

# computing today

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NOV 1979

50p



**BATTLESHIPS!**  
**Bring Out The**  
**Big Guns**

**Turing Machines**  
**Number Cruncher**  
**Triton Typecast**



**8K ON BOARD MEMORY!**

5K RAM 3K ROM or 4K RAM, 4K ROM (link selectable). Kit supplied with 3K RAM, 3K ROM. System expandable for up to 32K memory.

**2 KEYBOARDS!**

56 Key alphanumeric keyboard for entering high level language plus 16 key Hex pad for easy entry of machine code.

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64 character graphics option — includes transistor symbols! Only £18.20 extra!

**MEMORY MAPPED**

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low error rate tape interface

**2 MICROPROCESSORS**

Z80 the powerful CPU with 158 instructions, including all 78 of the 8080, controls the MM57109 number cruncher. Functions include +, -, \*, /, squares, roots, logs, exponentials, trig functions, inverses etc. Range  $10^{-99}$  to  $9 \times 10^{99}$  to 8 figures plus 2 exponent digits.

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**SINGLE BOARD DESIGN**

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**COMPLETE KIT**

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+VAT**

Cabinet size 19.0" x 15.7" x 3.3". Television by courtesy of Rumblelows Ltd. price £58.62

# POWERTRAN

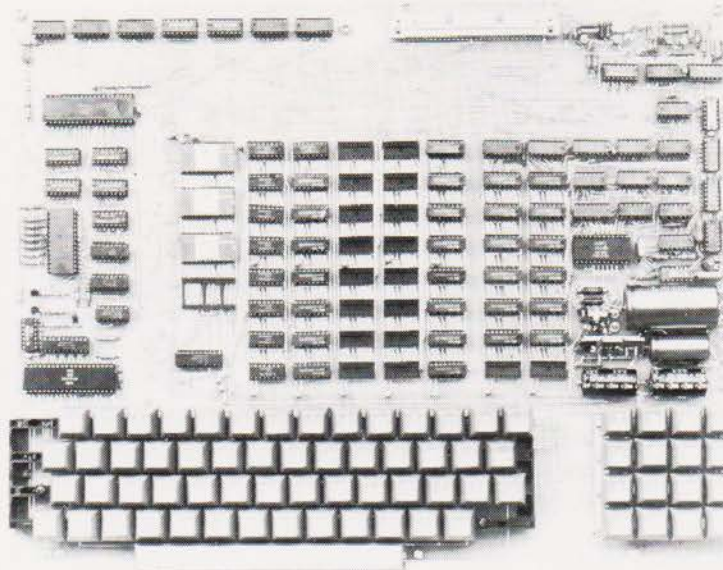
**PSI Comp 80.Z80 Based powerful scientific computer**  
Design being published in Wireless World — NOW!

The kit for this outstandingly practical design by John Adams being published in a series of articles in Wireless World really is complete!

Included in the PSI COMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board, 2 keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer, 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.

**SYSTEM EXPANSION COMING SHORTLY!**

e.g.  
**8K RAM Board**  
**8K ROM Board**  
**Prom programmer**  
**Printer Interface**  
etc.  
etc.



Kit also available as separate packs: e.g. PCB, Keyboards, Cabinet, etc.

PCB size 16.0" x 12.5"

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## POWERTRAN COMPUTERS

(a division of POWERTRAN ELECTRONICS)

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# computing today

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# STOP PRESS

## ...44 NEW PROGRAMS for the PET in the latest PETSOFT CATALOGUE including ...

**PAYROLL — 400 (Disk) £50** A totally new and complete disk based payroll system designed and written to meet the needs of small businesses. Up to 400 employees per disk are catered for. A 32K PET 2001-32 equipped with dual floppy, an Anadex DP800 or device 4 printer is required.

Facilities provided include Holiday Pay, Sick Pay, Bonus payments and two rates of overtime, as well as allowing a "standard week" to be specified for each employee. Weekly and monthly summaries are provided and amendments necessary because of a Budget (e.g. increasing employee's tax codes) are made very easy. Each week a wage slip is printed for each employee followed by an analysis of the coins/notes required for these employees paid in cash (payments by cheque and credit transfer are also allowed for). Tax and N.I. are computed automatically from a knowledge of the tax code and N.I. rate applicable to that employee. Update service available.

**JOB EVALUATION £25** Conducts the evaluation necessary to establish pay structures and grades. Program computes correct weightings for factors — education, training necessary, responsibility over other men and equipment, working conditions etc. — which comprise job value. A Job Evaluation Formula is created for use as a guide to the relative value of a job based on the thinking of the company or department concerned.

**STOCK CONTROL ON DISK £25** Facilities allow full or operational stock print out, total costing of items in stock and re-order level warning. Data is stored under Reference, Description, Supplier, VAT Rates, On order Quantity, Quantity in Stock, Unit of Quantity Designated, Minimum level, Stock allocated, Sale Price and Purchase Price. Approx 400 items per diskette.

**COURSE HANDLER £95** A must for School Timetablers. The program handles all the information relevant to creating a 4th, 5th or 6th year Option Scheme and is particularly useful where an "Open Choice" of subjects is offered to pupils. The program maintains, via a simple dialogue with the timetabler, a file of pupils and their requests and allocations and a file containing details of the Option Scheme. Facilities are provided for viewing the scheme, the classes, the pupils and the class clash matrix.

**CRYPTO PACK £8** This is the complete kit for all those interested in cryptography, codes, ciphers and cryptanalysis. Developed by Dr Michael Richter, the package includes Cryptosub, General Cipher, Cryptanalyser and New Cipher programs.

\*Send for a free Data Sheet.

**6502 FORTH £30** FORTH is a unique threaded language that is ideally suited for systems and applications programming on a PET. The user may have the interactive FORTH Compiler/Interpreter system running stand-alone in 8K to 12K bytes of RAM. The system also offers a built-in incremental assembler and text editor. Since the FORTH language is vocabulary based, the user may tailor the system to resemble the needs and structure of any specific application. Programming in FORTH consists of defining new words, which draw upon the existing vocabulary, and which in turn may be used to define even more complex application. Programs written in FORTH are compact and very fast.

**PHOTOGRAPHY TUTOR £12** A comprehensive course developed by a professional photographer making full use of PET's dynamic graphics capabilities to demonstrate and explain the mysteries of exposure, focus, aperture, shutter speeds, interchangeable lenses, depth of field, etc. The theory and practice of photography are explored interactively, and progress tested. Multiprogram pack containing eight 7K lessons. Available on Disk £15.

**HUNT £10** A new concept in fantasy simulations which has achieved wide acclaim. The context is that of a search for a defined object, typically Atlantis or the Holy Grail. The objective, the names and natures of the searchers, their antagonists and the properties of the space in which the hunt is conducted are defined — by you!

**PLUS**

### The Original Cassette Magazine for the Commodore PET... CURSOR

**CURSOR** — The cassette program magazine for PET owners. Mailed to you by first class post, each issue contains a dynamic graphic cover, table of contents and at least five new programs. There is a featured game which might cost £8 elsewhere, plus tutorials, programming aids and business routines, and of course CURSOR Notes with news and equipment reviews.

U.K.: £36 for one year's subscription (10 issues).

Overseas airmail: £45 for one year.

Send for a free Data Sheet.

**AND**

### PETSOFT PROGRAMMERS TOOLKIT

"10 Powerful New Commands for your PET!"

The Toolkit is a machine language program which is provided in a 2 kilobyte ROM chip. Just plug it in — no tools are necessary — and your PET's BASIC has 10 new and very useful commands including:

AUTO, RENUMBER, DELETE, FIND, APPEND, DUMP, HELP, TRACE and STEP.

For the new 16K and 32K PETs, the toolkit consists of a single ROM chip which plugs into the left most empty socket inside the PET. Price £55 plus VAT. For 8K and other 'old ROM' PETs a small printed circuit board is attached to the memory expansion and 2nd cassette ports of the PET. Price £75 plus VAT. Send for a free Data Sheet.

Recommended by Commodore

Programs are available on Commodore format cassettes. Some titles are available on disk for ACT PETSOFT and Commodore Disk systems.

PET is the trade mark of Commodore

# ActPetsoft

Radclyffe House, 66-68 Hagley Road, Edgbaston, Birmingham  
B16 8PF. Telephone: 021-455 8585 Telex: 339396

My name is \_\_\_\_\_

I live at \_\_\_\_\_

Postcode \_\_\_\_\_

I have a new/old ROM PET

I have NO PET

Please send me a copy of your  
latest catalogue







## MILLION BIT BOX

Rostronics have been appointed UK distributors for Micro-mation and the first product being sold is the Megabox. This is a double density, dual disk system with either single or double density units. Compatible with all 8080 and Z80 S100 systems at up to 4MHz it uses the CP/M operating system. Format is to the IBM 3740 standard but a special model is available for the TRS 80. The cost for the 1Mb unit is £1350 and the 2Mb unit is available at £1750. The special TRS-80 version includes 32K of RAM and an RS232 port so it can stand alone with the processor unit. Further details are available from Rostronics at 118 Wandsworth High St, London SW18.

## DUPED BY TAPE?

If you want to duplicate your software for your local club or friends a service is being offered by Simon Stable Pro-

motions. Virtually any taping standard can be accommodated and quantities of ten upwards cost 33p each. A single sample can be done for 50p. Library boxes are available at 10p each but these will increase the post charges. Please note that this service should NOT be used to

rip off others peoples software as you have to sign an indemnity form with each order that leaves you liable for heavy penalties if caught. For more details please contact Simon Stable at 46 West End, Launton, Oxon or ring 08692-2831.

## 2020 PRICE CRASH

ITT have announced that the price of their 2020 version of the Apple is being cut in price. The new suggested retail prices are £867 for 16K, £931 for 32K and £995 for 48K. These reductions have been caused by increased demand and cost saving through in-house manufacture of IC's. Expected soon is a larger disk for the small business and educational end of the market.

## NEW DEALER GIVES NEWSLETTER

A and G Knight of Aberdeen, a television rental company who are moving into the micro business are offering a free newsletter. Among their product range are Nascom and Xitex systems. After hearing many complaints about various newsletters they decided to produce their own. As well as covering their product range the publication includes detail on connecting a Nascom to replace a radio teletype, an article on bubble memories and more besides. For information on both the newsletter and their range contact them at 108 Rosemount Place, Aberdeen AB2 4YW.

## NEWBEAR BLAST OFF

For those of you with a desire to wipe out your own PROMS ready for new data Newbear are now stocking a range of UV lamps. These include a timer on all but the cheapest model and are of American origin. The cost for a six unit eraser is £56 going up to a 144 chip model at £1227. A leaflet is available from Newbear at 40 Bartholomew Street, Newbury, Berkshire.

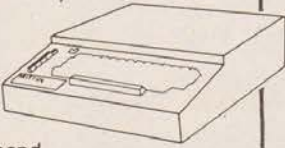




## TRITON

### SINGLE BOARD PERSONAL COMPUTER

Three new exciting expandable systems designed for ease of construction and flexibility. Kits come complete with case, power supply, full keyboard, PCB. All components available separately, see catalogue. Full hardware. Programming manual available. The system is easy to expand and is well supported. Features — 2, 2.5 or 7K Basic in Eprom (see catalogue).



- Single Board
- Holds up to 8K Memory
- Cassette Interface
- Three Firmware options
- Basic in Eprom
- Plug-in Expansion Boards

### Personal Computer

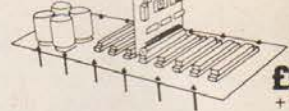
From **£286** + VAT

## EXPANSION MOTHERBOARD

**TRITON.** Expand your Triton simply and easily with our new 8-slot motherboard complete with its own P.S.U. takes 8 plug-in Euro cards. Plug-in 8k RAM card and Eprom cards now available. Kit complete with PSU + 1 set connectors.

### 8 SLOT

Uses Standard 64-way DIN Con



**£50** + VAT

## 8K RAM CARD

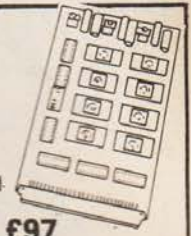
Triton 8k Static RAM card kit uses 2114L low power 4k static RAMS. On board regulation. Mem jump select. PCB only £15 — RAMS £5.50 Kit less RAMS £35 incl 5SKTS & components

Compl Kit **£97** + VAT



## 8K EPROM CARD

Triton 8k Eprom card kit designed to take up to 8 x 2708 Eproms (1k x 8) as RAM card PCB only £15 Kit less Eproms £31 Eproms (blank) £9



**£97**

Complete kit + VAT

## BI DIRECTIONAL MATRIX PRINTER

**£595** + VAT

The BD80 is a low cost, 80 column line printer with microprocessor control to provide excellent reliability and performance

- 5 x 7 Matrix
- 10 Char per inch
- 6 lines/inch
- 400 Char Buffer
- Full ASC II Char Set
- 10 lines/sec Paper Advance
- 112 Char/sec
- 84 lines per minute
- Self Test
- Fully Cased



A UNIQUE PRINTER FAST AND RELIABLE

Switch selectable baud rate from 110 to 9600 on a standard V24 and RS232 Interface — Send SAE for further details. Ideal printer for Triton or any system requiring high speed, reliable, hard copy. We can supply consumables.

