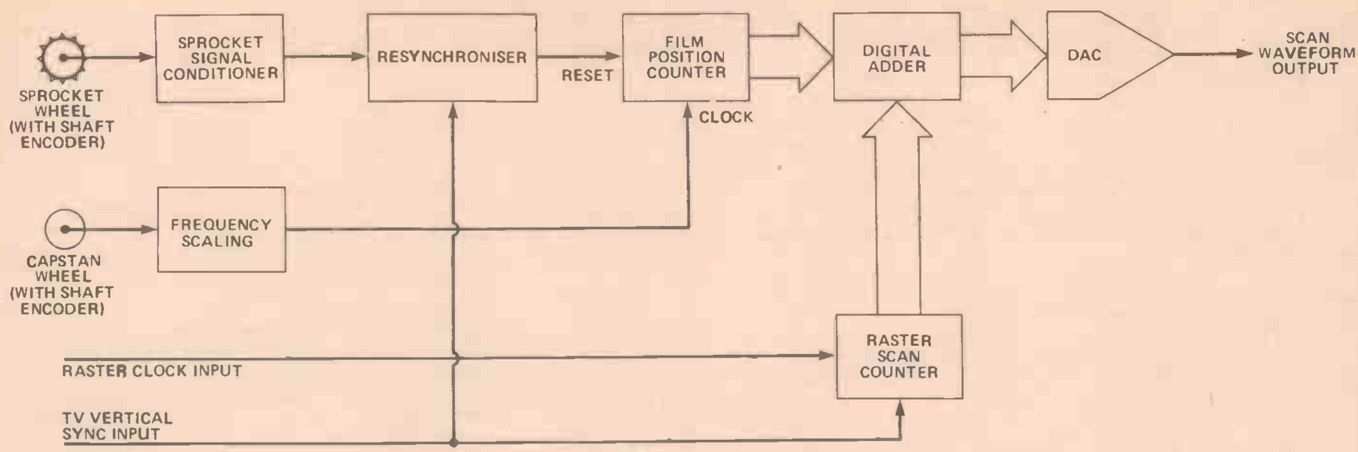


Figure 7. An example of a film lacing system. The tension arms are spring loaded, and their positions determine how much power is fed to the spool servo motors. A constant film tension is maintained almost regardless of speed.



projection, it is re-expanded to look natural, and fill a wide screen.

These operations need lenses having different focal lengths in the horizontal and vertical planes. The name for these is anamorphic lenses.

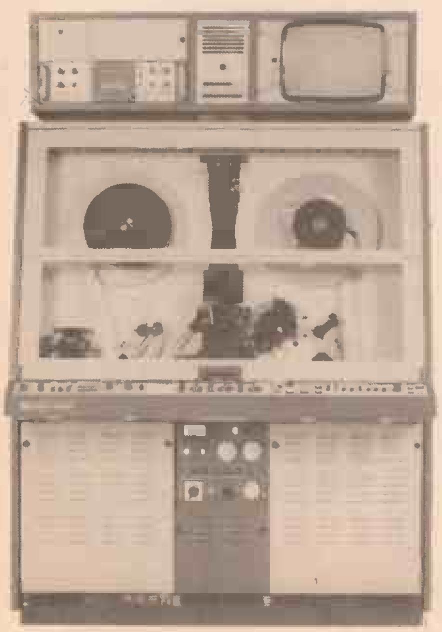
With wide-screen films, there are three main methods of translating them for television:

1. Simply display the whole picture on the screen. This can result in some very tall cowboys, and is sometimes done just for the credits. It can be done by altering the shape of the raster in a flying spot machine.

Below is the Rank Cintel Mk III, a widely used Flying Spot scanner. Film movement is from left to right, making the film path almost a mirror image of that in Figure 7.

A frame store is also used to allow the speed at which the picture information is read out to be independent of the speed at which it is read in to the machine, and to simplify some of the complicated adjustments needed to achieve broadcast-quality pictures.

Note also the monitor bridge on top of the machine: it includes a sound and picture monitor, as well as a waveform monitor.



Picture courtesy of Rank Cintel

Figure 8 shows a simplified scheme showing the principles of a film tracking system. The resynchroniser resets the film position on the first TV vertical sync signal, after a pulse from the sprocket wheel (requiring a jump to the next frame). Frequency scaling is applied to the capstan encoder signal in order to provide a convenient number of pulses per frame of movement from the inevitably inconvenient number of lines per revolution on the capstan encoder.

The raster scan counter generates a digital representation of the vertical deflection waveform required for a stationary film and this is added digitally to the film position signal. The digital to analogue conversion is at the output, so there is little chance for analogue drift to occur.

2. Keep the picture the same shape, and leave a space above and below it on the TV screen. This would involve modifying the raster shape in a flying spot scanner.

3. Pick out a part of the picture to fit the TV screen area, and pan across the film to centre the action on the screen. When the characters on either side of the cinemascope picture are speaking, alternately, and the operator is a little slow in following, the viewer may feel a little like a spectator at a tennis match.

