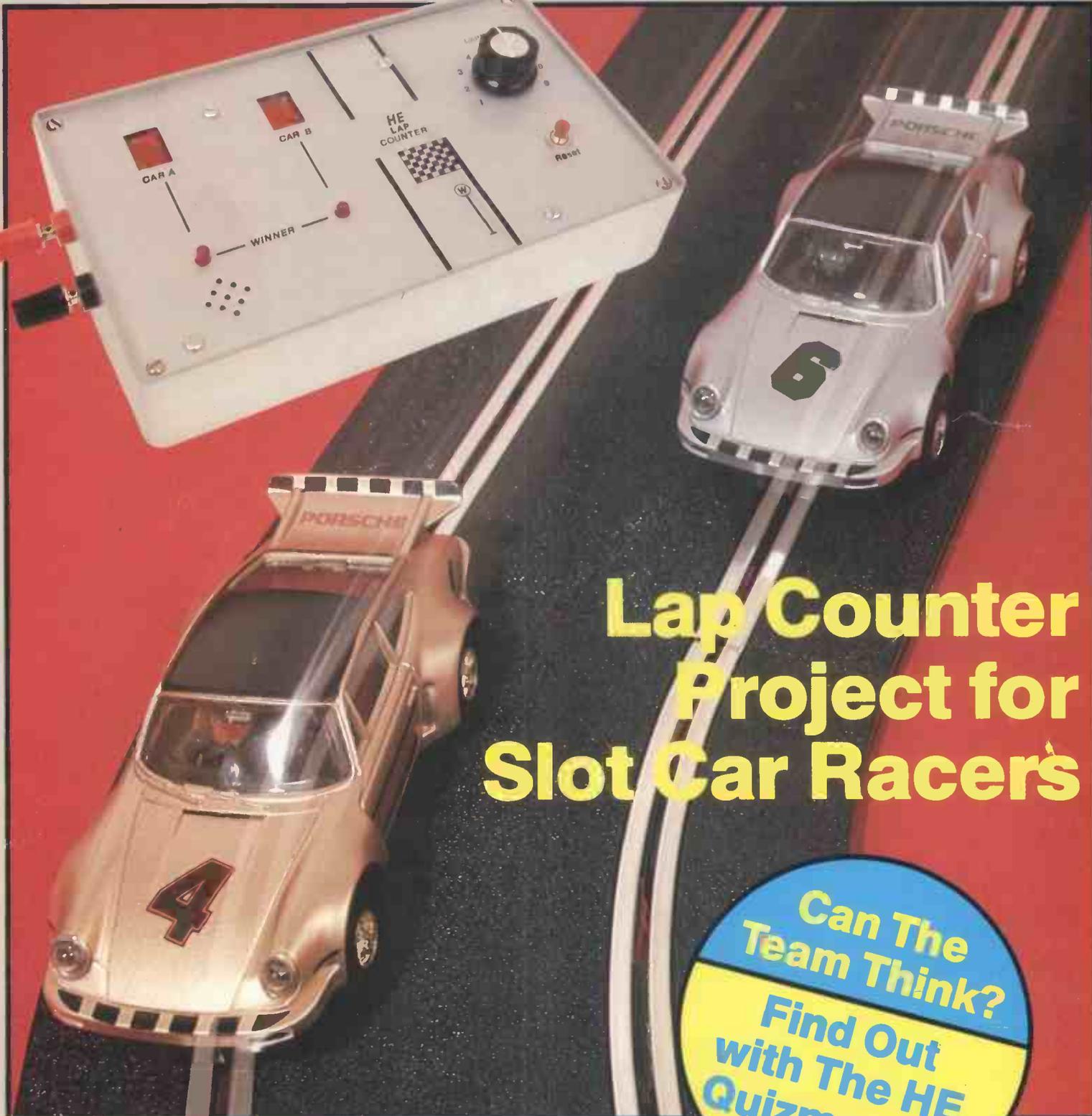


Hobby

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# Hobby Electronics

JANUARY 1984  
VOL 6 No 1

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*Take the heat off and make the coffee.*

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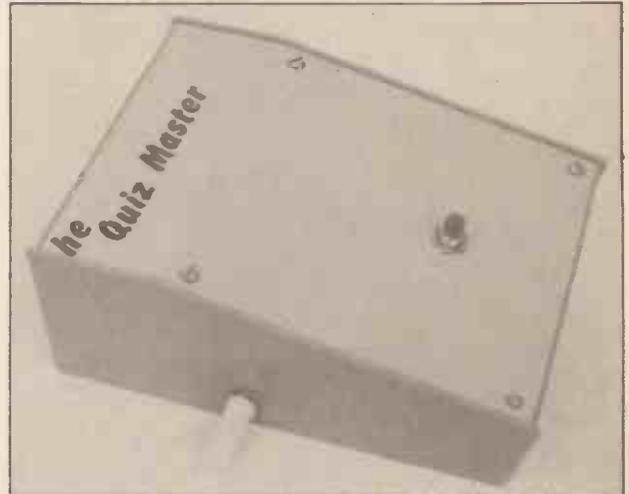
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*Front cover: Scalextric slot racing cars and equipment available in boxed sets and individual pieces from Hamleys of Regent Street, London.*

**Editor:** Ron Keeley  
**Assistant Editor:** Helen Armstrong BA  
**Technical Illustrator:** Jerry Fowler  
**Advertisement Manager:** Joanne James  
**Managing Editor:** Ron Harris BSc  
**Chief Executive:** T. J. Connell



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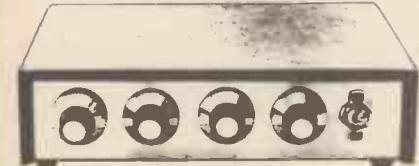
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## PREVIOUSLY ADVERTISED STILL AVAILABLE

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BOAC in-flight stereo unit	£1.50
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Nicad chargers, mains	£0.75
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ditto 12v resettable	£3.45
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Magnetic Clutch	£4.50
Mouth operated suck or blow switch	£2.30
Solenoid with slug 8 - 12v battery op.	£1.82
ditto 230v mains	£2.30
Timer Omron STP NH 110v AC Coil	£6.90
Key switch with 2 keys dp mains	£1.75
Air valve mains operated	£3.75
Latching relay mains operated	£3.50
Dry film lubricant aerosol can	£0.65
Coin op switch, cased with coin tray	£4.60



**8 POWERFUL MODEL MOTORS (all different)**  
for robots, meccanos, drills, remote control planes, boats, etc. £2.95.



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by 1/4" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form or £25.00 assembled and tested.

### 12 volt MOTOR BY SMITHS

Made for use in cars, etc. these are series wound and they become more powerful as load increases. Size 3 3/4" long by 3 1/2" dia. They have a good length of 1/4" spindle — Price £3.45.  
Ditto, but double ended £4.25.  
Ditto, but permanent magnet £3.75.



### EXTRA POWERFUL 12v MOTOR

Probably develops up to 1/4 h.p. so it could be used to power a go-kart or to drive a compressor, etc. £7.95 + £1.50 post.

### THERMOSTAT ASSORTMENT

10 different thermostats. 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc., or when fitted say in front of the element of a blow heater, the heat would trip the stat if the blower fuses; appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0 — 100°C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats could cost around £15.00 — however, you can have the parcel for £2.50.

### MINI MONO AMP

on p.c.b., size 4" x 2" (app.) Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or 10 for £10.00.



### — BARGAIN OF THE YEAR — The AMSTRAD Stereo Tuner.

This ready assembled unit is the ideal tuner for a music centre or an amplifier. It can also be quickly made into a personal stereo radio — easy to carry about and which will give you superb reception.

Other uses are as a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.

Some of the features are: long wave band 115 — 270 KHz, medium wave band 525 — 1650KHz, FM band 87 — 108MHz, mono, stereo & AFC switchable, tuning meter to give you spot on stereo tuning, optional LED wave band indicator, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands. All made up on very compact board.

Offered at a fraction of its cost: **only £6.00**  
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## THIS MONTH'S SNIP

**MAINS FILTER** — Don't let mains interference muck up your program or game — up to 13 amp load. Mains filter type FEC. SNIP PRICE ONLY £3.99.

### REVERSIBLE MOTOR WITH CONTROL GEAR

Made by the famous Framco Company this is a very robust motor, size approximately 7 1/2" long, 3 3/4" dia. 3/8" shaft. Tremendously powerful motor, almost impossible to stop. Ideal for operating stage curtains, sliding doors, ventilators etc., even garage doors if adequately counter-balanced. We offer the motor complete with control gear as follows:

1 Framco motor with gear box  
1 manual reversing & on/off switch  
1 push to start switch  
2 limit stop switches  
1 circuit diag. of connections

£19.50 plus postage £2.50

### FOR SOMEONE SPECIAL

Why not make your greeting card play a tune? It could play "Happy Birthday", "Merry Christmas", "Wedding March", etc. or "Home Sweet Home", etc. Wafer thin 3 part assemblies, for making cards musical. Mini microchip speaker and battery with switch that operates as the card is opened. Please state tune when ordering. Complete, ready to work £1.25.

### REEL TO REEL TAPE DECKS

Ex-Language Teaching School, Second, but we understand these are in good order; any not so would be exchanged. The deck is a standard BSR with normal record, replay facilities and an additional feature is tape rev counter. Nicely finished in teak type box. We have 30 only of these. Price £8.50 each + £3 carriage.

### TELEPHONE ITEMS

Plug and Wall socket — 4 pin or 5 pin	£3.45
Plugs only 4 pin or 5 pin	£1.15
Modern desk telephone	£7.50
Heavy black old type	£5.50
External bell unit	£6.50
Bell ringing power unit	£4.50
Pick up coil	£1.15

### STABILISED POWER SUPPLY (Mains Input)

By LAMDA (USA) — Ideal for computer additions, d.c. output. Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% — load regulation 1% from no load to full load — or full load to no load. Complete in heavy duty case — Models available: 5v - 6A £17.25. 5v - 9A £23. 12v - 1.5A £13.25. 15v - 1.2A £13.25. 24v - 2A £23.

**PRESTEL UNIT** — brand new and complete except for 7 plug in IC's — Price: £19.75 + £2.00 p&p.

Note: British Telecom may not connect this equipment as there is no manufacturer to guarantee it, however it is well worth buying for its immense breakdown value — sold originally at over £150.



### WATERPROOF HEATING

**WIRE** 100 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with pvc. Dozens of uses — around water pipes, under grow boxes, in gloves and socks. Price: 23p per metre.

### TIME SWITCH BARGAIN

Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with dials. Complete with knobs **FOR ONLY £2.50.** 10 for £11.50!

### ROPE LIGHT

6 metres of translucent plastic tube full of coloured bulbs makes a wonderful display — suitable indoors or out. £25 + £2 post.

## 50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items — panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, mions, earphone/microphones, nicad charger, power unit, multi-turn pots and notes on the 50 projects.

**YOURS FOR ONLY £11.50 plus £3.00 post.**

### MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, Jewelled bearings: 2000 o.p.v. mirrored scale. 11 instant range measures:

DC volts 10, 50, 250, 1000.

AC volts 10, 50, 250, 1000.

DC amps 0 — 100 mA.



Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only £6.75 + 60p post and insurance.

**FREE** Amps range: kit to enable you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but if you already own a Mini-Tester and would like one, send £2.50.

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## EXTRACTOR FANS — MAINS OPERATED

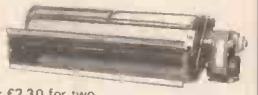
Woods extractor.  
5" — £5.75, Post £1.25.  
6" — £6.95, Post £1.25.  
5" Planair extractor  
£6.50, Post £1.25.  
4" x 4" Muffin 115v.  
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4" x 4" Muffin 230v.  
£5.75, Post 75p.

All the above ex-computer, those below are unused.  
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Tangential Blower 10x3  
air outlet, dual speed  
£4.60, Post £1.50.



### TANGENTIAL BLOW HEATER

By British Solartron, as used in best blow heaters. 2Kw approx 9" wide £5.95, 3Kw either 9" or 12" wide (your choice) £6.95 complete with 'cold' half and 'full' heat switch, safety cut out and connection dig. Please add post £1.50 for 1 or £2.30 for two.



**2.5 Kw KIT** Still available: £4.95 + £1.50 post.

### DISCO PANEL

Make your party or disco more thrilling — add to your record player or amp, a multi-coloured, sound-enhanced lighting display. Made for Amstrad, their ref. No. RP10. Mains operated stereo or mono controlled — has 48 coloured lamps (plus 4 spares) and light level controls. Brand new and unused — offered at a never to be repeated price of £5.75 plus £2.00 post.

**BLEEP TONE** These work off 12v and have an unusual and pleasant bleep. 69p each.

**CONNECTING WIRE PACK** 48 lengths of connecting wire, each 1 metre long and differently colour coded, a must for those difficult interconnecting jobs. 85p the lot.

**RED LEDS** 10 for 69p. 100 for £5.75. 1000 for £52.

**IN LINE SIMMERSTAT** Ideal heat controller for soldering iron and many other hand-held appliances. £2.30. 10 for £17.25.



### VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. These are without case but we can supply a plastic case — £1.75. Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/off's per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30.

### IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder — a complete mains operated kit, case included. £11.95 plus £2.00 post.

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R C Bridge Kit	£9.95
3 Channel Sound to Light — with fully prepared metal case.	£14.95
Ditto — made up	£25.00
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Silent sentinel Ultra Sonic Transmitter and receiver	£9.50
Car Light 'left on' alarm	£3.50
Secret switch — fools friends and enemies alike	£1.95
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2 Short & Medium wave Crystal Radio	£3.99
3v to 16v Mains Power Supply Kit	£1.95
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Morse Trainer — complete with key	£2.99
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electronize

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KITS OR READY BUILT

## TOTAL ENERGY DISCHARGE ELECTRONIC IGNITION



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  - ★ **TOTAL ENERGY DISCHARGE** is a unique system and the most powerful on the market, 3 1/2 times the power of inductive systems - 3 1/2 times the energy and 3 times the duration of ordinary capacitive systems. These are the facts:  
Performance at only 6 volts (max. supply 16 volts)  
SPARK POWER — 140W, SPARK ENERGY — 36mJ  
SPARK DURATION — 500µs, STORED ENERGY — 135mJ  
LOADED OUTPUT VOLTAGE  
50pF load — 38kV, 50pF + 500k — 26kV
- We challenge any manufacturer to publish better performance figures. Before you buy any other make, ask for the facts, its probably only an inductive system. But if an inductive system is what you really want, we'll still give you a good deal.
- ★ **All ELECTRONIZE electronic ignitions feature:**  
EASY FITTING, STANDARD/ELECTRONIC CHANGEOVER SWITCH, STATIC TIMING LIGHT and DESIGNED IN RELIABILITY (14 years experience and a 3 year guarantee).
  - ★ **IN KIT FORM** it provides a top performance system at less than half the price of comparable ready built units. The kit includes: pre-drilled fibreglass-PCB, pre-wound and varnished ferrite transformer, high quality 2uF discharge capacitor, case, easy to follow instructions, solder and everything needed to build and fit to your car. All you need is a soldering iron and a few basic tools.

Most NEW CARS already have electronic ignition. Update YOUR CAR

## ELECTRONIZE ELECTRONIC CAR ALARM



### HOW SAFE IS YOUR CAR ?

More and more cars are stolen each week and even a steering lock seems little help. But a car thief will avoid a car that will cause him trouble and attract attention. If your car has a good alarm system - well there are plenty of other cars to choose from.

#### LOOK AT THE PROTECTION AN ELECTRONIZE ALARM CAN GIVE :

- ★ **MINIATURE KEY PLUG** A miniature jack plug attaches to your key ring and is coded to your particular alarm.
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- ★ **30 SECOND EXIT DELAY** The system is armed by pressing a small button on a dashboard mounted control panel. This starts a 30 second delay period during which the owner can open and close doors without triggering the alarm.
- ★ **10 SECOND ENTRY DELAY** When a door is opened a 10 second delay operates to allow the owner to disarm the system with the coded key plug. Latching circuits are used and once triggered the alarm can only be cancelled by the key plug.
- ★ **L.E.D. FUNCTION INDICATOR** An LED is included in the dashboard unit and indicates the systems operating state. The LED lights continuously to show the system is armed and in the exit delay condition. A flashing LED indicates that the alarm has been triggered and is in the entry delay condition.
- ★ **ACCESSORY LOOP - BONNET/BOOT SWITCH - IGNITION TRIGGER** These operate three separate circuits and will trigger the alarm immediately, regardless of entry and exit delays.
- ★ **SAFETY INTERLOCK** The system cannot be armed by accident when the engine is running and the car is in motion.
- ★ **LOW SUPPLY CURRENT** CMOS IC's and low power operational amplifiers achieve a normal operating current of only 2.5 mA.
- ★ **IN KIT FORM** It provides a high level of protection at a really low cost. The kit includes everything needed, the case, fibreglass PCB, random selection resistors to set the code and full set of components etc. In fact everything down to the last washer plus easy to follow instructions.

fill in the coupon and send to:

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- Assembled ready to fit £26.70 £19.95
- D.I.Y. parts kit £15.90 £14.95

#### TWIN OUTPUT for cars and motor cycles with dual ignition

- Twin, Assembled ready to fit £36.45 £29.95
- Twin, D.I.Y. parts kit £24.55 £22.95

#### INDUCTIVE DISCHARGE (12 volt only)

- Assembled ready to fit £15.95 £12.75

Prices include VAT

£1-00 PP(UK) per Unit

#### CAR ALARM (12 volt negative earth)

- Assembled ready to fit (All wires and connectors incl.) ~~£27.95~~ £29.95
- D.I.Y. parts kit ~~£24.95~~ £19.95

I enclose cheque/postal order OR debit my Access/Visa card

VISA

Name \_\_\_\_\_

Address \_\_\_\_\_

Code \_\_\_\_\_

# MONITOR

## Easier To Digest

We have had a number of letters asking about back issues of *Electronics Digest*. You may have noticed that we rarely have room for a House Ad. for Digest, which is a pity because the back issues have some interesting stuff in them.

Our distribution department tells me that the following past Digests are still available:

Volume 1 no. 1 and 3; Volume 2 Nos 1, 2, 3, and 4; Volume 3 Nos 1, 2 and 3, and Volume 4 Nos 1 and 2.

To summarise briefly, Vol. 1 No.1 is a collection of circuits from *Electronics Today* (most of the project issues contain projects from ETI and HE); Vol 1 No. 3 "Data Book" is a components issue, with descriptions of different classes of components, types, pin connections, truth tables and general articles.

Vol. 2 No. 1 is a "Home Security" issue, with a collection of circuits for safeguarding home and car; Vol. 2 No. 2 is a project issue, primarily of ETI projects; Vol. 2 No. 3 is a bumper project issue with 150 projects; Vol. 2 No. 4 is a "Gateway To Electronics/Complete Constructor's Course", with twenty projects plus instructions on technique.

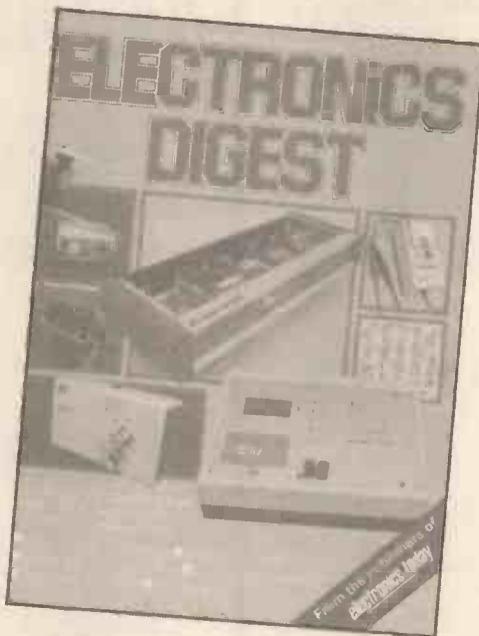
Vol. 3 No. 1 is a more advanced version of Vol. 2 No. 4, the "Designer's Notebook", with 120 circuits, design hints, techniques and construction notes; Vol. 3 No. 2 is a general projects issue; Vol. 3 No. 3 is a "Graded Course In Projects Building" based entirely around HE projects, with an introductory feature in components.

Vol. 4 No. 1 is an introduction to circuit design for the almost beginner, which starts by reprinting most of the popular HE series *Into Electronic Components*, and then follows with a section on techniques, followed by a directory of basic circuits: Vol. 4 No. 2 is a Data Book, this time on microprocessors and support devices, reprinting data on all the popular constructors' microprocessors. Vol. 4 No. 3, just out, is a collection of projects from ETI, under the headings *Home and Car, HiFi and Sound, and Lab Test*, and costs £1.95.

Because some issues have literally vanished from the face of the earth, we are *not* doing photocopies of the missing issues, but any of those listed above can be had for £2.25 a copy despatched to our usual backissues source, 513 London Road, Thornton Heath, Surrey CR4 6AR. Money orders and cheques should be made out to ASP Ltd.

## A Cool Handle

Litesold have introduced a mains-voltage electronically temperature controlled soldering iron. The EC50 incorporates an electronic temperature control circuit mounted inside the handle, which operates in response to a



thermistor fitted inside the bit-mount. Power to the 50W heating element is controlled by a triac operated by a zero-voltage switching IC, to minimise spiking and RFI, and the iron is fully earthed so that it may safely be used on sensitive equipment and components.

A special feature of the design is that the low-voltage supply necessary for the control circuit is obtained by means (for which a patent is pending) which does not involve fitting a dropper resistor in or near the handle. This problem has previously prevented a mains iron of this type being made to run with a sufficiently cool handle.

The control circuit provides a proportional control band, so that power to the heating element is only fully on or

off outside a temperature band centred on the set value. Within this proportional band, power is supplied in regular phases of equal interval but of a length which varies according to the difference between 'actual' and 'set' temperatures. This feature, we are told, gives an extremely close control, with no swing or overshoot. An internal neon indicator glows through the translucent handle when the element is energised. Access is provided to the temperature control potentiometer, the settings may be varied from approximately 280 to 400°C. The standard setting is 370°C.

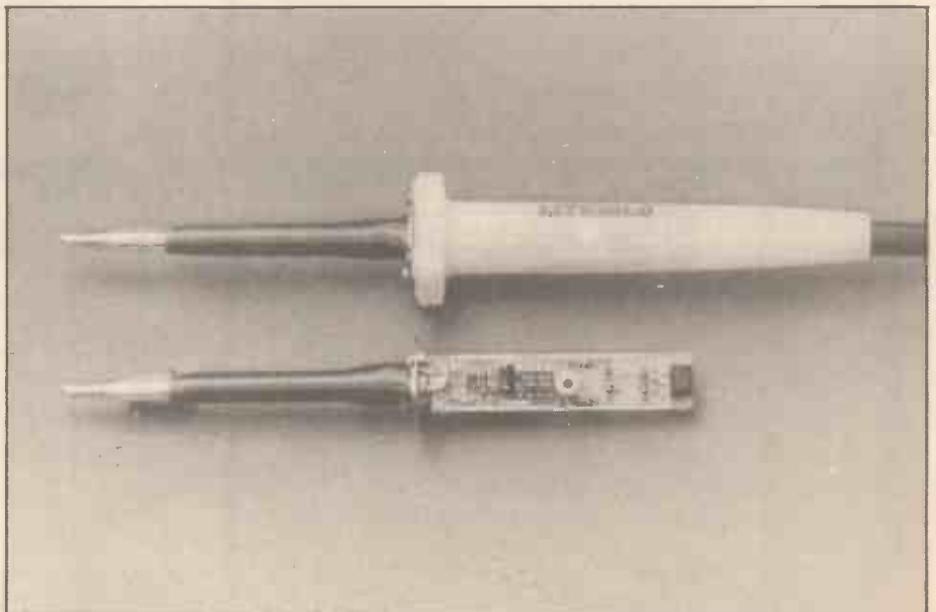
Prices and information from Light Soldering Developments Ltd., Spencer Place, 97-99 Gloucester Rd., Croydon CR0 2DN. Tel: 01 689 0574.

## Video Production Courses

JVC's Video Information Centre in London's Piccadilly is once again holding courses for those wishing to know more about video, video techniques and video production. The new lecturer at the Centre, Phil Compton, will be running two levels of course, basic and advanced, and, where requested, will also arrange special courses designed to suit particular needs. Courses are twice monthly, have already begun at the VIC and will begin shortly in Bristol.

The basic production course is a three day course designed for beginners with little or no experience of video production. Starting from the basics, the course builds over three days to form a complete education into the art of producing a coherent and effective programme or film.

The advanced course is a follow-on from the basic course, putting into practise much of what has been covered. However, the course broadens



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on the base and develops themes and ideas further, ensuring that the participants have comprehensive understanding of how to extract the most from their videos. Much of the emphasis of this two day course is on avoiding and correcting production problems.

For further information concerning availability and dates for these courses please contact Phil Compton or Mike Whyman at the JVC Video Information Centre, 82 Piccadilly, London W1. Tel: 01 491 3775.

## Modular Case System

Elinca Products have introduced a modular case system for electronic assemblies and instrument displays. Developed from the Elinca range of BEC cases first introduced in 1972, the new system is designed for use by manufacturers or for DIY.

The new BEC system comprises pre-formed body panels, facias and moulded end cheeks, which make up a wide variety of cases, ranging in size from 2x5x6in up to 2x5x13in. All case sections are pre-punched for instant assembly and are available in a choice of white or black, with natural aluminium or black fascia panels. Polished teak veneered end cheeks are also available.

The cases are manufactured in plastic coated metal which is anti-static with high insulation and screening properties, with end cheeks in textured high impact resistant polystyrene.

The BEC cases are available for DIY in hanging displays complete with screws and assembly instructions. Details of the new case system are available from Elinca Products Ltd., Lyon Works, Capel Street, Sheffield S6 2NL. Tel: 0742 339774.



## Electronic Memo Pad

A British-designed electronic memo pad which can carry out the functions of a calendar, diary, address book, note pad and expense account log has been launched into the UK by Domicrest Ltd. The unit measures 136x90x9mm and will therefore fit in the pocket or the handbag. Called the Biztek Pad, it will be priced £69.95.

Comprising a potential memory of 4000 characters, the Biztek Pad is battery operated and combines a 43 key push button keyboard with a large LCD with 16 alpha-numeric characters, 20 numeric and clock digits and 45 special symbols.

One of the Biztek Pad's prime uses is as memory aid. By keying in important appointments such as weddings,

birthdays and anniversaries, and adding a date and a time and utilising the alarm function the pad can be programmed to sound the alarm at the appointed time. The necessary reminder can then be recalled to appear on the screen. The unit will store such reminders for up to twenty years in the future.

As a diary the unit will store any day-to-day events that the user need to recall. Appointments for the day or the week can be recalled and reviewed in the order in which they were entered. Additional functions are a calculator, a stopwatch and a permanent calendar and time display. A memory save switch ensure that stored items are not inadvertently removed when the batteries are changed.

For further information contact Kestrel Communications Ltd., Regent House, Manor Place, Sutton, Surrey SM1 4BB. Tel: 01643 9131.

## Pics On The Printer

Softest of Romsey have produced an interface to connect the Spectrum or ZX81 with the Tandy GCP-115, and more recently a screen copy program which enables the contents of the Spectrum's screen to be copied onto the Tandy printer (in use with the same interface).

The Softest interface is a package designed to cope with the 'handshake' protocols between the micro and the printer, with a set of machine code device drivers to control the movement of the printer's four coloured pens. High level packages supplied allow listing of BASIC programs between line numbers and use of printer control codes.

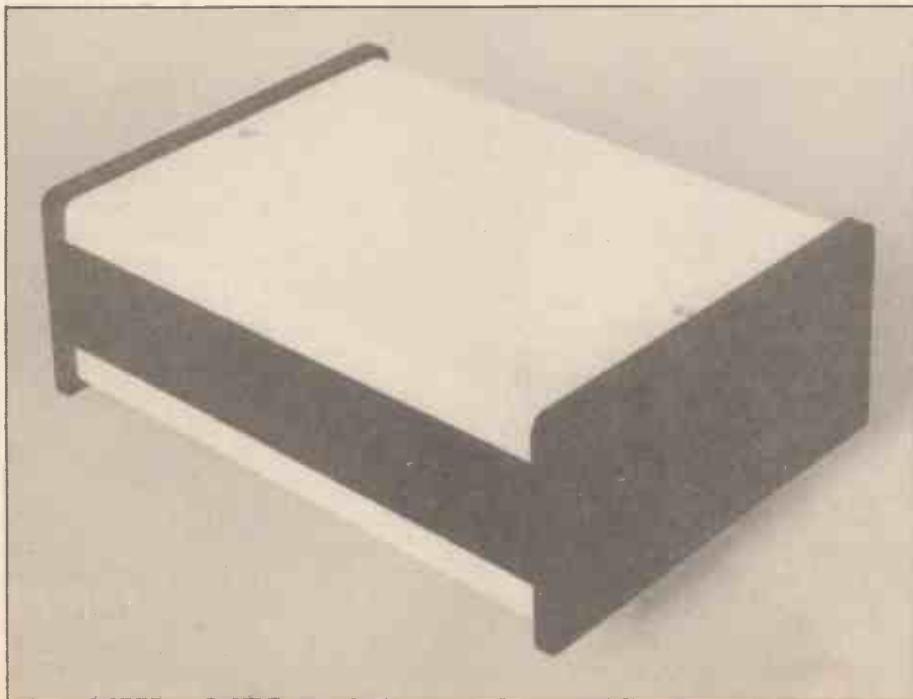
The package is suitable for text, plans, drawings, program listings, PCB layouts, graphic presentations, charts and oversize lettering.

The Screen Copy program allows a Spectrum screen to be copied onto the Tandy printer. The screen is scanned horizontally by software and the printer information sent to the printer in synchronisation, enabling text and graphics to be copied. Colours are mapped to the four colours available to the printer, the mapping of the colour's under the user's control. The Softest program can be merged with the user's own programs, and the ability to overprint means that large block letters can be produced in one or two colours.

Softest will be supplying programs to allow users to examine graphics on the screen and send plot data at higher resolution to the Tandy printer. This combines the speed of screen viewing with the high resolution of the printer.

The interface costs £35, including connectors, leads, cassette software, instructions, postage and packing. The screen copy program costs £5.00 (on cassette).

Enquiries to Softest, 10 Richmond Lane, Romsey, Hants SO5 8LA.



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## Computer Chess

Eureka Electronics have a new, high-level chess computer to complement the rest of their range. The Novag Constellation is designed for enthusiasts playing at experienced club level. And it costs £149.95. That's all the information we have, but Eureka should be able to provide more details.

Advanced Computach is a chess computer with eight levels of play and an "incredibly strong program with an extensive opening book". Response time is from 5 seconds to fifteen minutes depending on level of play, and it costs £29.95. Computachess is a simple low-cost computer with a fast response time (a maximum of 45 seconds), and aimed at beginners and casual players. This one costs £24.95.

The Novag Micro II is a portable machine with eight levels, a varied opening book and take-back facility to re-play moves. This one provides a "strong challenge at all eight levels of play" and costs £49.95.

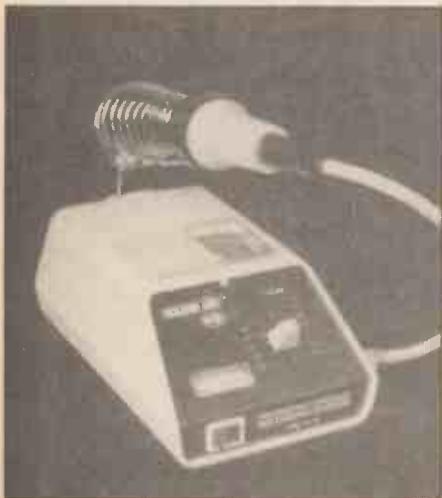
Further information from Eureka Electronics Ltd., 26 Castle St., Brighton, E. Sussex, BN1 2HD. Tel: (0273) 202016.

## Right, OK

New releases from OK Industries include a temperature controlled soldering station with tip mounted sensors and fast response and stability within 5% over 100 to 500°C. The mains powered unit comes with a 24V 48W low-leakage iron and is earthed for MOS and CMOS applications. The station iron has power and heater indications, proportional temperature control and a solder spool holder to take spools up to 7in (178mm) in diameter is also available.