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8k Static RAM board (450ns) £123.75  
8k Static RAM board (250ns) £146.25  
Z80 cpu board (2MHz) £131.25  
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30/60	£4.15	15/30	£2.20
35/70	£4.60	18/36	£2.30
36/72	£4.75	28/56	£2.65
40/80	£5.00	36/72	£3.30
43/86	£5.50	43/82	£3.90
50/100 (S100)	£5.80		£4.60 + VAT



## TRAP!

Triton resident assembly language package.

Links via the L6.1 monitor and new scientific basic to make Triton a stand alone development system. Trap is an 8k package in EPROM and resides on our EPROM card. Set of 8 x 2708 only £80 including documentation.

- EDITOR
- ASSEMBLER
- DISASSEMBLER
- SYMBOL TABLE
- CREATE
- BREAKPOINT
- SINGLE STEP
- TRACE
- PROGRAMME LOAD
- MONITOR

See catalogue for further details

### COMPONENTS 74LXX

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SN74LS10N	18	SN74LS578N	35	SN74LS155N	1.25	SN74LS243N	1.95	SN74LS368N	65
SN74LS11N	26	SN74LS581N	1.10	SN74LS156N	1.25	SN74LS244N	2.10	SN74LS373N	1.75
SN74LS12N	55	SN74LS582N	1.10	SN74LS157N	60	SN74LS245N	2.60	SN74LS374N	1.70
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## ALIEN—A REVIEW

What, you may ask is a film review doing in a computer magazine! Well the answer is quite simple. When we published the Dateline 5000 program a couple of months ago we wanted to get hold of a few pictures of spacecraft to illustrate the article with, so we tried all the companies who were making sf movies. We didn't get any pics but we did get an invite to the Press show of Alien. By now you have probably heard about the horror aspect of the film in a variety of reviews but this aspect aside it must surely rate as one of the best films of the

year, or even the decade. The whole film is set on a ship that has to make a landing to check out a distress call. It could be in the 18th century but instead it is in the future, and in space, not that this detracts in any way from the story. The central plot is the classic 'who gets got next' story and the 'getter' is of course the Alien. The superb use of the special effects in the film add to the story rather than turning it into yet another fantasy type film of the Star Wars or Gallactica type. Yes, this rates

as a true sf movie and as a necessary part of the story there is a quantity of gore. The novel, which I had read, does not in any way spoil the horror element of the film, it just fills in some of the details which have to be left out

because of time, I wonder just what was in the 13 minutes that they cut? The second very good reason to go and see the film is the presence of a young lady called Sigourney Weaver, making her film debut with a stunning performance as Ripley. It is mildly ironic that out of the crew of seven on the ship (plus a cat) she is one of the survivors. Alien is undoubtedly a true piece of science fiction, possibly an epic and if you don't mind being scared half to death you really should go and see it.

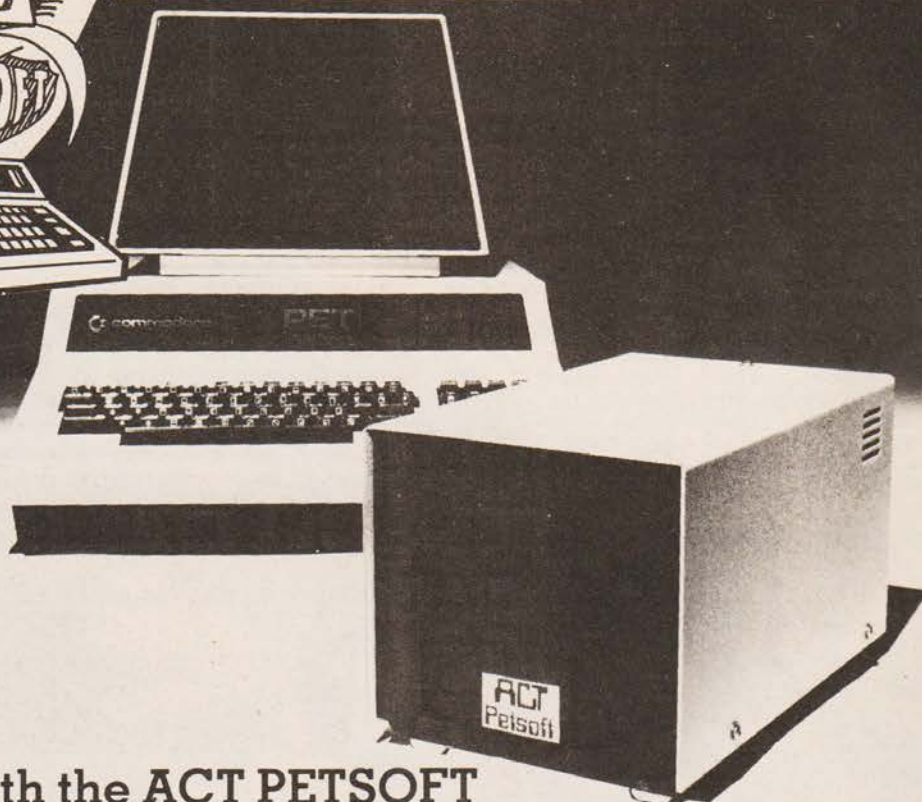
Alien, cert X runs for 1 hour and 56 minutes.







# Upgrade your PET...



## ... with the ACT PETSOFT PROFESSIONAL DISK SYSTEM

*up to 800K online!*

A complete stand-alone system for the Commodore PET allowing up to 800,000 bytes of mass storage online. Designed by Compu/Think for business use, this powerful double density system offers complete random or sequential file access and support.

The Disk Operating System is in a ROM which plugs directly into 16K and 32K (new ROM) PETs, or via an Expandamem memory expansion board for 8K PETs. The Disk Operating System adds 16 extra easy-to-use commands to PETs BASIC. The Disk unit comes with a complete set of utility programs and a comprehensive manual.

- ★ Supported by PETACT Business Software: Sales Accounting, Invoicing, Purchase Accounting, and soon Stock Control and Payroll
- ★ More memory power for your money
- ★ Reliable and easy to use
- ★ Languages supported include BASIC, 6502 Assembler, FORTH, FIFTH, PLM, PILOT, CESIL and soon FORTRAN and PASCAL
- ★ Wide range of PETSOFT programs including Payroll £50 + Stock Control £25
- ★ Supports the Pagemate Database £299

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**800K** Dual headed double density dual disk for 16K and 32K (new ROM) PETs **£995**

**400K** Double density dual disk for 16K and 32K (new ROM) PETs **£840**

**400K** Double density dual disk for 8K (old ROM) PETs. Requires Expandamem **£795**

**24K** Expandamem internal expansion memory board **£320**

Prices exclude VAT.  
PET is the trademark of Commodore who recommend PETACT Business Systems.

Try the ACT PETSOFT Professional Disk System and software at your PET dealer or write to us for full details and the name of your nearest stockist.

# ActPetsoft

Radclyffe House, 66-68 Hagley Road, Edgbaston, Birmingham B16 8PF. Telephone: 021-455 8686 Telex: 339396



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I have a new/old ROM PET .....





## GET IT WITH APPLE TOO!

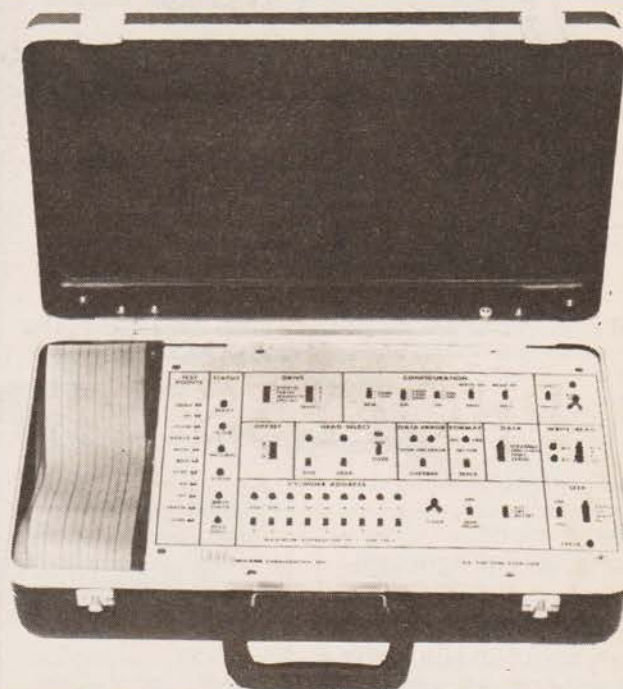
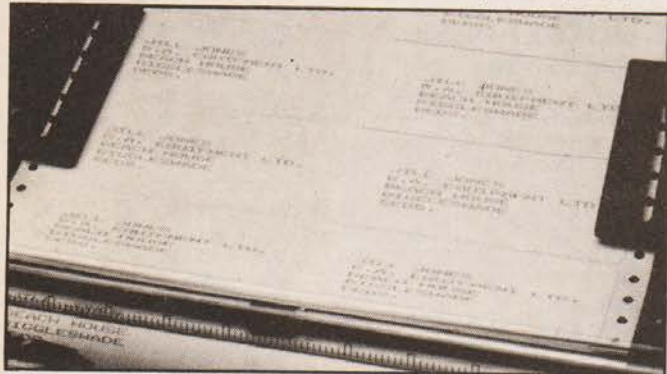
Pascal is now available. Microsense, the master UK distributor for the Apple are now about to start distribution of Pascal (starting September). The language is an implementation of the standard and includes extensions for graphic and filing as well as a text editor. The language requires 48K of RAM, at least one disk and a full VDU if the 80 character line is required. The

standard TV only gives the left or right 40. The new language is supported by a system card that adds 16K to the RAM and allows a choice of languages including Pascal to be used. Further features include an auto-start facility for either BASIC or Pascal. The price is a mere £296 and you can use old software under the new system. For more details please contact Microsense at Maxted Road, Maylands Avenue, Hemel Hempstead, Herts.

## LABEL YOUR OWN!

A range of self-adhesive labels has just been launched by the firm of Fisher Clark. Made in a new material that overcomes the problems of tractor fed printers they are available in a

wide range of sizes and numbers per sheet. Special sizes and shapes are available to order and a nationwide stockist network has been set up for their distribution. For details please contact Fisher Clark at 102 West Street, Boston, Lincs.



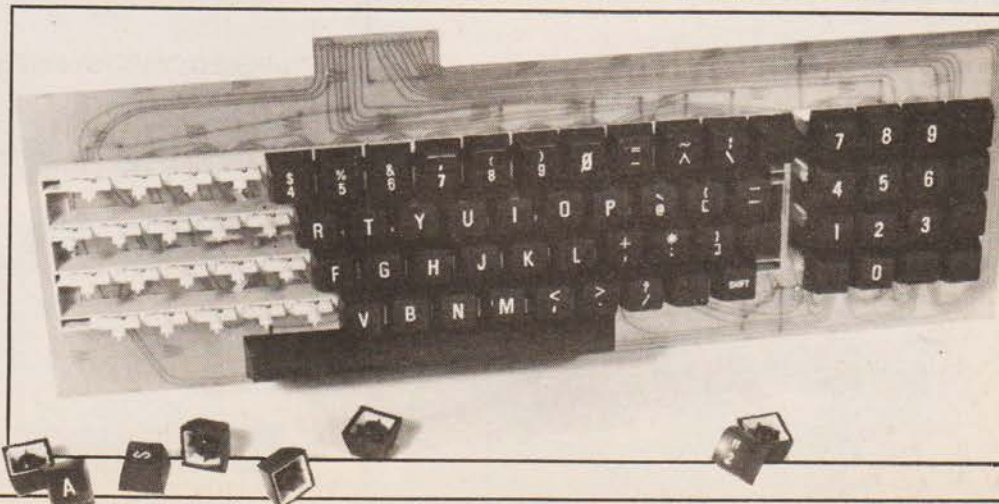
## CHECK IT OUT

Got a problem with your disk? Worry no longer because a new range of peripheral test gear has been introduced. Made by Wilsons and distributed by Rack Data the units cost between £700 and £1300 and check out all functions of disk tape and a variety of other mass storage devices. The floppy disk exerciser for

example can be used with mini or standard drives and is user programmable. It displays the current status at all times and provides three test patterns for data checking. All the units in the range are portable and self-powered, ideal for the field engineer. Details available from Rack Data at Rose Industrial Estate, Cores End Road, Bourne End, Bucks or ring 06285-27117.