CCD

Another variation of the flying spot scanner technique uses a frame store and a raster with one 625 line field instead of two 312½ line fields. This reads the lines into the frame store from the top, and reads them out alternately to obtain an interlaced field sequence.

A similar idea is employed in CCD telecines. Again the information is read in sequentially from the top, and read out in television standard manner. Machines using this system are made both by Rank and Marconi.

CCD machines have much in common with flying spot types, in that the film position must be measured accurately, and the colorimetry is still a problem.

However, they have no CRT with the problems of geometry and of burnt patches after long use. The main difficulties with the CCD itself are picture blemishes and poor signal-to-noise ratio, and it is still very difficult to produce CCDs of broadcast quality.

For reasons best known to their makers, machines using frame stores have their colour correction circuits before the frame store. This means that when the picture from the frame store is the only one available, as when the CCD machine is stopped at one frame, the effect of adjustments cannot be seen.

Apparently this can be a source of irritation to the operators on occasion, when they have to rerun a scene for the third time to determine the colour correction required.

There are many more points to cover before you could design your own telecine machine, such as the sound, and all the intricacies of the video signal processing. This should explain at least a little of what is required in order to televise the Saturday night feature film.

The Marconi B3410 installed with a Marconi VTR at Filmatic, London. In between is a Muchworth Video patching and monitoring rack, which provides a jackfield, a switched picture and waveform monitor, distribution amplifiers and many other facilities needed in order to use diverse signal sources in an integrated system.

Picture courtesy of Marconi Communication Systems

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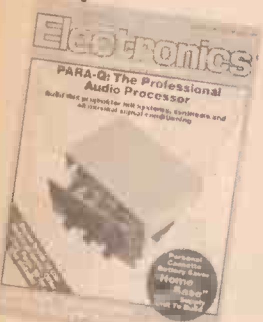
BACKNUMBERS



February 1983
Incremental Timer, Pop Amp 4 & 5, Power Supply for digital applications, the Birth of Broadcasting, Random Access Memories, A Directory of Electronic Kits and Modules, Book Guide.

March 1983
HE EPROM Programmer, Pop Amps 6 & 7, Signal Powered Loudspeaker Protector, Overvoltage Cut-Out, ROMs & EPROMs, the Arrival of Television, Car Computer Review, Radio Rules — Propagation and Aerials, Finishing Touches, Famous Names.

April 1983
Auto Power Down, EPROM Programmer Part 2, Stereo Voice Over, Tools and Test Equipment Survey, Components and Hardware Directory, Tools For The Trade, Components For Computing — Interrupts, Radio Rules — RF Interference and Measurements, Radio Controlled Gerbil.

May 1983
Car Security Cutout, Demister/Aerial Convesion, HE Auto Tester, BBC Micro/HEBOT Interface, Careers In Electronics Part 1, Radio Rules — the RAE, Aces High, DIY Loudspeakers Review, The Micro Age, Famous Names.

June 1983
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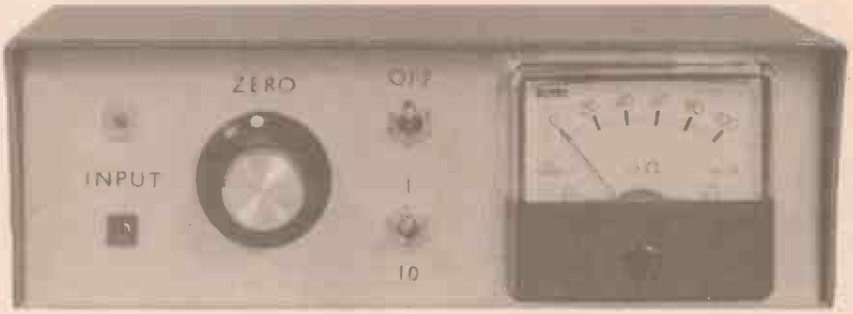
R.A. Penfold



MOST readers will probably have a multimeter capable of reasonably accurate resistance measurement over a wide range of values.

The average multimeter has its limitations though, and most instruments are not at their best when very low resistance values are involved. Apart from a lack of accuracy in most cases, the test current is often quite high on the lowest resistance range, with a maximum current flow of 100 milliamps being quite normal. Such a high current is less than ideal, since it could result in damage to delicate semiconductor circuits.

One use for a multimeter when set to a low resistance range is for static testing of a transformer. Checking the primary and secondary resistances and comparing them to those of a component which is known to be faulty (or perhaps comparing two identical secondary windings of a component) can reveal a "shorted turns" fault, with the damaged winding providing a lower resistance reading than it should.

The secondary resistance of something like a low voltage high current mains transformer or an audio output transformer is very low, being typically only a few ohms or less. The accuracy and resolution of an ordinary multimeter at such low resistances is often inadequate for this type of test.