The DE-720 is a flame-retardant ABS enclosure designed for data entry, keyboard or desk-top computer systems. 20in wide and 7in high to take 5¼ (U3) full, half or quarter rack frames, it is of modular construction so that all the panels can be easily removed for access and service.

A range of customizing services is



available, and features like bezels, control and connection openings or joysticks can be incorporated. There is even a choice of colours — the off the shelf colour is tasteful tan.

The SP-699 support unit is a mobile workstation with height adjustable between 555 and 780mm (with an additional 65mm if levelling feet or castors are used). Formica desktops and a mechanism to give ±18 degrees of tilt to the head are optional. Loads up to 50 kg can be carried.

Enquiries to OK Industries UK Ltd., Dutton Lane, Eastleigh, Hants SO5 4EE. Tel: (04246) 3993.



## Green On The Screen

Philips have introduced a low-cost video display TP 200 for personal computers. The mains-powered 12 in monochrome monitor has a composite video input compatible with most micro-computers including the Acorn/BBC Micro and Apple II. Crisp definition is achieved by the Philips green (P 31) anti-glare screen, which has 80 x 25 character resolution.

A useful design feature is an extendable stand fitting to the base of the display which enables the front of the unit to be raised tilting the screen to the correct angle for individual users.



Enquiries to Philips Digital Recording Department, c/o MEL, Manor Royal, Crawley. Tel: (0293) 28787.

## Going, Going, Gong

Siemens have developed an acoustic warning device for drivers which emits a signal as soon as reverse gear is engaged. The device is based on the SAB 0600 gong module, which emits a musical triad (a chord of three notes). The warning signal is triggered by the reversing-light switch.

Those who need to hire a car frequently are familiar with the problem of finding (or avoiding) reverse gear. Gear shift patterns differ from vehicle to vehicle, and the gear shift lever can be positioned in any of the corners of the gear shift pattern. It can be helpful if the action of selecting reverse gear is accompanied by an acoustic signal. A warning tone is always heard, irrespective of where the driver happens to be looking at the time. The SAB 0600 emits a triad from a very small and very compact loudspeaker. The three notes ensure that the signal cannot be obscured by any continuous tone.

The circuit requires very few external components. It comprises only ten items in addition to the gong module. The entire circuit is accommodated in a casing some 20x30x40mm.

For more information contact the Press Office, Siemens House, Windmill Rd., Sunbury-on-Thames. Tel: (09327) 85691.

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## Microprocessor DMM

Keithley's Model 175 is a microprocessor-based DMM offering six measuring functions and featuring many facilities that are normally found on high priced system DMMs. The measurement range is wide, giving 10uV resolution on DC to 1000V; AC measurements up to 100KHz using the TRMS convertor from 10uV to 750V; TRMS current from 10nA up to 10A; DC current from 10nA to 10A; Ohms from 10m up to 200M ten times more than conventional DMMs, dBs from -58dBm to -59.8dBm.

The internal processor enables the user to store a hundred readings in the built-in memory and monitor the maximum and minimum values at any time. There is no calibration pot in the 175; the calibration constants are held in the non-volatile memory, calibration can take place either from the front panel or over the IEEE bus. Security links are provided to defeat the digital calibration should this be required.

The 175 has a fast advantage with a 4½ digit LCD display. The display also carries a full set of annunciators to make it easy to use.

IEEE and battery options can be installed in the unit. The IEEE interface enables the user to program the range and take readings using simple bus commands. The battery pack gives field operation of up to six hours before recharge. Recharge takes place automatically when the instrument is switched on.

For further information please contact Keithley Instruments Limited, Boulton Rd., Reading, Berkshire. Tel: (0734) 861287.

## Sensible Authors

Microbooks, a newly established publishing company, has its first book coming out shortly. Entitled 'The Sensible 64' (128 pp, £5.95) and written by David Highmore, it is aimed at CBM 64 owners who have discovered this computer's many capabilities and want to expand their knowledge further.

David Highmore is currently writing a book using machine-code on the Dragon and this will be published in January 1984.

Microbooks are looking for new material for future books on all makes of home computer — any budding authors of either complete books or just individual programmes suitable for publication are invited to contact us at Microbooks, 443 Millbrook Rd., Southampton, SO1 0HX. Tel: (0703) 78020/1.

## Don't Move!

Riscomp have a number of additions to their range of security modules. Of particular interest is the US5063, an ultrasonic movement detection module which employs digital techniques for processing the received signal.

Such an approach has not only provided a superior performance analogue circuitry, but also allowed a choice of three levels of discrimination against false alarms. An exit delay and fixed alarm time have been incorporated together with a selectable entrance delay, whilst the transmitter section of the module being crystal controlled allows the use of several units, where large areas are to be covered, without inter-action problems. A 'hold' facility, together with a built-in LED indicator, is provided for setting up purposes.

Priced at £13.95 + VAT the module is supplied with a comprehensive Data Sheet. For further details please contact Riscomp Ltd., 21 Duke Street, Princes Risborough, Bucks HP17 0AT. Tel: (08444) 6326.

## A Rat's Nest

SF author Harry Harrison is one of several writers who have signed with a British publisher to create an entirely new form of fiction: using a home computer to take an active part in stories.

Harrison, best known for his 'Stainless Steel Rat' novels, is working with a computer programmer to create adventure game programs tied in with his own stories. Readers will be able to 'play' the scenes and determine the outcome.

The combined book and program package will be published early next year by a new company, Mosaic Publishing, which has been formed to produce books in combination with home computer software. The result will give a new meaning to the expression 'reader involvement': in future, authors may have to find out from their readers whether the hero got eaten or not... In addition to the Harry Harrison project, plans for 1984 include a package based on the 'Unorthodox Engineers' SF stories by Colin Kapp and a selection of children's, detective and educational non-fiction titles.

Sounds like a video game to me!

Enquiries to Mosaic Publishing Ltd., 187 Upper St., Islington, (land of the telephone call boxes and Hot black & Desiato), London, N1 1RQ. Tel: 01 359 7693.

## A Little Power

Edwards Electric, a small company specialising in low-voltage DC power supplies, mainly for education and industry, has produced a leaflet detailing their range of 2V to 65V supplies, providing a maximum power output of 4VA or 10VA. The units cost between £15.65 and £18.50 (plug provided), and the list is available if you send an SAE to Edwards Electric, P O Box 27, Unit 3, Mill Lane, Church St., Bridgewater, Somerset TA6 5AT. Tel: (0278) 421530.



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## Digital Thermometer

Candis Electronics have launched a new range of hand held digital thermometers. Their low cost model, the 1001, at £47.00 is designed for out of door and laboratory use. The casing is moulded ABS, the display is 3½ digit LCD, and all temperatures from -50°C to 1150°C can be measured, with automatic ambient and cold junction compensation. Candis also do a range of twenty standard probes, plus custom probes for special uses.

Leaflet and further information from Candis Electronics Ltd., Highdown Works, Highdown Avenue, Worthing, W. Sussex. Tel: (0903) 690750.

## Get Clamped

Electronic & Computer Workshop has available two forcep-type clamps in its range of high quality tools. These nickel-plated carbon steel clamps, designated PFC1 and 2, are 5in and 5½in long respectively and weigh about 30 gms. The jaws of these ratchet-operated clamps are cross-serrated, 15mm long x 4mm wide (type PFC1) or lateral-serrated, 25mm long x 3mm wide (type PFC2) and provide an extremely firm grip. Made entirely with a heat-conducting material, these clamps can be used as heat sinks, providing thermal shunting for delicate components during soldering. They are effective wire-clamps, and can be used to retrieve small articles from restricted areas, making a useful 'third hand'. Both types of clamp are £2.50 plus 45p p&p and VAT.

A 1000 watt dimmer kit is currently available priced from £4.33 to £13.80 for the suppressed version. These electronic dimmers incorporate a specially-designed circuit that frees them from hysteresis effect — in particular from switching systems. The dimmers are protected for use with drills and other inductive loads.

The unit has a 5 to 98 per cent regulation and is ideal for use with both resistive and inductive loads. The suppressed version is supplied with a toroidal choke.

A robust electrician's multimeter, the

Electro ISC, manufactured by Pantec, features a phase sequence and voltage indication. It also has overload protection which is given via both a fuse and neon discharger.

With a measured accuracy of two percent for DC and resistance and three percent for AC, this meter has a wide indicating range. It will measure DC voltages from 3 to 1000V, AC voltages from 15 to 1500V, DC and AC current from 3 to 30A and resistance from 0R5 to 1MR in two ranges. Overall dimensions are 130 x 125 x 40mm.

The Velleman four channel infra-red remote control priced at £38.58 plus £1.00 p&p and VAT, for the receiver and transmitter, is available in kit form.

The remote control which, with optional flip-flop ICs, provides a latched push-on/push-off function, may be used to operate several functions, including opening garage doors and for lighting control. Without the flip-flops the function is a straightforward on/off. Power switching relays may be connected directly to the output (50mA) if required. Maximum operating range is 20m.

The receiver pre-amplified is supplied in a screened box, which mounts onto a PCB with the remaining components, and a stabilised power supply operable from 12V to 14VAC supplies. A high degree of immunity to interference signals is provided with the use of coded signals.

The transmitter uses four power infra-red LEDs with reflectors, and comes complete with a compact styled case. Powered by a 9V battery normal operating life is approximately twelve months.

For further information please contact Caroline Stewart, Electronics & Computer Workshop Ltd., 171 Broomfield Rd., Chelmsford, Essex CM1 1RY. Tel: (0245) 62149.

## EPROM Eraser

Ground Control are offering an EPROM eraser for home computer owners (or other small-scale EPROM erasing operations). Their UVIPAC uses a low-profile transformer to attain the compact dimensions of 90 x 80 x 40mm

(cased). The unit can erase any three EPROMs or one CPU with an on-board EPROM in five to twenty minutes depending on type. The UVIPAC can be supplied with a built in fifteen-minute timer as an optional extra, and spare discharge tubes and conductive foam pads for loading the EPROMS can be supplied.

The standard UVIPAC costs £19.95 plus £1.95 p&p (UK only) and the timer version costs £24.95. Both prices include VAT. Overseas buyers please enquire, enclosing an IRC, for shipping costs. All enquiries to Ground Control, Alfreda Avenue, Hullbridge, Essex SS5 6LT. Tel: (0702) 230324.

## DIY Detector

C-Scope International, a leading manufacturer of metal detecting equipment, have produced a detector in kit form. The K5000 kit is designed for construction by the hobbyist with only a limited range of equipment and comes, say C-Scope, with a comprehensive construction and user's manual, so that even a beginner can be confident of success.

When complete, the K5000 is a six-control detector comparable to a £250 off-the-shelf model. We aren't told what the kit will cost, but you can enquire at your local hobby shop or direct to C-Scope International Ltd., Wotton Rd., Ashford, Kent TV23 2LN. Tel: (0233) 29181.



## A Day By The Sea

Taking a bold decision to put faces to some of the press releases, catalogues and trade circulars I wade through at *Monitor*, I ventured down to Brighton early in October to visit *Internecon*, one of the major trade hardware exhibitions and conferences.

My first response, after inveigling my way through the side entrance, was one of advanced sensory overload. The Metropole Hotel is a grand and plush building on the Brighton seafront, with a very large amount of exhibition space inside. Olympia it ain't, however, and most of the space is distributed in comparatively small parcels, with the effect of a monstrous technological termite nest.

However, having sorted that out, and discovered that, yes, the Press Office actually was under the stairs, although not the same stairs as originally indicated, I set out to circulate.

I retain the impression that the exhibition was around 40% industrial cables and connectors, and 40% custom mouldings machinery. The remainder, distributed seemingly at random, were dealing in small connectors and hand-tools of interest to home constructors.

What I wanted to find out was how these suppliers, who are normally geared up to dealing with industry, reacted to interest from amateurs, or if, indeed, they had a significant number of enquiries from amateurs. Particularly I had heard rumours that some firms set a high minimum-order value to forestall the classic handwritten-letter-and-postal-order request for one or two parts.

The picture that emerges is, as usual, somewhere between the extremes of wild enthusiasm and complete revulsion. While it is true that many firms set a minimum order value of, say, £50, this is less to discourage one-off orders than it is to encourage regular customers to order in packages which it's economic for the firm to handle (unlike HE, they can't tell their customers to 'send an SAE'), and often only applies to cash customers and not those with trade accounts or paying by credit card. Besides, these companies rarely deal in anything which the amateur could find a use for.

Believe me, industrial connectors are an art and science all to themselves.

Other companies, making mostly industrial goods but with some stuff useful to amateurs, have outlets through other distributors which

individuals can either access directly, or through local traders.

Some of them actually encourage amateur trade, and set up departments to deal with it.

**AB Engineering**, whose tools appear in *Monitor* from time to time, are one of such. They are, they tell me, going carefully but definitely into the amateur market. They will now take credit card orders, which are easier for all concerned. And they are going to be at Breadboard this year, so if you want to check out their range, this is the place to see them.

**Honeywell Control Systems** are in the rather different situation of not objecting to small orders, not pursuing small orders, and sometimes getting a rush of them unexpectedly — for instance, some time ago ETI published a light-pen project which generated a sudden demand for fibre optic links. *Monitor* has occasionally featured their touch-keypads. Honeywell have their own distributors, including RS, who you should be able to order from through your local electronics dealer.

**DAU**, who deal mostly in connectors, have a £50 minimum order limit, as it costs them too much otherwise, but automatically route any small orders to one of their distributors. **Swift-Sasco**, on the other hand, have a minimum cash-with-order value of only £5, and produce a catalogue. **Green Connectors** always refer enquiries to their distributors, and prefer not to have small order enquiries — this came as news to me, as we feature their projects from time to time. But news releases and product news is often handled by a PR company which spreads it more widely than the manufacturers realise.

(We get product news releases in this office which we would not dare to feature. Our readers would have a good laugh, and the manufacturers wouldn't thank us, either...)

**Bicc Vero Electronics** (close relations of Verospeed) who are best known for their project-boards and boxes, produce their own Hobbyist catalogues, with a department in charge of amateur orders, and there is no minimum order charge. They outlet a lot to the small constructor through local shops, and their stuff is used in schools and colleges.

**Litesold** on the other hand, are well known for their temperature-controlled soldering irons. I had always thought that they were mainly selling to home constructors, but not a bit of it. However,

they are one firm that is very definitely geared up to dealing with amateur orders, and occasionally do special offers for them (and they advertise regularly in HE, too).

Lest you be tempted to believe that it is only the amateur who is the victim of 'economies of scale', ie firms not catering for small buyers, I spoke later in the week to my sister, who buys components for a small electronics firm. She had also been to *Internecon*, searching for an economically priced flow-soldering machine (a device which solders a whole PCB in one go by washing a carefully-controlled ripple of solder over the underside of the board). Apparently, if you want to spend £5000 or £15000, you're well away, but if you only want to spend £2000 for a unit you can stand in the corner, the choice is pretty meagre. You think *you've* got problems!

The strategy to adopt if you want to obtain something from an unfamiliar source with no clear-cut ordering policy is to write to them with your enquiry and send an SAE — this is not to save the company money, as is popularly thought, but to save them the process of acquiring, typing out and stamping an envelope. The rule is this: for every part of the correspondence you can take out of *their* hands and see to yourself, your chances of getting a prompt and successful response increases. It's a by-product of Murphy's Law, and can be taken as fundamental without in any way derogating any company's order department. The other, related, rule, is to give as much useful information about your enquiry as possible. If this is beginning to sound like HE's Reader Services Page, it's because the same rules apply!

Oh yes — and when the time comes to send money, there's nothing wrong with the handwritten-letter-and-postal order, but print all part numbers etc., and cross your PO. For your own sake, it's safer if you use a cheque, and make a photostat or a carbon copy of your letter — if anything goes missing, it is then much easier to trace.

As a final thought, in case anyone is tempted to scorn their corner component shop, an acquaintance not entirely unconnected with a major aircraft concern with extensive dealing in both civil and military aviation are in the habit of nipping down to their local when they need a few bits for radio repairs and the like. It's the quickest way, they say, to get spares.

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## Speaking Spectrum

Currah Computer Components have produced a speech synthesis module for the Sinclair Spectrum.

Designed to be straightforward to use, the Microspeech gives a voice to all the keys on the Spectrum, requires no preprogramming, and can alter the intonation of sounds keyed in.

The technique used for building words is the now-established allophone system, which is flexible and allows an unlimited vocabulary — in English at least (I would be interested to know if anybody has succeeded in getting a speech synthesiser to produce reasonable results in any non-English language). It has a self diagnostic feature for syntax checking, microdrive capability and an audio output for use with hifi amp or tape recorder (immortalise your speeches).

The Microspeech costs £29.95 and comes with a demonstration and games cassette, and it will shortly be available for the ZX81, Oric, Dragon and BBC Micro.

Enquiries to Currah Computer Components Ltd., Graythorp Industrial Estate, Hartlepool, Cleveland.



## Interface The Facts

Sinclair Research have been busy: as well as their flat-screen television, newly come on the scene, they have launched the ZX Interface 2. The Interface provides the Spectrum with joystick and ROM cartridge facilities.

It's a solidly-built piece of equipment which plugs either directly into the Spectrum's rear expansion port, or the ZX Interface 1. There is a hinged porthole for cartridges, and two joystick ports for standard nine-way D plugs. The joystick ports are neatly covered with flush lids, which will, we anticipate, provide endless opportunity for losing them, as they are not hinged. We managed to lose three of ours within ten minutes of unpacking the unit, which is good going as there are only



two. In this respect, they have the same qualities as biro caps, only moreso. Still, this is only the preproduction model; perhaps they will think of something. Two lengths of strong elastic? Perhaps the easier option is just to let the covers go and give the unit a quick Hoover once a week.

all the ROM cartridges will work with a 16k Spectrum, even where the cassette version requires 48k — a real boon. Joysticks connected to the Interface will then work with ROM cart, cassette, or Microdrive programs. The Interface and cartridges are initially only available mail-order. We have been given the price £19.95 (inc. VAT but no mention of p&p) and suggest you contact Sinclair Research, Stanhope Rd., Camberley, Surrey GU15 3PS. Tel: (0276) 685311, for further information.

## Come In, Enterprise

The Elan Enterprise 64, announced as the first of a range of British home computers designed by Intelligent Software Ltd., boasts more built-in features than any other current machine in its class.

The Enterprise keyboard has sixty-nine full-travel contoured keys (like an electronic typewriter). Eight special 'user definable' keys allow you to write programs in which just one keystroke will carry out a number of commands.

The built-in joystick, on the right of the keyboard, is used for games and text manipulation, and two extra joystick sockets mean that games can be designed for three people.

The machine's memory — 64K RAM — lets you achieve the most from the outstanding colour graphics capability. It contains a unique memory controller and plug-in expansion system to allow

unrivalled RAM capacity. Providing more scope for helpful commands in the BASIC programming language, the Enterprise's large ROM (32K) also allows for a more powerful operating system.

The specially designed chips in the Enterprise are also noteworthy. The video chip (called 'Nick') gives the machine a tremendous flexibility in its screen display, and the sound chip ('Dave') handles the audio: four sound sources, each with full volume control on stereo output.

The built-in word processor handles word wrap, text centering, justification and paragraph moving, while its text handling makes it possible to choose a display with fifty-six lines on the screen — each with 84 columns.

In addition to the ability to generate stereo sound other outstanding features of new machine include a cassette loading meter, which helps you set the correct volume on the recorder, so that programs will load into the computer without difficulty.

Elan Computers are supported by Intelligent Software, who are putting together an extensive catalogue of software, written by them and by other software designers. Categories within the Elan Software range include video games, games of strategy, home applications, small business applications, educational programs and computer applications.

The Enterprise 64 and 128 models will reach the market early in 1984 and retail prices are from £200. Further enquiries to Elan Computers Ltd., 31-37 Hoxton Street, London N1 6JN. Leaflets are available.

The photograph shows a flexible connector linking the Enterprise to a 64K RAM expansion and a 3.5in microfloppy disk drive. New units can be plugged into the peripheral stack.



## Technology For Schools

**BBC School Radio** is breaking new ground with three series designed to prepare schoolchildren for the new technology, a computing series for junior schools, complete with software, and electronics series for junior schools and a microtechnology series for 'O' level and CSE students, complete with filmstrips and kits of parts. Working in collaboration with the Microelectronics Education Programme and the Department of Industry, School Radio hopes to make a major contribution to both teachers and pupils in their approach to the new technology.

The first series is *'Using Your Computer'*, a unit of five programmes in the *'Introducing Science'* slot for 9-12 year olds, which started on Tuesday, November 1 at 2.20 p.m. on Radio 4 VHF. This series will help teachers in primary and middle schools introduce children to the computers supplied to schools under the Dol 'computers in schools' scheme, the BBC Micro-computer, Model B, the Sinclair Spectrum and the Link 480Z. The series, which is designed for recording, offers a completely new dimension in educational broadcasting in which radio broadcasts are synchronised with computer software. The children cue the computer at the direction of the broadcast. In this way the computer is given a friendly voice which guides the children through the initial stages of the operation and application of the machine. Thus children learn to use a computer by using a computer. The software, consisting of four computer programs, costs £7.00.

*'Junior Electronic'* is a series for children in the same age range which starts the Spring term on Tuesday, February 28, at 2.20 p.m. on Radio 4 VHF. In the five programmes children are piloted through very simple practical work, learning to construct basic

electrical and electronic circuits on a specially designed circuit board. The circuit board is included in a special kit of parts, on sale from BBC Publications. The fifth broadcast is a Radiovision programme in which the children are shown the relevance of the real life applications of the circuits — why a street light lights up, how a burglar alarm works. The kit of parts, suitable for up to four children, costs £5.25 (there is a Dol subsidy of £1.50 on the first kit for each school). The Radiovision filmstrip costs £5.40.

Both *'Using Your Computer'* and *'Junior Electronics'* are designed so that they can be handled by teachers with little or no previous knowledge of the subjects. Each series is accompanied by very extensive teacher's notes.

Also in the Spring term is *'Microtechnology'*, ten programmes for 'O' level and 'O' grade CSE candidates starting at 10.45 a.m. on Friday, January 20. This series forms an introduction to basic microelectronics leading to ideas of control technology and is dependent on the medium of Radiovision (five of the programmes are Radiovision) associated with practical work. There is a kit of parts and a specially developed circuit board and power supply unit. (The kit is compatible with commercial prototype boards which schools may already possess). Computer software associated with the series will become available in the Spring. The Radiovision filmstrips cost £5.30 each. The kit of parts, suitable for use by up to three students, costs £18.50.

The series are produced by Arthur Vialls, and will be repeated in the autumn of 1984. For brochures detailing how to order suitable equipment for the series contact The BBC Press Office, 12 Cavendish Place, London W1.

## School PSU

Built for educational use, *PMF Design And Development's* twin channel power supply has been built to BBC School Radio specifications and passed by BBC Engineering, and is both physically and electrically robust, we are told. It is designed to fulfill normal power supply requirements for logic and analogue electronics courses.

The unit features twin 1A supplies separately switchable to 5, 9 or 12V. Supplies may be used independently, in common earth mode or to provide a split rail supply. Each supply has independent short circuit and thermal protection.

Regulation is better than 0.4% over full load range; ripple and noise is better than 12mV peak to peak at full load.

The price of the unit is £36.85 plus p&p and VAT. For quotation and specification contact *PMF Design and Developments Ltd.*, PO Box 5, Romford, Essex RM3 7LH.

## London Home Computer Show

Building upon the great success of the 1983 London Home Computer Show, the 1984 event is to be staged in the much larger New Hall of the Royal Horticultural Society, just around the corner from the Old Hall where the Show was held in 1983.

Staged just after Christmas, this will be the show for the micro hardware and software enthusiast wanting to try out and then buy the hardware or software of his choice. Its central location just behind Westminster's Victoria Street makes it ideal for visitors from London and the provinces, and is close to Victoria BR station.

Open from Friday January 6th to Sunday January 8th 1984 from 10 am to 6 pm each day except Sunday, when it closes at 4 pm, admission to the Show is £2.00 — under-sixteens £1.50.

Further enquiries to *ASE Ltd.*, Wolsey House, Wolsy Rd., Hemel Hempstead, Herts HP2455. Tel: (0442) 41221.

## Red, Amber, Green

*Vulcan Electronics*, a new company only doing mail order at the moment, have produced a car battery voltage monitor with a seven-LED display (two red ones, four green ones and an orange one). The monitor is built into a black box about 4 x 3 x 1½ in (97 x 73 x 37mm), and is connected up by means of two wires — very simple. It's suitable for positive or negative earth cars.

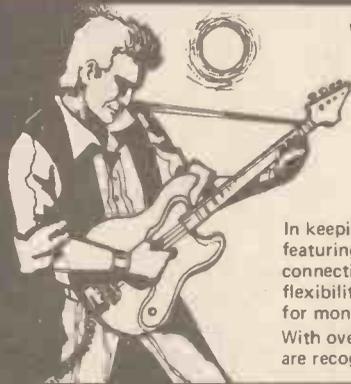
The unit costs £8.00 inc. p&p. Enquiries and orders to *Vulcan Electronics*, 32 Wigan Rd., Billinge, Wigan WN5 7XS.

# GET BIG POWER



## Modular Amplifiers the third generation

Due to continuous improvements in components and design ILP now launch the largest and most advanced generation of modules ever.



### WE'RE INSTRUMENTAL IN MAKING A LOT OF POWER

In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.



#### BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance $\Omega$	DISTORTION		Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
			T.H.D. Typ at 1KHz	I.M.D. 60Hz/7KHz 4:1				
HY30	15	4-8	0.015%	<0.006%	$\pm 18$	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	$\pm 25$	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	$\pm 25$	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	<0.006%	$\pm 26$	120 x 78 x 40	410	£20.75
HY128	60	4	0.01%	<0.006%	$\pm 35$	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	<0.006%	$\pm 35$	120 x 78 x 50	520	£25.47
HY248	120	4	0.01%	<0.006%	$\pm 50$	120 x 78 x 50	520	£25.47
HY364	180	4	0.01%	<0.006%	$\pm 45$	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	<0.006%	$\pm 60$	120 x 78 x 100	1030	£38.41

Protection: Full load line. Slew Rate: 15v/ $\mu$ s. Risetime: 5 $\mu$ s. S/N ratio: 100db. Frequency response (-3dB) 15Hz - 50KHz. Input sensitivity: 500mV rms. Input Impedance: 100K  $\Omega$ . Damping factor: 100Hz >400.

#### PRE-AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc. VAT
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre amp	Mic/Mag. Cartridge/Tuner/Tape/Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU-30 is available purely for pre amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

#### Mounting Boards

For ease of construction we recommend the B6 for modules HY6-HY13 £1.05 (inc. VAT) and the B66 for modules HY66-HY78 £1.29 (inc. VAT).

#### POWER SUPPLY UNITS (Incorporating our own toroidal transformers)

Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93
PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83
PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

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

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

#### MOSFET MODULES

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

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).

Slew rate: 20v/ $\mu$ s. Rise time: 3 $\mu$ s. S/N ratio: 100db

Frequency response (-3dB): 15Hz - 100KHz. Input sensitivity: 500mV rms. Input impedance: 100K  $\Omega$ . Damping factor: 100Hz >400.

#### 'NEW to ILP' In Car Entertainments

##### C15

Mono Power Booster Amplifier to increase the output of your existing car radio or cassette player to a nominal 15 watts rms.

Very easy to use.

Robust construction.

£9.14 (inc. VAT)

Mounts anywhere in car.

Automatic switch on.

Output power maximum 22w peak into 4 $\Omega$

Frequency response (-3dB) 15Hz to 30KHz. T.H.D. 0.1% at 10w 1KHz

S/N ratio (DIN AUDIO) 80dB. Load Impedance 3 $\Omega$

Input Sensitivity and impedance (selectable) 700mV rms into 15K  $\Omega$  3V rms into 8 $\Omega$

Size 95 x 48 x 50mm. Weight 256 gms.

##### C1515

Stereo version of C15.

£17.19 (inc. VAT)

Size 95 x 40 x 80. Weight 410 gms.

Model Number	For Use With	Price inc. VAT
PSU 72X	2 x HY248	£22.56
PSU 73X	1 x HY364	£22.56
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

ILP Electronics Ltd., Dept 2, Graham Bell House, Roper Close, Canterbury CT2 7EP, Kent, England.  
Telephone: (0227) 547778 Technical (0227) 64723. Telex: 965780.

# Digital & Micro ELECTRONICS

No 1 WINTER 1983

An Argus Specialist Publication

£2.25

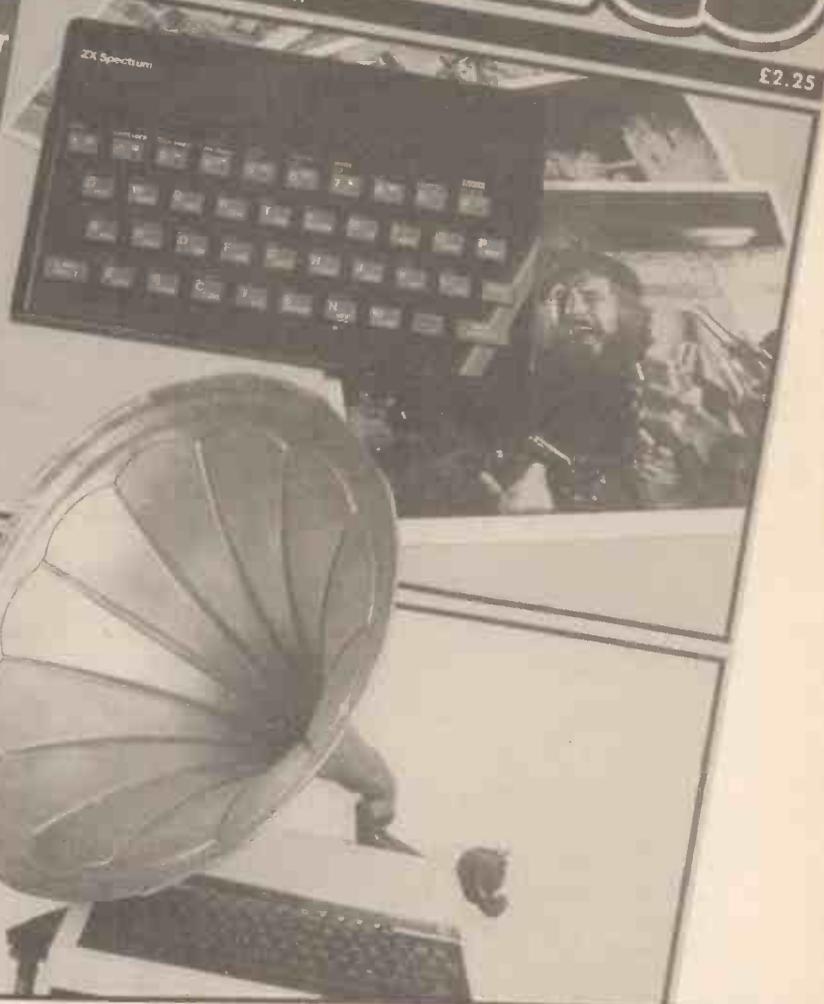
**Photographic Colour-Process Monitor: use your darkroom for accurate Spectrum**

**State Scope kit  
A low-cost high performance Solid**

**Build a low-cost joystick for the Video Genie**

**The BBC Finds Its Voice!  
Speech synthesis system for the BBC Computer reviewed**

**Spectrum Scanner  
X-Y Digitizer**



# NEW! OUT NOW

# POINTS OF VIEW

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

## Next Question . . .

*Dear Sir*  
*If you're short of material for HE might I suggest you reprint old projects (anything provided its nothing to do with !!\*\*\*!! computers, as every mag is crawling with them, micro this micro that. Thank goodness for Hobby, an analogue sanctuary. Although the beasts are creeping in).*

*And where's CD, is the Superhero of the Semiconductors recharging his ni-cads? Finally, why does everybody beg for lots of binders, one will do? I'll have to go now, my radio controlled gerbil has just eaten my best shoes.*  
*Yours constantly variable,*  
*P. Greenhouse,*  
*Kingstanding,*  
*Birmingham.*

This reader isn't happy with Excerpts From The Hobby Electronics Errata Box — he wants the original errors. Quick, nurse, the screens. However, for the mildly deranged, there is a source of HE reprints: it's called Electronics Digest, and can be found on your newsstands four times a year. Just to confuse the issue, the current ED has no Hobby reprints in it — but wait long enough and they'll soon come round again.