## KEY TO SUCCESS

A new range of modular keyboards is available from Devlin Electronics. By using a one piece moulding they have eliminated the need for metal frames. Both standard 60 and 16 way units are available in either flat or sloping types and they can be supplied to suit a users own PCB or on a PCB to suit PET, ASCII or XY matrix applications. All keytops are double shot engraved and prices range from £7.20 for the 16 way unit to £26 for the 60 way. Further details from Devlin at Caroline Court, Cranbourne Lane, Basingstoke Hampshire.





# STRATHAND



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### MICRO COURSES

A large number of micro based courses have been scheduled for the next few months. First we have a three day course being run by Microsystem consultants of PO Box 65, Camberly, Surrey. Based on the AIM 65 processor the course runs 5-7 November at the Euro Crest Hotel in Maidenhead. Cost is £185+VAT and includes lunch, refreshments and course material. You can ring Microsystem on Camberly 27417.

A one day course is being run at Thames Poly on 21 Nov. Called an Introduction To Microprocessors in Engineering it costs £32 and interested parties should contact Mr Tyler at the Poly in Wellington Street, Woolwich or ring him

on 01-854 2030 extn 396.

Next on the agenda is a three day course from 5-7 November called Micro Computers, Application and Planning. This is being run by the Coventry and district Engineering Employers Association. The fee is £138 incl of VAT and lunches and the course is based around the Commodore PET. Anyone interested should contact Mr Jackson at Woodland Grange, Leamington Spa CV32 6RN or ring 0926-36621.

Finally a bumper bundle of courses from the Central London Poly and ICS. Included are courses on Pascal, Computer Graphics, Trouble Shooting and a whole lot more. Details are available from ICSP at Pebblecoombe, Tadworth, Surrey KT20 7PA or ring on Leatherhead 79211.



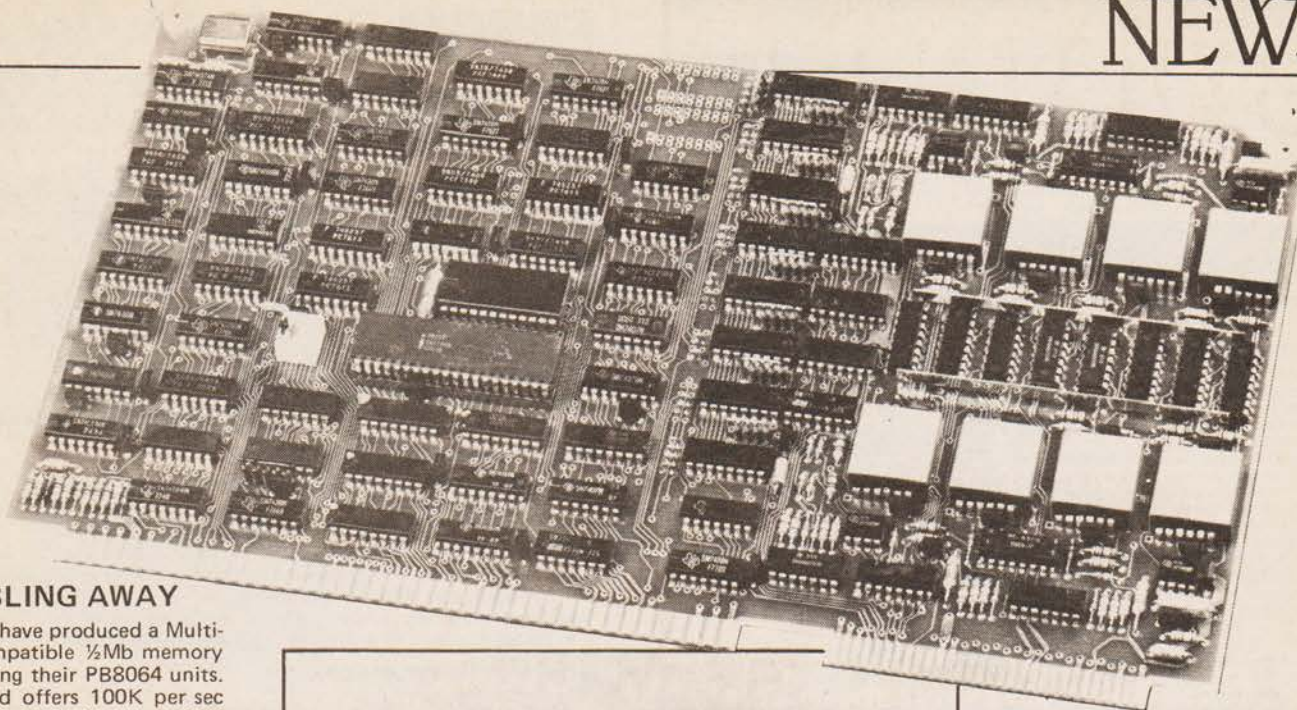
### PETSOFT GOES HARD

Petsoft are now moving into the hardware market with an exclusive UK distributorship of the Compu/Think disks. The first product is a 400K double density, dual drive floppy. At around £795 it is faster and cheaper than other commercially available units. Also being sold are the Expandamem boards for PET, KIM and AIM systems. Another recently

announced product from Petsoft is a cassette based magazine called CURSOR. Each tape contains at least 5 new programs and has a full graphics cover and contents table. Full documentation is supplied with each tape and also included is news on all PET related products. The cost of a years sub to the magazine is £36 for ten issues, a trial sample is available for £4. For details contact Petsoft at PO Box 9 Newbury, Berks.

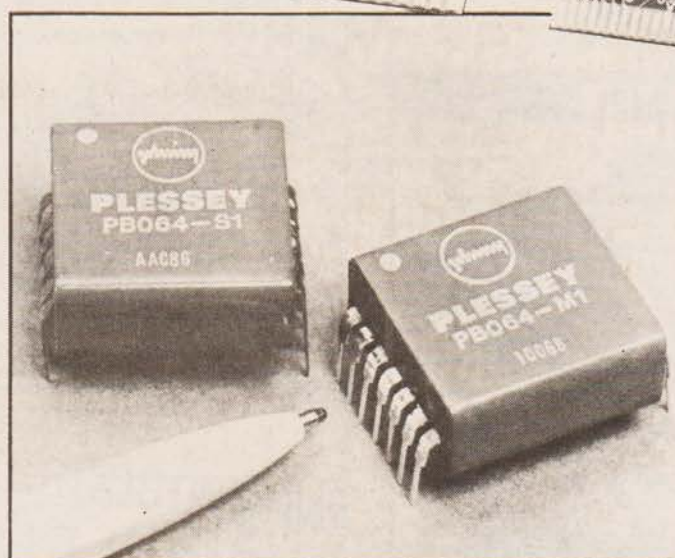






## BUBBLING AWAY

Plessey have produced a Multi-bus compatible 1/2Mb memory card using their PB8064 units. The card offers 100K per sec transfer rate and uses the 64K device. A MIL spec version, the PBM90M offers 8Mb in an ATR module as an alternative. Prices range from £500 to £1300. Also in the bubble field this month are GR Electronics of Newport who have produced a serially interfaced unit designated GR7000. The units are packaged with a PSU in 'black box' style and offer 10 to 40K with daisy chain capability. An integral V24/RS232 connector offers Baud rates of up to 9600 giving a 30mS access time to any new start address. The need for special software is reduced by having integral firmware. Prices range from £750 for 10K to £1000 for 40K.



## PET MEETS THE WORLD

A communications unit is now available for the PET. Plugging into the user port it provides eight channels for either input or output or mixed. The device is called the Communicator and will allow you to use the PET as an intelligent control device for such systems as a burglar alarm or central heating. Supplied ready built at £135 it comes with software details for some examples. Further information from Mektronic Consultants at Linden House, 116 Rectory Lane, Prestwich, Manchester.

## POWER ON WITH POWER ONE

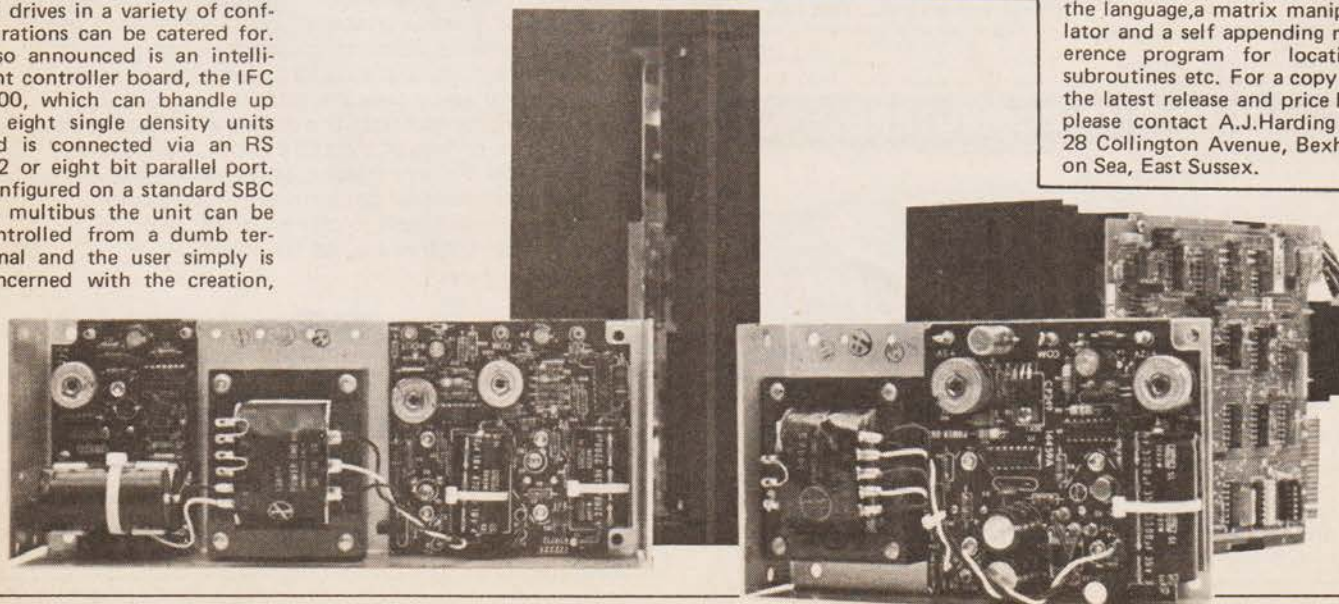
HAL Computers are stocking a range of power supplies for both standard and mini disk units. IBM, Shugart and Per-Sci drives in a variety of configurations can be catered for. Also announced is an intelligent controller board, the IFC 8400, which can handle up to eight single density units and is connected via an RS 232 or eight bit parallel port. Configured on a standard SBC 80 multibus the unit can be controlled from a dumb terminal and the user simply is concerned with the creation,

appending and deletion of files as the operating system is built in. Details are available from HAL Computers at 133 Woodham Lane, New Haw, Weybridge, Surrey.

## MORE FROM MOLIMERX

A.J. Harding have added yet more software to their already vast range for the TRS-80. Inc-

luded in the new range is a software routine to allow you to pack 117740 bytes onto a standard diskette instead of the normal 89600 bytes. Also announced is a level 2 expansion adding 70 commands to the language, a matrix manipulator and a self appending reference program for locating subroutines etc. For a copy of the latest release and price list please contact A.J. Harding at 28 Collington Avenue, Bexhill on Sea, East Sussex.

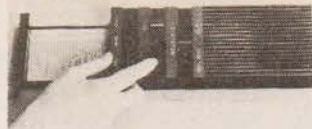




## 24 TUNE DOOR CHIMES

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## T.V. GAMES

### PROGRAMMABLE £29.50 + VAT. COLOUR CARTRIDGE T.V. GAME.

The TV game can be compared to an audio cassette deck and is programmed to play a multitude of different games in COLOUR, using various plug-in cartridges. At long last a TV game is available which will keep pace with improving technology by allowing you to extend your library of games with the purchase of additional cartridges as new games are developed. Each cartridge contains up to ten different action games and the first cartridge containing ten sports games is included free with the console. Other cartridges are currently available to enable you to play such games as Grand Prix Motor Racing, Super Wipeout and Stunt Rider. Further cartridges are to be released later this year, including Tank Battle, Hunt the Sub and Target. The console comes complete with two removable joystick player controls to enable you to move in all four directions (up/down/left/right) and built into these joystick controls are ball serve and target fire buttons. Other features include several difficulty option switches, automatic on screen digital scoring and colour coding on scores and balls. Lifelike sounds are transmitted through the TV's speaker, simulating the actual game being played. Manufactured by Waddington's Videomaster and guaranteed for one year.