Continuity Checker

Another common use for a multimeter set to a low resistance range is as a continuity check for such things as testing for short circuits between the tracks of a printed circuit board caused by solder blobs.

As mentioned earlier, the high test current used could damage integrated circuits and other delicate semiconductor components in the circuit. Switching to a higher resistance range gives a lower test current, but at the expense of accuracy and resolution which could make it very difficult to distinguish between a short circuit and a low resistance path in the circuit. The problem is made worse by the use of a test voltage of about three volts or more. This can result in forward biased semiconductor junctions, which could be present in the circuit as part of a transistor or an integrated circuit as well in the form of diodes giving misleading low readings in parts of the circuit where they would not be expected.

A futher shortcoming of a multimeter when used as a continuity checker is that it does not provide an audible indication of continuity, and it is necessary to keep looking away from the test prods to the meter. As anyone who has made numerous tests in this fashion will be only too aware, this is rather awkward and it soon becomes a very tedious task.

Low Current Tester

The unit which is featured in this article has been designed to overcome the problems outlined above. It has two resistance ranges of 0 to 1 ohm and 0 to 10 ohms, giving far better accuracy and resolution than most multimeters at low resistances.

An analogue multimeter normally has a reverse reading and non-linear scale for the resistance ranges, but this circuit has a linear, forward reading scale. This makes it easy to set up ready for use, and no recalibration of the meter is required.

The test current is only about three milliamps, which should be low enough to ensure that no components in the circuit under investigation are damaged by the unit. The voltage across the test prods is only a few millivolts even when the test resistance is near to the full scale value. This is insufficient to bias a semiconductor junction into conduction, even a germanium type, and misleading readings are thus avoided.

Audible Indication

Finally, the unit has a built-in audio oscillator that provides an audible tone when a resistance of less than the full scale value is present across the test prods. The unit therefore functions as a straightforward continuity tester in addition to operating as a low value resistance meter.

The circuit which drives the audio oscillator is also used to control an electronic switch that disconnects the meter when a resistance greater than the full scale value is present across the test prods. This cuts off the meter under stand-by conditions where the extremely high resistance across the test prods would otherwise result in the needle being driven hard against the end stop. It also provides ordinary overload protection for the meter.

System Operation

Figure 1 shows the block diagram for the Milliohm Meter project. It operates on the principle of voltage being proportional to resistance if a constant test current is used.

For example, using a current of one amp, a potential of one volt would be developed across a one ohm resistor (1 amp x 1 ohm = 1 volt).

A test resistance of two ohms would give two volts (1 amp x 2 ohms = 2 volts), three ohms would give three volts (1 amp x 3 ohms = 3 volts), and so on.

Therefore, by feeding a constant current to the test prods and using a voltmeter to register the resultant voltage, the voltmeter will register the test resistance and will have the required forward reading, linear scale.

In this case the constant current generator provides an output current of only about three milliamps so that the circuit under investigation is spared from a dangerously high test current. This gives a full scale voltage of only three millivolts on the one ohm range, and 30 millivolts on the 10 ohm range. This is inadequate to drive a moving coil panel meter, and an amplifier must be used ahead of the meter. This is necessary since the meter circuit must not tap off a significant current from the constant current generator, as this would impair the linearity of the circuit.

A high gain DC amplifier is thus used to drive the meter, and by having two switched levels of voltage gain the two ranges are provided.

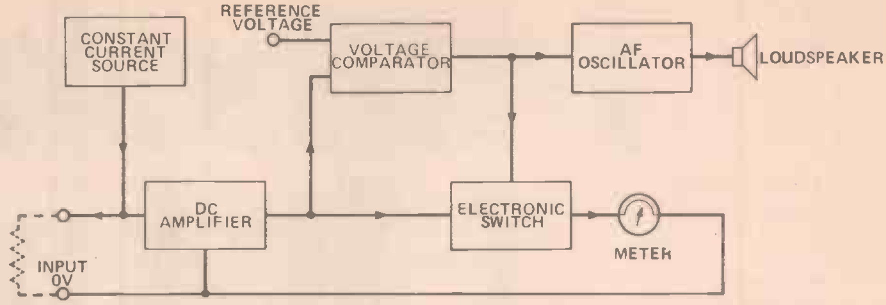


Figure 1. The block diagram showing the operation of the Milliohm Meter.

Meter Cut Out

With no resistance connected across the test prods the amplifier is fed with the maximum voltage that the constant current generator can provide. The amplifier in turn drives the meter as hard as it can, providing an output current several times the full scale value of the meter.

The most common way around this problem is to simply have a push button on/off switch, with the push button not being operated until a test resistance is connected to the unit. This would not be very satisfactory in this context, as it would make the unit difficult to use as a continuity checker. The alternative of a meter cutout has therefore been chosen.

Electronic Switch

One input of a voltage comparator is fed from the output of the DC amplifier. The other input is fed with a reference voltage which is slightly higher than the full scale output voltage of the amplifier.