As for CD, at the last count he was nursing a badly sprained ankle somewhere in the Canary Islands. That was his story, anyway, but rumour has it that he was actually launching the first issue of *Digital And Micro Electronics*. Time alone will tell.

## No Joystick

*Dear Sir,*  
*I bought your August issue with the specific intention of making the joystick interface, but when I opened the issue I was faced with an incomprehensible component layout. Could you please send me separate component layouts for both side of the PCB, and the PCB foil patterns.*  
*Yours sincerely,*  
*G. Kelly,*  
*Limerick,*  
*Ireland.*

Sorry, but the PCB layout is copyright by Cambridge Computing, who designed the interface. If you write to them at 1 Benson St., Cambridge CB4 3QJ they may be willing to supply you with PCBs. Expect a delay in getting an answer, as demanded for the joystick interface has been vigorous.

## Now See Here

*Dear Sir,*  
*I have been a subscriber of yours for some time but I have a problem. Where can I get fibre optic cable from? I have looked through your magazine and can't find it anywhere. Perhaps you could help me.*  
*Yours hopefully,*  
*Richard Milburn,*  
*Burnham-On-Sea,*  
*Somerset.*

Our RS catalogue quotes part no. 367-909 for single core and 367-937 for double core optical cable, along with a bulkhead connector no. 456-403 and end-termination no. 456-396. You cannot of course order from RS directly but any reasonable components suppliers should be able to order for you. The Maplin catalogue also features optical cable under 'Fibre Optic Light Guide' on page 188. Maplin can be contacted at Maplin Electronic Supplies Ltd., PO Box 3, Rayleigh, Essex SS6 8LR. We would recommend that you find a local components supplier and get them to order for you, as an alternative to obtaining your own catalogue.

## A Poor Reception

*Dear Sir,*  
*I am writing for your help. Is it possible to use an aerial dish with my television, if so could you help me in finding one suitable as I've tried frantically in vain through all my electronics magazines and catalogues.*  
*And also would I need a special licence to use a dish as a television receiver.*  
*Thank you for any assistance.*  
*Yours faithfully,*  
*Martin Robertson,*  
*Glasgow.*  
*P.S. Keep up the good work! I enjoy your magazine very much.*

You don't say whether your question was sparked off by *Cable And Satellite Television* (HE September '83), but we'd like to think it was.

As public direct broadcast satellite TV has not yet begun in this country, there's no benefit in having a receiver dish unless you are a specialist hobbyist trying to catch continental programmes. It won't receive ordinary UHF transmissions. Likewise, the licensing terms have yet to be worked out. There is nothing to stop you from buying one (a few major

television/video stores in big cities can obtain them) but there is not a lot to use them on at present. All will become clear in the fullness of time as various new forms of transmission become established. Monitor will transmit whatever it hears as soon as it hears it, of course.

## Collector's Items

*Dear Sir,*  
*A subscriber to HE, some time ago I ordered all the backnumbers of HE from May '80 to January '82; I received all the backnumbers with the exception of February '81 and July '81. As a balance still stands in my credit side, I should like to ask you to send me photocopies of the two parts of the serial Into Electronics Construction, by Ian Sinclair, namely part 2 (March '80) and part 3 (April '80) to reach me by air.*

*How did I become interested in HE? By good luck! I entered the Mauritius Institute Public Library to cast a glance at Practical Philosophy Magazine, when I just came across some numbers of HE lying on the table. A student of Telecommunications Engineering, I plunged into the Electrical Components series and read about components not obeying Ohm's Law, that is, about diodes and transistors.*

*I could not believe that such a writer as Ian Sinclair existed in the world. I am temporarily handicapped, but I hope to order photocopies of the serial Into Electronics next year and some valuable missing parts. Clever Dick and Points Of View also make good reading. The way HE deals with electronics is praiseworthy. It takes the mystery out and puts it in its naked simplicity. HE is a great magazine. Please keep up the good work.*  
*Yours faithfully,*  
*I. Auleear,*  
*Fond De Sac,*  
*Mauritius.*

Ahem yes, as the backnumbers and photocopies are dealt with by different departments, if you order one and it is not available, the backnumbers dept. won't be able to supply a photocopy instead. When ordering backnumbers, always check on the ad. to see which ones we say are available. Save time and anguish.

We'll see about those photocopies although I can't promise anything about air mail.

You sound as if you may be interested in *Electronics Digest*, as featured in Monitor this month.

Ian Sinclair has oft been praised for his clear, down-to-earth approach to writing about electronics, through rarely in such extravagant terms! A writer who can make complicated things easy to follow has a worth far above rubies, perhaps even the equivalent of refined silicon (mind you, this has nothing whatsoever to do with what we pay him). Naked simplicity is perhaps going a bit too far. A fresh, new, unused resistor is nakedly simple. After that, things get interesting again (hence the need to consult such documents as *Practical Philosophy?* What next? *"Zen and the Art of Resoldering?"* *"Yoga and Relaxation for Fault-Finders?"* Why not?)

## Flatter Than Your Average Battery

Dear HE,  
A flat battery is not always a dead loss. Open the case with pliers (don't get acid all over yourself or your clothes), cut off the positive strip, then solder red and black wires onto the positive and the negative. Cover the connections over with insulating tape, and you end up with an almost free PP3 battery connector.



Yours faithfully,  
John Wardle,  
Doncaster,  
Yorkshire.

We always said it! HE readers do it with less . . .

## Missing Manual

Dear Sirs,  
I have just been given a Telequipment Serviscope D52 Dual Beam Oscilloscope, second hand of course, but there is no operator's manual. I want to write to Telequipment, but I can't find their address.

Keep up the good work.  
Andrew Pett,  
Norfolk,  
Dereham.

Can anybody help?

## Bowled Over

Dear Sirs,  
The Electronic Revolution article published in HE February '83 brought back many memories of the 1920 period when the wireless boom captured the imagination and crystal sets, then valve sets, were breathtakingly constructed on the kitchen table from diagrams published in the local paper. Yes, oscillation was a problem (when you got it to work) and yes, the headphones were placed in a basin as a loudspeaker until Dad was persuaded to buy a small Sterling speaker.

Since reading your articles and adverts enthusiasm boils again and I am truly amazed at the range and complexity of electronics today. I would like to construct a two transistor set using a small speaker. The kits advertised in your paper all seem to use headphones. I would be glad if you could help me on this.  
Yours faithfully,  
Charles Reid,  
Gateshead,  
Tyne & Wear.

We don't have any suitable projects, and can't advise on kits, but you could consult a small book published by Bernard Babani, *Electronics Simplified — Crystal Set Construction* (£1.75) or consult their catalogue to see if there is anything you prefer.

Unfortunately, adapting an amplifier designed for use with headphones to use with a loudspeaker is not a very simple job. I won't suggest getting a bigger basin!

BB's address is Bernard Babani (publishing) Ltd., The Grampians, Shepherd's Bush Road, London W6 7NF.

## Obscured Issue

Dear Editor,  
I have begun the 30V PSU project in HE September '83. However, upon making my PCB, it seems that there is an error involving the connection of the preset to the output.

The circuit diagram shows one side of the preset connected to IC2 pin 2, and emitter of Q3. The wiper arm then feeds the output. The other leg of the preset is then shown connected to the +ve side of the meter.

However, the PCB overlay does not correspond to this, as the wiper arm is shown to 'feed' the meter instead of the output.

I have been bying HE for a long time, but the clarity of the PCB overlay in the project is diabolical!

Could you please then clarify my query, and even perhaps enlarge or clarify the PCB overlay in the preset and transistor region.

Yours gratefully,  
M. S. Higgins,  
Hillsborough,  
Sheffield.

Unfortunately, the detail of the PCB

was obscured in the area of the preset by a line representing the wire joining the emitter of Q1 to the base of Q2. It thus appears that the preset is shorted out!

In fact the lower terminal of PR1 has simply been left open circuit, ie connected as a variable resistor. The wiper of PR1 does feed the meter, but electrically this is equivalent to the arrangement shown in Figure 1, and therefore is of no consequence.

## Alternative Technology

Dear Sir,  
As a regular reader of your magazine I notice what appears to be a growing interest in alternative energy. One reader writes enquiring about the purchase of Solar Heat Panels, another about a windmill generator using a car alternator. May I advise readers to write to 'Sun, Wind and Water', The Centre For Alternative Technology, "Machynlleth", Powys, South Wales. They are a conservation group who specialise in this field.  
Yours sincerely,  
K. Vitty,  
Huntingdon,  
N. Yorkshire.

## Lost And Found

A reader has written to ask if we know the present address of Doram Electronics Ltd., or whether they are still trading. Can anyone help?

In response to an enquiry last month, we have heard reports that T. Powell is still in business at 311 Edgware Road, London W2 (where else?). Tel: 01723 9246.

Reader A. Pickard of 14 Far Lash, Burbage, Hinckley, Leicestershire LE10 2PJ reports that he is interested in the use of the Science Of Cambridge (Sinclair) MK14 Micro for interfacing with the BBC and for robot control, and would like to hear from anyone working on similar projects.

A reader from Kingston On Thames wants to know if anyone knows of a firm making a 'bleeper finder' for locating lost carkeys and the like. We haven't had any success. Do you know?

For interested people, the Centre For Alternative Technology deals with all kinds of alternative technology and also welcomes visitors — their brochures can be found in tourist offices all over Wales, if you are passing through.

## Short Circuit Authors

Please will contributors G. Foote and B. Adams get in touch with us.

# COMING SOON TO . . .

# Hobby Electronics

## INFRA RED CAMERA CONTROL

Any camera which can be remotely released using an electric release facility should be able to operate with this infra red remote control. The control uses an AC, directional system with a range of about seven metres. The IR signal can be transmitted through glass as well as in the open, and multiple receiver units can be triggered by the same transmitter if required for more than one camera. A major photographic project.

## CB FIELD STRENGTH METER

This is a field strength meter with an extra feature. Usually, field strength readings have to be taken beside the transmitter, so that the operator can see the meter. Ideally, the readings would be taken further away, to give a true picture of the signal being transmitted. The HE meter includes a simple memory circuit, which holds the reading for a minute, enabling the operator to set it up well away from the transmitter.

## CAREERS IN ELECTRONICS

Our three part look at the Armed Forces continues with the Royal Navy.

## A BATTERY GUIDE

Britain's leading battery manufacturer, Ever Ready, explains the working and uses of a battery of batteries.

## GENERAL PURPOSE POWER SUPPLY

This is a versatile power supply suitable for use with Hobby Electronics projects past and future. It is also in effect the first part of a major audio preamp project to be featured in coming months (although an independent unit). It features two outputs, and a connection for a daughter board so that the PSU can be customised for special applications.

Please reserve me — copies of the February issue

**Hobby  
Electronics**

for  
Name .....

Address .....

.....

.....



**Hobby  
Electronics**

**February Issue on sale at  
your newsagent from 13th  
January. Place your  
order now!**

Although these articles are being prepared for the next issue, circumstances may alter the final content.

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

# Sparkrite

SELF ASSEMBLY ELECTRONIC KITS

PRICES REDUCED  
ON SUPER SAVE  
D.I.Y. KITS



## SX 1000 Electronic Ignition

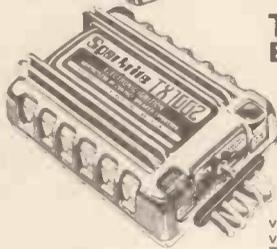
- Inductive Discharge ● Extended dwell circuit stores greater energy in coil ● Three position changeover switch ● Patented clip-to-coil fitting ● Easy to assemble, easy to fit ● Contact breaker triggered - includes bounce suppression circuit.

**SUPER SAVE**

## SX 2000 Electronic Ignition

- Reactive Discharge ● Combines inductive & capacitive energy storage ● Gives highest possible spark energy ● Patented clip-to-coil fitting ● Easy assembly sequence ● Contact breaker triggered - includes bounce suppression circuit.

**SUPER SAVE**

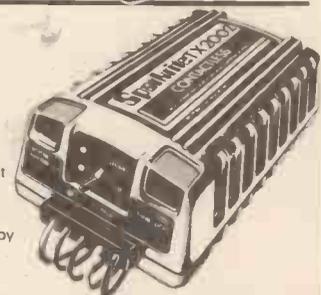


## TX 1002 Electronic Ignition

- Inductive discharge ● Extended dwell circuit stores greater energy in coil ● Three position changeover switch ● Contactless or contact breaker triggered ● Clip-to-coil or remote mounting ● Rugged die-cast case ● Contactless adaptors included for majority of 4 & 6 cylinder vehicles ● Easy to build ● For details of vehicles fitted by contactless trigger, ring Technical Service Dept on (0922) 611338-9.

## TX2002 Electronic Ignition

- Two separate systems in one unit! ● Reactive Discharge OR Inductive Discharge, with three position changeover switch ● Gives highest possible spark energy ● Clip-to-coil or remote mounting ● Rugged die-cast case ● Contactless or contact breaker triggered ● Contactless adaptors included for majority of 4 & 6 cylinder vehicles ● For details of vehicles fitted by contactless trigger, ring Technical Service Dept on (0922) 611338-9.



## AT-40 Electronic Car Alarm

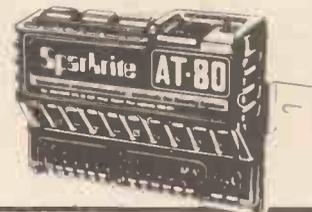
- Guards doors, boot, bonnet from unauthorised entry ● Armed/disarmed using concealed switch ● 30 second delay-to-arm: 7 second entry delay ● Can alternatively be wired to exterior key switch ● Flashes headlights & sounds horn intermittently for 60 seconds when activated ● Security loop protects accessories ● Low consumption C-MOS circuitry.



**NEW**

## AT-80 Electronic Car Security System

- Guards doors, boot, bonnet from unauthorised entry ● Armed/disarmed from outside vehicle by magnetic key fob passed across sensor pad adhered to inside of windscreen ● Individually programmable code ● 30 second delay-to-arm ● Flashes headlights and sounds horn intermittently for 60 seconds when activated ● Security loop protects accessories ● Function lights to assist setting-up ● Low consumption C-MOS circuitry.



**SUPER SAVE**

## ULTRASONIC Intruder Detector

- Supplementary to AT-40 & AT-80 ● Will work in conjunction with any door switch input or voltage sensing alarm ● Detects attempted break-in and movement within passenger compartment & triggers alarm ● Includes high efficiency ultrasonic transducers ● Crystal controlled for low drift ● Ingenious sensitivity control allows freedom from false alarms ● Low current consumption



**NEW**

## VOYAGER Car Drive Computer

- 12 functions centred on Fuel, Speed, Distance and Time ● Single chip microprocessor ● Large high brightness fluorescent display with auto-dimming feature ● High accuracy distance & fuel transducers included ● Displays MPG, L/100km and miles/litre at the flick of a switch ● Visual & audible warnings of excess speed, ice, lights-left-on ● Independent LOG & TRIP functions ● Low consumption crystal controlled circuitry.



**SPECIAL OFFER**  
"FREE" MAGIDICE KIT WITH  
ALL ORDERS OVER £40.00



## MAGIDICE Electronic Dice

- Triggered by waving hand over dice ● Completely random selection ● Bleeps & flashes during 4 sec tumble ● Throw displayed for 10 seconds then flashes to conserve battery ● Low consumption C-MOS circuitry.

**SUPER SAVE**

SPARKRITE (A Division of Stadium Ltd.), 82 Bath Street, Walsall, WS1 3DE England Tel: (0922) 614791

Allow 28 days for delivery

KIT	OLD PRICE	NEW PRICE
SX 1000	<del>£12.95</del>	£11.95
SX 2000	<del>£19.95</del>	£18.95
TX 1002	£22.95	£22.95
TX 2002	£32.95	£32.95
AT-40	—	£9.95
AT-80	<del>£32.95</del>	£24.95
ULTRASONIC	—	£17.95
VOYAGER	£64.95	£64.95
MAGIDICE	<del>£9.95</del>	£6.95

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I ENCLOSE CHEQUE(S)/POSTAL ORDERS FOR

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CHEQUE No. \_\_\_\_\_

**BRANDLEADING BRITISH ELECTRONICS**

**CUT OUT THE COUPON NOW!**

# SLOT CAR LAP COUNTER

The chequered flag drops and they're off and racing in the 1984 British Grand Prix . . . or is it the Le Mans 24 Hour? Count down to the finish line and flag the winner with this clever project.

Original circuit by Steven Devaney  
Development by Ram Chandru  
Text by Barry Foster

The original design of this project was for a lap counter and winning car detector for a fixed six-lap car race. This seems a little inflexible, so we decided to add a facility for selecting any number of laps between one and nine. This was easily achieved with the addition of just two low cost CMOS ICs and a double pole nine-way switch. Certain other refinements to guarantee reliability and to avoid ambiguity, were needed; and the odd gates remaining were used to add "bells and whistles", to make the working item just a bit more interesting!

The final design permits a race of between one and nine laps, with a lap counter for each car and positive detection of the winning car — a draw is not possible. The winning car is indicated by a flashing LED and a pulsed audio tone signals that the race is over. In addition a short audio tone sounds each time a car completes a lap.

An overflow of the design, in terms of circuit blocks, is given in the "How It Works" box.

## The Details

The full circuit of the Lap Counter is shown in Figure 1. The input sensors are magnetic reed relays, fixed to the tracks exactly on the Start/Finish line and triggered by small magnets glued underneath the racing cars. Each switch is by-passed by a capacitor, C10 and C11 respectively, to eliminate contact bounce and produce reliable low-going pulses each time a switch is closed. These pulses are fed to one or the other of a pair of input



Scaletric slot cars from Hamleys of Regent St.

gates, IC5a and b; these gates are enabled after Reset by a low from IC8d, pin 11. So as the pin 1 or 13 inputs go low, the gate outputs go high. ICs 1 and 2 count these pulses and produce outputs to drive the seven-segment LED display ICs, producing a continuous lap count for each car.

The high-going pulses from the input gates are also fed to IC5c. Between laps both inputs will be low so the output at pin 4 will be high; but when one car or the other completes a lap, either pin 5 or 6 will go momentarily high, taking the output low and triggering the one-second monostable flip flop formed by ICs 8a and 9a. Before triggering pins 8 and 9 of IC9a are both pulled low by pull-down resistor R23, so its output will be high; and with two high inputs the output of the NAND gate IC8a will be a low.

When pin 6 goes momentarily low,

pin 4 of IC8a will therefore go high. The voltage across a capacitor cannot change instantly, so this high is applied to pins 8 and 9, IC9a, forcing pin 10 low. This is fed back to the other input (pin 5) of IC8a, ensuring that its output stays high even after the lap pulse has ceased. Meanwhile the high on pins 8 and 9 falls off as C5 charges from IC5c; the time constant of C5 and R23 has been chosen so that the voltage takes about one second to drop below the high logic threshold, and when pins 8 and 9 drop below this level pin 10 switches high again.

At this time the output from IC8d, pin 11, is still low so the output from NAND gate IC8b will be held high. Thus both inputs to IC8c are high until the monostable is triggered at the completion of a lap, at which time pin 8, IC8c goes low for one second. The output of IC8c will therefore go high, and this is inverted by IC9b and

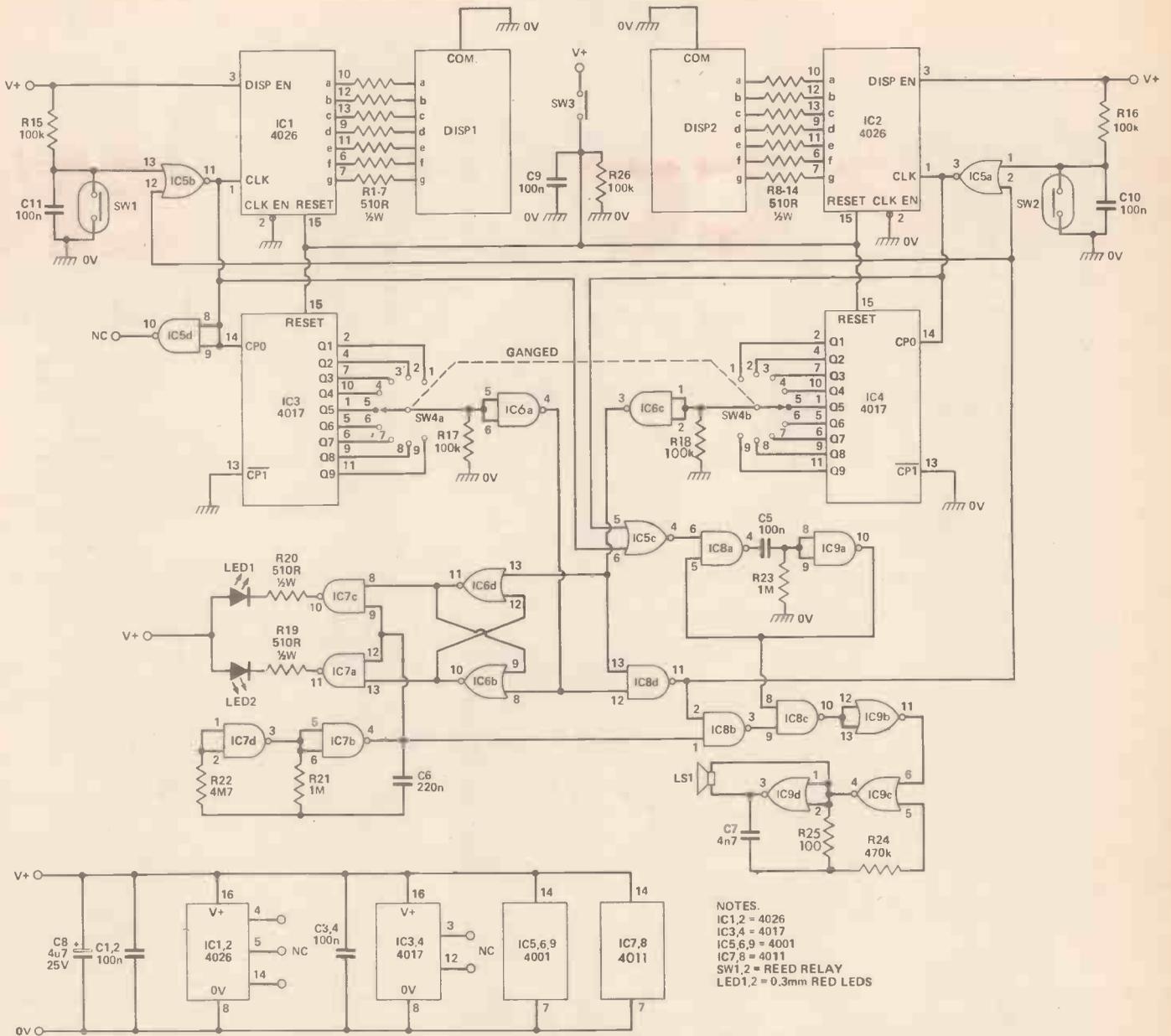


Figure 1. The circuit of the Lap Counter comprises two identical counting and display blocks, together with the win detection and indicator circuits, below.

Figure 2. The pin-outs of the 0.43" Common Cathode display IC.

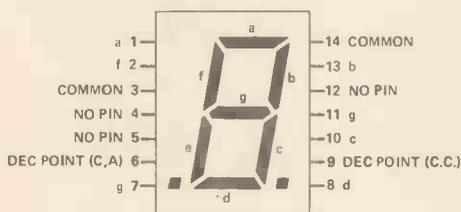


Table 1. Memory refresher — logic truth tables for AND, NAND, OR and NOR gates.

Table 1					
A	B	A.B	A.B	A+B	$\overline{A+B}$
0	0	0	1	0	1
0	1	0	1	1	0
1	0	0	1	1	0
1	1	1	0	1	0

triggers the 1kHz audio tone generator formed by ICs 9c and 9d, which sounds for around a second.

Backtracking a little, the high-going lap pulse from ICs 5a and 5b are also fed to a pair of 4017 decade counters, ICs 3 and 4. These devices have ten outputs which go high one after the other, taking ten clock pulses to cycle through a count from one to ten. However only nine outputs are used by this circuit with the output corresponding to the number of laps making up a race selected by SW4. The Q0 output goes high on the tenth clock pulse, so this is the one neglected by the circuit; also, lap selection for each car is performed by a dual ganged switch, which makes it impossible to cheat by selecting, say eight laps for one car and nine for the other!

After the preselected number of laps have been completed the inputs to either IC6a or IC6c will go high, depending on which car was fastest;

these inputs are normally pulled low by R17, 18, so the output of one or the other will switch from high to low.

Now IC8d has one low input, so its output will go high, and this is applied to the enabling pins of gates 5a and 5b which, being NOR gates, will be locked up with a low output until the circuit is reset.

The high from IC8d also gates a 1Hz squarewave from ICs 7b, d through IC8b; and then through IC8c (because pin 8 is high), thus sounding the 1kHz tone at 1Hz pulsed intervals to indicate the end of the race.

Meanwhile the output from either IC6a or 6c has tripped the latch formed by ICs 6b and 6d. Before this pins 8 and 13 are high, so the output from each gate will be low. However when one of the inputs from 6a or 6c goes low, the corresponding output will immediately switch high and, since the outputs are cross-coupled to the other gate's spare input, the second, losing gate, stays low.

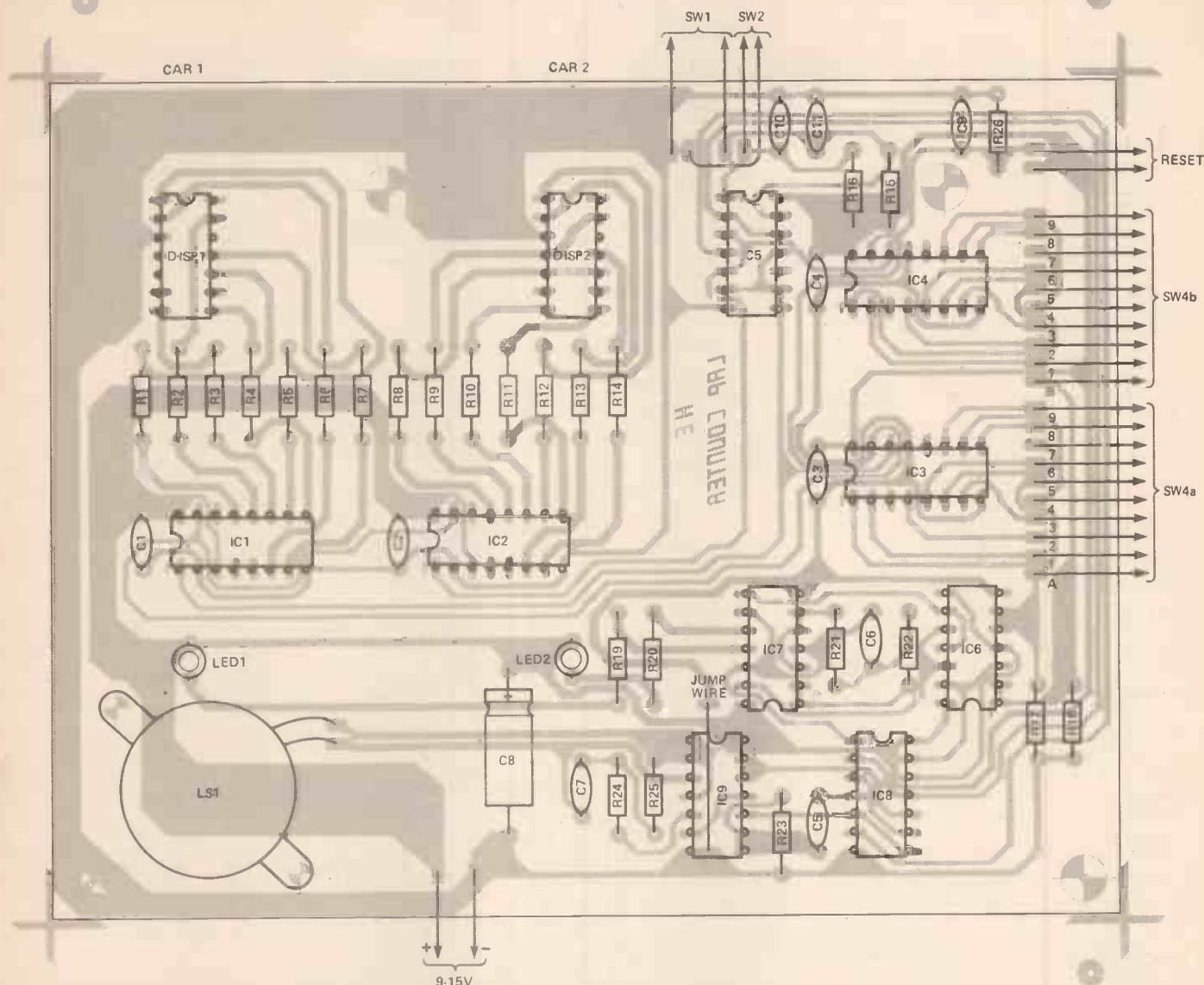


Figure 3. The PCB component overlay; most components are mounted on the board, including the piezo sounder. The power supply must be between 9V and 15V DC but does not have to be regulated.

## Parts List

### RESISTORS

(All 1/4 watt 5% unless noted)  
 R1-R14, 19, 20 ..... 510R 1/2W  
 R15-18 ..... 100k  
 R21, 23 ..... 1MR  
 R22 ..... 4M7  
 R24 ..... 470k  
 R25, 26 ..... 100k

### CAPACITORS

(Miniature layer unless noted)  
 C1-5, 9-11 ..... 100n  
 C6 ..... 220n  
 C7 ..... 4n7  
 C8 ..... 47u  
 25V axial electro

### SEMICONDUCTORS

IC1, 2 ..... 4026  
 decade counter/divider  
 IC3, 4 ..... 4017  
 decade counter

BUYLINES ..... page 26

IC5, 6, 9 ..... 4001  
 quad 2-in NOR  
 IC7, 8 ..... 4011  
 quad 2-in NAND  
 DISP 1, 2 ..... 0.43in  
 7-segment LED display  
 LED1, 2 ..... 0.2in  
 any colour

### MISCELLANEOUS

SPK1 ..... PB2720  
 piezo sounder  
 SW1, 2 ..... reed relay  
 SW3 ..... SPST  
 push-to-make momentary  
 SW4 ..... DP9-way  
 rotary  
 2 x 3.5mm jack sockets for sensors  
 connections; 2 x 4mm sockets for  
 power supply connections; case,  
 215 x 130 x 47/78mm, eg Maplin  
 M1006; small magnets; red filter  
 plastic; nuts, bolts, wire, solder etc.

Finally the high from the winning side of the latch gates the 1Hz squarewave through either IC7a or 7c to flash the LED and indicate which of the two cars has won.

The only other point to mention is the reset system, operated by SW3; when pressed, this applies a momentary high pulse to the reset inputs of ICs 1, 2, 3 and 4; when reset the outputs of these ICs set up the conditions for the remainder of the circuit so that all logic levels are ready for the race to begin.

## Construction

The PCB designed for the Lap Counter (see Figure 3) makes assembly of the electronic parts relatively easy. The board is single sided, with just one wire link running under IC8 — don't forget it! Nearly all components, with the exception of the reset and lap selection switches, power supply and sensor connectors, are mounted on

the board. No special precautions are needed when assembling the PCB, other than the usual CMOS handling procedures and taking care that polarised components (ICs and LEDs only, in this case) are correctly oriented. IC sockets can be used if desired, and the LED leads may need to be extended so that they project at least 10mm above the surface of the board; use Veropins soldered into the PCB and solder the LEDs to the Veropins to reach the correct height.

The PCB bolts onto the front panel of the case, so the next step is to mark out the position of all holes and cut-outs on the panel. Use the full sized PCB mask reproduced on page 64 as a template for this operation: if you are making your own PCB from the mask then trace out the perimeter of the board, the position of the LEDs, dimensions of the display holes and the position of the mounting holes, and use the tracing paper as the template. Also a number of small holes should be drilled in the panel immediately above the piezo sounder, to act as a speaker grille.

The prototype was nicely finished by spray painting the case and labelling the various controls and functions with rub-down lettering; this should be done before mounting the components on the panel.

If the recommended case is used, the PCB must be mounted to one side, leaving space at the other end for the reset and lap-select switches. There is plenty of room under the board for the power supply and lap-sensor connectors.