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Grand Prix motor racing with gear changes, crash noises.

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using your own TV to display the board and pieces. Star Chess is a new absorbing game for two players, which will interest and excite all ages. The unit plugs into the aerial socket of your TV set and displays the board and pieces in full colour for black and white on your TV screen. Based on the moves of chess. It adds even more excitement and interest to the game. For those who have never played, Star Chess is a novel introduction to the classic game of chess. For the experienced chess player, there are whole new dimensions of unpredictability and chance added to the strategy of the game. Not only can pieces be taken in conventional chess type moves, but each piece can also exchange rocket fire with its opponents. The unit comes complete with a free 18V mains adaptor, full instructions and twelve months guarantee.



### CHESS CHALLENGER - £85.65 + VAT. PLAY CHESS AGAINST THE COMPUTER.

The stylish, compact, portable console can be set to play at seven different levels of ability from beginner to expert including 'Mate in two' and 'Chess by mail'. The computer will only make responses which obey international chess rules. Castling, on passant, and promoting a pawn are all included as part of the computer's programme. It is possible to enter any given problem from magazines or newspapers or alternatively establish your own board position and watch the computer react. The positions of all pieces can be verified by using the computer memory recall button.

Price includes unit with wood grained housing, and Staunton design chess pieces. Computer plays black or white and against itself and comes complete with a mains adaptor and 12 months guarantee.

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DISPLAY £163.04 + VAT.



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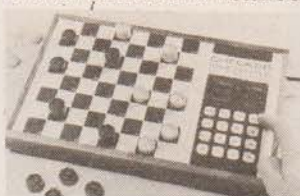
A special bulk purchase of these amazing chess teaching machines enables us to offer them at only £19.75 less than half recommended retail price. The electronic chess tutor is a simple battery operated machine that can actually teach anyone to play chess and improve their game right up to championship level. This machine is not only for total beginners but also for established players wanting to play better chess. Unit contains the electronic chessboard with 32 chess pieces, a 64 page explanatory booklet and a set of 32 progressive programme cards including 6 beginners cards, 16 check mate positions, 9 miniature games, 5 openings, 3 end games, 28 chess problems and 2 master games.

## DRAUGHTS COMPUTERS

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The draughts computer enables you to sharpen your skills, improve your game, and play whenever you want. The computer incorporates a sophisticated, reliable, decision-making microprocessor as its brain. Its high level of thinking ability enables it to respond with its best counter moves like a skilled human opponent. You can select offence or defence and change playing difficulty levels at any time. Positions can be verified by computer memory recall. Machine does not permit illegal moves and can solve set problems. Computer comes complete with instructions, mains adaptor and twelve months guarantee.

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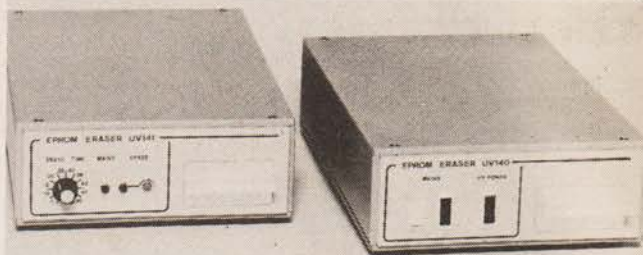
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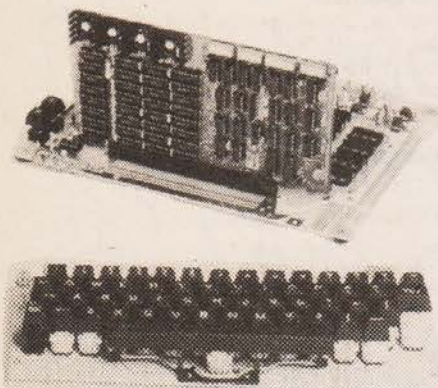
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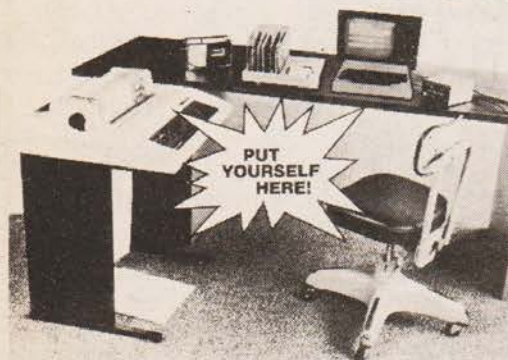
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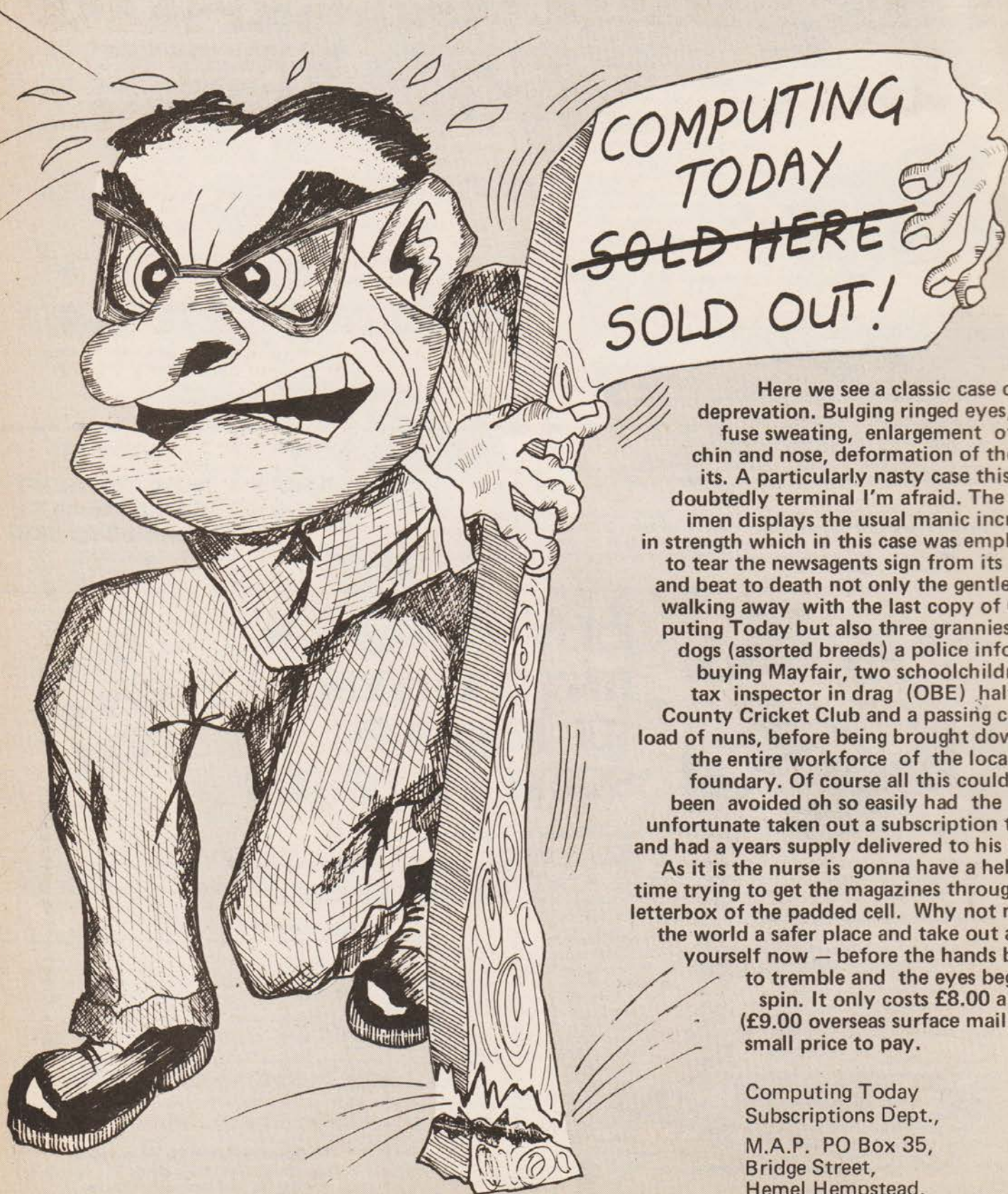
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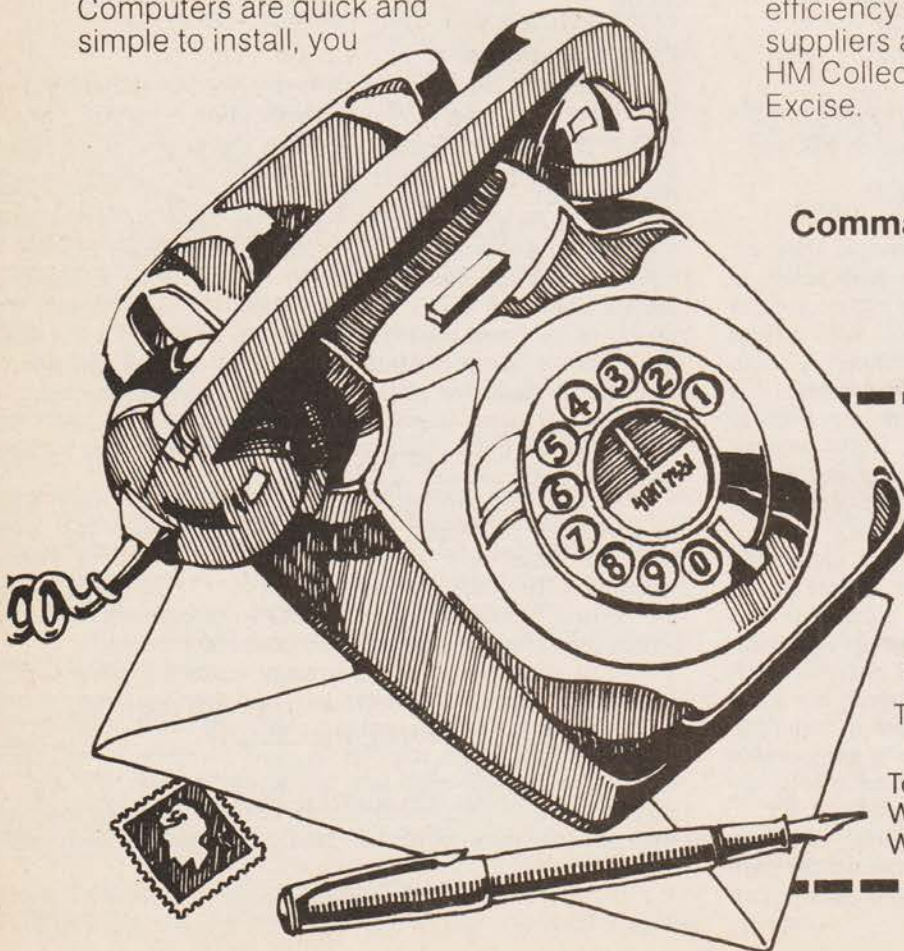
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## The art of Computability is the subject of this article. We also present a simulation program to try it out

One of the questions that Computer Scientists ponder in their baths is "What questions can computers never answer?". Much research has gone into describing simple "computers", because once such a machine has been described, the task of defining what problems it can (or can't) solve can proceed, much as algebraic proofs are built on the basic ideas of lines and angles.

Of course one could expect that the classes of unsolvable problems for each machine would be entirely different, but it is one of the triumphs of the subject that this can be proven not to be the case. Although many different approaches to the task of defining a machine have been made, starting from abstract mathematics such as the theory of recursive functions, or from a simple, easily visualised physical model, like the Turing Machines I am going to describe, or from a mixture of both like the register machines of Marvin Minsky, each can be shown to be equivalent to the others. Problems that can be solved by one "machine" will be amenable for solution by another, and a problem that it is impossible for a Turing Machine to solve will also be unsolvable on a Minsky Machine.

This subject is known as the study of Computability, and a problem that can be solved by one of these universal computing systems is termed Computable.

### Unsolvable Problems

Three questions that my pocket calculator cannot answer are:

- 1) What is the square root of  $-1$ ?
- 2) What is 9 raised to the 9th power of 9?
- 3) Who won last year's Derby?

The first and last of these I will discount now, as they are merely beyond the scope of a machine that deals solely in real numbers. The second is "unsolvable" for rather a more subtle reason, since if I were given a calculator with a large enough display, I would be able to find the answer. A calculator is a finite machine (and so is an I.C.L. mainframe if it has no exchangeable storage media) so there are a finite number of 'states' it can exist in. Simply, if its internal circuitry consisted of  $n$  flip-flops, then it could assume no more than  $2^n$  states, and its state at any one time could be given as an  $n$ -digit binary number.