Under stand-by conditions the output of the amplifier goes to a potential which is substantially higher than the reference voltage, resulting in the output of the voltage comparator going low. This switches off the electronic switch between the meter and the output of the DC amplifier, and no significant deflection of the meter is produced.

With an in-range resistance connected across the input of the unit the output of the DC amplifier goes below the reference voltage, and the output of the voltage comparator goes to the high state. This activates the meter and a reading is obtained.

Audio Oscillator

The output of the voltage comparator is also used to drive an audio oscillator which is activated when an in-range test resistance is present, and the output of the comparator goes high. The output of the oscillator drives a loudspeaker, which in practice is an uncased ceramic resonator fixed on the inside of the unit' rear panel.

This does not give a very loud tone, but in this application a quiet 'buzz' is all that is really needed, and a loud tone would soon become tedious.

Circuit Operation

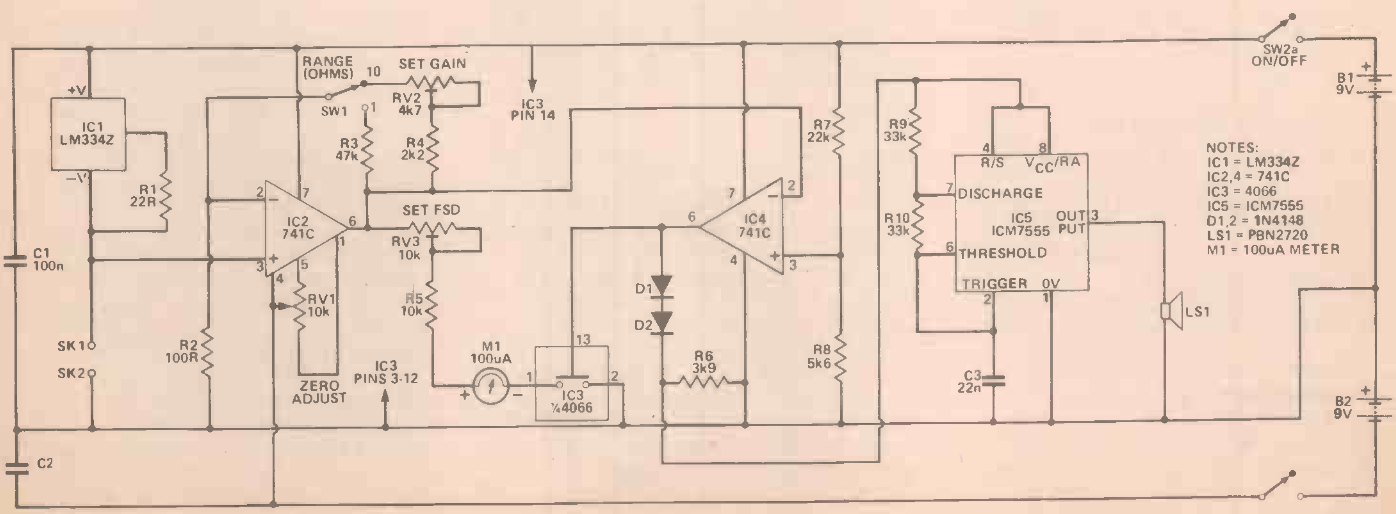
Figure 2 shows the full circuit diagram of the unit.

There are only two components in the constant current generator; IC1 and R1.

The integrated circuit is an LM334Z which is specifically designed to act as a constant current source, and it requires only a discrete resistor to set the required output current. The current is equal to 0.0677 divided by the value of R1, or approximately three milliamps with the specified value for R1.

The DC amplifier uses operational amplifier IC2 as a standard non-inverting amplifier. In this mode the input signal is applied direct to the non-inverting input, pin 3 and

Figure 2. The circuit. RV1 is a panel control to enable the output of IC2 to be adjusted for drift. RV2 and RV3 are both presets.



negative feedback to control the voltage gain of the circuit is taken from the output to the inverting input, pin 2.

On the one ohm range the negative feedback network is comprised of R3 and R2. The voltage gain is equal to R2 plus R3 divided by R2, or 471 times in this case. This boosts the three millivolt full scale input voltage of something approaching 1V5 which is more than adequate to drive a moving coil meter.

On the 10 ohm range, R3 is switched out of circuit by SW1, and the feedback resistance is then provided by RV2 and R4 in series.

The preset, RV2 is adjusted so that the gain of the amplifier is exactly one tenth of its value on the one ohm range. Ten times the input voltage, and therefore ten times the test resistance are then needed to give full scale deflection of the meter.

Integrated circuit, IC1 needs a negative supply so that its output can provide output voltages right down to the OV supply potential. It also requires an offset null control, RV1. In theory the output voltage of IC2 should be zero volts with the input tied to OV.

In practice the output of an operational amplifier tends to be slightly offset from its correct potential, and when used at high gain, as in this case, the error can be quite large.