After completing the PCB and preparing the front panel, the off-board components can be wired in. We used Molex plugs ('PCB connectors') for neatness and convenience, though of course the switches etc can be hard wired; in either case be sure to make the connecting wires long enough (ribbon cable makes a neat job of it).

When this stage is finished the project is more or less complete. Test it by connecting up a power supply (this can be any unregulated DC voltage between 6V and 15V, capable of supplying at least 100mA) and switch on. There should be a short 'beep' and the display will light up with a random number. Reset; select a high lap number and then briefly short out one of the lap sensor inputs, then the other. In each case a short beep should be heard and the relevant lap counter advance from '0' to '1'. Continue to pulse the input by shorting it briefly; the lap counter should advance until the selected number is reached, at which point the appropriate LED will begin to flash and the sounder to beep at 1Hz intervals. Repeat this test with the other input, and then for each input on each of the lap numbers. This checks out every possible variation!

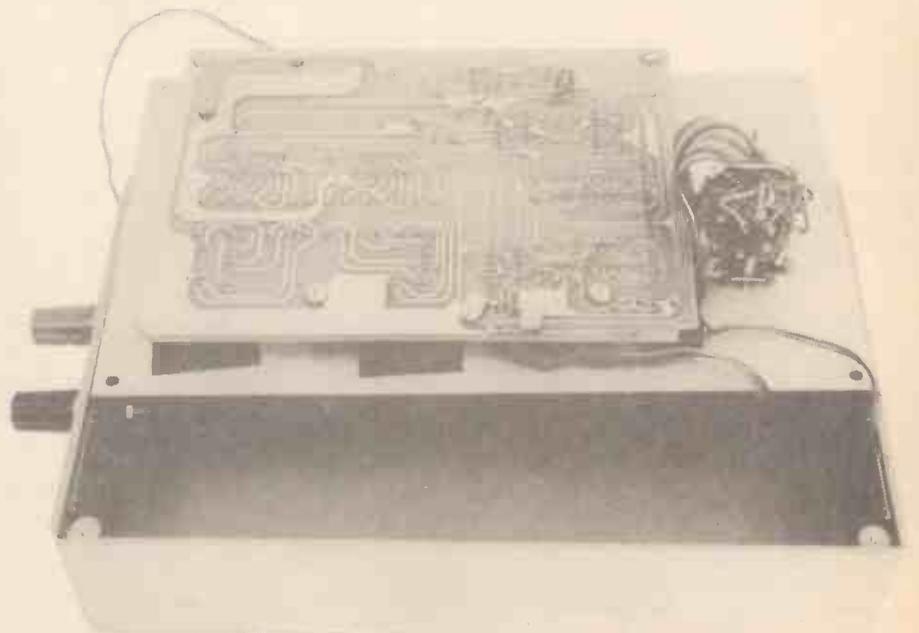
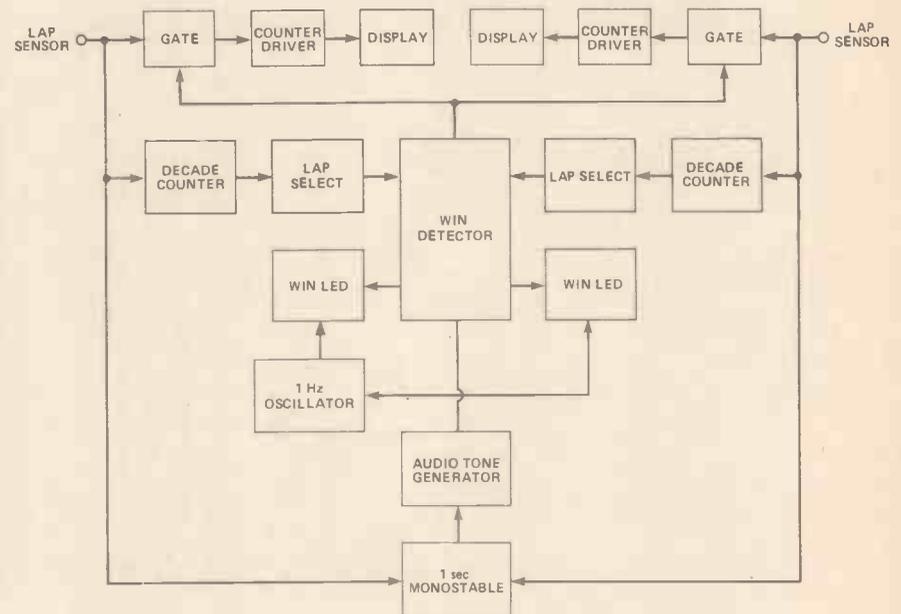
Now the components can all be mounted in the case; the PCB is fixed on 15mm spacers to set the correct distance of the displays and LEDs. The

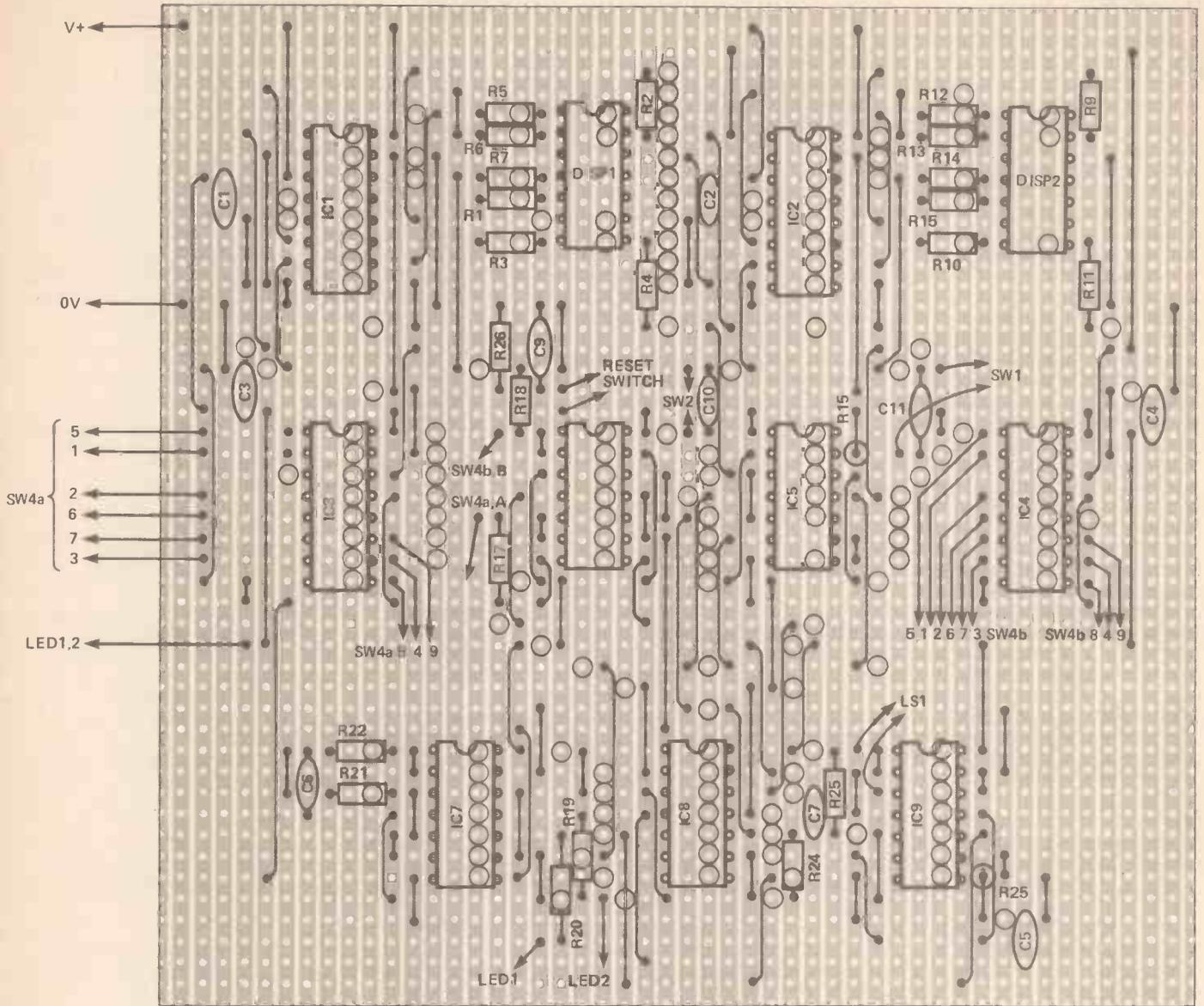
## How It Works

The Lap Counter can easily be broken down into a number of distinct circuit blocks. Many of these are duplicated, for each car and track.

The inputs from the lap sensor are fed via a normally enabled gate to counter/driver circuits, which feed seven-segment LED display clips producing a lap count for each car. The lap sensors also trigger a one second monostable flip-flop, which sounds an audio tone each time a car completes a lap.

At the same time, the lap pulses drive decade counters whose outputs are tapped by the lap-select switches. When the preselected number of laps have been completed, the win detector is triggered; a flashing LED indicates the winning car and a pulsed audio tone signals the end of the race. An output from the win detector is fed back to the input gates so that the pulses from the losing car are locked out.

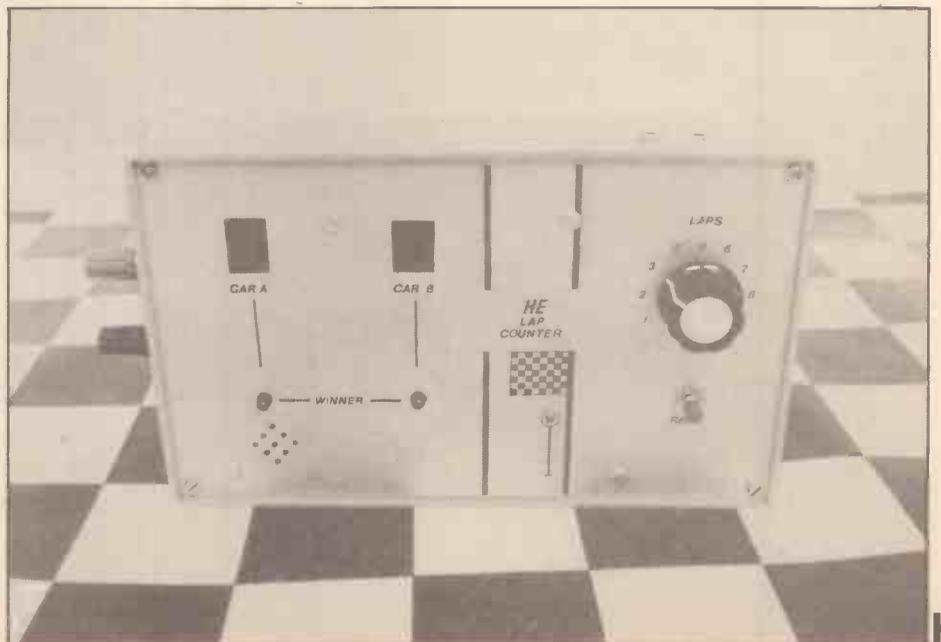




**Figure 4. Veroboard component layout for intrepid experimenters; it has not been constructed and tested, and so cannot be guaranteed to work — see also the note below! Stop Press: C8, which should be connected across the DC supply rails, has been omitted.**

final steps are to mount the reed relays on the slot car tracks and to fix the trip magnets under the racing cars. We have no advice to offer here, as the arrangement will depend entirely on particular cars and layouts. All you need then is the theme music from "Grand Prix"!

*Note: A Veroboard layout for this project has been designed but not tested. It must be regarded as an experimental layout, only, and Hobby Electronics will not be able to advise on constructional problems using the Veroboard. Also more off-board wiring is required and, possibly, a larger case.*



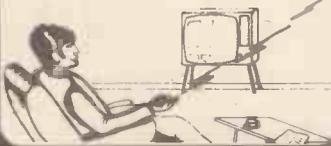
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A case is recommended for the project, but any box capable of holding all the parts can be used.

The Veroboard layout in the article has neither been built nor tested and must be regarded as experimental. Hobby Electronics cannot answer enquiries concerning constructions based on this layout.

## Lap Counter

A couple of the components for this project, namely the 0.43" common cathode LED display IC and the 2-pole 9-way switch, may be hard to find.

The latter has to be made up from a Mini Wafa switch kit, with two 12-way wafer mechanisms; don't forget to adjust the end stop for nine positions.

All the components, including displays and switch — but not the PB2720 piezo buzzer, are available from Cricklewood Electronics. Unfortunately they do not appear to stock the PB2720, which in the prototype is mounted on the PCB.

The alternatives are to source the device from elsewhere, or accept another type from Cricklewood, which must then be mounted inside the case and wired to the PCB.

The specified case is available from Maplin, though a suitable alternative can be had from Cricklewood.

## Power Reducer

The SC412D triac specified for the circuit is an isolated-tab type, for safety reasons, which may be difficult to obtain. Any triac rated at 8A or better, such as the C146D (10A) can be substituted, but bear in mind that it does not have an isolated tab (most triacs do not) and therefore the heat sink will be live. "Caution: do not touch with the naked foot", as they used to warn on the back of Japanese TV sets!

All the components, including the C146D, are readily available from Maplin Electronics. Cost, excluding case and PCB, should be under £5.00 with VAT, p&p. A suitable case, to the dimensions given in the Parts List, is also available from Maplin.

Incidentally both Cricklewood and Rapid Electronics have new catalogues out at the moment. They are well worth getting as a reference and source for a variety of components.

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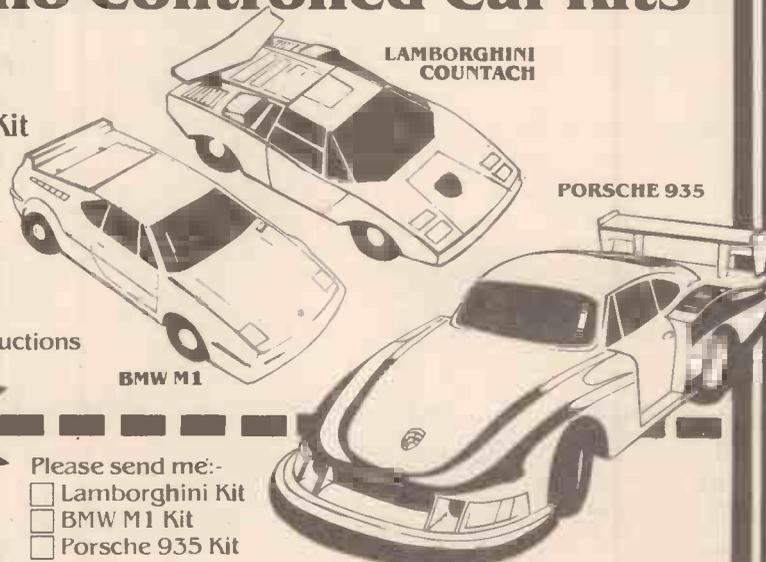
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# In The FRAME

Hobby Electronics meets the group Mainframe, who take their microcomputers on stage with them.

Helen Armstrong

I WAS INFORMED that Mainframe had recorded their first album in a bedroom.

Was I surprised? Not really. Many a fledgling act puts its demos, or even the finished articles, together in the cosy simplicity of a living room or garret. It took a couple of close encounters with the record itself, listening to its multi-tracked percussion, finely controlled synthesisers and dense sound for it to dawn that 'bedroom' did not necessarily mean amateur.

On the contrary, Mainframe have taken a professional line from the start. The bonus is that they have been able to run an initial career prospect, computing, in tandem with their first love, music, to pursue a project which is unusual in its scope at present, although it must point the direction for things to come.

The players in the band (see the mugshots below) are computer programmer John Molloy, 23, and guitarist-turned- multi-instrumentalist Murray Munro, 20. Murray, who took up music at the age of eight, also writes, sings, produces and engineers their recordings, while John, who can't remember when he started playing (piano, graduating to other keyboards), does arrangements, vocals and percussion, as well as most of the keys, adding a plethora of general ideas, and a big slice of the computer graphics which are the band's special feature.

Just behind the scenes — hardly even behind them — however lurks the rest of the 'band', a team of friends well versed in both the software and hardware side of microcomputing. In a classic case of 'a little help from my friends', the band have created their album and two singles, elaborate computer graphics to complement the music in live performances, an album-length video which they intend to release commercially, plus other shorter videos for stage use, and a percussion synthesiser (alright — drum box) to their own specifications.

All the design and promotion of their album *Tenants Of The Latticework* has been done by — you guessed it — the group, (including a complicated Masquerade-style quest with a £2500 gold "M" as the prize for the first person to unravel the clues), and they have





Mainframe's studio-cum-bedroom in Hemel Hempstead.

logged up a personal first by becoming the first group to release a computer program on a pop record: their first single, *Radio*, had a short program for the Apple II, containing a secret message, and their subsequent single *Talk To Me* has continued the theme, but this time with programs for the Apple, Spectrum, ZX81 and the BBC Micro. And they have material for another album, all laid down (ouch) in that bedroom.

And a bedroom it is — it has a bed in it. And a painting on the wall. Apart from that, the accommodation is dedicated to making music. Recording gear is ranged on one wall, a pile of drums against another. A clump of well-used guitars rests in one corner, and in the other is the wooden frame where the R.S.D. Studiomaster 16:4, a popular small mixing desk nests when it's not being used live.

Where did it begin? John had done some computing at school and technical college. Meeting Murray in a semi-pro band, the pair of them broke away to pursue a different style, and began to incorporate the graphics which they, plus friends, had been working on with their Apple II. The friends — Colin Holgate (who operates the Apples on stage), Dave Green, Jezz West, Martin Poole, Grahame Collins — et al — form a more or less integral part of the

operation.

Working almost entirely on Apple IIs (the band has had as many as four Apples in their stage show at a time) the team devised a visual show that gives their fascination with graphics full rein. The displays became an integral part of the live show, using monitors and, subsequently, a pair of video projectors hired from Rank, with twelve-foot projection screens.

Graphics have also been worked in as part of the video of the album. The record, titled *Tenants Of The Latticework* (it sounds whimsical but is meant literally), tells the story of a business man who is one day told that he is, in fact, a computer program who has been created to explore an artificial landscape by a group of scientists. The hero, Oscar (not your typical rock'n'roll hero), finds a way to emerge from the computer-landscape into the real world. then becomes determined to bring his family out of the computer as well. The story leaves the program-people about to emerge into reality, and the scientists waiting in anticipation.

In the video, the six coloured discs which hold the key to Oscar's ability to move in an out of the program are seen tumbling through a space of advancing stars; the chequered pattern of the latticework floats and expands towards the screen as Oscar 'falls' down into it,

and resolves itself into the form of the piano from his very-average suburban living room; a skeletal globe rotates; geometric forms alter and repeat themselves in kaleidoscopic rhythms, and the band's logo drifts in swarms across the screen. During another song, yet to be recorded, the figures of a deep-sea diver resolves itself line by line into the word 'Diver' in coloured letters.

In the meanwhile, another friend, Andrew Earle, shoots the band and audience through a video camera and onto the screens, juxtaposing live images with the prerecorded sequences, or with projected slides. The stage lighting, a combination of manual and preset control, and sound-to-light, is overseen by Jezz West.

The effect is less that of a band with visuals than of a giant video show incorporating the group.

As they played their first gig in a full-sized hall, the teenage audience, sitting on the floor, watching intently puzzled some members of the team, used to playing discos and clubs and other venues with a shifting population. It wouldn't surprise anyone who (literally) sat through the "getting into it" era in the Sixties, when music was treated with a similar reverence. Not hard to see why: swirling synthesiser riffs, soft-toned harmonic vocals and rich, Pink Floyd-esque lead guitar, along with high-

## Program Preparation

Colin Holgate

AS WE SAID, all the graphics for the video of *Tenants Of The Latticework* were created on the Apple II. Because no animation facilities were available, each sequence had to be displayed in real time and shot with a video camera straight from the monitor screen.

It's easy to overlook the amount of preparation that goes into a particular effect when watching it. The opening scene of the 'Tenants' video shows an aerial view of a blue grid, passing 'beneath' the viewer. The 'viewer's eye' then tilts upwards until the grid has dropped from view at the bottom of the screen. After this, a 3D coloured MAINFRAME logo flies past from right to left, and is then replaced by the stationary *Tenants Of The Latticework* title.

Taking this as an example, we can see the sort of preparation that is required. First of all, a three dimensional image of the logo had to be created. Numbers representing the 500 coordinates and 750 lines that make up the logo had to be entered into a special 3D program called *Apple World*. Having done this, the logo could be viewed from any angle. Fifteen views of the word, as it passed the viewpoint, were saved onto disc.

Each of these wire frames were then treated with a colouring program called *Micro Painter*. At this point any lines that should not be visible had to be changed to the desired background colour.

After this stage, the fifteen frames needed for the flypast were ready, but there was still a major problem. To understand this problem we need to look at some facts and figures on the Apple II. The 64K memory map is not all available as RAM on the Apple, or any other micro. Locations \$9600 to \$FFFF (in Hex) are used for the Apple's disk operating system and Applesoft BASIC.

Locations \$0000 to \$0800 are used for the text page, keyboard buffer, 6502 stack and by BASIC and DOs, all except for about 200 bytes.

In order to replay the prepared frames fast enough to form an animation, all the frames need to be in memory at once. So 28K has been used up; there is more to go.

An Apple hi-res picture occupies 8K of RAM. In order to show the flypast sequence, both of the Apple's hi-res picture

buffers were needed. The next frame to be seen is placed onto the buffer not in view, and then switched over to store the 15 x 8K pictures plus the control program.

Using this method with pictures can be very efficient. The fifteen flypast screens, plus two blank screens, were stored well within the available 20K.

The finished effect is achieved by 'expanding' each frame into the relevant picture buffer.

Whereas Mainframe uses commercial programs to help generate the logo graphics, of all the 'in betweening' programs were written by people associated with the band. One program is used to generate the start and end frames for the change sequence. Another program then uses these to calculate the in-between frames and saves the resultant pictures, in compressed format, onto disk ready for replaying.

The new position for any point of line end is calculated by subtracting the start frame coordinates from the end frame coordinates, dividing the answer by the numbers of frames required and adding this figure to the coordinates of the previous frame. If that is not very clear, the formula for a new x coordinate would be

$$\frac{(LFx - FFx)}{NoF} + PFx$$

where LFx = Last Frame x coordinate, FFx = First Frame x coordinate, NoF = Number of Frames and PFx = Previous Frame x co-ordinate.

Each frame takes on to two seconds to draw, but by using the frame replay, as with the logo, eight frames per second can be achieved.

These difficulties were overcome by 'compressing' the pictures. It is possible to cheat a little by checking through the picture memory looking for repeated values, and storing them in 'shorthand'. The group of letters ppppppaaacd can be expressed as r6pr4acd, where 'r' is a marker to signify a repeat sequence, followed by the number of times that 'p' is repeated. Likewise 'a' is repeated four times, and 'c' and 'd' are without a marker byte and are taken as separate bytes/characters. Should a genuine 'r' be needed, it would have to be stored as r1r.

tech associations are a reminder of that music, but the horror of associating with either pop or heavy metal music which split the field in those days seems — thankfully — to have vanished, and long may it remain so.

But having spared a minute to look at the music, back to the computers. Initially, the group worked entirely on Apple IIs, as this was what they had easiest access to. To write the graphics for the *Tenants* video, they used the Accelerator Card, to increase the speed of all the sequences while keeping the amount of memory to a minimum. The card consists of a 3.58MHz 6502B processor, and 64K of fast access RAM. The programs were run in real time.

The team used software by Appleworld, Micropainter, Bit Stik, Bill Budge's 3D Graphics, EBS and a special American graphics language suited for audio/visual effect, Ceemac, using the *Fire Organ* program, in addition to original software and adaptations written among themselves. They planned to take the video signal directly from the computers to the video tape, but had great difficulty in synchronising the computer's video signal to the video recorder.

While recording the BBC's *Show Me Show*, they had hoped that some super-technician would come to their rescue; however the best solution was to run the signal through a Quantel video effects controller.

The Quantel uses a frame store, capturing a television picture pixel by pixel, digitally — and therefore has synchronizing facilities beyond the pockets of all but full-sized pro video studios.

But alas, the machine had a mind of its own. Finding a single frame of signal which suited its circuits better than any other frame, it 'grabbed' it and refused to accept any other. The operators were stuck. They had one frame in store, but one frame is not much use to a whole visual show. Regretfully, they switched off the recalcitrant controller and resorted to the time-honoured method of taking the image off the monitors via a television camera. This was the technique they used when eventually putting down the complete video for the album.

When making their video, the band had the help of Andrew Earle, another friend, who just happened to be the proprietor of a small pro video company, Gothic Audio Visual. This gave them access to high-band, broadcast-quality video equipment. They tempted him with the prospect of making a video which would be seen at the band's gigs, and potentially on cable television here and in the USA (where the album is released early next year). He spent a number of weekends shooting while the group scripted, acted and produced Oscar's story. Now they are planning to refine the editing of the video and offer it for commercial sale.

The video's backing track, to synchronise it with the video, was DBX encoded, and then run on the soundtrack of the pro-standard U-matic video recorder on which the video had

been recorded.

But the group's 100% first is the release of a computer program on a record. Their first single, *Radio*, had a thirty-second program called The Message on the end of it. If a hi-fi amplifier is connected into an Apple, the program can be played off the record onto the computer — but the contents of the message is kept secret for those who actually run it. The band's second single *Talk To Me* has four programs on the back, one each for the Apple II, Spectrum, ZX81 and BBC Micros. These continue the content of the first 'message'.

Incidentally, on the sleeve of this single, the group recommend that the program is recorded onto cassette tape before loading to save wear on the record grooves — this must be the first record release which actually asks a buyer to copy it, instead of expressly prohibiting such activity! An added benefit of putting computer games and graphics on one side of singles, should it become a common option in the future, is removing the excuse from bands whose attitude is "can't be bothered to put something decent on the B side — let's do a remixed/lyricless/back to front version of the A side and save the studio costs."

Mainframe don't have to worry too much about studio costs as yet; having recorded their album themselves, costs up to pressing stage were £900 plus a few weeks work (after months of planning). They could have spent that in two or three days in a commercial studio.

They have also saved money, and anguish, by paying attention to the technical aspects of recording; for instance, Murray, who engineers the recordings, spends a lot of time getting the recording levels right, and includes a carefully set 1kHz tone prior to each track to give the engineers in the mastering studios a levels reference to work to. Making sure that the equalisation on the recording corresponds to that needed to cut a master disc (as far as possible) is also important and saves later processing (quite apart from getting a better result).

A fundamental problem faced in recording a group is the interference to the sound causes when the signals from one instrument, particularly the bass guitar with its low-frequency sound (which can set up standing waves in the room, instead of dissipating) get onto the recording via another instrument's microphone in a different phase from that which the 'real' recording takes. Use of directional microphones, and careful placing of microphones at the right distances apart avoid this problem. This effect can ruin a recording, and it is expensive and difficult to correct.

Mainframe also point out that, using a four-track tape recorder as they do, the extra expense of a DBX or other noise-reduction unit is worth every penny, as quite apart from improved sound to start with, it doubles (or more) the number of cross-recordings possible from track to track or recorder to recorder, and advantage for any recording group, and



A detail from the cover of Mainframe's album, painted by Murray Monro. The fine details are all clues to the band's "quest".

essential when there are only two people to play half a dozen instruments.

Another personal triumph for Mainframe is their percussion — it's all controlled by the Apple. One of the team, Dave Green, developed the hardware and software for a drum machine which can handle both machine-generated and live-recorded drum sounds (and any other sound which meets the beat). The result is an on-stage drum sound which has much of the sound of live drumming, but with the mechanical drive of a drum machine. Murray augments the sound with Rotosound drums on stage. The sound can also be altered by the drum-box — they are working at connecting up John's Liberation keyboard synthesiser through the device, but early attempts led to Dave blowing up his Apple — so research is still in progress.

Working in the band has led every member and associate member to extend his technical expertise. I asked John whether they hadn't had to spend a great deal on equipment: between them they play Moog Prodigy and Liberation synthesisers (the Liberation is one of those keyboards worn round the neck like a guitar — possibly the world's ugliest musical instrument), Juno 60, Yamaha SK20 organs and Fender Stratocaster guitar, together with their amplification and sundry other guitars/bass/drums bought or borrowed, plus their computers. But the band don't see it as a big investment — the equipment has been built up gradually, much of it before the present band came into existence just over a year ago. (For instance, they make good use of echo and reverb without having access to expensive digital effects unit. One source being an ETI Chorus Unit, built as an 'A' level project at school. That should give hope to those doing

Hobby projects as part of their exams...

The computer bug has proved infectious. When the band began, most of their musical associates had no interest in computing. "Now" says John "Every single person involved with the band has a computer and uses it. They just got interested." Others nod and bear witness to the tenacious grasp of the microcomputer once the owner has investigated it beyond the games-playing stage.

Not deterred by their earlier encounter with the Quantel machine, Mainframe are determined to make their next video with the help of just such a machine, and in the long term they would like to develop their own graphics effects generator. There is no doubt that they will do it, one way or another. The wealth of software and hardware engineering skill within the group puts them in control of their machinery and material, and not only their music.

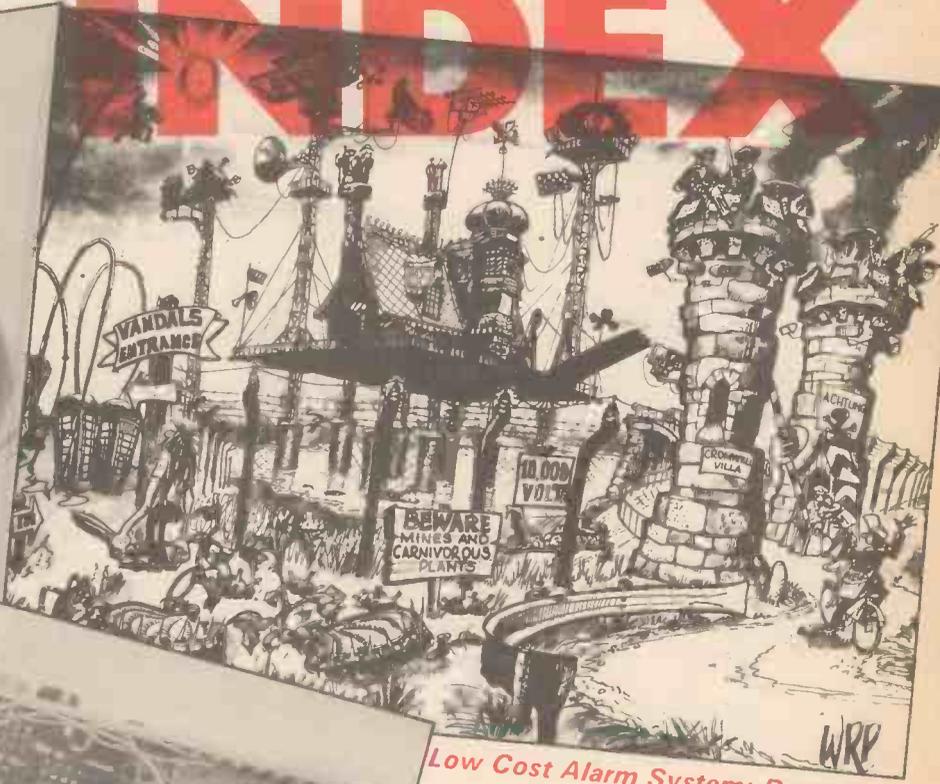
Having pursued a musical career on the strength of some savings, some freelance computing work, and record sales the most satisfying thing about Mainframe's career so far is that they have succeeded in taking one hobby (computing) and making a career out of it, and then using that to turn another hobby, music into a career as well. Perhaps not everybody has the opportunity, but then again, why not? Family and friends have supported them, but the level of imagination and professionalism they have built up in a short time is not so much a product of their technical or even their musical skills, but their determination to do it rather than just think about it. Their motto could be "Have bedroom, will travel."