Any finite machine can be fooled into giving the wrong answer merely by increasing the size or complexity of the problem it is posed. If my new large calculator was asked to find the factorial of nine to the (nine to the nine), it would fail where an even bigger one would not. Although I cannot comprehend the magnitude of the answer, nor guess the time that a calculator would take to produce it, nevertheless,  $(9 \text{ to the } (9 \text{ to the } 9))! = ?$  is a computable problem. All I need to solve it is integer arithmetic and very large internal registers and amounts of backing store.

If I now replace 'very large' with 'infinite', I have an infinite machine, with the knowledge of how to perform integer arithmetic (a program in firmware) and an unbounded amount of memory.

### Turing Machines

Turing machines are also infinite. The invention (published 1936) of British mathematician Alan Turing, they consist of a program written as a sort of flow chart called a Finite State Diagram, which controls a single tape-head moving up and down a strip of magnetic tape that extends without bound in both directions. It is much easier to think about an infinite tape than to buy one, and this is one of the reasons why Turing Machines are still 'thought computers', and not built in hardware.

The tape-head moves over the tape, which remains stationary. The tape may be thought of as being divided into squares, each of which may contain a symbol. The head reads one symbol at a time, and moves one square at a time, either right or left. Fig 1 represents a tape and head, the zero's are blank tape. A Turing machine cycle consists of moving the tape head one square in the direction the program requires, reading the symbol now beneath the head, and perhaps overwriting it with another symbol. Data may be presented by writing it on the tape before setting the machine to work, and results appear as the symbols on the tape once the machine has halted at the end of its computation.

### Finite State Diagrams

All the actions of a Turing Machine may be described (i.e. controlled) by means of a (Finite) State Diagram, though such diagrams are also used for other purposes. Fig 2 shows a simple example of a Diagram representing a program to find the parity of a binary number (whether it has an odd or even number of ones). It has two states, the large circles labelled E and O. The machine starts in state E. The binary number is input to the machine one bit at a time. State E has two arrows labelled 0 and 1 pointing from it. These indicate the action to be taken upon reading in a 0 or a 1. If a 1 is read, the machine assumes state O. If a 0 is read, it remains in state E. Similarly for state O, a 1 takes the machine back to E, while a 0 leaves it where it is. The machine will count the number of 1's in its input, and exist in state E if that number was even, and in state O if it was odd.

This Diagram has written no symbols, nor has it tried to control a tape-head. Fig 3a shows a Diagram that does both of these, and which may be used to run a Turing Machine. When the Machine shown in Fig 3b starts under the control of Diagram 3a, the binary number written to the left of the A on the tape will be incremented twice.

It works like this. The machine starts in state L. The L indicates that it is to move left, and then look for a 0 or a 1. If it finds a 1 it is to replace it with a 0 (the symbol in the middle of the arrow labelled 1), and continue in the same state. Thus it will step left, replacing 1's with 0's until it encounters a 0. This it will replace with a 1, and the machine then changes state to R. The binary number has been incremented.

In the R state, the machine steps right, looking for an A or a B. It will ignore any 1's or 0's it reads, and will even-



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tually find the A marking the end of the number. The Diagram shows that the machine must replace this with a B and start again on the left search for a 0. The tape will now look like Fig 3c. The head will next move left, read the 0, replace it with a 1 and start on the right search. It immediately finds the B it wrote two steps before, and on reading this the machine halts (Fig 3d). Two has now been added to the number on the tape.

## Programming Turing Machines

The second example above operated on only one number, a binary integer with the symbol A marking the least significant bit. The number could grow as large as it pleased, since the tape extended without bound to the left (and right). If two or more numbers are needed, they must be delimited in some way, and extra symbols may be brought into use as markers. Fig 4a shows one layout for three binary numbers. The X's mark the start of virgin tape.

Since we have introduced more symbols, there is no reason why the numbers on the tape need be represented in binary. Denary and Hexadecimal are just as legal, but in fact the base which is easiest to program in is Unary. In this base the number  $n$  is represented as  $n$  ones in a line, suitably delimited. It is a very primitive and simple counting system. Fig 4b shows the tape of 4a written in Unary. Fig 4c is a Diagram to increment a Unary number placed anywhere in a string of such numbers delimited as in Fig 4b. The tape head must start on the number or on the marker to its right. The diagram has seven states and four symbols; the same problem with numbers in binary would have been considerably more complicated. In general, you can write state diagrams with fewer states by employing more symbols, and vice-versa. The symbols used in a diagram and on a tape to solve a problem are called the alphabet of the Turing Machine that performs the solution. Taking Fig 3a and modifying it to add five to the number on the tape can be done by enlarging the alphabet (Fig 5a), or by adding more states and some data on the tape (Fig 5b).

Fig 5c shows the program and tape for adding two Unary numbers (very easy!) and Fig 5d is a program to multiply two Unary numbers by repeated addition, showing also the tape at the beginning and the end of the calculation. By making a few additions to Fig 5d you can get a program that will square a number, or raise it to an arbitrary power, or produce its factorial. Hence a fairly simply Diagram could be produced to calculate in Unary, the value of (nine to the (nine to the nine))!.

## Universal Turing Machines

Without doubt the most important discoveries about the behaviour of Turing Machines, and therefore the other computing systems, stems from the study of Universal Turing Machines, or Turing Machines that simulate the action of other Turing Machines. The problem is this: produce a state diagram for a Turing Machine which will be able to simulate in a recognisable way the action of any Turing

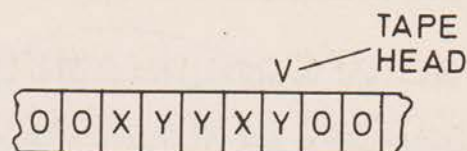


Fig.1. The tape on a Turing Machine extends to infinity, both left and right.

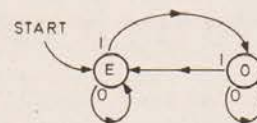


Fig.2. A simple example of a Finite State Diagram.

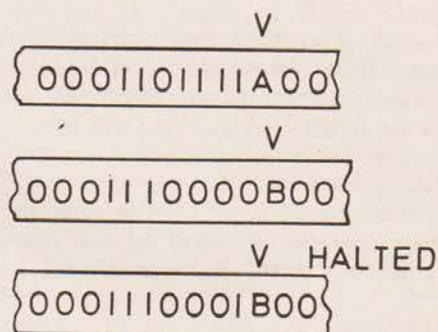
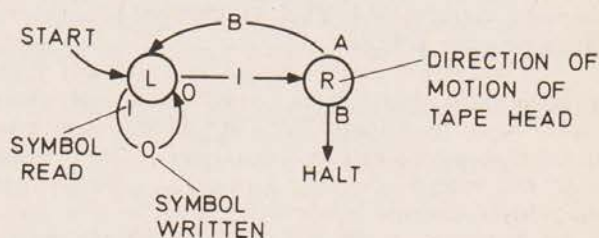


Fig.3. A Finite State Diagram that controls tape. The various stages are shown.

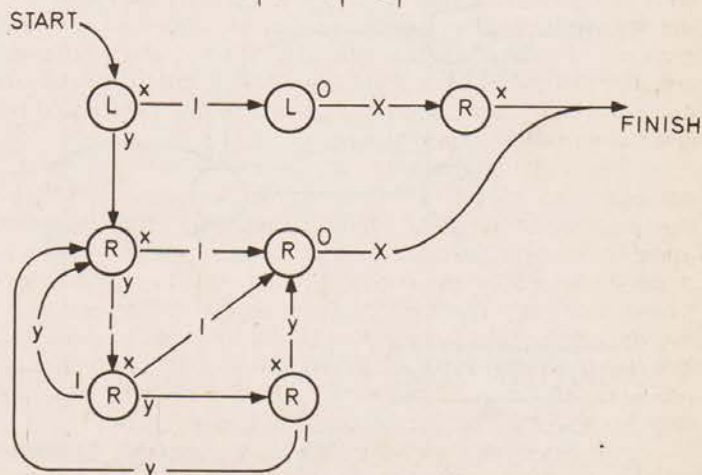
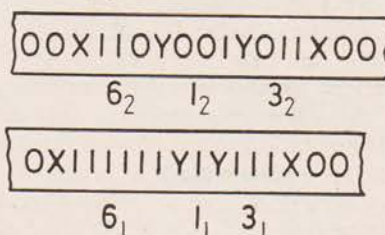


Fig.4. The State Diagram for the Unary system.



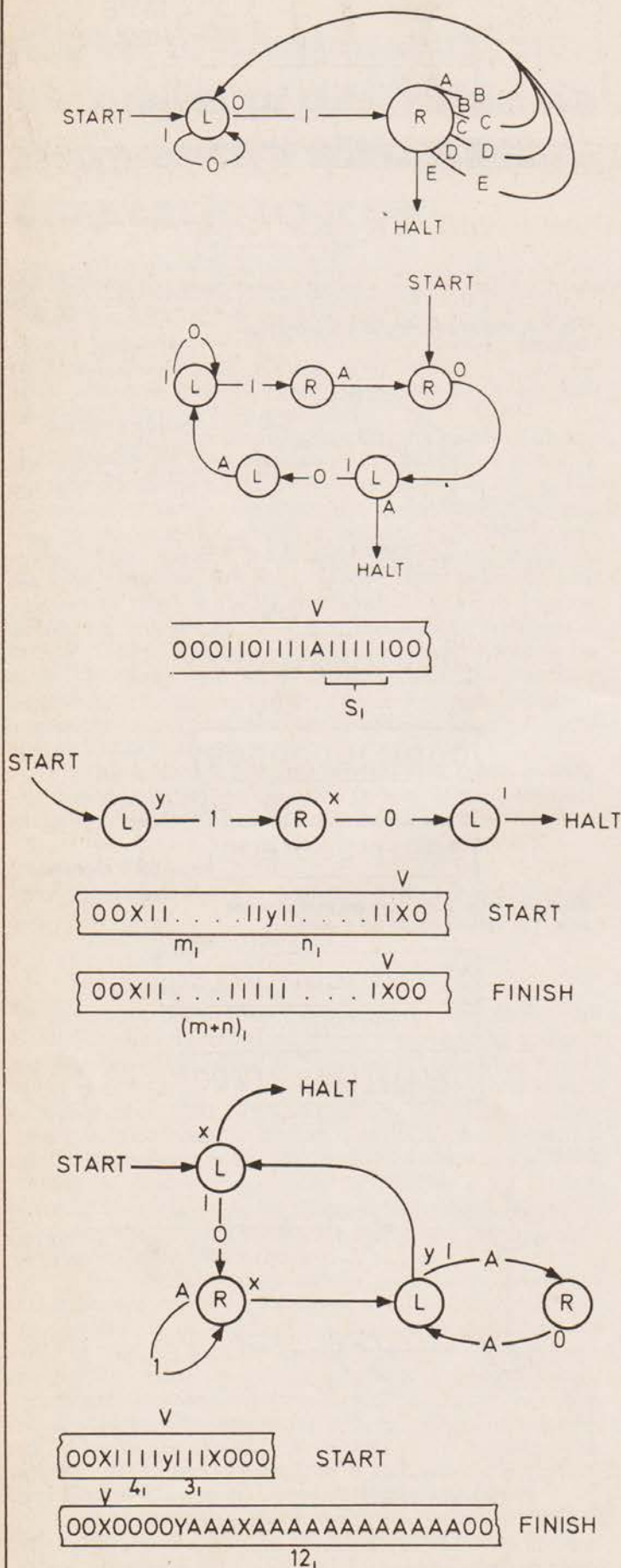


Fig.5. State Diagrams for handling Unary calculations.

Machine. It will need 1) the tape symbols that the simulated Turing Machine would start with and 2) a description of the state diagram that controls the simulated Machine, both written on the simulating Machine's tape as its data.

This is not too hard a problem. Once approach, that taken by M. Minsky in his excellent book 'Computation: Finite and Infinite Machines', Prentice Hall International Inc. 1972, is to keep a direct copy of the tape that the simulated Machine would produce. Certain simplifications can be made to the simulated Machine; its alphabet can be restricted to two symbols, since if its Diagram is written so as to consider these in groups of three (or four) then it can be made equivalent to a Machine with up to eight (or sixteen) symbols, and similarly it can be shown that a Turing Machine whose tape extends in only one direction can do anything that an ordinary Turing Machine can do. With these simplifications we need only simulate a Machine with the alphabet (0, 1), whose tape extends only to the left of a marker, and the space to the right of that marker is then available for describing the simulated Machine's State Diagram. Minsky keeps a 'File' of states, symbols recognised and corresponding actions, together with a record of the current state, and the current head position and input symbol. Different parts of the simulating machine then perform the actions of reading the input symbol, looking up the current state to find what to do, if necessary changing the current state and writing an output symbol, and moving the simulated tape head.