Potentiometer, RV1 enables this offset to be trimmed out, and has been made a panel control rather than a preset one, so that it can be easily retrimmed if there is any significant drift due to changes in supply voltage or temperature.

Voltage Comparator

The third IC, IC4 is another operational amplifier, but here it acts as the voltage comparator. Its inverting input is fed from the output of IC2 while R7 and R8 provide the reference voltage for its non-inverting input.

The electronic switch which provides the meter cutout facility is one section of a CMOS 4066 quad analogue switch, IC3. When this is fed with a high control signal from IC4 it switches on and provides a resistance of only about 200 ohms. It then connects the negative terminal of meter to the OV supply and completes the circuit. When supplied with a low control voltage, IC3 cuts off and has a resistance of many megohms so that no significant current can flow through the meter. Preset, RV3 enables the sensitivity of the meter circuit to be adjusted so that the unit can be accurately calibrated.

Audio Output

The audio tone is generated by IC5 which is an ICM7555 — the low power CMOS version of the popular 555 timer device.

The low power version of the 555 is preferable in this circuit since there is only a limited drive current available from IC4, and the lower output drive capability of the 7555 is all that is needed here since only the high impedance load provided by a ceramic resonator is being driven from IC5.

The minimum output voltage of IC4, about two volts is sufficient to produce oscillation from IC5, and D1, D2, and R6 are therefore used to provide a voltage drop of about 1V3 to ensure that the audio oscillator cuts off when the output of IC4 goes low.

Power is supplied by two small nine volt batteries. One to provide the positive supply and the other to provide the negative supply. The current consumption from the positive supply is only about four milliamps, rising to approximately eight milliamps when the unit is activated. The current drain from the negative supply is only about two milliamps.

Construction

A metal instrument case having approximate dimensions of 150 x 100 x 50mm is just about adequate to accomodate all the parts, and this represents the smallest case that is suitable. It also assumes that a small meter is used for M1.

The case used for the prototype

Parts List

RESISTORS
(All ¼ 5% carbon

R1	22R	
R2	100R	
R3	47k	
R4	2k2	
R5	10k	
R6	3k9	
R7	22k	
R8	5k6	
R9, 10	33k	

POTENTIOMETERS

RV1	10k	lin carbon
RV2	4k7	horiz preset
RV3	10k	horiz preset

CAPACITORS

C1, 2	100n	ceramic
C3	22n	carbonate

SEMICONDUCTORS

IC1	LM334Z	current regulator
IC2, 4	741C	op amp
IC3	4066BE	quad analogue switch
IC5	ICM7555	low power timer
D1, 2	1N4148	silicon diode

MISCELLANEOUS

SK1, 2	2mm	sockets
SW1	SPDT	miniature toggle switch
SW2	DPDT	miniature toggle switch
B1, 2	9 volt	PP3 size
M1	100u	moving coil panel meter
LS1	PBN2720	ceramic resonator, uncased version

Instrument case 150 x 100 x 50mm; printed circuit board; control knob; 14 pin DIL IC socket; three 8 pin DIL IC sockets; two PP3 battery connectors; test leads and prods; wire; solder; fixings; Veropins etc

BUYLINES .... **page 26**

was supplied with an aluminium chassis, but there is not room for this unless it is cut away so as not to foul the rear of the panel meter. It is probably best just to leave out the chassis altogether.

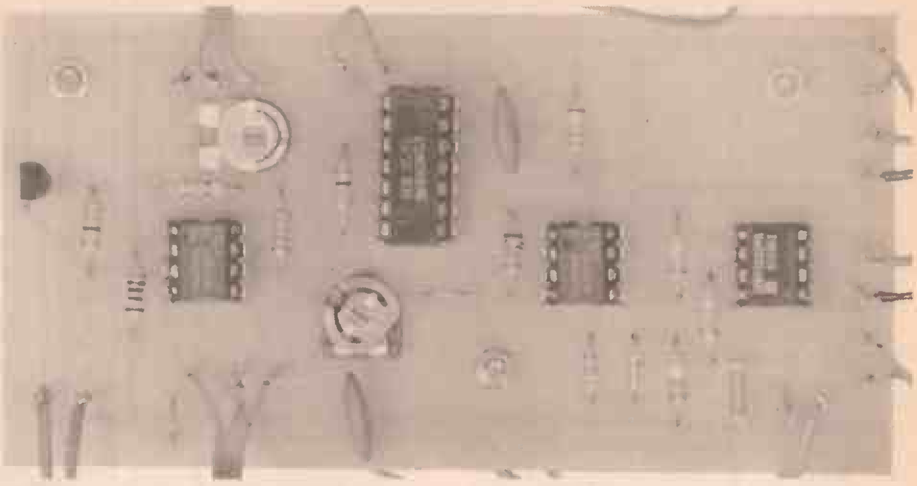
The front panel layout can be seen from the accompanying photographs. The only awkward aspect of constructing the unit is when making the main cutout for the meter in the front panel. Most meters require a cutout 38mm in diameter. This can be made using a fretsaw or a miniature round file.