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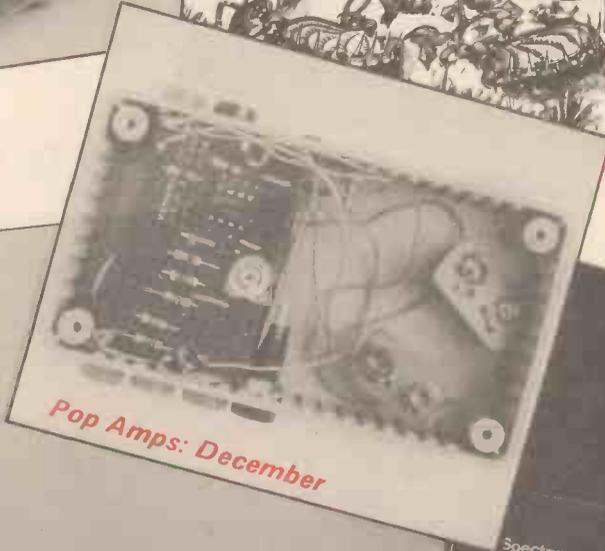
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*Low Cost Alarm System: December*



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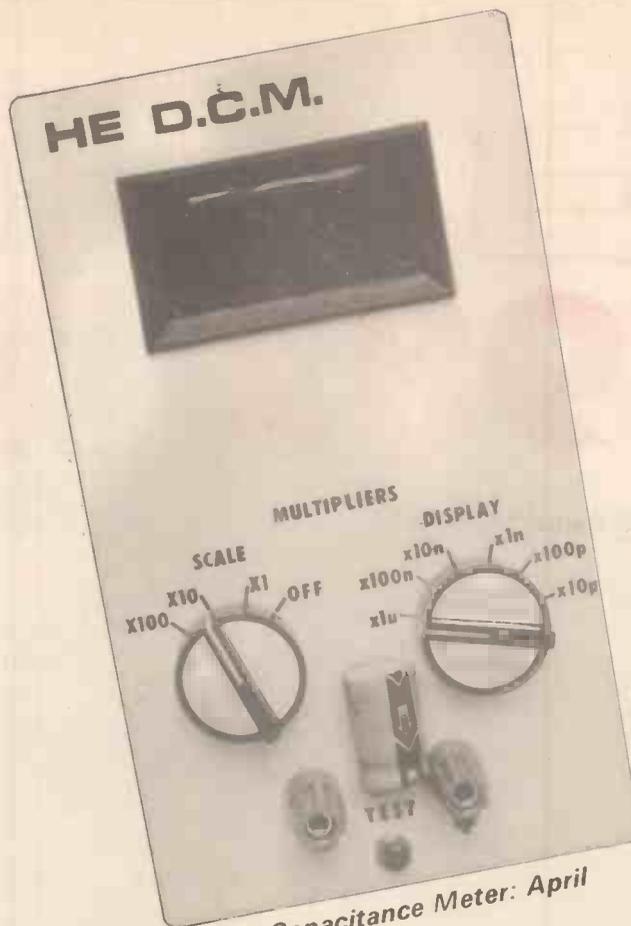
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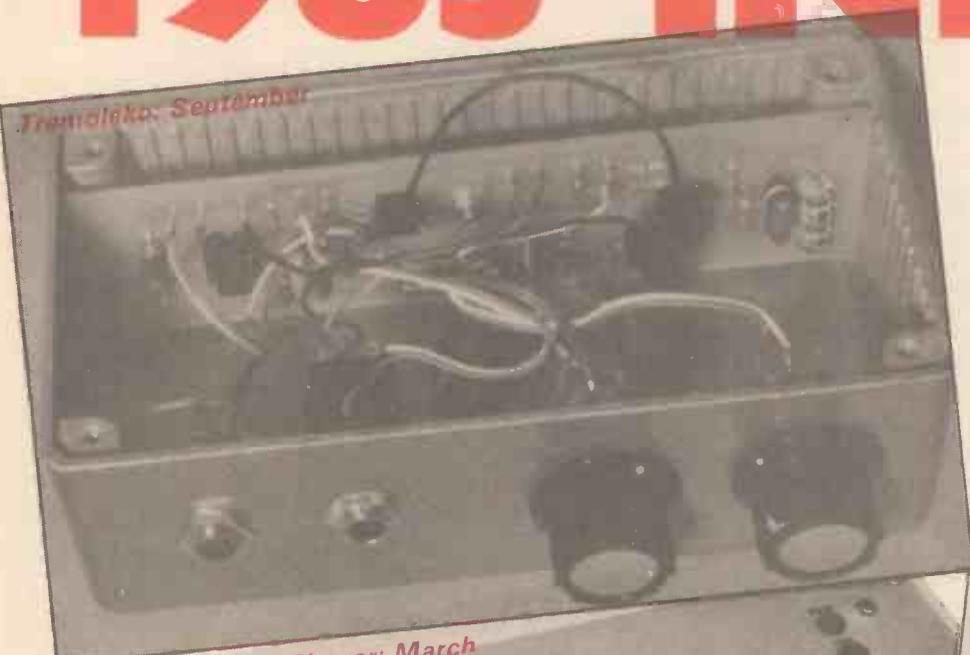
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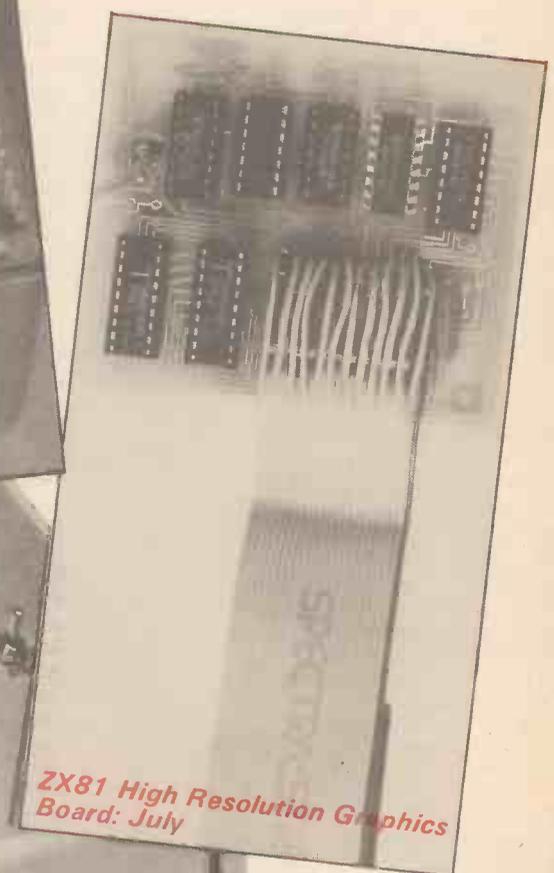
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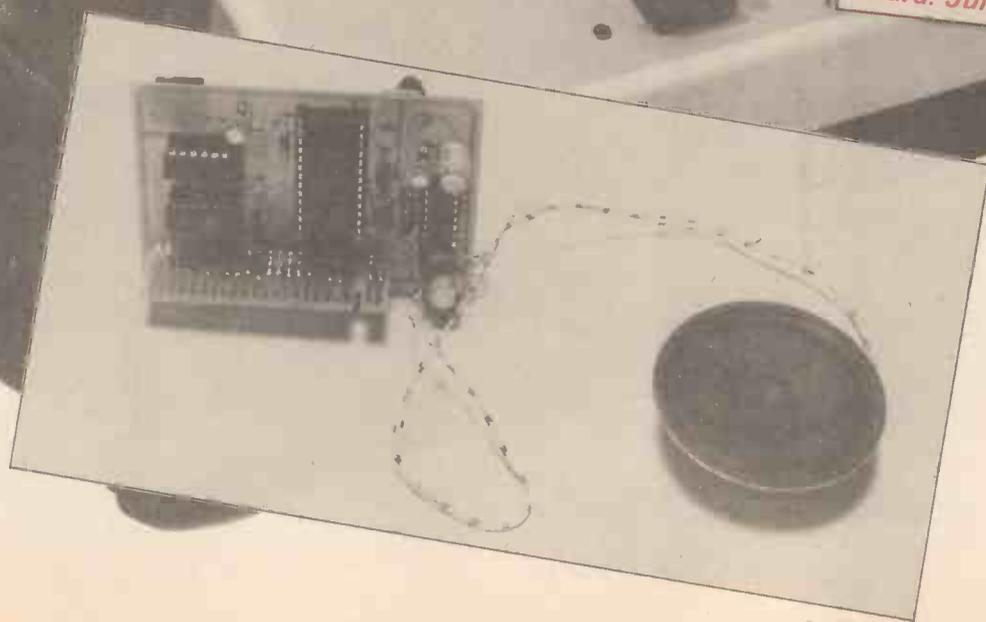
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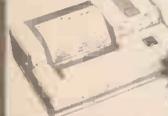


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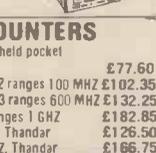
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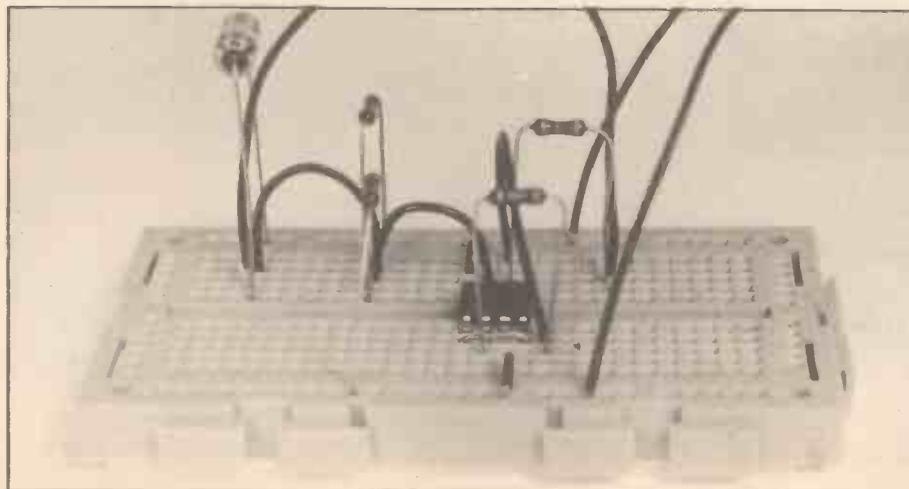
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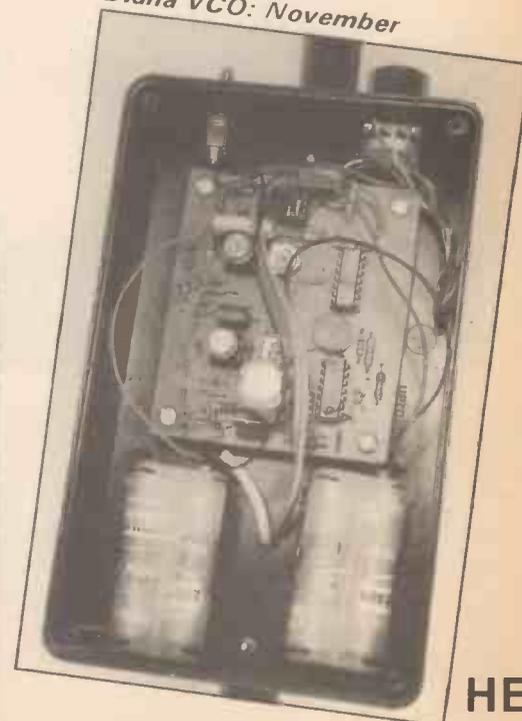
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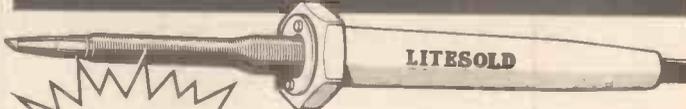
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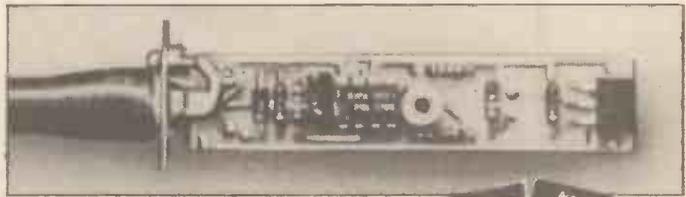
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# QUIZ MASTER



All hands on the buzzer . . .

Rory Holmes

THE QUIZMASTER is a design for a universal quiz reaction/lockout system that is capable of being expanded to cope with any number of players. A quiz system generally enables a number of people to react to a question by activating an individual buzzer, preferably giving

some kind of visual indication as well, and should determine who was first to react. This system uses a special technique for indicating the first player to 'buzz'; it is based on a bi-directional busline which links all the quiz stations in use. The first player to 'buzz' sends a signal down the busline

to disable all the other stations, locking them out of the contest. Using this special technique it is possible to expand the system for any number of players or teams simply by linking identical buzzer units into the busline.

The buzzer stations are built into boxes, one for each player, so that as many as required can be linked up in any one of a number of configurations. Each unit naturally includes a pushbutton which activates a variable tone bleeper to indicate a fast reaction.

A bright visual display, which can be a number as illustrated above, is also built into each station; the light stays on for three seconds to allow the successful player to be identified. Each station has preset volume and tone controls, and the circuit draws next to nothing when in the reset state, ie waiting for a 'buzz'.

## All Tied Up

It should be noted that if two players hit their buttons at exactly the same moment then both will 'buzz' and light up, indicating a draw. In the event this will have to be resolved by a further question. Since the individual stations have a three-second 'time out' which resets all stations after that time, it is impossible for any player to cheat!

A number of possible link-ups are illustrated in Figure 1. The versatility of the system allows large school quizzes or games at home for a smaller number of players; it could be used as the ultimate arbiter in Snap or similar card games, or simply as a reaction tester in a contest between any number of people.

Each buzzer station may be powered by an internal battery or, alternatively, a simple external power supply could drive any number of link stations. All can be controlled via the busline from a remote "Master Station", which consists of a simple

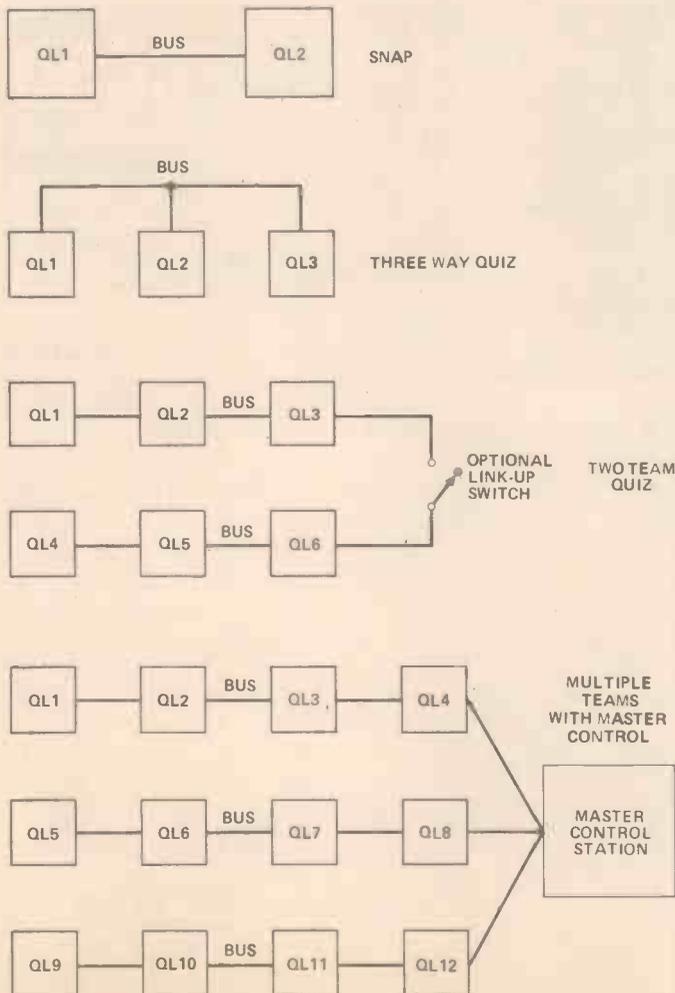


Figure 1. The Quizmaster can be connected up in a versatile variety of ways, including a link-up with a master control station. The method of connecting this up is shown in Figure 2, over the page.

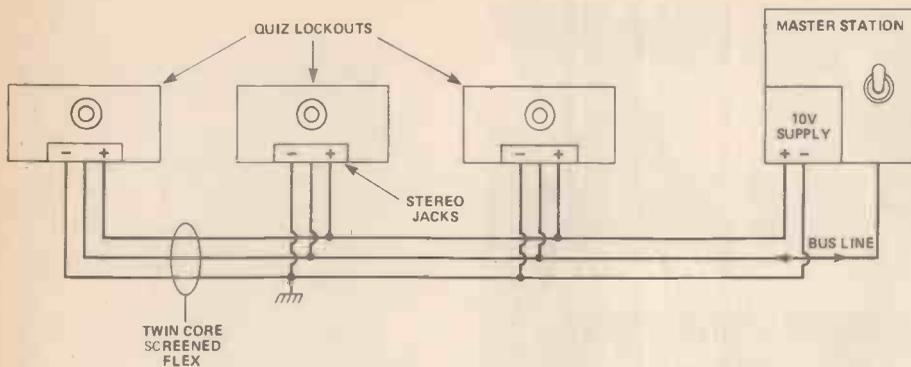


Figure 2. Connecting up a number of Quizmasters to a Master Control switch. See Figure 7 for a suggested circuit.

switch and indicator arrangement as shown in Figure 2. This method would allow timed questions by enabling or disabling the system from a central control point.

## The Circuit?

The pushbutton arrangement is designed to produce a single positive-going pulse to pin 13 of the NAND gate IC1a. This input is normally held low by R2, while R1 ensures that C1 is fully discharged. When the pushbutton is operated both sides of C1 go positive, but then the capacitor rapidly discharges through R2. This positive-going pulse lasts for a few microseconds only, whereupon the pin 13 input is returned to zero volts as C1 discharges.

If all units are in the reset condition the busline is being held high, maintaining a high on the pin 12 input to IC1a via R3 and R4. Thus the positive input pulse appears at the output of the NAND gate as a low-going pulse. This is coupled directly to the pin 1 input of IC1b which, together with IC1c, forms a monostable circuit.

However if another player has got

in first, the busline will be low, holding the output of IC1a at logic 1 until the busline is reset.

Pins 5 and 6 of IC1c are held low, normally, by R5, keeping the output pin 4 at logic high, and this output is also fed back to the other input of IC1b at pin 2. And since the pin 1 input is normally high until a low-going pulse comes from IC1a, IC1b output at pin 3 will normally be low. This keeps the monostable timing capacitor C2 discharged while in the reset condition. But when the negative pulse arrives at IC1b from the pushbutton, the output will immediately go high, taking pins 5 and 6 with it since there is zero voltage drop across C2. Pin 4 of IC1c then goes low, taking pin 2 of IC1b low and disabling the gate by keeping pin 3 at logic 1. The monostable period lasts until R5 discharges C2 below the Schmitt trigger threshold, at which point the monostable resets to its rest state, awaiting another input pulse.

The time period is set by C2 and R5 at about three seconds, and the monostable cannot be re-triggered within this time.

Transistor Q1 is turned on via R6 by

## Parts List

### RESISTORS

(All  $\frac{1}{4}$  watt 5% carbon)

R1, 2	100k
R3	2M2
R4, 6	10k
R5	3M3
R7	100R
R8	4M7
R9	27k
R10	10R

### POTENTIOMETERS

(both miniature horizontal presets)

PR1	470k
PR2	4k7

### CAPACITORS

(Ceramic unless noted)

C1	1n
C2	1u
	35V Tantalum
C3	68n
C4	22n
C5	10n
C6	22u
	16V axial electro

### SEMICONDUCTORS

IC1	4093B
	CMOS Quad 2-in Schmitt trigger NAND
Q1	BC184L
Q2	BC214L
Q3	BFY51
D1, 2	1N4148

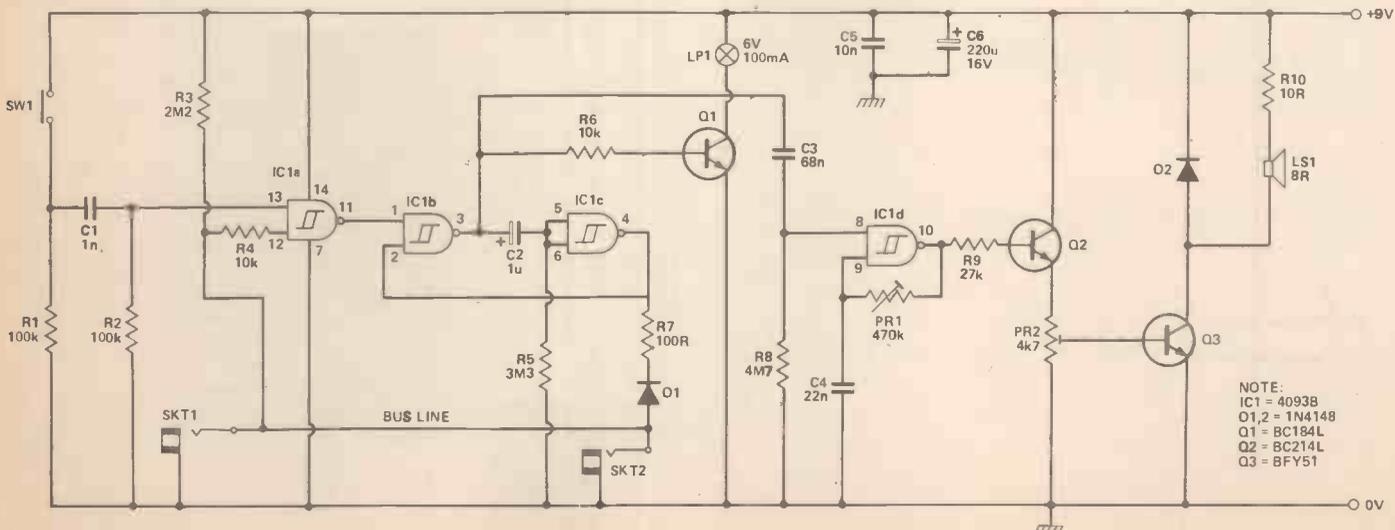
### MISCELLANEOUS

SW1	push-to-make
SPK1	8-16R mini speaker
LP1	6V/100mA bulb
J1, 2	2.5mm sockets (see text)

Case, Bimbox 6005; PCB; Veropins; 9V PP7 battery & clips; wire, solder, nuts and bolts etc.

BUYLINES .....page 26

Figure 3. The Circuit. An On/Off switch is not included as power consumption is less than 1mA in the rest state.



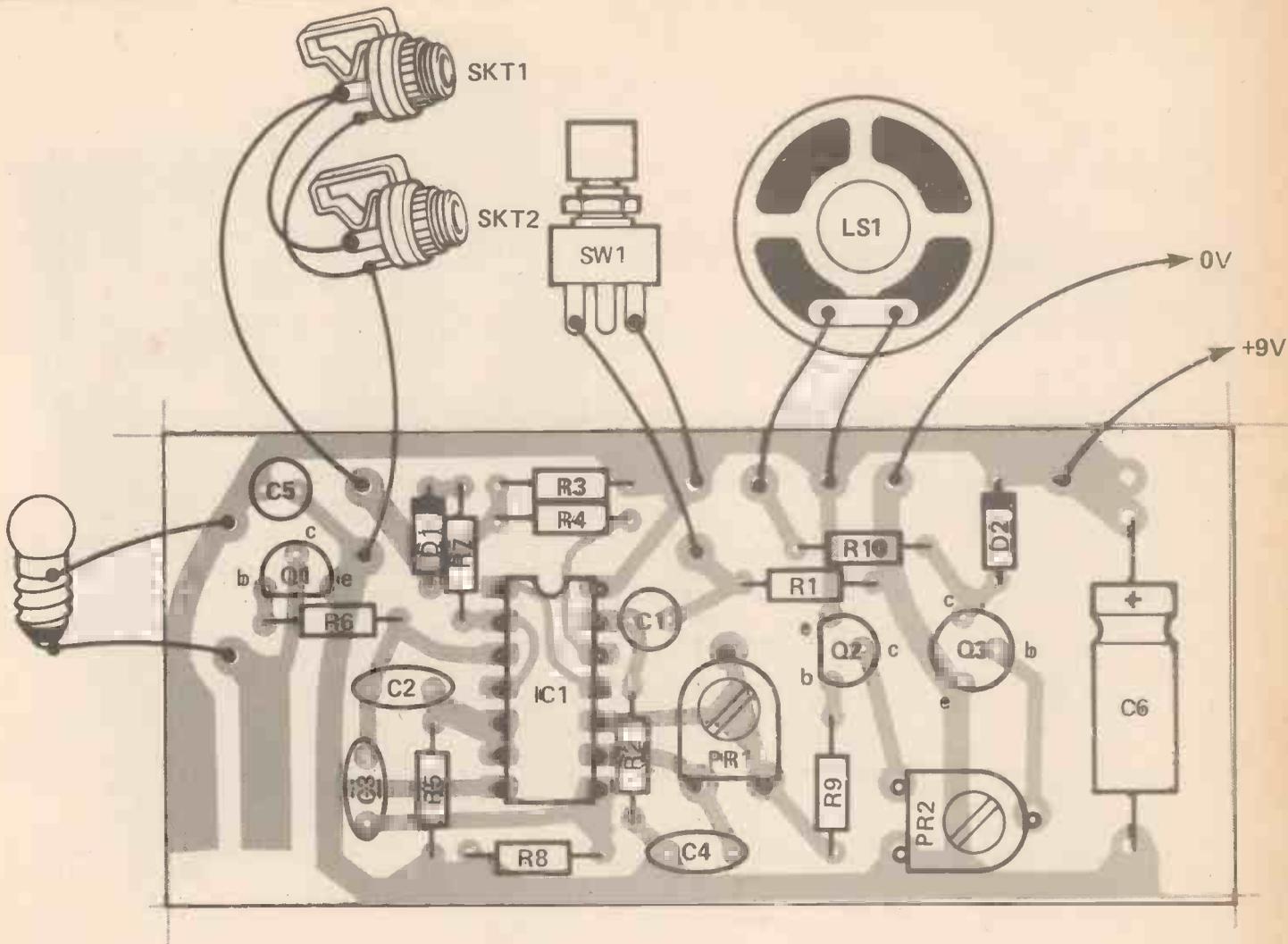


Figure 4. The Component Layout. Note the orientation of D1 and 2, C2 and IC1.

the logic 1 voltage from pin 3 of IC1b, and remains on for the period of the monostable. Q1 supplies up to 200mA for the indicator lamp, LP1.

Meanwhile the low-going signal from the monostable output (pin 4 IC1c), is coupled to the busline via R7 and D1; R7 is there to limit the current on the busline in the event of a short circuit, and D1 allows other stations to take the busline low without affecting the monostable.

At the moment that the first monostable triggers, another monostable based around IC1b is also triggered via C3. IC1d is really a gated squarewave oscillator, with the frequency set by PR1 and C4, to produce an audio tone. When the positive edge of the first monostable pulse is passed via C3 to pin 8 of IC1d the oscillator is gated on, but will turn off after a period determined by the discharge of C3 through R8; this is set

for about one second. Q2 and Q3 are used to amplify the squarewave and drive a small eight Ohm speaker. PR2 adjusts the drive to Q3 and thus the volume; D2 is included to protect Q3 against inductive transients.

Owing to the use of CMOS ICs and the arrangement of the amplifying transistors, the current consumption is held to less than 1mA in the rest state, and so an on/off switch is not included. One could easily be arranged by using, for the busline, a socket with an additional pair of normally-open contacts wired to the power supply, so that power is switched automatically when the unit is connected into a Quizmaster system.

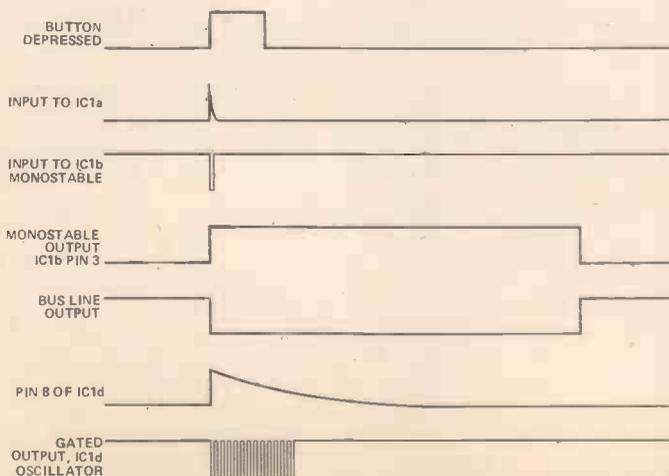


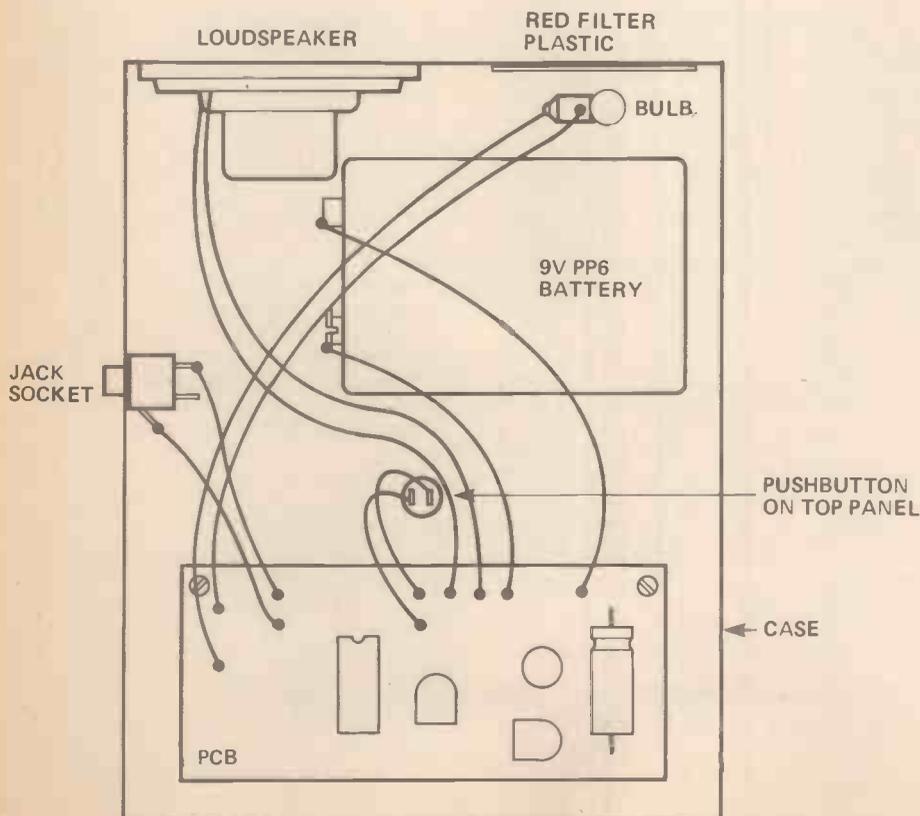
Figure 5. This diagram shows the sequence of signal level changes when the Quizmaster is operated, as described in the text.

### Construction

The circuit layout is not critical and could be built on Veroboard, but we recommend using our PCB for a much simpler and neater construction. The PCB overlay is shown in Figure 3, and there should be no problems with this as long as the orientation of the IC and the two diodes are carefully noted. The tantalum capacitor C2 must also be mounted with correct polarity. The transistors are specified as the 'L' versions to match the



Figure 6. Internal wiring of the Quizmaster.



overlay diagram. Different versions may be used, but their pinouts will vary and should be checked before soldering.

Solder in all the components, following the overlay diagram and leaving all the semiconductors to last. It is a good idea to use an IC socket from the CMOS chip. To complete the PCB, solder in ten Veropins at the points marked for external connections to the switches etc (this is not essential, but makes connecting up a great deal easier, particularly when the board has been mounted in the case). Finally, don't forget to check the PCB tracks for solder bridges or bad joints.

The case used for housing each quiz station should ideally have a sloping top panel with sufficient room at the high end of the box for the bulb display and loudspeaker. There should also be room for a PP6 or PP7 9 Volt battery, unless a mains power unit has been opted for.