Because some Turing Machine will be able to perform the solution of any given computable problem, this simulating machine will be able to perform the solution of any computable problem, given the correct data. It is thus called a Universal Turing Machine. Minsky manages to pack its Diagram into 23 states with an alphabet of 8 symbols, and if you think that is small, his book goes on to describe, amongst other things, a 7 state 4 symbol Universal Machine.

### The Halting Problem

I started this article by asking "What problems can Computers never solve?", and the Halting problem is held to be one such. The stumbling-block remains that we cannot prove a Turing Machine to be a Computer, or a Computer to be a Turing Machine, in the same way that we cannot prove Newton's laws of motion. Nevertheless, the evidence in favour of both Newton (with due consideration given to Relativity) and Turing is considerable; in our case particularly the astonishing equivalence of Turing Machines and the other universal systems that model computability.

The Halting Problem concerns the existence of a particular Turing Machine, call it A, which, when presented with a description of another Turing Machine M, and the data that M starts with, will determine whether or not M will ever halt when started on its tape. It is quite possible for a Turing Machine never to reach the halt state when started on some tape, and it would be of value to know before we set a machine going on a lengthy calculation whether or not it is going to give us an answer. The description of M given to A could be in exactly the same form as the Universal Machine described above would need to simulate M.

Now the machine A which will tell us whether the Machine its data describes will ever halt may take a long time to decide, and indeed it itself may never halt. So perhaps the first thing to do is to give A a description of itself, and ask it if it will ever halt when set going on a tape containing a description of M. We now have A studying a simulated version of A studying a simulated version of M. If A exists,



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and works, it will at some point now halt, saying 'Yes, I will halt and answer your question about M', or 'No, I will never halt'.

Sadly at this point we can shoot ourselves down. By sabotaging our machine A in a legal fashion by attaching to the 'YES' halting exit an infinite loop, we have a new machine B which acts like A except that it can only halt if the machine it is studying does not halt, and it takes the 'NO' exit. If B is set to studying the behaviour of itself, we now have a logical impossibility. For B can only halt if the machine it is studying does not, but it is studying itself, and will thus halt if it does not halt, and fail to halt if it halts! These are the only possibilities, and both are contradictions. This means that B cannot exist, and since if A exists, we can easily construct B, then A cannot exist either, and the problem that A was to solve is not computable.

This problem is truly unsolvable, and by reducing other (equally abstract) questions about Turing Machines to problems whose solution requires a machine like A we can build up a large family of provably unsolvable problems. Many of these problems have specific instances which are solvable; I can easily tell whether my Turing Machine is going to halt, but I have no general procedure for determining this for an arbitrary Diagram and an arbitrary tape, and by this definition the problem is non-computable. By studying these questions we are extending our knowledge of what computers as we understand them are ultimately capable of.

## Nascom I Turing Machine Simulator

This program provides an animated simulation of a programmable Turing Machine. It runs on an unmodified Nascom I under T2. Facilities are provided to create a representation of the State Diagram within the Nascom, to write the memory tape's initial data configuration, and to step the Turing Machine through its computation either manually or automatically at variable speed.

The program executes from 0C50 and has three phases: the State Diagram, the Memory Tape and the Simulation.

## The State Diagram

This section of the program (mostly the subroutine ENLIST) builds a chained Data Structure in core starting from 0F50. Fig 6 shows its logical and physical structure. Since entering a long state diagram is tedious, the first question the computer asks is 'N.S.D.? (=New state diagram?). Type Y for a new one; any other key will leave the existing Data Structure undisturbed. This means that existing Diagrams may be re-used or saved on tape for reloading later.

The computer first wants to know how many states there are in your new Diagram. Enter this as a hexadecimal number, remembering that the HALT state must count as one too.

Next you must enter information about each state, one state at a time. The computer will prompt you in the upper left corner of the screen with five mnemonics indicating which piece of data it is expecting. The mnemonics are:

- 1) STID for the state identity
- 2) NRSY for the number of symbols recognised by the state
- 3) IPSY for the code of the input symbol
- 4) DNST for the identity of the destination state
- 5) OPSY for the code of the output symbol

## STID

States are identified by a two digit hexadecimal number. The direction of head movement associated with the state is given by the most significant bit of the identity number. ID's greater than 7FH are LEFT SEARCHING states. The other seven bits must be distinct for each state (97H and 17H are the SAME state) but need not be in a continuous numbered sequence. The state the Turing machine starts in MUST be the first state to be input to the computer.

## NRSY

This Hex number defines how many times the diagram building program cycles round the next three prompts. The HALTING state is distinguished by being the only state to recognise no symbols.

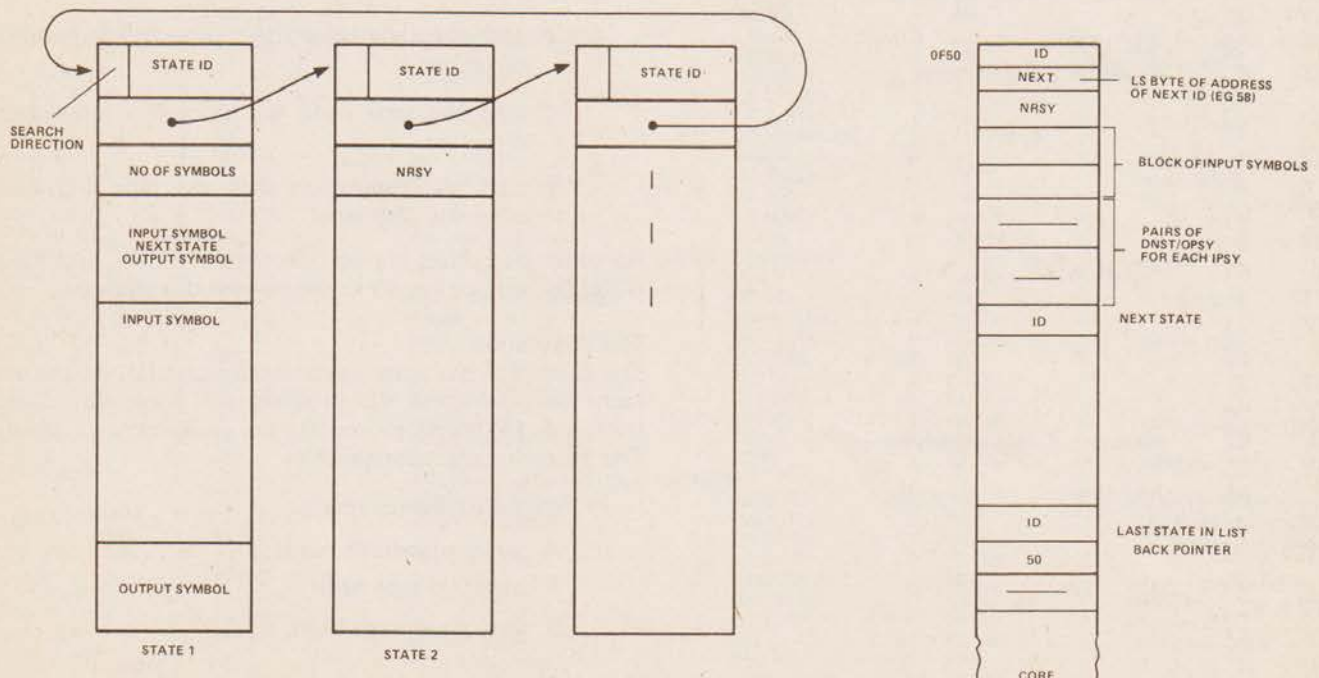
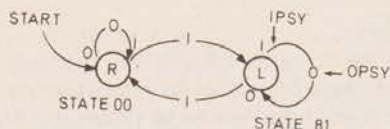


Fig.6. Finite State Diagram and data for the example program.

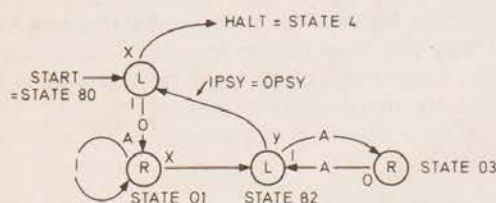




No. of States? 2

STID	00	The start state; right searching
NRSY	02	or 2
IPSY	30	ASCII 0
DNST	0	i.e. this state
OPSY	30	=IPSY
IPSY	31	the second symbol recognised
DNST	1	the other state; 81 would have done as well
OPSY	31	
STID	81	the left searching state, no. 1
NRSY	2	
IPSY	31	order doesn't matter
DNST	1	
OPSY	30	
IPSY	30	
DNST	0	
OPSY	31	after this the machine will display the tape.

Start this one on a blank tape.



No. of States? 5 including the HALT state

STID	80	start state, left searching
NRSY	2	
IPSY	58	ASCII X
DNST	4	4 will be the halt state
OPSY	58	
IPSY	31	
DNST	1	
OPSY	30	
STID	01	
NRSY	2	
IPSY	41	ASCII A
DNST	1	
OPSY	31	
IPSY	58	
DNST	2	
OPSY	58	
STID	82	state no. 2. left searching
NRSY	2	
IPSY	59	ASCII Y
DNST	0	
OPSY	59	
IPSY	31	
DNST	3	
OPSY	41	
STID	3	
NRSY	1	

Fig.7. State Diagrams and data lists for the program.

## IPSY

The ASCII code of the symbol read in. During the simulation this is compared with the symbol currently under the tape head.

## DNST

The identity of the state that the machine must assume upon recognising IPSY. This is again a two digit Hex number. Space has been left for implementing the simulation of NON-SEARCHING state diagrams, and the most significant bit of DNST is not used at present.

## OPSY

The ASCII code of the symbol to be written under the tape head. If no change to the symbol is needed OPSY must be the same as IPSY, or strange characters will appear.

## Errors

Errors in each line may be corrected by backspacing, but once Newline is pressed, the line is processed. If you make a mistake and cannot correct it for this reason, type FF in response to the next prompt. This will return you to the STID prompt and that whole state may be re-entered. If you type FF when the STID prompt is being displayed, the computer will step back to the previous state, so errors early in the procedure may be corrected. The error message 'NO!' is output and the monitor re-entered if you try to step back too many states. Fig 7 shows two State Diagrams and the corresponding input to the Nascom.

## The Memory Tape

Fourteen lines of the Nascom's screen can be used to display the tape (which is of necessity not infinite. . .). After inputting the State Diagram the blank tape is displayed (filled with 0's) and can be manually written on to provide the initial tape configuration required. The following control characters are used:

- > step the tape head right once and remember the direction
- < step the tape head left once and remember the direction
- \$ start the simulation with the tape and head as currently displayed

All other characters are written onto the tape, and the head is stepped on one square in the current direction.

## The Simulation

The \$ control character starts the simulation. At the end of each Machine cycle the program will look for characters from the keyboard to control the movement of the head. The following are recognised:

- M set to manual mode
- A set to automatic mode
- F speed up tape head
- S slow down tape head

## Manual Mode

All keys except A will cause the Turing Machine to execute one machine cycle. A invokes automatic operation.



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	LD (HL),A	4	77	
	LD A,D	5	7A	
	SLA A	6	CB 27	
	ADD A,L	8	85	
	SUB A,B	ED9	90	
	LD L,A	A	6F	
	LD A,3H	B	3E 03	
	CALL DISPLAY	D	CD 78 0E	
	RET	E0	C9	
NOT1ST	TEST Cb4	1	CB 61	
	JRNZ LAST	3	20 0A	
	SET Cb4	5	CB E1	
	LD (HL),A	7	77	
	INC HL	8	23	
	LD A,4H	9	3E 04	
	CALL DISPLAY	B	CD 78 0E	
	RET	E	C9	
LAST	LD (HL),A	F	77	
	LD A,B	F0	78	
	ADD L	1	85	
	LD L,D	2	6A	
	SLA L	3	CB 25	
	SUB A,L	5	95	
	LD L,A	6	6F	
	DJNZ MORE	7	10 02	
	JR ENDL	9	18 08	
MORE	LD C,3H	B	0E 03	
	LD A,2H	D	3E 02	
	CALL DISPLAY	F	CD 78 0E	
	RET	F02	C9	
ENDL	POP AF	3	F1	
	POP BC	4	C1	
	DJNZ NMORE	5	10 02	
	JR ENDST	7	18 10	
NMORE	PUSH BC	9	C5	
	PUSH AF	A	F5	
	LD A,(IX+1)	B	DD 7E 01	
	LD L,A	E	6F	
	PUSH HL	F	E5	
	POP IX	10	DD E1	
NEW	LD C,0H	2	0E 00	
	LD A,C	4	79	
	CALL DISPLAY	5	CD 78 0E	
	RET	8	C9	
ENDST	PUSH AF	9	F5	
	LD L,E	A	6B	
	LD (HL),50H	B	36 50	
	SCF	D	37	
	RET	E	C9	
ERR	PUSH IX	F	DD E5	
	POP HL	21	E1	
	LD A,L	2	79	
	OR A	3	B7	
	JRNZ NEW	4	20 EC	
	PUSH BC	6	C5	
	LD BC,F50H	7	01 50 0F	
	SUB HL,BC	A	ED 42	
	POP BC	C	C1	
	LD A,L	D	7D	
	OR H	E	B4	
	JRZ CRASH	F	28 11	
	POP AF	31	F1	
	POP BC	2	C1	
	INC B	3	04	
	PUSH BC	4	C5	
	PUSH AF	5	F5	
	INC D	6	14	
	LD C,D	7	4A	
	SLA C	8	CB 21	
	LD A,L	A	7D	
	SUB C	B	91	
	SUB D	C	92	
	LD L,A	F3D	6F	
	PUSH HL	E	E5	
	POP IX	F	DD E1	
	RET	41	C9	
CRASH PRINT		2	EF 1F 4E 4F	
	JP PARSE	9	21 1F 00	
	4(NOP)	C	C3 86 02	
		C	00 00 00 00	

START OF STATE DIAGRAM F50

write IPSY in table, then advance HL to point to top of DNST/OPSY pair. IPSY's in table for lookup.