Alternatively, a ring of closely spaced holes about three or four millimetres in diameter can be made just inside the perimeter of the required cutout, and a miniature round file can then be used to join up the holes. Finally, a large half round file can be used to enlarge the cutout to precisely the required size.

Four small mounting holes are required for the built-in mounting threads of the meter, and the positions of these can be marked on the panel, once the main mounting hole has been made, using the meter itself as a form of template.

The ceramic resonator is glued to inside of the rear panel of the case. It does not have leadout wires attached as supplied, and the constructor must solder two insulated wires about 100mm long to the resonator before it is fixed to the panel. One lead connects to the outer, gold coloured ring, and the other connects to the inner, silver coloured disc.

It is not difficult to make these connections, but be careful not to leave the soldering iron on each joint



for any longer than is absolutely necessary so that overheating of the resonator is avoided.

Printed Circuit Board

Details of the printed circuit board are shown in Figure 3.

The 4066 IC is a CMOS device and consequently requires the relevant handling precautions. Fit it in a 14 pin DIL IC socket, and do not fit it in place until the unit is finished in all other respects. Handle this device as little as possible. Be careful when fitting IC5 to the board as this has the opposite orientation to the other three ICs.

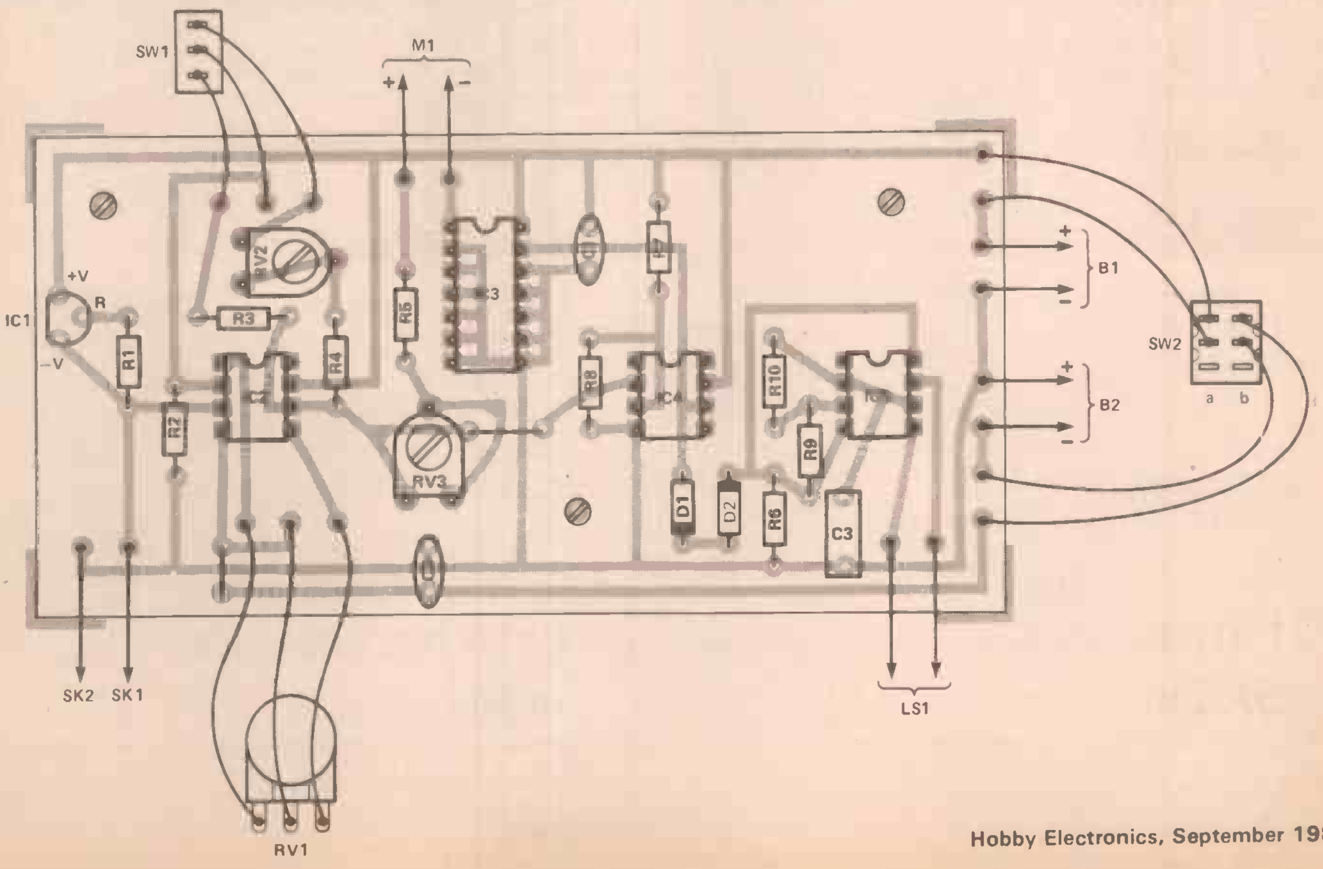
Although IC5 is a CMOS device it does not require the normal MOS handling precautions due to its internal protection circuits. Do not overlook the link wires, and fit Veropins at points where connections to the meter, etc will eventually be made.