The box used as seen in our photograph is a BIMBOX 6005, very reasonably priced at about £2, and the ideal size for each station. The internal photographs and diagram show the mounting arrangement for the speaker pushbutton, jack socket and lamp display. The assembled PCB is screwed down in the box and wired

## HOW IT WORKS

The quiz lockout system provides every player with a buzzer station. The block diagram shows the various circuit blocks that are involved in these stations. Each unit is linked to all the others via a common bus rail as shown in the diagram, allowing any number of buzzer stations to be simply incorporated into a complete system. The bus rail carries a single logic level relative to ground and is bidirectional, in that each station can

both send a logic level to all other stations and can also receive a signal from any other station. The bus rail allows the system to determine who buzzed first, from a number of players.

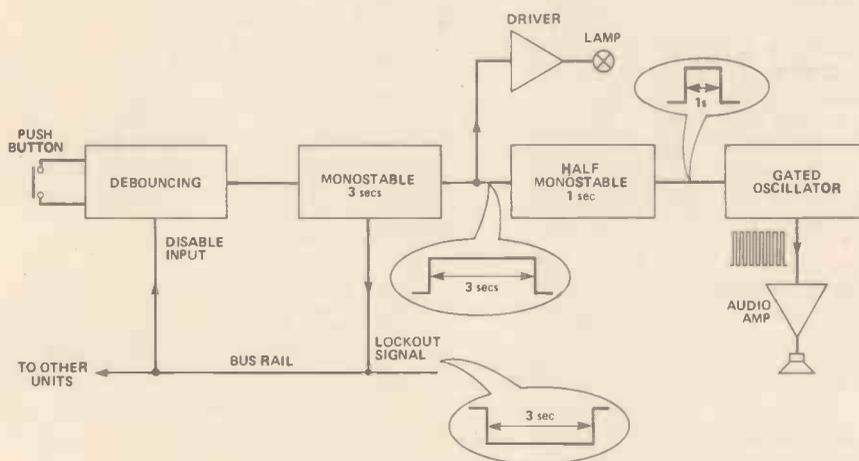
Studying the block diagram from left to right, we start with the player's pushbutton and debouncing circuit. This ensures that we get one brief pulse every time the button is pressed. A disable input on this circuit prevents these pulses appearing

when it's at logic low; it is connected to the bus rail to receive logic signals from the other units.

The push button pulses then trigger a full monostable circuit which goes from low to logic high for three seconds and then back to its rest state of logic low. The high period of this monostable is used to light a lamp, via a sample driver circuit, to indicate that this buzzer station has been successfully activated. At the same time a complementary version of the monostable period goes to the bus rail, transmitting a three second logic low signal to all the other buzzer stations.

In this way the firing action of all the other push buttons is disabled, locking them out for the duration of the monostable period. The first player to buzz will light his display lamp to the exclusion of any other players.

A half monostable circuit, triggered as the push button is pressed, is used to provide a loud one second bleep. The monostable turns on a gated audio oscillator to provide a short variable frequency tone which is amplified to drive a loudspeaker. Each buzzer station can be individually adjusted over a wide range of tones and volume, so adding 'personality' to different player's buzzers!



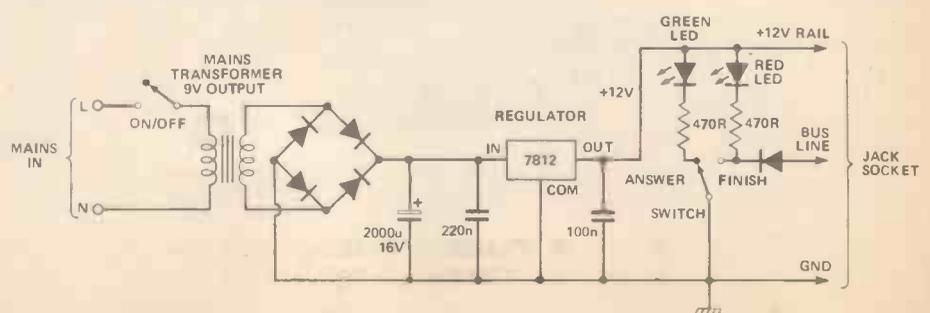
up to the external components from the terminal connections as indicated on the overlay diagram.

If a battery supply is not being used then miniature stereo jacks should be used in place of the mono type to provide an additional inlet for the positive supply rail. The jack connections will then be ground, bus rail, and positive supply. Otherwise, the jack connections would be simply ground, and the bus rail; one or two jack sockets may be provided. In either case, battery or mains, an on-off switch is not required. If a master station for a number of quiz terminals is built, then this could house the mains power supply and would connect up in the same chain via a stereo jack to supply any number of units. A suitable power supply is shown in Figure 1. The loudspeaker was simply glued to the high end of the case with a number of holes drilled in the plastic for sound outlet.

Using a filament bulb as the display indicator allows any number to be displayed by each unit. This is easily achieved by blocking out areas of a piece of red filter plastic with black ink, leaving the desired number outlined, and securing this behind a square hole cut out in the front panel. The display bulb behind this mask will then brightly illuminate your chosen number.



Figure 7. A circuit for a Master Control switch, incorporating a power supply which can replace the Quizmaster's batteries.



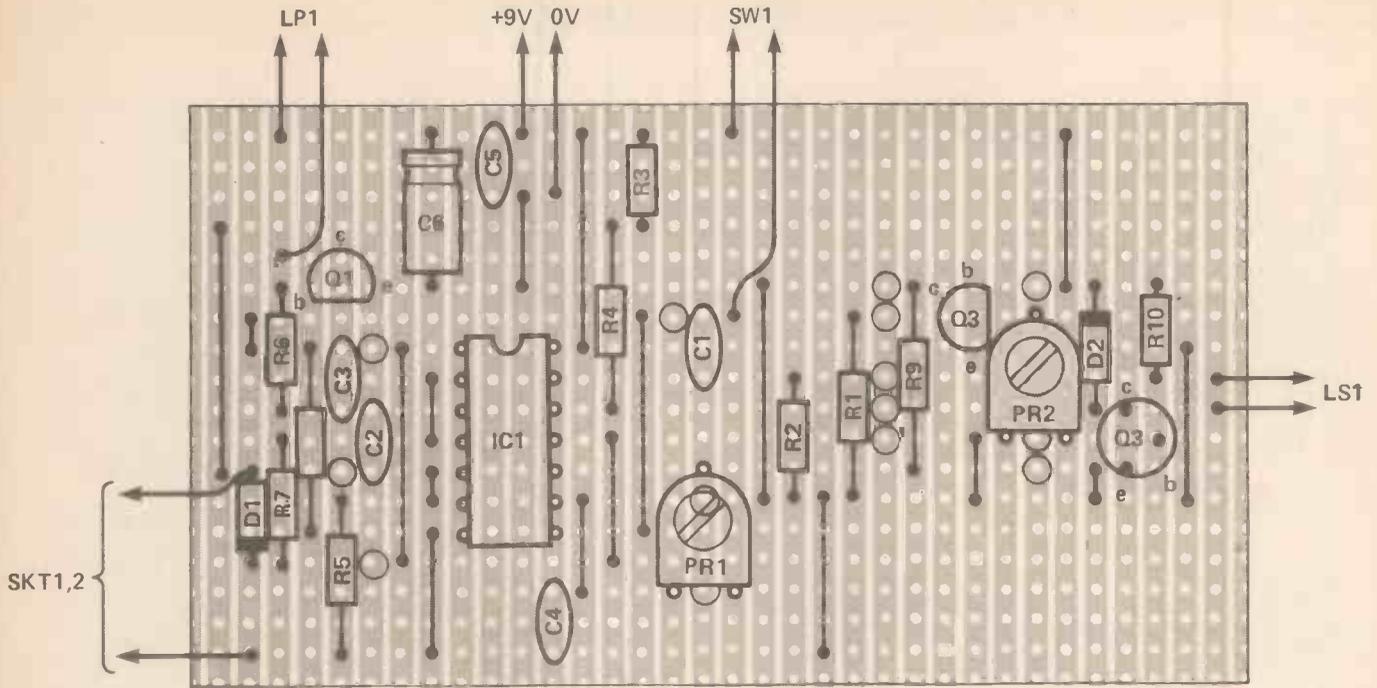


Figure 8. An untested Veroboard layout is given as an alternative to the PCB, for those who prefer building on Vero.

When assembly is finished the buzzer station can be tested. With power applied, and no bus line connections, the unit should emit a loud bleep the pushbutton is pressed and the display light will come on for about three seconds. PR1 can now be adjusted to set the desired buzz tone,

and PR2 will set the volume level. Now connect a jack plug into the bus rail socket and short together the terminals; if the buzzer is now inactive, everything is OK. Releasing the terminals will return the buzzer to its normal mode. Are you ready, then? Your subjects is . . .

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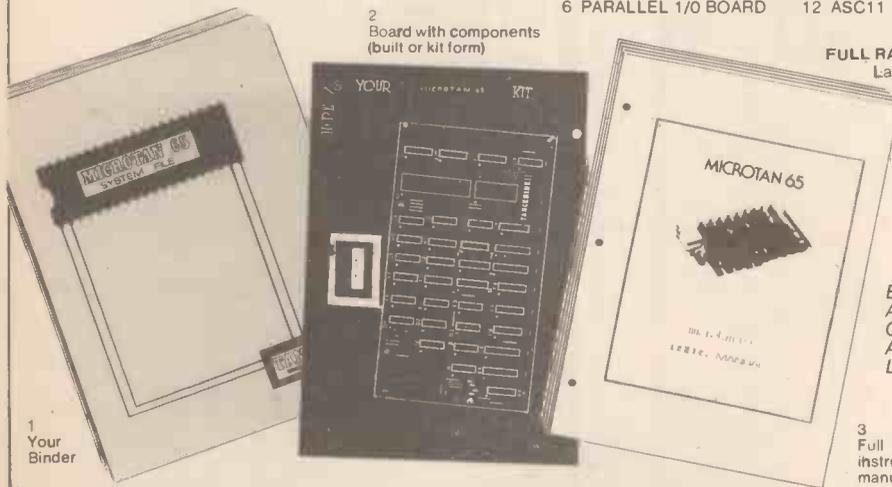
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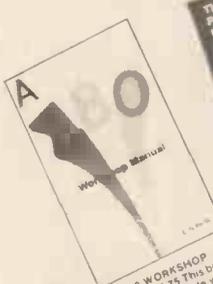
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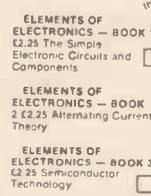
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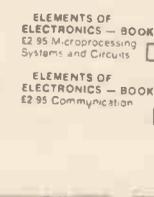
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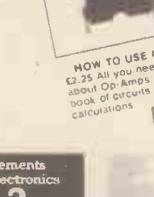
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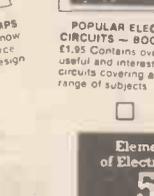
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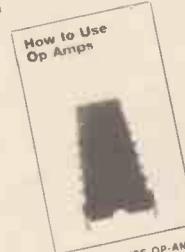
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# CAREERS IN ELECTRONICS

Careers In Electronics begins 1984 with the first in a three-part look at electronics in the Armed Forces. This month we concentrate on the Army, with the Navy and Royal Air Force to follow.

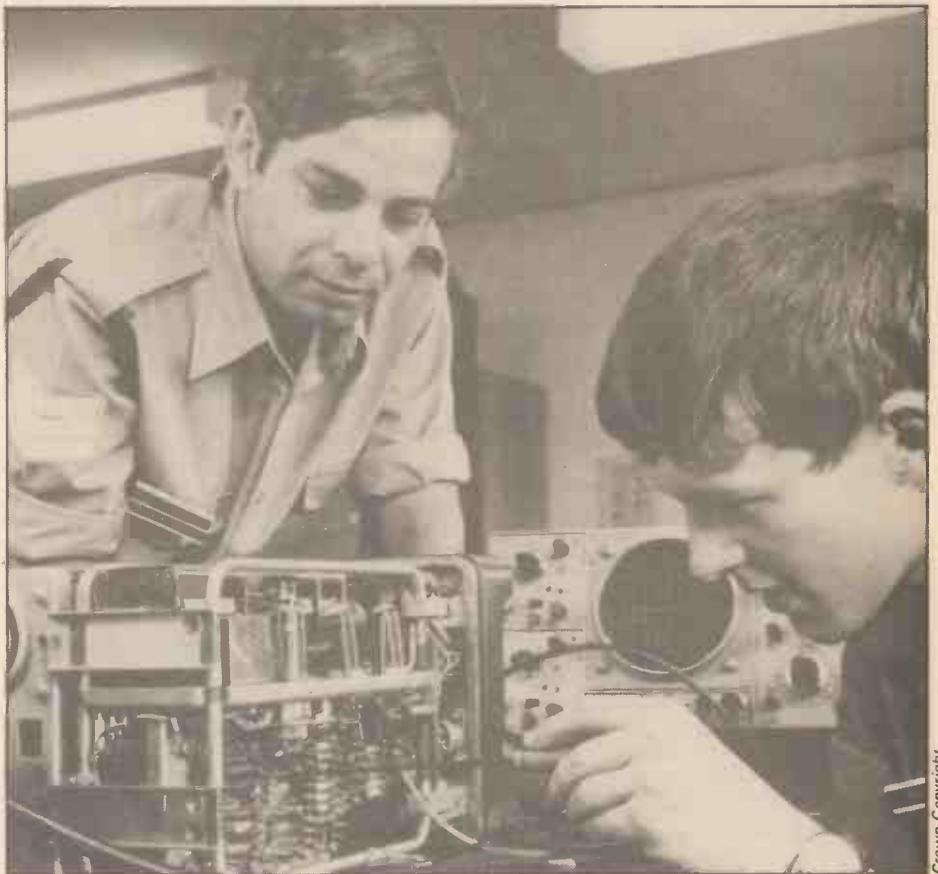
Helen Armstrong

Most readers will be at least passingly familiar with the word 'Milspec'. For those who aren't, 'Milspec' is short for 'Military Specification', and refers to components and hardware whose accuracy and reliability measures up to the demands of military use. If a piece of hifi or a commercial control system breaks down, it can cause anything from mild anguish to heavy financial loss; if a weapon, aircraft or military communications system packs up, lives could be at stake. Add to this that military equipment in active use has to stand up to long hours, rough handling and expeditious maintenance, and it's obvious that it must be designed and built and serviced to very high standards. These standards have to be maintained and improved in peacetime in constant preparation for the possibility (however slight) of real conflict.

When industrial engineers want specially high standards of reliability, they look for Milspec components. The same could be said about military engineers, logically enough: there is no point in having top-grade manufacture and design unless the engineers who are looking after it are also top-class.

While the three 'branches' of the Armed Forces are independent of each other and responsible for their own administration, there are a few generalisations which can be made. They are designed to run like a very well oiled and tuned machine, to respond quickly and efficiently in situations where the results of their actions could be momentous. The men are as much a part of the machinery as the machinery: even at the lowest levels of responsibility, the soldier/sailor/airman is responsible for his personal kit and weaponry, and above this level he is responsible for organising and supervising other men in addition.

Because continuous training is given, you cannot quit for Forces at a moment's notice if you don't get on with the people you work with. So it's not a



comfortable option for anyone who is not happy with the idea of accepting and delegating responsibility while at the same time following instructions (or "orders", as they are known in the trade) and putting a certain amount of implicit faith in the hierarchies above him. It's not a venue for argument or indecision, which is not to say that you are not required to think.

All the services place great emphasis on 'leadership' and 'management', by which they mean the ability to get men and material resources working

effectively, not only by organising them but by being able to demonstrate that you are not asking them to do anything that you would not do yourself. This responsibility means being able to feed back your opinions and assessments to the people above you, without inducing trouble and strife. The trouble and strife is meant to come from the 'other side', not from within: management is the name of the game, with a vengeance. Where does electronics fit in?

The Army, Navy and Air Force need engineering skills at all levels. They set

## Careers In Electronics

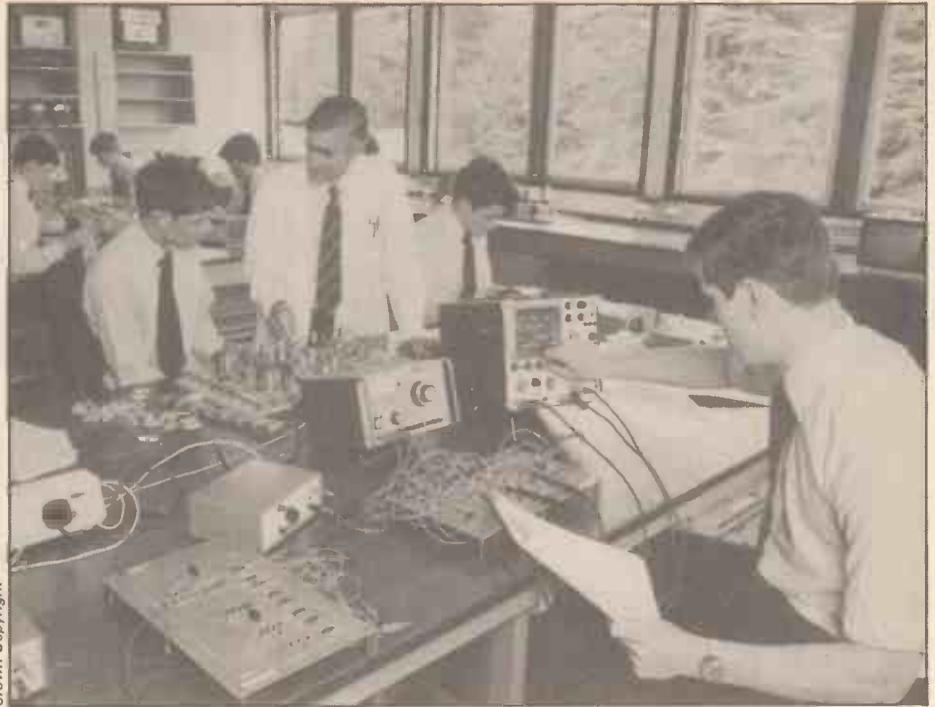
An electronics teaching lab. at an Army college.

high standards, and, of more interest to anybody who has not already decided to choose the forces life *per se*, offering thorough training, from basics on to higher degree level, in all relevant engineering subjects, (which are most). Again, because of the 'management' aspect, specialised as it is to Service life, the engineering training has aspects which you wouldn't expect to acquire in civilian life. And yes, these aspects do include 'square bashing' (marching in formation), saying "Yes sir", and negotiating your way on foot across a rain-sodden moor with a pack load of equipment. If you think you can't cope with all this — don't join the forces.

But read on: there's more on offer for the bloke who has electronic aspirations. I say bloke: opportunities for ambitious or technically minded women exist but are limited because the British Services do not accept women in a fighting role. Why not? There are lots of excuses given, which I am not going into. Don't expect that to change until the US Armed Forces get over their own teething troubles integrating women into the fighting forces. Meanwhile, engineer = male, unless otherwise noted.

### In The Army Now

In the ARMY there are three corps which train and deploy engineers: The Corps of the Royal Electrical and Mechanical Engineers (REME), the Corps of the Royal Engineers (known as "Sappers") and the Royal Corps of Signals. The Sappers are highly trained combat engineers and their work doesn't involve electronics to any extent; the Royal Corps of Signals are



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entirely concerned with communications, so there is a certain amount of radio and data processing electronics involved. REME however is the corps which employs most electronics technicians and engineers.

The Army expects to take in recruits from age 17 upwards (or 15¾ for Apprentice Technicians) and train them from scratch at one of their colleges. In the case of REME Electronics Trades the training is at the School of Electronic Engineering at Arborfield. This begins with basic electronic theory, and is followed by more specialised training as a telecommunications technician, radar technician or control equipment technician. This involves familiarity with the equipment being used, the principles on which it works, and fault-finding and repair.

Avionics Technicians, who are trained by the Aircraft Engineering Training Wing at Middle Wallop, follow a similar course, as do Instrument Technicians from the Weapons trades, who are based yet another establishment, the School of Electrical and Mechanical Engineering at Bordon; their specialisation is gunnery.

REME basically accepts men of its own choosing regardless of whether or not they are technically qualified, and then trains them for its specific needs. Between 23 and 35 they may be chosen for an artificer course bringing them up to the rank of Staff Sergeant, where they will act as supervisors or junior managers, and may be registered as technician engineers (CEI) if they attain the right qualifications. The qualifications studied include HNC and City and Guilds Full Technological Certificates (or Technician Education Council Awards).

This is the career route which can lead, eventually, to commissioned rank for some technicians.

In common with all the services, REME and the other Army technical corps have an apprenticeship scheme, which takes entrants between school leaving age and 17 and puts them through a two or three year course involving all their technical training, military training and whatever educational and academic subjects they need to study, putting them a bit ahead of later entrants in their progress through the ranks. They study for the Certificates and Diplomas of the Technician Education Council.

REME trainees have twelve weeks of 'basic military training' before their technical education gets going. This means learning the procedures, rules, regulations and reasons by which the Army operates, and includes learning

Setting up a radio under field conditions with a field regiment.



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how to look after the uniform and kit, drilling, weaponry, and fitness and survival training. The Royal Corps of Signals come right out and say it: "It's tough. Not everyone enjoys it". Even so, this is the part of the training which people who have been through it remember with a sense of achievement, and it underlines the fact that you are a soldier from day one.

## Qualifications For Life

The Royal Corps of Signals cover such trades as Electronic Warfare Operator, Telecommunications Mechanic, and Data Telegraphists, and all technicians learn basic electrical and electronics theory to start with. Recruits join the field units generally as Class III tradesmen at the end of their training period, and work up from there. Between 15¾ and 17½ you can join as an Apprentice or between 16 and 17 as a Junior Signaller, both of which include an earlier start and extra education. Apprentices study for the BTEC or City and Guilds Certificates; Junior Signaller training follows the same basic career structure, with the added proviso that they are looking for leadership qualities suitable for possible promotion. This is only a difference of emphasis; promotion towards and into officership is possible from any part of the Service.

All the Services emphasise that the courses of training, and qualifications gained are basically the same as those in civilian life, and are recognised by industry and the trade unions.

Combine this with the facts that few men spend their whole working lives in the services, and that there are regular options to leave the service during the basic term of engagement and it is apparent that Army training provides a good technical education for those who do not want to make a long-term career in the Army, as well as those who do. Ex-technicians from these three corps quickly find good jobs in civilian life. Some people join one of the forces specially to get a good education in a particular field, plus the all-round experience of doing a physically as well as a mentally demanding job for a few years.

The same is true for more highly qualified men who can enter the Army as officers at various levels, and on Regular or Short Service commissions.

Non-commissioned members of the Army enlist for twenty-two years, after which they normally have to leave the service, but there are numerous factors governing when they can (or must) leave before that time, quite apart from factors of health and competence (which govern any career, but more so in the services where comparatively high standards are needed just to do the job). A new recruit has a period of about six weeks after joining when he can opt to

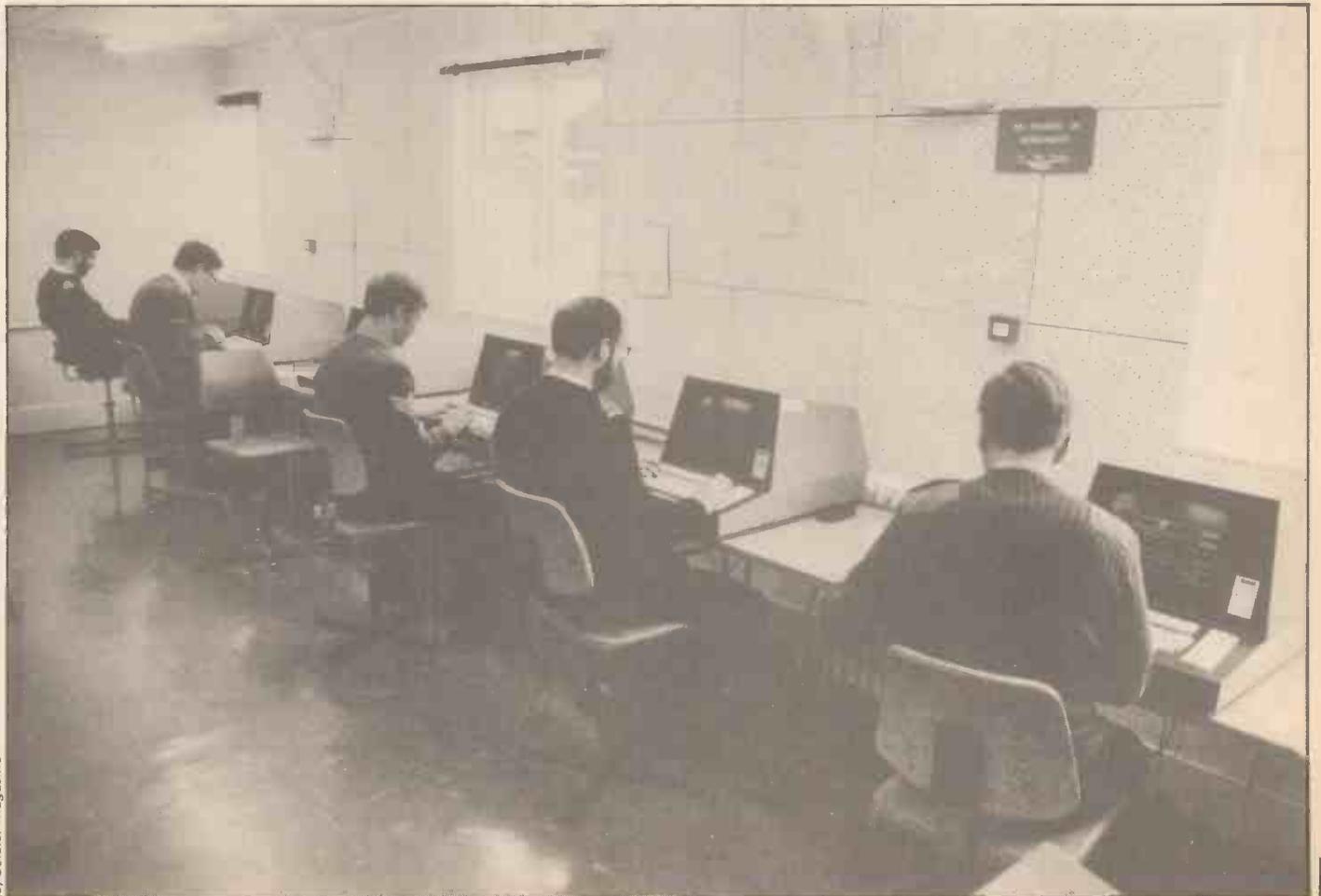
leave (or be asked to leave); after this, options to leave come at three, six and nine years; after this, the soldier can re-sign for further set periods, up to the twenty-two years.

REME officers, with the exception of some Short Service officers, must be graduates in a relevant subject. There are various ways of achieving this: you can enter as a graduate, or as an under-graduate, or show that you have the ability to study for a degree under Army sponsorship.

A graduate or imminent graduate going in as a Direct Graduate Entrant attends a four or five month Graduates' course at Sandhurst before going on to the REME Officers School at Arborfield for a Postgraduate course in a chosen specialist discipline. People just going into University, or in their first or second year, can apply to an Army Undergraduate Cadetship, where the Army pays fees and a salary; entrants joining direct from school, on the other hand, spend a year at Sandhurst as an officer cadet and then spend some time in Officers School and REME Engineering schools covering basic REME engineering practice. This is followed by a 'posting' of up to eighteen months as a junior subaltern in an active workshop.

A three year degree course will then be taken, normally at the Royal Military College of Science, Shrivenham, with workshop practice courses and projects to be undertaken in the long vacations.

A group of Army and Navy trainees taking a computing test at a Data Processing Centre.



(c) Soldier Magazine

## Careers In Electronics

This is very much the course for some one who wants to make a long-term career in the Army, as studies are directed towards the Army's needs from the start, which gives a head start in Army practice.

At some stage in his studies, the officer will begin to work towards one of the three areas — Mechanical, Aeronautical or Electronic Engineering, as described earlier on — which he has chosen to specialise in. Again, the Army has final say in which area you specialise, with the intention of using your abilities to their best advantage.

For Short Service Commissions the routes are very similar. The early undergraduate can apply for an Army Undergraduate Bursary to supplement his local authority grant. Short Service Commissioned officers can also be accepted with an HNC or ONC in Engineering with 60% in maths and two other relevant subjects, or an HNC or Full Technological Certificate in a relevant subject. You can convert to a Regular Commission after a year's active service in REME, but must then study for a degree.

### Field Experience

After degree and postgraduate study, REME officers are sent on a posting as commanding officer on a Light Aid Detachment, a small unit looking after the equipment and vehicles of another division, and responsible to the commanding officer of that division. This is active service experience, giving the officer actual responsibility for commanding a group of men and making certain that the equipment in his charge is fully operational whenever it is needed. In peacetime, this may be the only 'field' experience an engineering officer has, and it is important in that it gives him the experience of organising and motivating a group of men working as near to combat conditions as possible without a war. This is a different proposition entirely from the experience of most civilian engineers: out of doors, in all weather conditions, at short notice, and with expensive and delicate equipment which is expected to work first time, or — in real combat conditions, or even under exercise conditions — cost lives.

The Officer's progress in REME after this will tend to take him to workshops, HQs, research establishments and civilian manufacturers rather than to the front line.

The story is a bit different for a Royal Signals officer, where the work is less theoretical and academic, and more practical. Signals officers do not have to be graduates, and — although they must have a thorough understanding of the equipment they are working with — have less 'hands on' involvement with the insides of equipment. Their business is to keep communications gear connected up, and keep the signals going through, and the officers are



(c) Soldier Magazine

Connecting a Telebrief (ground communications) line to a Harrier in the field.

primarily involved in planning and supervision. The Signals are very much a front line corps, and operate right up to the forward edge of the Battle Area.

Young Signals officers undergo a five-month Communications Qualifying Course at the School of Signals at Blandford. The technical syllabus covers radio and electronics, computers, microprocessors, and audio systems and microwaves, as well as all kinds of transmission techniques and radio and data processing equipment. Instruction is as practical as possible. The course also covers military studies, including tactics, command and control, leadership and equipment management.

From here, the trainee will go to his (or her) squadron or regiment as a working officer. During this time there may be the opportunity to study for a degree, or a Telecommunications Engineering Management course (graduates and a few non-graduates), which will lead to eligibility for possible membership of the IEE (Institute of Electrical Engineers — the main professional body for electrical and electronics engineers). Careers opportunities after this include advancement through the regimental or administrative (Staff) sides of the Army, or a combination.

The basic qualification for a Signals officer is an 'O' level in Maths, English language, a Science subject and two other subjects, but the competition is such that better qualifications are usually needed; however, the Army itself will often put candidates through and extra 'O' and 'A' levels if it thinks they have other qualities which are worth developing.

It is possible to opt for the Army while still at school at a minimum age of 15 years 5 months, by applying for an Army Scholarship. Because of the range of non-combat jobs involved, the Signals is the best Corps to investigate if you are a female with technical aspirations.

There are some general qualifications for entry into the Armed Services which I will mention at the end of the feature — they are mostly to do with nationality. All Army officer candidates have to undergo around three days of leadership and character tests at the Regular Commissions Board at Westbury, and their course from there will be determined by several factors including age, educational and professional attainments, and personal interests and ambitions. Promotion for officers goes in steps determined in part by the officer's age and his length of service, the level he can achieve being determined by merit and the Army's requirement at any given time.