HL now points to address of DNST. parameter for DISPLAY.

bit 4 set if expecting OPSY.

now points to home for OPSY.

that one was easy. store OPSY then restore HL to point to next place in IPSY table. B has no. of symbols left to read. D has total no. of symbols.

check if more symbols for this state. if list has ended. set two flags.

don't lose return address. B now has no. of STATES.

if no more states. hide BC. and put back return address. i.s. byte of top of next state. point HL there. and LD IX,HL.

clear flags.

save return address. complete data structure by pointing from last state to top of first state at F50. Carry flag set for main pgm.

point HL to top of state (in IX).

check for return to previous state.

clear state and start again. hide BC. don't step back beyond 0F50.

recover BC.

if HL-0F50=0 return address. state count must be incremented.

now point HL to top of previous state.

and put HL in IX.

if step back too far: 'N/LN0IN/L'. re-enter monitor. padding.

## MAIN PROGRAM

START 0C50

TAPEI 0CA5  
CLINE 0CE4  
TAPE 0CF5  
GO 0D28

## CALLS

INIT 0E10  
LINE 0DF3  
DISPLAY 0E78  
ENLIST 0EA3

MOVE 0DCA  
MONIT 0E40  
SETDIRN 0DE8  
MOVE 0DCA  
DELAY 0E00

## CALLS

DISPLAY 0E78  
MOVLINE 0D85  
MOVLINE 0D85

## Summary Of Subroutine Functions

INIT	Sets up registers and flags.
LINE	Reads a hexadecimal number from the keyboard, displays it, and puts its value in A.
DISPLAY	Takes a number in A and displays on the screen a 4 letter message which depends on A's contents. Numbers greater than 4 give strange results.
ENLIST	Uses the alternative register set, and creates a Data Structure representing the Turing Machine's State Diagram.
MOVE & MOVLINE	Take the position of the tape head in HL, the direction of required movement in B and move the head one square, perhaps skipping a line.
SETDIRN	Sets B according to whether the state pointed to by IX is R or L.
MONIT	Reads control characters from the keyboard and can change the speed of the delay loop. In automatic mode it will not wait if no key is pressed.
DELAY	Executes a delaying loop. One loop parameter can be altered by MONIT.



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bracelet.

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6mm thick.



**M1**

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**M2**

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10X secs., mins.  
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**M3**

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6 digits, 3 flags  
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display of day  
and date  
or seconds  
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Only 9mm thick  
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**M4**

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- ★ Hours, mins., secs.
- ★ Month, date, day
- ★ Basic alarm
- ★ Memory date  
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with dual time  
and 5 country  
zone
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6 digits, 5 flags,  
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optional seconds  
or date display  
AM / PM indication  
Month, date  
Continuous display  
of day  
Stop-watch to  
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in 1/10 second steps  
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Guaranteed same  
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**M6**

### SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

6 digits, 5 flags,  
22 functions  
Solar panel with  
battery back-up  
6 basic functions  
stop-watch to  
12 hours 59.9 secs.  
in 1/10 sec. steps  
Split and lap timing  
modes  
Dual time zones  
Alarm  
9mm thick  
Back-light  
Fully adjustable  
bracelet

**£27.95**



**M7**

### ALARM CHRONO with 9 World Time Zones

- ★ 6 digits, 5 flags
- ★ 6 basic functions
- ★ 8 further time  
zones
- ★ Count-down alarm
- ★ Stop-watch to  
12 hours 59.9 secs.  
in 1/10 sec. steps
- ★ Split and lap  
timing modes
- ★ Alarm
- ★ 9mm thick
- ★ Back-light
- ★ Fully adjustable  
bracelet

**£29.65**



**M8**

### SOLAR QUARTZ LCD Chronograph

Powered from  
solar panel with  
battery back-up  
6 digit, 11 functions  
Hours, mins., secs., day,  
date, day of week  
1/100th, 1/10th secs  
10X secs., mins.  
Split and lap modes  
Back light, Auto  
calendar. Only 8mm  
thick  
Stainless steel bracelet  
and back  
Adjustable bracelet.  
Metac Price

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Guaranteed same  
day dispatch



**M9**

### QUARTZ LCD

Lady's Day Watch  
only 25x20mm  
and 6mm thick.  
Hours, minutes,  
seconds, day, date,  
backlight and auto  
calendar.  
Elegant metal  
bracelet in silver or  
gold fully adjust-  
able to suit very  
slim wrists.  
State colour pre-  
ference.

**£9.95**

Guaranteed same  
day dispatch



**M15**

### QUARTZ LCD

Lady's Fashion  
Watch. Elegant  
bracelet in bronze/  
gold finish or silver  
colour. Hours,  
minutes, seconds,  
day, date, backlight  
and auto calendar.  
Adjustable for the  
slimmest of wrists.

State colour pre-  
ference.

**£14.95**

Guaranteed same  
day dispatch



**M17**

### QUARTZ LCD

Lady's Cocktail Watch  
Highly functional  
watch which also suits  
those special occa-  
sions. Beautifully  
designed with a very  
thin bracelet which  
retains strength as  
well as elegance.  
Hours,  
mins., secs., day, date,  
backlight and  
autocalendar.  
Bracelet fully adjust-  
able to suit slim  
wrists.  
State gold or silver  
finish.

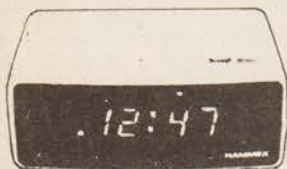
**£19.95**

Guaranteed same day  
dispatch



**M18**

### HANIMEX Electronic LED Alarm Clock



#### Features and Specification:

Hour minute display. Large LED display  
with p.m. and alarm on indicator. 24 Hours  
alarm with on off control. Display flashing  
for power loss indication. Repeatable  
9-minute snooze. Display bright dim modes  
control. Size: 5.15" x 3.93" x 2.36" (131mm  
x 11mm x 60mm).  
Weight: 1.43 lbs (0.65 kg).

**£10.20** Thousands sold!

Mains operated

Guaranteed same  
day dispatch.

**M13**

### EXECUTIVE ALARM WATCH

6 functions plus alarm:  
Conference signal, 5  
minute snooze alarm.  
Conference signal  
sounds 4 secs. before  
main alarm to give ad-  
vance warning and  
option to cancel.  
Snooze sounds 5 mins.  
after main alarm and is  
always preceded by the  
conference signal.

**£14.95**

**M60**



### MACY QUARTZ ANALOGUE

Automatic calendar  
day and date, infinite  
bracelet. This man's  
watch has elegance as  
well as the robust  
appearance provided  
by a watch with  
traditional features.  
Accuracy is provided  
by a quartz crystal  
powered by a long life  
miniature battery.

**£24.95**

**M21**



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#### OUTSTANDING FEATURES

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and you can set and recall any other  
time zone (such as GMT).  
Also has a light for night viewing
- ★ **CALENDAR FUNCTIONS** include  
the date and day in each time zone.
- ★ **CHRONOGRAPH/STOPWATCH**  
displays up to 12 hours, 59 minutes  
and 59.9 seconds.  
On command, stopwatch display  
freezes to show intermediate (split / lap)  
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Can also switch to and from  
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without affecting either's operation.
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24-hour period. At the designated  
time, a pleasant, but effective buzzer  
sounds to remind or awaken you!

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**M16**

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A vintage computer setup featuring a CRT monitor displaying a pixelated, abstract image, a keyboard, and a system unit. A document with text is visible next to the keyboard.

( Delivery within 7 days)

instruct it or program it to do whatever you want, but you don't have to. You don't because it comes with a complete software library on cassette including programmes for each application stated above. Ohio Scientific also offers you hundreds of inexpensive programs on read-to-run cassettes. Program it yourself or just enjoy it, the choice is yours.

## 25





## A first time buyers review of one of the top selling home computers

**T**his is a report on how a "beginner" bought a TRS-80. Beginner? I'll admit to having programmed before, but that was using FORTRAN, and it was before BASIC was invented. I'll admit cheerfully to having a certain amount of experience of MPU's and other hardware, as the columns of this magazine witnesseth. But as far as BASIC programming and the use of the microcomputer goes, I'm a beginner. Or I was. . . .

Why did I wait so long? Being an old hand in the electronics business, and having seen what happened to the prices of calculators, I felt that prices had to drop. In addition, I had been in the States in 1977 and seen the prices which were being charged there; I've kept in touch with their prices ever since! Next item was that I didn't want to buy a computer to play games, if the thing couldn't earn its keep, it wouldn't be bought. Third item was that I already had a spare TV and a cassette recorder, and it seemed a bit pointless to buy a computer which included these items all over again.

### A Problem Waiting For Solution

Time came and went, and I kept reading specifications. By

this time, early this year, several applications were starting to crystallise. I spend a bit of time writing textbooks, and one of the most time-consuming parts of the writing process is indexing the page proofs. At present, it involves underlining, on the page proofs, each word that is needed in the index, and writing that word, with its page number, on a sheet which is reserved for its initial letter. The words then have to be arranged in strict alphabetical order, and where the same index word occurs on several pages, the page numbers grouped alongside the word. It's a messy bit of donkey-work, with 26 sheets of paper flying about, and the sorting of words into strict alphabetical order takes a surprising amount of time. This task looked like a prime target for the use of a computer.

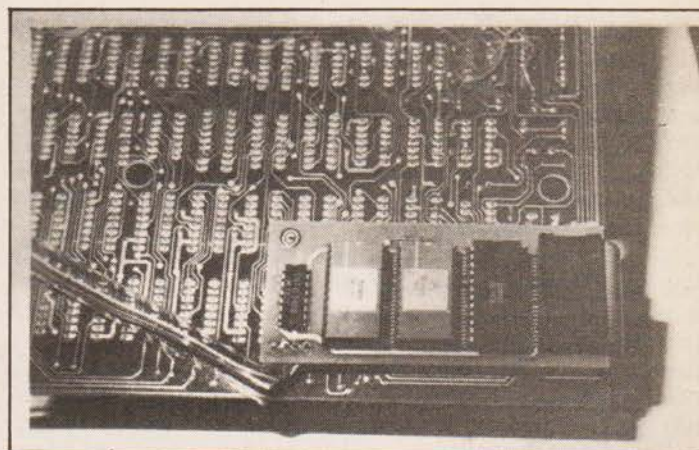
The other main item was the keeping of drawings files. I have a collection of drawings, copies which by now must amount to about five hundred items. They are filed under subject headings, but to find the one I want, I may have to look through more than one index. This looked like another target, provided the computer could handle files on cassette, possibly going to disc later. Thirdly came the inevitable financial application, keeping track of who paid what, and when, for what, and when, and if not, why not.

The tentative specification, then, was for plenty RAM, around 16K, and no need for frills like colour graphics (or any graphics, for that matter) provided there was plenty of string-handling capability. At the time I had reached this stage, prices were still well above the level at which I judged the thing could pay its own way, but the TRS-80 Level-2 looked a useful contender.





The traditional QWERTY layout is retained on the TRS-80 and it also offers a separate numeric pad.



The Extended BASIC ROMs on their sub-chassis for level two.

## Price Cut Equals Problem Solution

That situation suddenly changed when Comp of Barnet decided to bring a touch of realism to U.K. prices by offering the 16K TRS-80 Level-2 at £399 (plus Very Atrocious Tax). The Level-2 has very much greater string-handling capability than the Level-1, and 16K of memory is a respectable amount. In addition, being dynamic memory means that the power supply doesn't have to be a miniature version of Battersea Power Station, glowing a dull red; and adding yet another 16K later doesn't strain the power requirements too much. Were there any snags? Cassette compatibility with other machines didn't worry me too much — most of my programs are of interest only to me, and when you're compatible with the world's biggest-selling microcomputer, that's compatible enough. Similarly, I don't worry overmuch about not having the S-100 bus (should anyone?). Standard connections and systems are essential if you don't know anything about the hardware; they become less important if you know what's going on, and hardly matter at all if every shop stocks interfaces and hardware for your system.