Once completed the board is mounted on the base panel of the case. Either M3 or 6BA fixings are suitable, but if a metal case is used these must include spacers to hold the underside of the board clear of the case.

The wiring is then added, and for most connections ordinary multistrand PVC insulated connecting wire is suitable. For the two connections to SK1 and SK2 it is preferable to use a thicker wire that has a lower resistance. Something like 18 SWG tinned copper wire is ideal. It is also advisable to use a fairly heavy guage of wire for the test leads, and to use leads that are as short as practicable, about 400mm or so should be adequate.

The point of all this is to keep the

Figure 3. The construction is designed to keep the resistance from the PCB to the test prods as low as possible to ensure the best possible results from the Meter.



resistance from the printed circuit board to the test prod tips as low as possible, since more than a few milliohms here could prevent the unit from giving really good results.

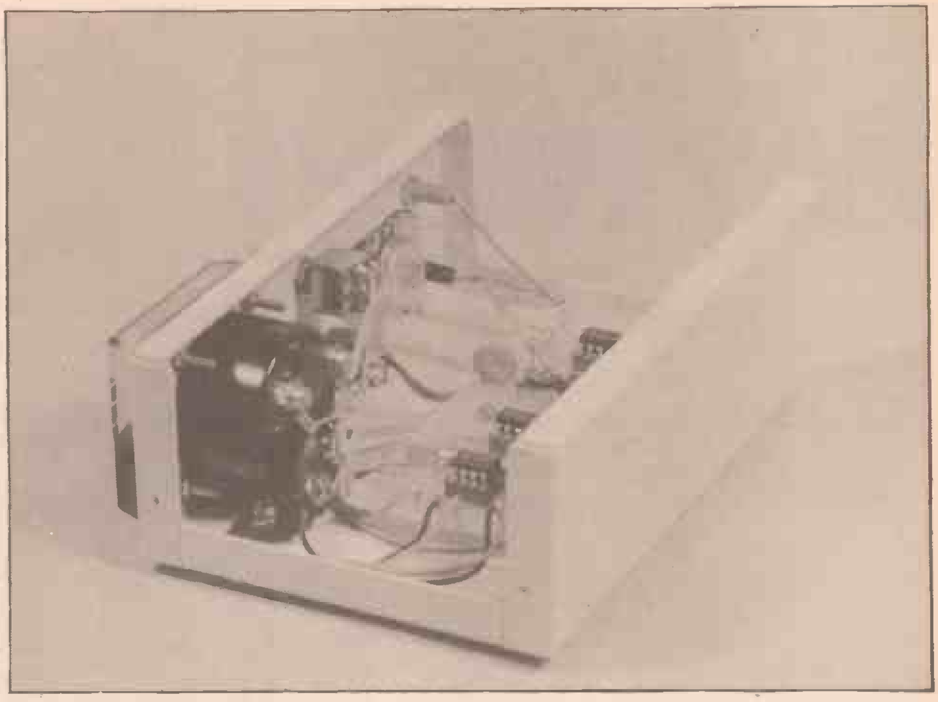
Adjustment

Start with RV1, RV2, and RV3 all at a roughly midway setting. Connect the two test prods together and then switch the unit on. There will almost certainly be a small deflection of the meter, which could be positive or negative, but in either case RV1 is used to immediately zero the meter. With the test prods connected together the audio tone should be audible, if not exactly overbearingly loud!

The unit is calibrated on the one ohm range first. Connect a one ohm resistor across the test prods — this should preferably be a precision (one per cent tolerance) type. Then adjust RV3 for precisely a full scale deflection of M1. Next switch to SW1 to the 10 ohm range and connect a 10 ohm resistor across the test prods. Again, in the interests of good calibration accuracy it is preferable to use a one per cent tolerance component. Preset, RV2 is then adjusted to give precisely full scale deflection of M1.

There is not really any need to recalibrate the meter as the 0 to 100 scale is obviously quite convenient for both the one ohm and 10 ohm ranges, but it is possible to remove the scale from the meter, carefully scrape off the original numbering, and add new numbering using rub-on transfers, if desired.