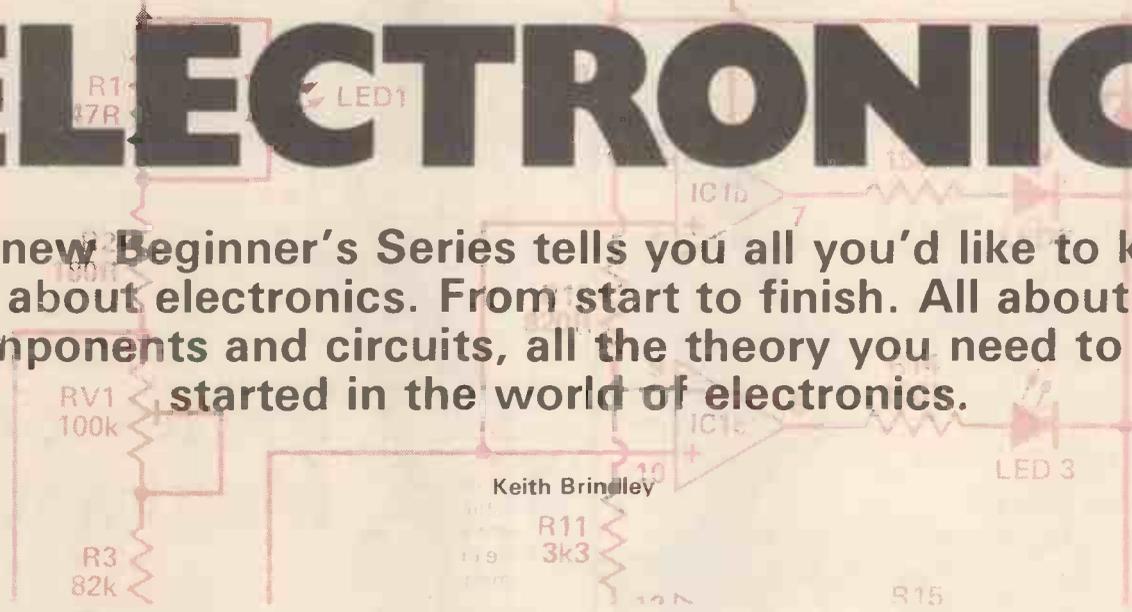
Interested? There is a lot more to find out than the outline I have given here: the first step is to get in touch with an Army careers office, pick up as much paperwork as you can, and ask questions. Then, ask about visiting an Army establishment of the corps you are attracted to, or more than one. Recruitment offices can be found in the telephone directory, or write to one of the addresses given at the foot of the article, asking for brochures and the address of local careers offices.

*Careers In Electronics continues next month with the Royal Navy.*



# ALL ABOUT ELECTRONICS

Our new **Beginner's Series** tells you all you'd like to know about electronics. From start to finish. All about components and circuits, all the theory you need to get started in the world of electronics.



IN THIS MONTH'S All About Electronics we are going to take a close look at one of the most important types of linear ICs — the operational amplifier, normally abbreviated to op amp. From now on I will refer to op amps.

Op amps are just what their name implies — amplifiers which can be used (ie, are operational) with only a minimum of extra components. This is not to say that the circuitry inside an op amp is simple. We can, in fact, think of an op amp in block diagram form, an example of such is shown in Figure 1. Here the block diagram shows an amplifier with a voltage gain of ten. This means that whatever voltage is applied to the amplifier input will be increased tenfold ie, if a voltage of 1VDC is applied at the input, 10VDC will be obtained at the output.

Usually, when anyone discusses op amps in modern day terms, the op amp takes the form of an integrated circuit (IC). In days gone past this was not the case and discrete transistors, even valves, were combined together into a complete op amp circuit. The use of ICs simplifies circuit design, and enhances the use of block diagrams in electronics, because the designer no longer needs to think along the lines of complex circuits with components galore but can design quite versatile circuits with only a handful of components.

Probably the most common IC-type op amp is the 741. In its most used form the 741 is an 8-pin DIL IC. The internal circuit of a 741 is shown in Figure 2 and you can see the IC has far more to it than would at first appear. I counted twenty transistors in the circuit so it is obviously quite a complex device. However, its very complexity also makes it extremely versatile.

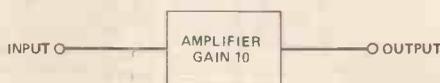


Figure 1. An amplifier shown in block diagram form, with the gain (in this case, x 10) specified.

## Mix And Match

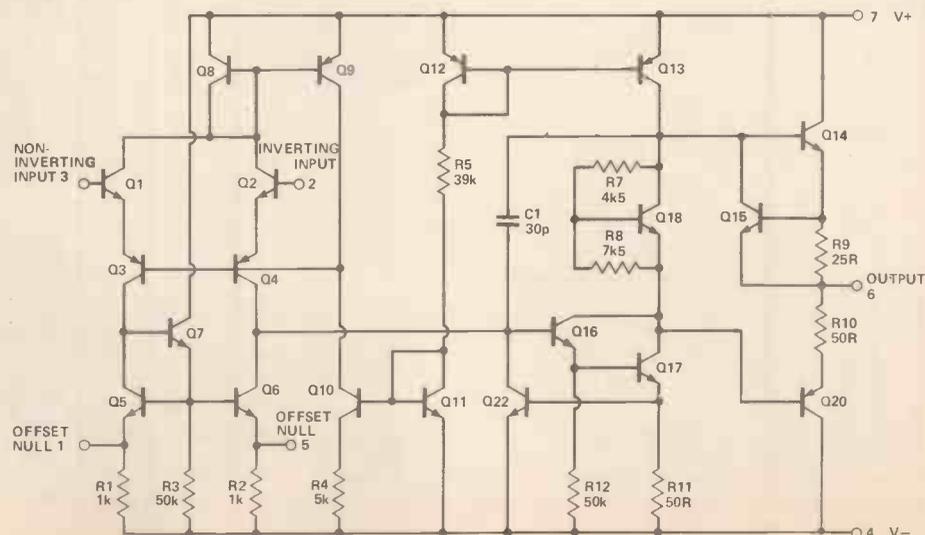
Simply by adding components, say a couple of resistors or capacitors etc., to an op amp can result in very different characteristics, although in essence all that an op amp can do is amplify whatever is at the input. Let's look a bit closer. The circuit symbol for an op amp

is shown in Figure 3. It has two inputs (labelled + and -) and an output. Electric power to operate the amplifier is supplied to the terminals V+ and V-. Note that a 3-rail power supply is used to provide three voltages: V+, 0V, V-.

An op amp is termed more correctly a differential amplifier, ie it will amplify the difference in voltage between the two input terminals. The gain of an op amp connected as in Figure 3 is very, very high (say 10,000).

Now, if the - input (known as the inverting input) is tied to 0V, the amplifier works such that if the voltage applied to the + input (the non-inverting input) is higher than 0V (ie, it is of a positive potential), then the output is also higher than 0V. Likewise, if the

Figure 2. The internal circuit of a 741 op amp.



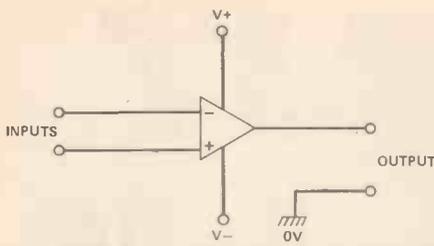


Figure 3. Op amp circuit symbol.

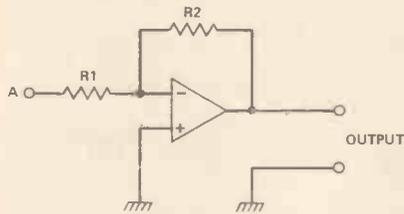


Figure 4. An inverting op amp shown with negative feedback.

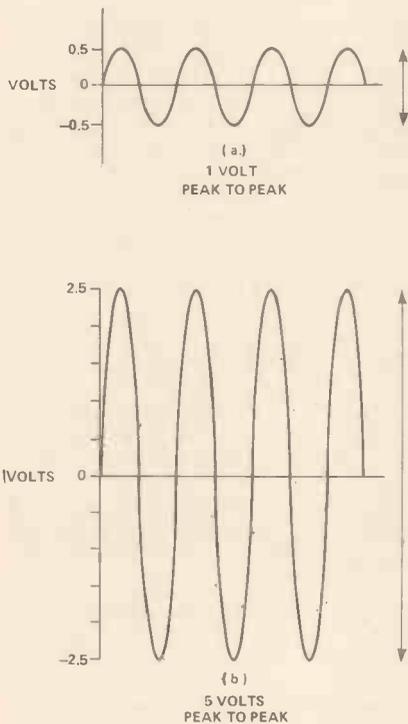


Figure 5. AC input and output voltages to and from an op amp with a gain of five.

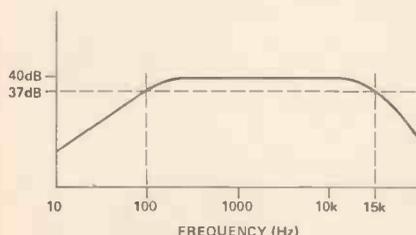


Figure 6. The frequency response of an amplifier with a bandwidth of 100Hz to 15kHz.

non-inverting input voltage is below (ie, negative), the output voltage is negative. It is because of this basic action that the non-inverting input is actually called the non-inverting input.

Similarly, if the non-inverting input is tied to 0V, the inverting action of the op amp is displayed. So, if the voltage applied to the inverting input is above 0V (ie, positive), the output voltage is negative and, if the input voltage is negative the output voltage is positive.

Of course if the gain of the op amp is very high, only a tiny differential input voltage is needed to produce a large output voltage. Although this may be suitable in some instances, the majority of applications will require a much lower gain, say ten, or two etc. We can compare the gain of an op amp in the circuit of Figure 3 with a transistor gain  $\beta$ , back in All About Electronics in the HE November 83. If you remember, Figure 20 of that month shows a transistor amplifier which used a technique known as feedback to control the gain of the common emitter transistor circuit, to a readily definable value. The gain of the circuit simply came down to the ratio between two resistors and by changing one or both of the resistor values the common emitter amplifier gain changed.

Op amp circuits use a similar feedback technique, but with op amps the application is far more apparent than in a transistor circuit. A portion of the output is literally fed back to an input. Because we wish to decrease the value of gain the input chosen to feed back to is the inverting input. The process is called negative feedback. If positive feedback was chosen, ie from the output to the non-inverting input, gain would effectively increase and become uncontrollable, although it can be tamed and then used quite effectively as a later example will show.

### Negative And Positive

Generally speaking, negative feedback is executed with the use of a component connected between output and inverting input, generally passive (but not always). The simplest passive component is the resistor and it is a resistor to which we shall now turn to demonstrate the action of an op amp in a negative feedback circuit.

Figure 4 shows an op amp with a feedback resistor, R2, from output to inverting input. Also shown however, is a resistor connecting the input voltage applied to the circuit to the inverting terminal. This resistor is known as the input resistor, R1. Now it can be proved with some quite complex mathematics that the gain of the circuit equals:

$$\frac{V_{out}}{V_{in}} = -\frac{R2}{R1}$$

The minus sign indicates the amplifier is an inverting amplifier. So, we can control the gain of the amplifier by altering one or both resistor values. For example, if a gain of say, 5, was required

then we could choose resistor values of 10k for R2 and 2k for R1. Or 50k for R2 and 10k for R1. Or 80k for R2 and 16k for R1 etc.

If we now applied a DC voltage of say 1V to point A in the circuit, we would obtain a DC voltage of -5 volts at the output. Similarly, if we applied an AC voltage of 1V peak-to-peak as in Figure 5a to point A, we would get an output of 5V peak-to-peak but inverted in phase by 180° compared with the input (Figure 5b).

From this brief description of op amps you might assume that this would be true whatever frequency is used as the AC input signal voltage. This is not, however, the case because any op amp has what is known as the gain-bandwidth product. I'll explain gain-bandwidth product shortly, but first we need to understand bandwidth.

Now the bandwidth of an amplifier (any amplifier) is defined as the frequency range over which the gain is almost constant — or more correctly speaking it is the frequency range over which the gain does not change by more than a factor of 2 ie, 1.414 times or  $1/1.414 = 0.7$  times the chosen gain.

### A Gain And A Gain

Gain of an op amp (in fact any linear circuit's gain) is often expressed as a ratio of output to input voltages. In electronic terms, the gain can be expressed as a particular number of decibels (dB) where it has been calculated as

$$20 \log_{10} \frac{V_{out}}{V_{in}} \text{ (dB)}$$

So, a numerical gain of 100 is equivalent to a gain of 40dB; a numerical gain of 10 is equivalent to a gain of 20dB; a numerical gain of 1 is equivalent to a gain of 0dB; a numerical gain of 1.414 is equivalent to a gain of 3dB; a numerical gain of 0.7 is equivalent to a gain of -3dB.

So, as the bandwidth of an amplifier is defined as the frequency range over which the gain does not vary by more than 1.414 or 0.7 this automatically means that the gain does not change by more than  $\pm 3$ dB. The bandwidth of an amplifier can be expressed as a frequency range and can be shown on a graph (Figure 6). The X-axis of the graph in Figure 6 shows frequency (in Hertz) on a logarithmic scale but the Y-axis shows gain (in dB) on a linear scale — but the dB is a logarithmic measure of gain anyway. Over the central part of the frequency range amplifier gain is shown as being almost constant at 40dB (ie, a numerical gain of 100). The upper and lower frequencies, where the gain has fallen by 3dB, to 37dB (ie, 15kHz and 100Hz) are known as the corner frequencies, or the 3dB points. These terms are commonly used in electronics so it's worth remembering them, and what they mean.

Now, the gain-bandwidth product of

any op amp is a constant. For the 741 type op amp, the gain-bandwidth product is 1MHz. Thus for an op amp circuit using a 741 IC, if the gain is 100 (ie, 40dB) the maximum bandwidth will be 0Hz to 10KHz.

If the gain is increased by a factor of, say 5, the maximum bandwidth will correspondingly decrease by a factor of 5 (to 0Hz/2KHz). The fact that the figures quoted here for the bandwidth of a 741 op amp go down to 0Hz signify that the 741 can be used to amplify DC input voltages. In certain instances, however, it may be required that a bandwidth having a lower-corner frequency above 0Hz is used. There are ways to do this and we'll see an example later.

## Frequency Response

Gain-bandwidth product of an op amp can be represented as a graph of frequency response (Figure 7) showing how the bandwidth varies with the gain. Figure 7 shows how the bandwidth varies with gain for a 741 op amp and here you can see the effect. If you take a gain of say 40dB, the bandwidth is 10KHz. By reducing the gain for example to one tenth (to 20dB), the bandwidth increases tenfold to 100 KHz.

One very important point which is also displayed in the graph of Figure 7 is the slope of the gain. This slope has a particular angle of 20 dB/decade. In other words the gain decreases by 20 dB for every tenfold increase in frequency.

Another electronic circuit (using only passive components) can produce the same sort of effect. Being passive, such a circuit (shown in Figure 8) cannot amplify an applied signal, and at best can only allow the signal to pass through without reduction in amplitude. The graph of frequency response of the circuit (Figure 9) therefore shows this as a maximum 'gain' of 0 dB ie, a gain of 1, or 'unity gain'.

At the corner frequency the signal amplitude is 3dB down (ie, -3dB) and above this the signal amplitude reduces at a rate of 20dB/decade. Therefore in terms of physical appearance the frequency response is identical to that in Figure 7, only the gain of the circuit is different.

This simple resistor/capacitor circuit is often called a low-pass filter because it passes frequencies lower than the corner frequency and filters out frequencies above the corner frequency. As you would expect, the corner frequency of a resistor/capacitor low pass depends on the values of the resistors and the capacitor used. A simple formula can be used to calculate it:

$$\frac{1}{2\pi RC}$$

and so the resistor and capacitor values shown give a corner frequency of 15KHz.

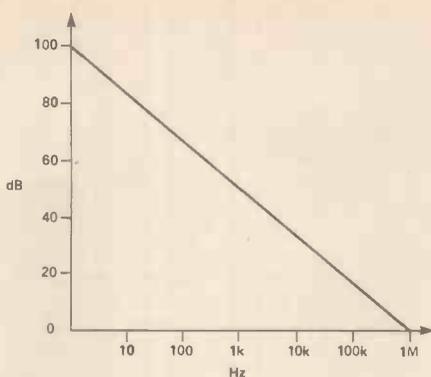


Figure 7. Open loop frequency response of a 741 op amp.

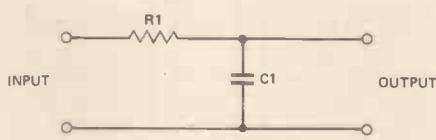


Figure 8. A low pass filter circuit using a resistor and a capacitor.

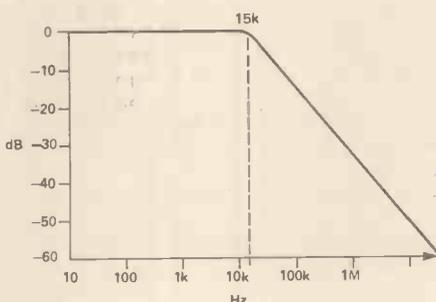


Figure 9. The frequency response of a low pass filter with a corner frequency of 15KHz.

## I Pass

Just as there is such a thing as a low-pass filter, so there is a high-pass filter which allows frequencies above a corner frequency to pass through but filters out frequencies below. The graph of frequency response of such a filter is shown in Figure 10, the circuit of a simple resistor/capacitor network which exhibits this response is shown in Figure 11. The very same formula  $1/2\pi RC$  is used to calculate the corner frequency — so the values shown give a corner frequency of 100Hz.

This circuit should give you a clue to how the frequency response shown in Figure 6 can be obtained. If we simply cascade a low-pass filter and a high-pass filter, ie place one after the other, then an upper and a lower corner frequency will occur above and below which frequencies will be filtered out. But between these two corner frequencies the signal will be passed. Figure 12 shows this using the two

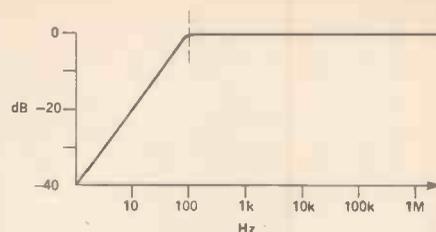


Figure 10. The frequency response of a high pass filter with a corner frequency of 100KHz.

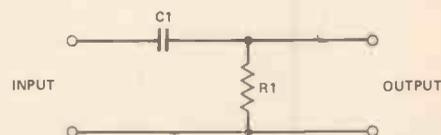


Figure 11. High pass filter using a capacitor and a resistor.

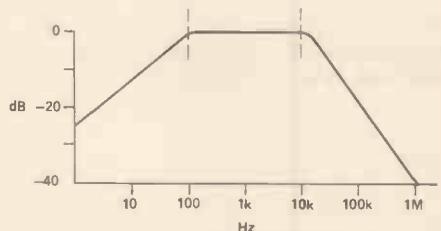


Figure 12. The frequency response of cascaded high pass and low pass filters with corner frequencies of 100 and 15KHz.

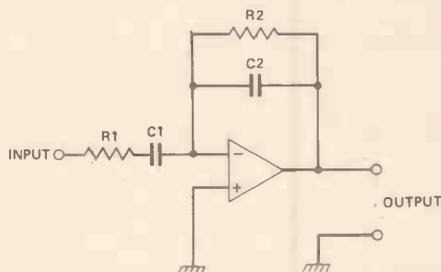


Figure 13. An amplifier bandwidth defined by an op amp with high and low pass filters.

corner frequencies of Figure 9 and 10, but this still has no greater gain than unity over the bandwidth of the response.

To add to the required gain we could simply now include an op amp with a fixed gain into the circuit, that the three networks: amplifier, low-pass filter, high-pass filter are cascaded one after the other. However, a much more elegant way to form a circuit which provides the frequency response of Figure 6 is to use the effect of negative feedback which we already use to control the very gain of the op amp.

Consider Figure 13. The values of R1 and C1 are chosen so that their corner frequency is 100Hz. Above this frequency the signal passes through to the amplifier, but frequencies below are filtered out. The values of R2 and C2 give a corner frequency of 15KHz. Above this frequency more feedback occurs and so the amplifier gain goes down. Thus the combination of the low-

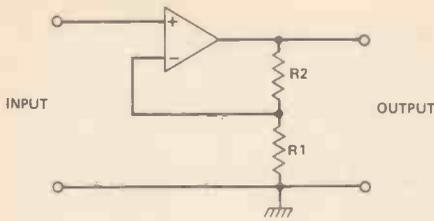


Figure 14. A non-inverting amplifier using an op amp with negative feedback.

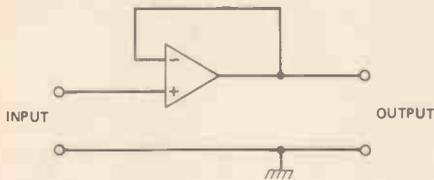


Figure 15. A unity gain buffer using a non-inverting op amp with full negative feedback.

pass and high-pass filters into the feedback circuit of an op amp provide the overall circuit which as the bandwidth we require.

So far we have only studied the op amp in inverting mode. Let's now look at the non-inverting mode. Figure 14 shows the basic non-inverting circuit. Resistors R1 and R2 form the feedback components, (this in essence is a resistive potential divider); the output of which, at the junction between the resistors is fed back to the inverting input of the op amp. Amplifier gain in this mode is calculated from the formula

$$1 + \frac{R2}{R1}$$

From this, you will see that the op amp gain in the non-inverting mode cannot be less than unity — even if the resistor R2 is zero.

### Let's Have Unity

In fact, many applications call for a unity gain amplifier and this mode is often used (Figure 15) as a unity gain buffer. Configured as in Figure 15 an op amp has a very high input impedance and so possesses excellent qualities to be a buffer ie, it does not load a previous circuit. Buffers and loading were explained in last month's All About Electronics.

The same principles we saw with op amps in inverting mode can be used with op amps in non-inverting mode to define their bandwidth.

So, to summarise what we have seen so far: an op amp is simply an amplifier which — with the minimum of external components — can be made functional. It can amplify a wide range of input signals (from 0Hz to many kilohertz) so that the output is either inverted or non-

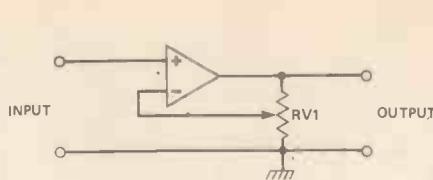


Figure 16. A non-inverting amplifier with variable gain.

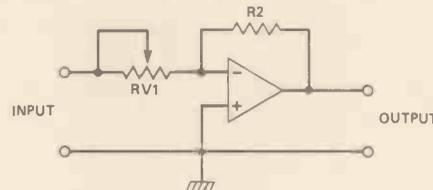


Figure 17. An inverting amplifier with variable gain.

inverted. We can control the level of gain in either inverting or non-inverting mode simply by altering the ratio of two resistors. This is all made possible using the principles of negative feedback.

Now, let's look at some examples of the applications of what we have just summarised. By making one or more of the components in the feedback divider variable the gain of the op amp circuit can be correspondingly varied. Figure 16 shows a non-inverting amplifier with a pot, acting as the potential divider in the feedback circuit. This circuit will provide a large range of gain values depending on the position of the pot wiper.

Figure 17 shows how a pot as the input resistor of an inverting amplifier can be used to give variable gain. In some instances a three-rail power supply may not be desirable (for example, in battery-powered equipment). In such examples we can use a method whereby we trick the op amp into believing that a three-rail power supply exists. Figure 18 shows how. A resistive potential divider at the input terminal provides an artificial earth point about which the op amp functions. DC blocking capacitors at input and output ensure that all DC conditions are

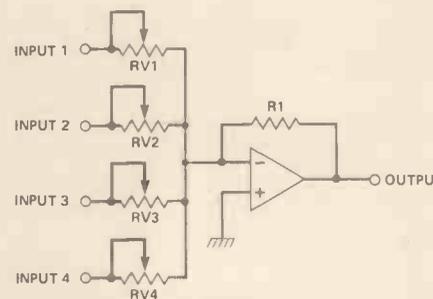


Figure 20. A four channel audio mixer using four potentiometers in the place of four fixed input resistors.

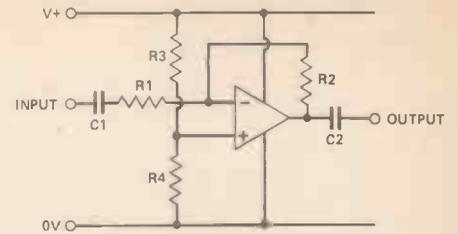


Figure 18. Using an op amp with dual-rail power supply.

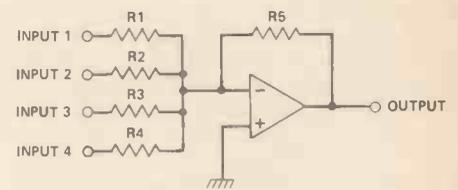


Figure 19. A four input summer amplifier.

maintained while still allowing the AC signal to pass and be amplified. This technique can be used for a non-inverting op amp, too.

A circuit known as a summer is shown in Figure 19. It is shown with no less than four inputs (theoretically, it could have any number). Circuit output is simply an addition of each input multiplied by the amplifier gain — hence the name.

Gain of each individual input signal is the ratio of R5 and that input channel's resistance, so we can very easily turn this into a four channel audio mixer by using pots instead of fixed input resistors (Figure 20). Such a circuit may be used as the basis of a mixer to combine four audio signals before recording the required mix onto, say, a tape recorder.

### Meter Circuit

An op amp can form the basis of a sensitive electronic meter circuit. Because of its high impedance input buffering action, the measured circuit is

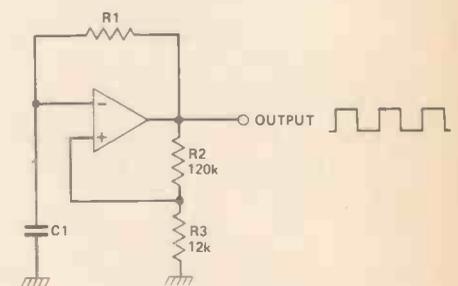


Figure 22. A squarewave generator using an op amp with negative and positive feedback.

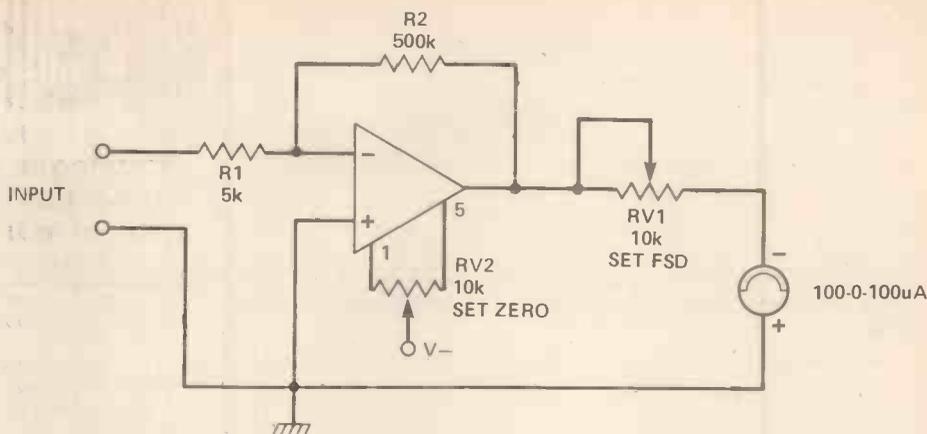
## ■ All About Electronics

Figure 21. A 1uA high impedance meter using a 100uA meter movement.

not loaded in any way so the reading will be accurate. Figure 21 for example shows a 741 in an inverting amplifier mode with a gain of 100. The meter mechanism used is a 100-0-100 uA mechanism. Full-scale-deflection of the meter (100 uA or -100 uA) is obtained when a current of 1 uA (or -1 uA) is passed through the input resistor.

One point to note in this circuit which we have not seen before, is pot RV2. This is labelled 'set zero' and is used to make sure the pointer of the meter does actually point to zero when no current is begin measured. This pot is commonly known in op amp circuits as the offset null control and is used to cancel out the output offset which may occur due to minute voltage offset changes at the input. These will vary with temperatures so readjustment will be needed periodically. Use of such an offset null pot is normally only required in circuits with high gain and where high accuracy is demanded.

Finally, the circuit of Figure 22 (see page 55) uses the principle of positive feedback coupled with usual negtive feedback to produce an oscillator giving a square wave output rather like that of



an astable. Oscillation frequency is dependent on resistor R1 and capacitor C1.

The op amp we have used so far to illustrate all of the applications and principles of op amps is the 741. It just so happens that the 741 is probably the most common op amp available. It is certainly one of the cheapest — a glance through the mail order company advertisements in this issue of Hobby Electronics will show you that a 741 can be bought for as little as 20p. This is a

wonderously small price for such a complex and versatile device and it goes a long way to show why the 741 is the most common op amp.

Other op amps exist, however, for a variety of prices and also a variety of performances. The 741 is a general purpose device and because of its gain-bandwidth product cannot be used for much more than simple audio amplifiers and the like. The principles of all other op amps however, are the same as those we have studied.

HE

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# TEXAS INSTRUMENTS



# FORWARD BIAS

Questions, answers and errata from readers and writers.

## COLLECTED BOOBS

Continuing excerpts from the Hobby Electronics Errata Box

### Hobbycom (HE April '80)

On Figures 3 and 4, on the Overlay, the labels 'C2' and 'C3' should be swapped. There is a track missing on both the overlay and the main PCB. Wire a link from the positive side of C6 to the junction of C5 and R5.

### Digital Frequency Meter (HE April '80)

On the Parts List, C1 should be 470n carbonate (not ceramic).

### Short Circuits (HE March '80)

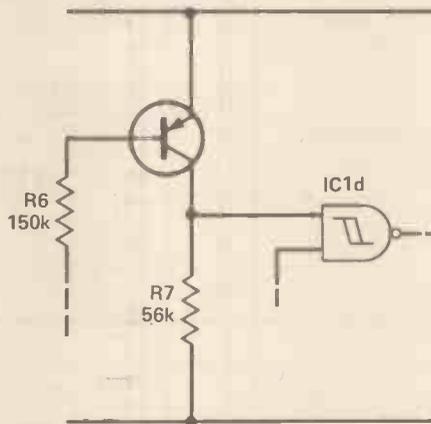
On the Sound Operated Switch (p 33) the unmarked resistor above C3 and C4 is R2, 47k. The junction of R6 and R7 is connected to the base of Q3.

On the Thermostat, (p 52) the capacitor C1 is 1000uF. The resistor next to C2 is R3, 1k2 and the capacitor next to that is C3, 2u2.

On the One Armed Bandit (p 72) IC1 pin 11 should go to IC2 pin 1 but should not be connected to OV. IC1 pin 9 should be connected to OV.

### Miniclocks (HE May '80)

On Figure 5, the circuitry around Q2 is incorrect. It should be:



On Figure 7, the pins of Q1 and Q2 are wrongly labelled. They should read e, c, b from top to bottom.

### The Egg Timer (HE June '80)

On Figure 1, there were several

components missing, also several component values were incorrect. The Parts List gives the correct component values, and the corrected circuit is given here:

In the Parts List, Q1 and 2 must be either BC184 or BC109, and *not* BC184L, as the pins are different on the latter.

### Equitone (HE August '80)

On the Component Overlay, the earth and input connections have been transposed. The top two connections are the input leads.

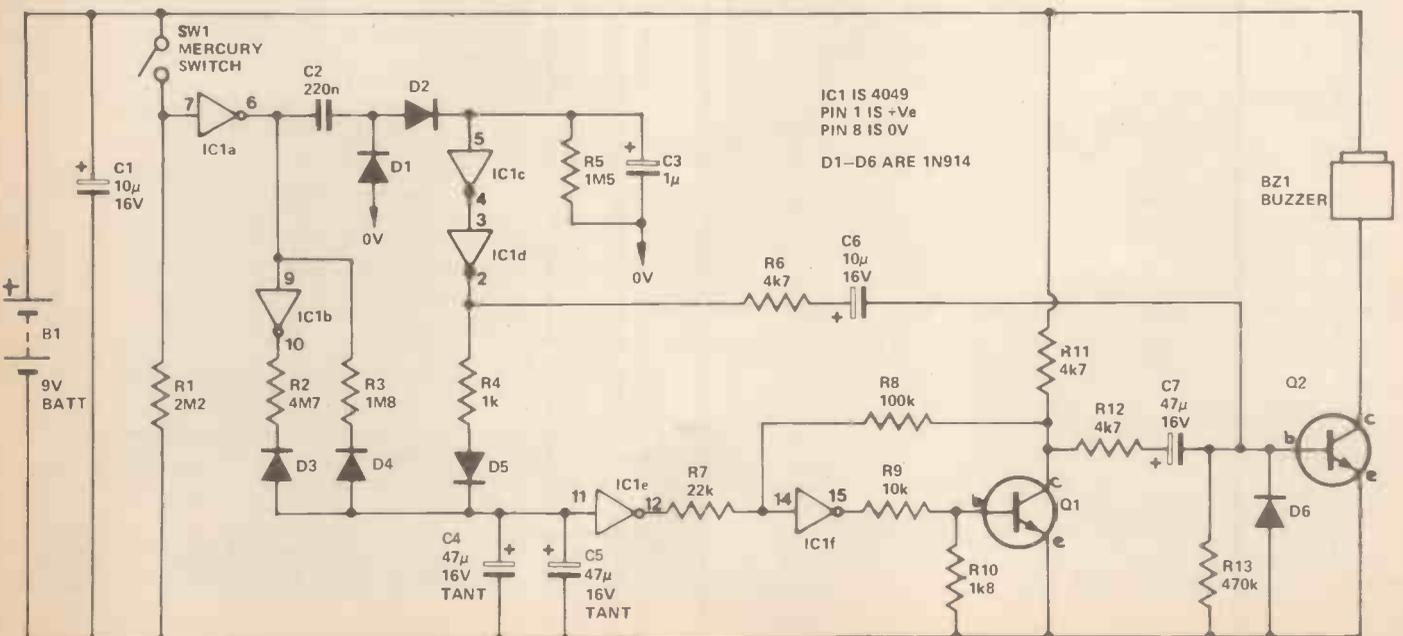
### Pass The Loop (HE August '80)

On Figure 2, the chip shown as IC3 should be labelled IC2 and vice versa.