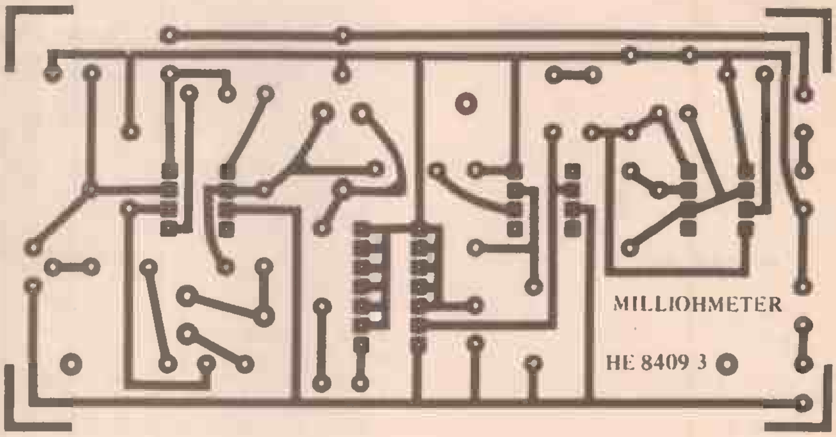
However, it is a lot easier to damage the meter than it is to make a good job of the renumbering, and it is something that it is probably not worthwhile contemplating unless you are particularly good at this type of thing.

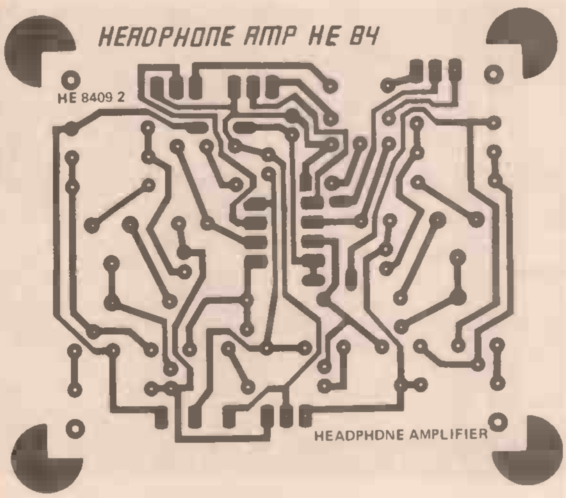


HE

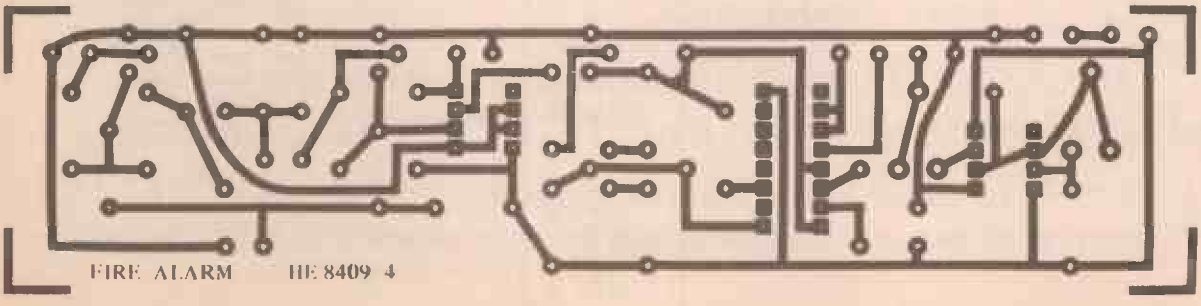
PCB FOIL PATTERNS

To the right is the foil pattern for the Milliohmeter.





Above right is the foil pattern for the Headphone Amplifier. The large three-quarter circles are there to mark the corners of the board and are not mounting holes as you might think. Below is the pattern for the Ultrasonic Fire Alarm project. There is plenty of room for drilling your own mounting holes if required.



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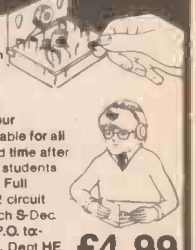

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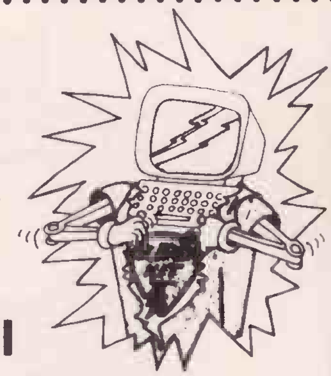

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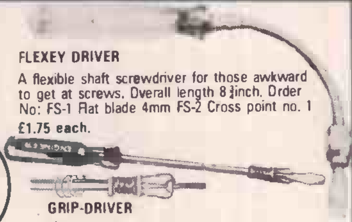

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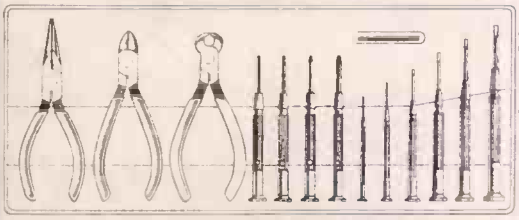

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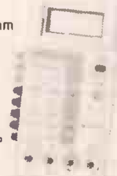

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