### Echo Reverb (HE May '82) Telephone Timer (HE June/July '82)

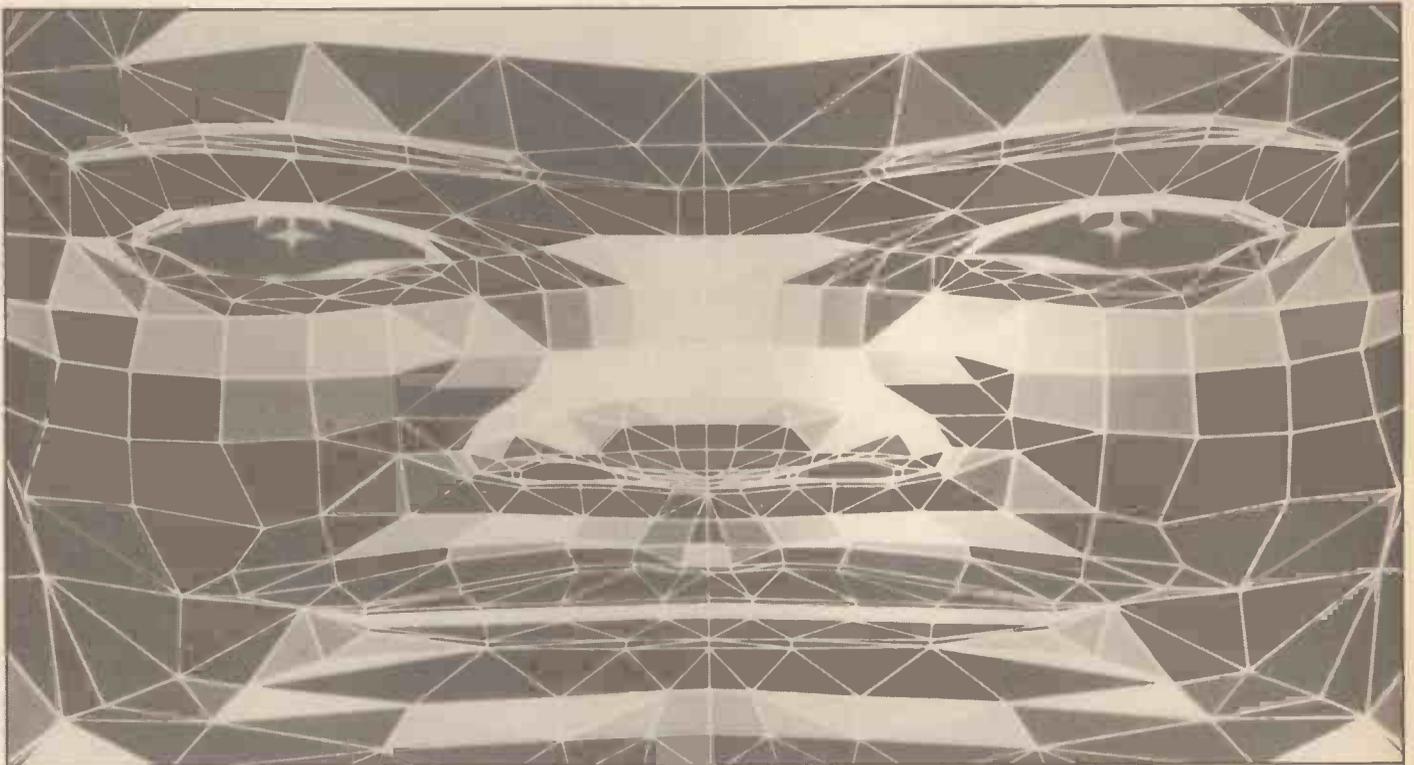
Both these projects have now been overhauled, and the corrections will be published within the next few issues. Enquiries accompanied by SAEs will be answered shortly, possibly, in fact, before you read this.

### The Egg Timer Circuit



# POWER REDUCER

Andrew Armstrong



Picture from "Tron" courtesy Walt Disney Productions

Is your 110V/120V gadget being dominated by our 240V mains supply? Cut the power down with this useful project.

## Caution

This project is mains powered: use all caution when testing the device and ensure that all earths are securely connected.

The Power Reducer operates by switching power to a heating coil for only one mains cycle out of four, and so is *not suitable for motor speed*

*control or lamp-dimming applications;* a motor would run very unevenly and a lamp would flicker at the highly noticeable rate of 12.5Hz.

ONE of the lesser known risks of international travel is the possibility of inadvertently picking up an electrical device designed to operate on a foreign mains supply voltage. So when my mother-in-law recently found herself in possession of an American-made coffee perculator, intended to plug into a 110/120 volt supply, she asked me if I could price a suitable transformer for it. I did, and discovered that the transformer would cost £40 — more than the price of the perculator!

Yet this coffee pot has a distinct virtue; it was large enough to satisfy even my thirst for coffee, when we

visit, and I resolved to find a cheaper solution to the problem rather than abandon this paragon of pots.

### I Did It My Way

For a while I considered using something along the lines of a light dimmer (but more powerful) to reduce the power, but two things dissuaded me: first of all the amount of interference radiated by such a powerful phase controller would be a bit anti-social; and second to properly calculate the component values to give the correct power reliably seemed to involve integrating a

function of a function (a painful mathematical manoeuvre I have mercifully forgotten).

The method I finally decided to use is to switch the mains on and off for whole cycles, starting at a zero crossing. The mains voltage in Britain is approximately double the rating of the coffee pot, so if connected straight to the mains it would operate at four times its correct power ( $\text{Power} = V^2/R$ ). Therefore one complete cycle out of four had to be applied to the heating element. The use of a 4039 as a zero crossing detector and a 4013 as a divide-by-four form the heart of a very economical solution.

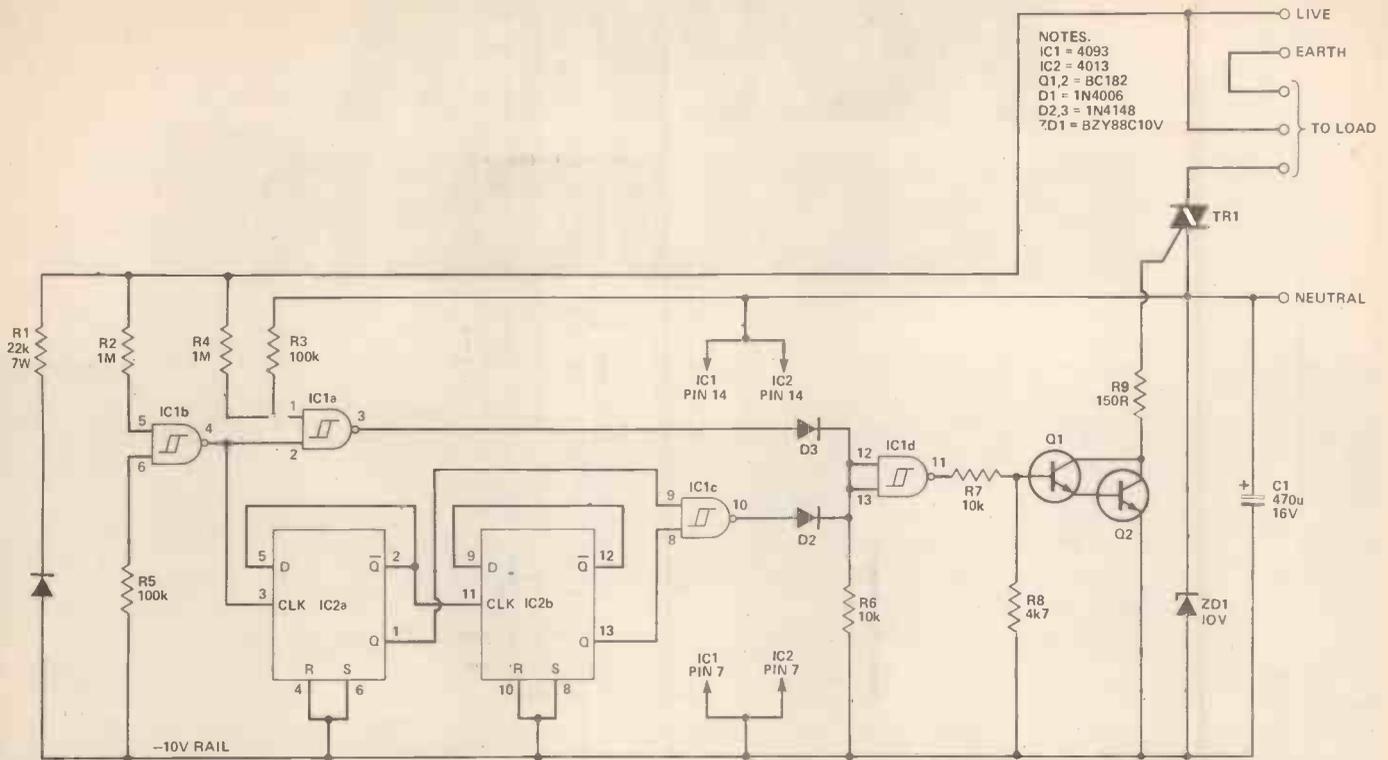


Figure 1. The circuit. The CMOS input protection diodes prevent the inputs from a possible swing to around  $\pm 34V!$

## Design For Power

The design criteria were that the circuit should work without special adjustments, and that the cost of components should be as low as possible, consistent with the first requirement. The obvious requirements of the circuit are:

- 1) something to detect mains zero crossings
- 2) something to count four mains cycles and trigger a triac
- 3) a triac to control the load
- 4) a power supply

Starting with 4, the cheapest power supply can be made using a mains dropper resistor. The fact that the circuit is 'Live' does not matter here as it need not be adjusted once built. Since the other circuit requirements can be carried out with CMOS, the current requirements are low, so I chose the largest conveniently available value to minimise heating. Triacs normally do not trigger reliably with a positive trigger voltage and a negative load voltage (some types are not specified to work under these conditions), so to avoid this problem I chose a negative supply voltage. Nothing in the circuit relies on analogue voltage levels, so bit of ripple on the power supply does not matter; a Zener in parallel with an electrolytic capacitor fulfills this function.

The power dissipated in the resistor can be calculated simply:

$$\text{Power} = \frac{V^2}{R} = \frac{240^2}{22k} = \frac{57600}{22k} = 2.62 \text{ Watts.}$$

Because there is a diode in series

with the resistor, however, this power is applied for only half the time so the power dissipated is 1.31 watts, which is not too serious. The Zener diode ZD1 limits the negative peaks of the power to  $-10V$ , and C1 smooths the voltage somewhat. The current available from this supply is slightly more complicated to calculate — but not beyond the wit of man! See the box headed Programmed Power for the procedure.

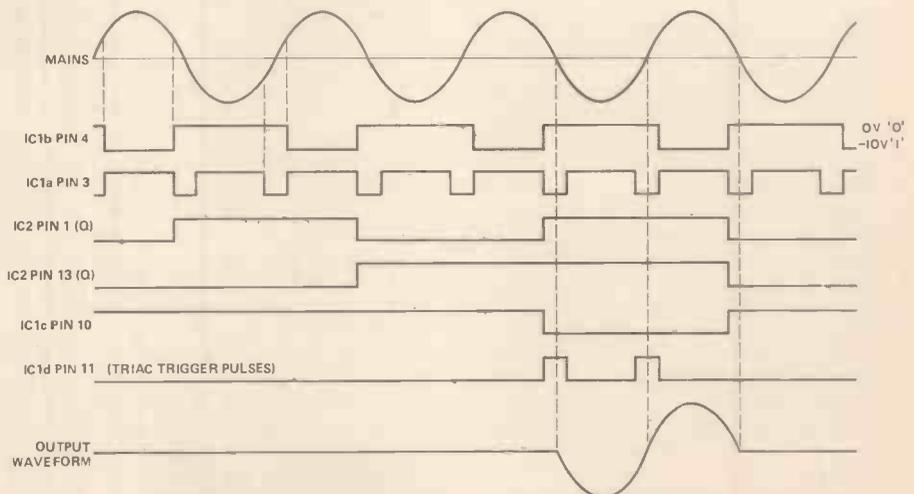
Going back, now, to the main circuit Schmitt trigger NAND gates IC1a and IC1b form an economical zero-crossing detector. When the mains voltage is positive, both inputs to IC1b are at logic 1 and its output at pin 4 is therefore logic 0; so with pin 2 low,

IC1a at pin 3 can only be logic 1.

Now as the mains swings down towards zero the voltage will fall below the Schmitt threshold, and pin 4 will switch to logic 1. But because the voltage on pin 1, IC1a, is always 10V more positive than the voltage on pins 5 and 6 (because pin 1 is connected between Live and Neutral whereas pins 5 and 6 are between Live and the  $-10V$  supply rail), both inputs to IC1a will momentarily be at logic 1 and its output will go to logic 0. The pin 1 voltage then rapidly falls below the Schmitt threshold so that, with one input low, IC1a switches back to logic 1.

Conversely when the mains voltage is swinging up from the negative

Figure 2. Modifications to the mains cycle made by the Power Reducer.



NOTE. SCHMITT TRIGGER GATES ACTUALLY TRIGGER AT DIFFERENT LEVELS, DEPENDING ON WHETHER THE INPUT(S) ARE SWINGING POSITIVE OR NEGATIVE (HYSTERESIS) HOWEVER IN THE INTEREST OF CLARITY THIS DETAIL HAS NOT BEEN SHOWN.

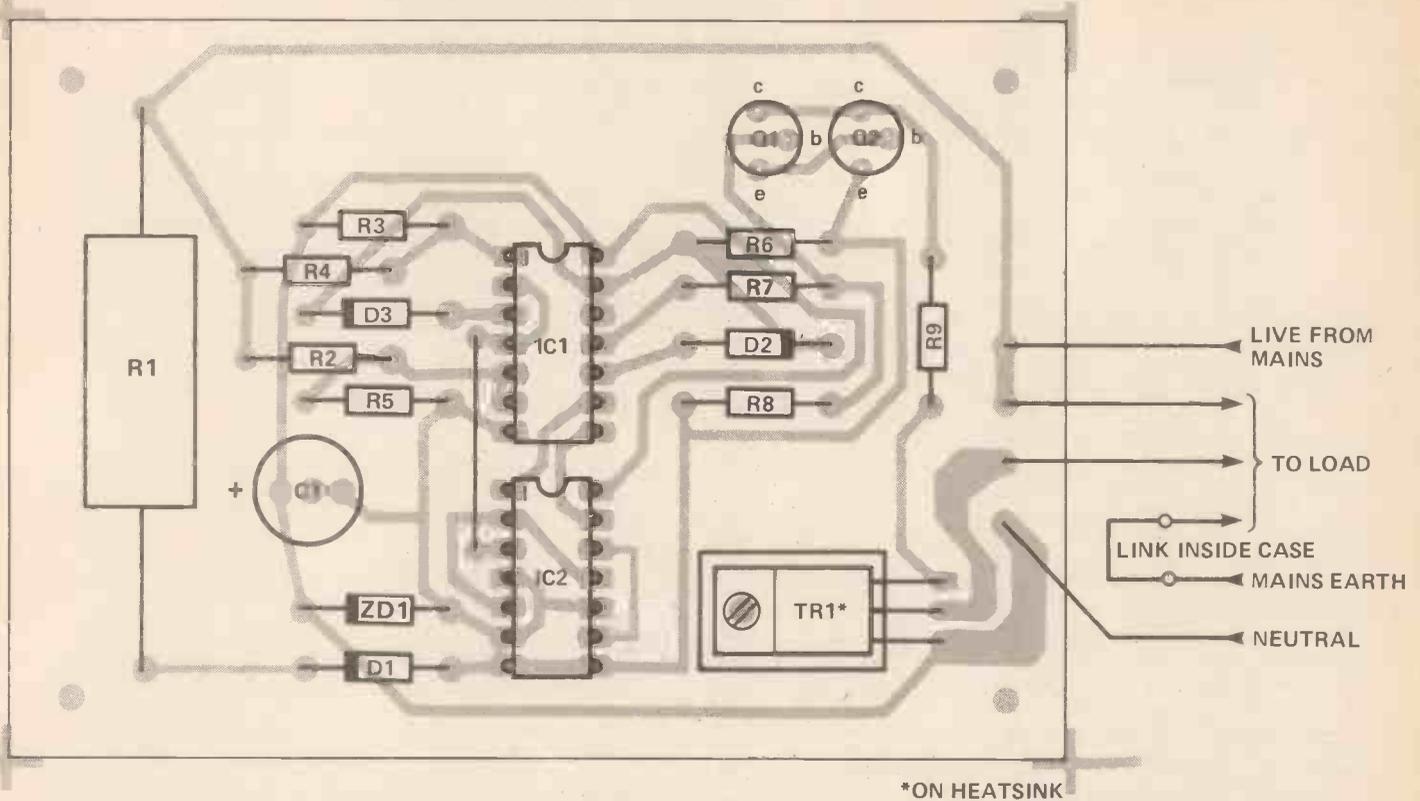


Figure 3. The component layout. Build and test the power supply section first, checking that R1, C2, D1 and ZD1 are the right way round.

peak, the IC1b inputs are both low so pin 4 is high; pin 1, still 10V more positive, will pass through the threshold before pins 5 and 6 so with both inputs momentarily high, IC1a output will go low. Soon after IC1b switches low, restoring IC1a logic 1 output.

The net effect of this action is to generate brief low-going pulses at the output of IC1a, which straddle the mains zero-crossing point. The first few graphs of Figure 2 illustrate the point.

Meanwhile, back to pin 3 of IC1: this gives a signal which goes positive just before negative-going mains zero crossings, so it can conveniently be used to clock a dual D-type flip-flop, a 4013, which is used to count to four whole mains cycles.

The use of a D-type flip-flop as a counter is reasonably common practice and is shown in the timing diagram. Very briefly, on a positive clock edge the Q output takes up the logic state that was on the D input just before the clock edge. If this logic state is fed back from the Q output then the D-type will change state each clock edge.

The Q outputs of the 4013 are decoded by IC1c to give a logic 0 output for one whole mains cycle out of four. This is gated together with the mains zero-crossing signal in IC1d; with the aid of two diodes and a resistor, IC1d performs the function of a NOR gate, so that the transistors can only turn on and trigger the triac when both the aforementioned signals are at logic 0.

This is important, because if the triggering current were to be left on the whole cycle, then the current required would exceed the 4.9mA available! This leads on to another interesting point: when an inadequate power supply is available, CMOS outputs sometimes do silly things. It is quite possible for the 4093 output to switch to logic 1, regardless of what its inputs tell it, if the power supply falls to, say, 2V. If it were possible for the triggering transistors to switch on under these conditions, then the power supply would never reach more than this voltage, and some constructors would be faced with inexplicably non-functioning circuits. Therefore a 4k7 resistor from base to negative supply has been included to prevent the transistors from having any chance of switching on until the logic has enough power to work logically!

Adequate trigger current must be allowed for the triac, too. Assuming that the Darlington pair of transistors switch on so as to drop about 1V, and the triac requires 1V maximum to trigger, then the trigger current is 8V divided by 150R = 53.3mA, adequate for most types of triac.

### Parts List

#### RESISTORS

(All 1/4W 5% unless noted)

R1	22k	7W
R2, 4	1M	
R3, 5	100k	
R6, 7	10k	
R8	4k7	
R9	150R	

#### CAPACITORS

C1	470u	16V radial electro
----	------	--------------------

#### SEMICONDUCTORS

IC1	4093	
-----	------	--

IC2	4013	
Q1, 2	BC182	
D1	IN4006	
D2, 3	IN4148	
ZD1	8ZY88C10V	
TR1	SC142D	

#### MISCELLANEOUS

Plastic case, eg Verobox 3in x 4.5in x 1.25in; small heatsink; four self-adhesive pillars; wire, solder, etc.

BUYLINES ..... page 26

## Power Reducer

Construction of the board may be carried out with reference to the overlay. The power supply should be built first, then tested before other components are added. To do this fit R1, C2, D1 and ZD1 — and carefully check they are the right way round! Then connect a voltmeter across the Zener diode, with the positive end of the voltmeter to the mains neutral side of the Zener. Now plug in and check that the meter reads about 10V. Unplug before touching anything, and if it didn't read correctly check the components. This could avoid an expensive *bang*.

Assuming all was well, complete the construction. It is as well to bolt down the triac before soldering its legs so as not to strain the soldered joint. If the recommended type is used it can be bolted straight away to the heatsink, otherwise insulating washers may be needed.

A plastic case is used to house the unit, with self adhesive plastic pillars to support it (for safety reasons). Self adhesive pillars stick like limpets if the surface is thoroughly clean and grease free, so position them carefully by attaching them to the PCB first. If on the other hand, the surface is not well cleaned they are a pain in the anatomy, so clean the box with washing-up liquid, rinse and dry with kitchen paper before proceeding.

## Testing

The unit should be connected to its load, which can be any heating element — typically a coffee pot or a kettle. For the purposes of the test connect a mains neon or lamp in parallel with the load to indicate proper functioning; the lamp should start to flicker visibly one or two seconds after plugging in. If it comes on at full power then unplug and check that the triac is not shorted out. If it doesn't come on at all, connect a voltmeter to C1, plug in and retest the power supply.

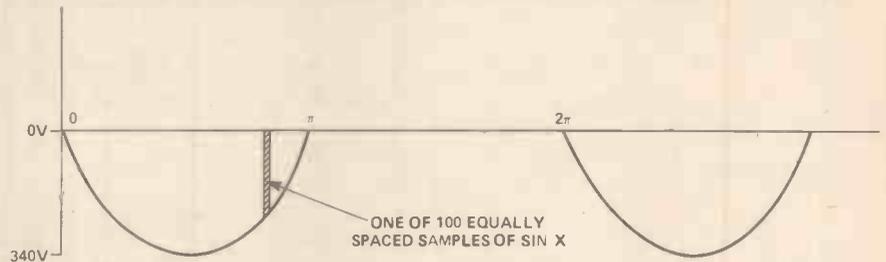
The unit I made caused more than the test lamp to flicker, it was used in a farm house at the end of a long length of supply cable, and every light in the house flickered in sympathy while the coffee percolated!

If the appliance is earthed the earth wires should be connected via and extra insulated terminal block inside the case of the unit. In any event, some thought should be given to the safety of a 120V appliance running on 240V. The coffee pot involved was metallic, but not earthed, but just in case the insulation should ever fail on 240V pulses I added an earth wire.

Once you have taken care of all these points, screw on the lid and the power reducer is finished. Care for a brew?

## Programmed Power

The graph below shows the waveform of the voltage on resistor R1 - negative since D1 conducts only on half cycles. At every point on the waveform the current is equal to the instantaneous voltage divided by the resistance (Ohm's Law), but the average current available over the entire waveform is not immediately obvious. It is equal to the area under the curve divided by the resistance and divided by length of the baseline before the cycle repeats itself (in this case  $2\pi$ ). A program can be written to calculate how much current is available, but it does not indicate that it is negative — you know that already!



$$\text{Average current} = \frac{\text{area of curve}}{(\text{total base length})(\text{resistance})} = \frac{\text{Area of curve}}{(2\pi)(22k)}$$

And:

$$\text{Area of curve} \approx \frac{(100 \text{ samples of sin } x)(\text{base length of curve})(\text{height of peak})}{100}$$

Certain of these values are known and are constants in the equation; we can therefore write the constant part:

$$\text{Constant} = \frac{(\text{base length of curve})(\text{height of peak})}{(\text{Total base length})(\text{resistance})} = \frac{340 \cdot \pi}{2\pi \cdot 22k} = 7.72727 \cdot 10^{-3}$$

The program (in ZX81 BASIC) for calculating the average current is:

```

10 LET A = PI/100
20 LET Y = 0
30 FOR N = 1 TO 100
40 LET X = A*N
50 LET B = SIN(X)
60 LET Y = Y + B
70 NEXT N
80 PRINT (Y/100)*7.72727
RUN
4.9189283
    
```

Note that by ignoring the scale factor ( $10^{-3}$ ) in the program we get an answer in milliamps. The more elegant solution is to use calculus to evaluate the area under the curve. The equation is:

$$\frac{340}{(2\pi)(22k)} \int_0^{\pi} -\sin x \, dx = [2.46 \cos x]_0^{\pi} \text{ mA} = 2.46 \cdot -2 = -4.92 \text{ mA}$$

This method also indicates the direction of current flow! The constant part of the equation differs from the program solution because the multiplication by  $\pi$  is included in the integral.

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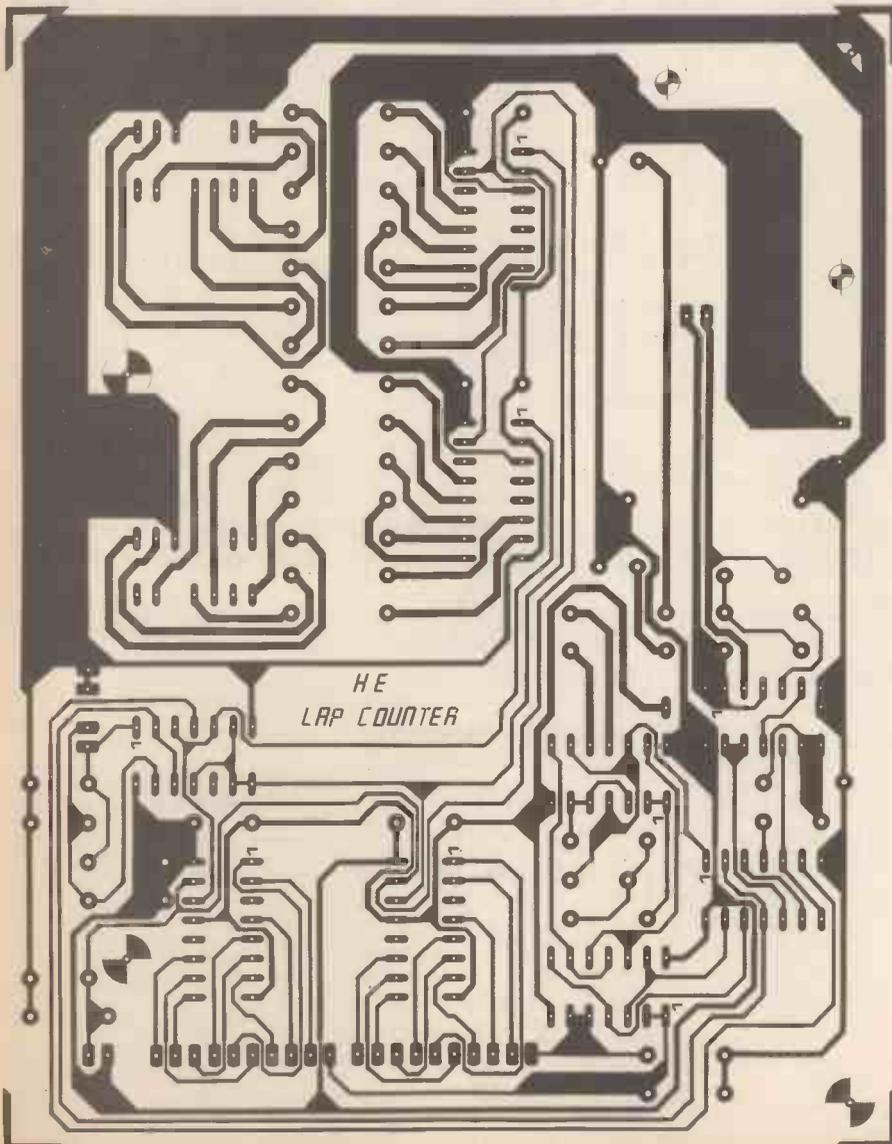
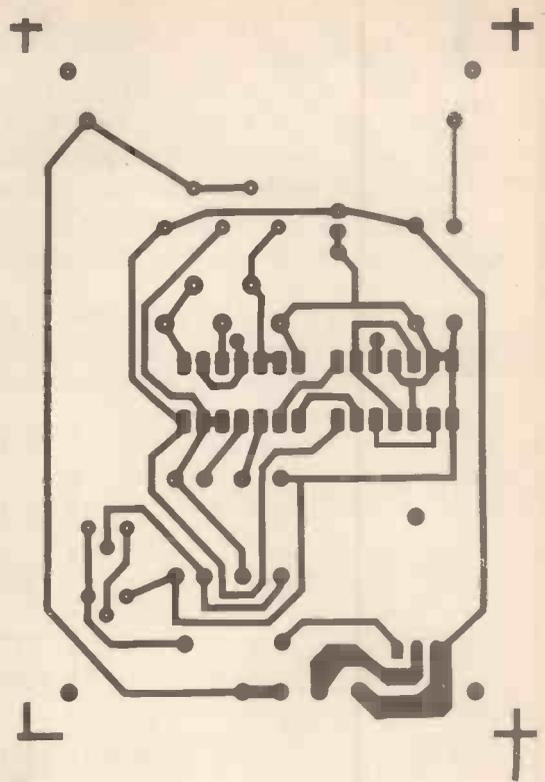
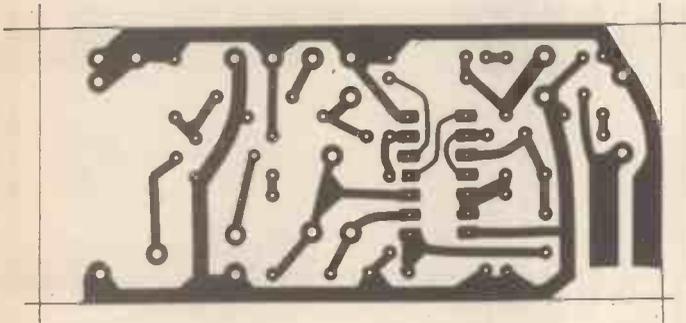
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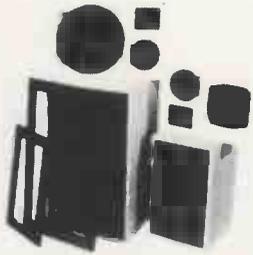
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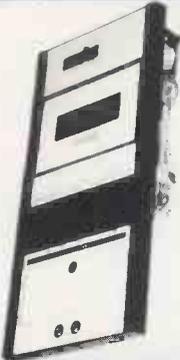
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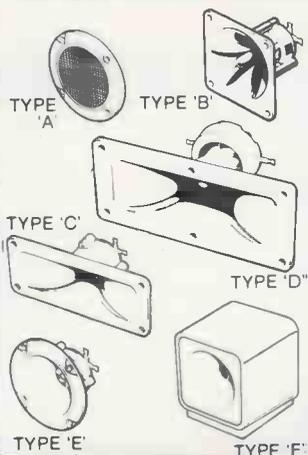
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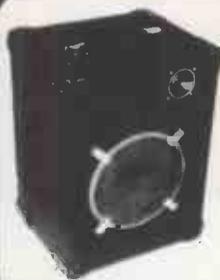
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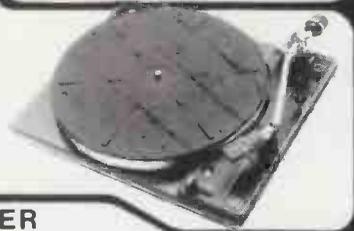


3 watt FM Transmitter

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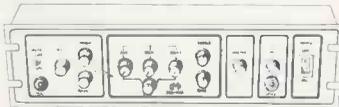
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