All in all, it looked like a good case for getting on a train at Moorgate and, when BR could find a train to go all the way, off at New Barnet. A few yards from the platform, in Station Road, TRS-80's were changing hands rapidly. Not, perhaps, like Tottenham Court Road on a wet Saturday afternoon, but fast enough to bring a smile to their faces. I saw mine flash up its memory size, slapped it back in the box, and went off with it.

How do they do it? Officially, I don't know, but there's a clue on the back of my TRS-80. It has the Radio Shack LEVEL 2 4K label on, which suggests that the merry men of Barnet probably ship them in as 4K units, add another 12K of RAM and, bingo, 16K. At the same time, they sort out the old US/UK TV standards bogey, so that the picture on a TV receiver is absolutely rock steady. Since the price includes the power supply and the video modulator, your unit is complete and ready to go as soon as you take it out of the box and connect a plug. They have, need I say, installed a 240 V transformer. Full marks, chaps, for initiative, friendliness and good soldering.

## The Home Stretch

Now for that can't-wait-to-get-it-home feeling. With all the hardware unpacked, I found some of the very useful software that comes with the TRS-80. There was, to start with, the LEVEL-1 BASIC MANUAL. Now I've read quite a few books on BASIC, most of them, in fact, but the TRS-80

LEVEL-1 manual knocks them all into a cocked hat. It's a model of clarity, logically set out, well written, and a sheer joy to read. There are no comic strip sequences, no learned obscurity, just sheer good explanation with lots of examples. The name to remember is Dr. David Lien — I'll be very happy if my writing ever becomes half as good as his.

There's just one small snag — quite a lot of the LEVEL 1 material doesn't apply to LEVEL-2, as you discover on the first page when you try to print the memory size. On LEVEL-1, the abbreviation PM is used to do this; LEVEL-2 requires the words to be typed out a bit more fully, as PRINT MEM. Differences of this sort don't really cause too much bother, once you've met the first few.

The LEVEL-2 manual is also included with the outfit. This isn't intended for beginners, it's more of a dictionary to the LEVEL-2 dialect of BASIC than a textbook. As far as I can judge, LEVEL-2 BASIC is pretty standard, with several of the little luxury touches, such as TAB, which delight the keen typist. The software package is completed by three cassettes, one with games (Backgammon and Blackjack), one with systems programs in machine-code (Z-80, if you didn't know) and one blank. All in all, you get a lot for your money.

The real test, though, is of its ability to do the job it was bought for. First indications were that it would. I could get only indications at first, because I need rather specialised programs, which were going to need time to write. I started to run small adaptations of standard programs, and also to run across the points which are not covered completely by any manuals — more of these later.

## Loaded To Save It

The first thing I knew I had to sort out was cassette loading and saving, so that a precious program developed with sweat and tears (no blood, because there are no sharp edges) over days of effort could be saved and used. Just as important, a program which was not fully debugged could be saved for a later effort without all the hassle of keying in again. I type fairly quickly, but it's no fun to type in a really long program. Intensive reading about this caused me some worries, because there were endless reports of problems with TRS-80 cassette loading and dumping. My own problem number one was that the microphone and control inputs of my cassette recorder (Normande 391) were at a 7-pin DIN input, whereas the TRS80 uses sensible 3.5 mm and 2.5 mm jack plugs. Out came the soldering-iron and the metal-basing tools, and after a bit of work an adaptor had been created. Two of the plugs



from the TRS-80 now go into sockets on a small box, whose output cable sports a 7-pin DIN plug — the remaining jack-plug goes into a headphone jack socket on the recorder. Just as a touch of luxury, I added a switch so that I could recover control of the recorder motor when the computer had switched it off—it makes rewinding much easier. The first priority was to get replay going, so the Blackjack cassette came in for its only likely use.

If you're not familiar with the system, the cassette loading scheme for the TRS-80 is quite neat. An asterisk appears at the top right of the monitor screen to show that a program is present on a cassette, and a second asterisk flashes to show that a program is loading. If you've selected a labelled program ("A", "B", "5", etc.) then any programs you pass on the way to your selected one are also indicated on the right hand side. It works beautifully, once you know what you are doing — but that can take time!

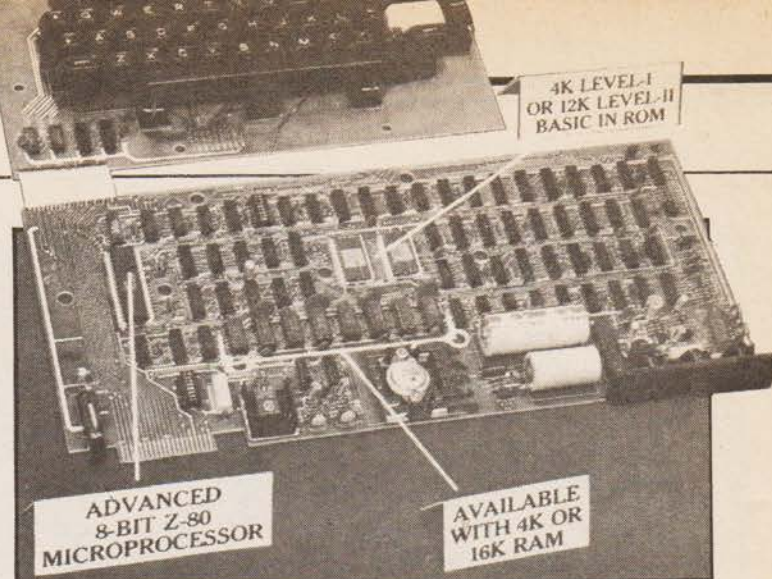
Pillock's progress went something like this. I set the playback volume low, popped in the cassette, pressed "play", entered CLOAD on the computer, and watched. Nothing happened, no asterisks, volume setting too low. Rewound the tape, set the volume up a bit, went through the ritual again. This time, asterisks appear, but no blinking and no program loaded. Rewind, reset volume, try again — several times. At this stage I started to believe that cassette loading can damage your health; so I had to turn away for a time and re-engage the brain. Surely these \*\* asterisks were still on the screen while I was rewinding the cassette? They must be latched, so I have to cancel them on each run. A quick fumble through the manual reveals the presence of a reset button under the expansion flap on the rear left side. This causes recovery from the cloding condition (sounds painful), and the asterisks vanish when the next CLOAD is keyed

in and entered. Ho, ho and try again. After two more runs, the cassette was loaded. There was slight corruption on the data (would you believe 100 FPB \* VT @GH' SKLGH RMP?) so I upped the volume control a little bit, reset and tried again. It loaded perfectly, and loading has given me no trouble since. That lot was enough for one day!

### Converging On A Program

Next spare day was try-a-program day. I have already a collection of program listings, but I wanted to write one of my own to check two things — my understanding of BASIC so far, and the convergence of the colour receiver I was using as a monitor. The first seemed OK — the program is shown in Fig. 1; it simply writes the character of your choice in lines all over the screen. I had suspected that the set had lousy convergence, and I wasn't wrong. Furthermore, being a pre-PIL receiver, the convergence was unstable. Ten minutes of twiddling could get reasonable white letters with just a few touches of colour at the edges, but by the time the back was on again, and certainly at the next switch-on, it was as bad as ever, with ghostly red letters at the side of the off-white ones. Mental note, get a black/white receiver, or go the whole hog and nip back to Barnet for a monitor. I don't need colour — the receiver just happened to be there. A little inner voice then says "Chicken! Call yourself an engineer?" OK, I'll try again.

The important thing now was to save the program on a cassette to check the recording process. I typed in CSAVE "A", jabbed enter (it's not RETURN on the TRS-80) and watched the recorder start. Yes, it would have helped if I had pressed the "record" key as well. Back to square one, and repeat. This time it ran — then the 'phone rang and that was



the end of work for the day.

Day three started with loading the convergence program back in — or trying to. It wouldn't load at any setting, and no amount of juggling with the controls would give anything but gibberish loaded. By this time, I once again had to get on with something else, and there was no more spare time that day. Who says computers save time?

On day four, I decided to be calm and rational. I tried the Blackjack program again at the original loading settings I had found. It loaded perfectly, but the convergence program didn't. Since the computer couldn't tell me what was going on, I took the earphone plug out and listened to each program in turn. No doubt about it, the convergence was a much fainter and noisier program. We obviously had recording problems. I tried several more CSAVE's of a short program, one, and only one, of which was perfect. The first instinct was to open the box. At that point I remembered the Second Law of the Marquis de Sod (Sod's Law, you know) which says that when you have problems with a complex bit when it's a simple bit that's gone wrong. When your computer doesn't record on cassette, you naturally blame the computer. The fault was, in fact, in my adaptor. The tip of the TRS-80 jack plug is fractionally longer than the jack plugs I normally use, and it was touching — just — the earth wire in the socket. That obviously didn't do the signal any good at all; and I was glad I didn't take the TRS-80 apart. Quite apart from anything else, if I can short out a jack plug, what could I do to 16K or RAM chips? After that small point was sorted out, every save and load worked perfectly. Two small points might be of interest. One is that the recorder has internal motor and microphone switches operated by the DIN plug. The plug I used didn't reach the switch, so a short chunk of matchstick was inserted in the recess of the socket, and inserting the plug then had the desired effect. The other point is that there is an earth loop, because both the microphone and the earphone leads are earthed. I cut away the braid from the earphone lead, which resulted in even better recordings, and I need less volume for reliable playback. The same effect can be achieved with no destruction by making up a socket and plug, connecting only the centre terminals so that the earth is not linked in.

### Data Versus Files

With that lot finally sorted out, I could then start on the real work. Details probably aren't of interest to you, unless you are an author with a TRS-80 and in need of an indexing program, but a few conclusions might be, especially if they provoke some solutions to problems. One conclusion is that the TRS-80 is generally pretty well suited to my needs. Another is that cassette file handling is a joke. With only about 248 bytes on each INPUT and PRINT cassette instruction, any reasonable amount of file data takes a long time, and has the reed switch (which operates the recorder motor)



clicking like a demented pool table. The technical manual hints that this reed switch can have a short life in such circumstances, so I make use of that 16K of memory and simply keep my files as DATA statements within the program which enters and reads the files. That way, one cassette load inputs the whole of the program and the data. I agree that the advantage of filing is that one set of data can be used for several purposes, but unless there's a better way, I'll wait for a disc unit when the long-promised Japanese disc drives become available. I believe it must be possible to control that reed switch with a program, but it must either need machine language or a POKE statement. The only reference to machine language in the manual is to loading from cassette, and where and what do you POKE? My problem is that time is limited; much as I would like to experiment, I have to spend time earning a living.

Another conclusion is that there is a considerable variation in the quality of the software which is available. Now I appreciate that software can never be cheap, because of the hours of effort that it takes to prepare and debug, but need it be all that expensive for a standard product which sells in the States for quarter of the price? I have a book called "Some Common Basic Programs", published by that guru of the microcomputing movement, Adam Osborne. It contains some 76 program listings for a price of £6.30 (from L.P. Enterprises). The point is that many of the cassette programs I have seen on offer look uncannily like programs in the book, but at about the same price for each program!

Obviously, no dealer is going to let you have a cassette, or even a listing, on approval, since copying is so easy, and the only way to be sure that a cassette program is good value is to see it running. I wouldn't buy unseen unless I had a great deal of faith in the supplier, built up by experience, or had seen a detailed review of the cassette.

Meantime, between bouts of writing this and other things, my book indexing program is bug-free and is now committed to cassette. I can now enter each word with its page number, and at the last page start an alphabetical sort. When this is complete (and it takes a surprising amount of time), I can type in a letter, and receive an index for this letter, in alphabetical and numerical order. What makes this a bit more than a straightforward sorting operation is that entries are correctly combined. For example, if I have entries of Transistor 47, Transistor 68, Transistor 92; these appear as Transistor 47 68 92, with no repetition of the index word. This is the form I need, and it was worth all the effort.

## SCREEN FILL FOR CONVERGENCE

```
2 CLS
3 INPUT 'TYPE SYMBOL TO BE USED';A$
4 FOR N = 1 TO 1023
5 PRINT@N , A$;
6 NEXT
```

Fig.1. To run, type RUN, press ENTER. At the first question, type in the character you want to use (the full stop and + signs are the most useful), and press ENTER again.

## Conclusion

Half-fun, half-spice, the machine is often called the TRASH-80. For me, it's TRUSTY-80, and I'm very satisfied. Thank you, Tandy Corporation, thank you, Comp. Now about that cheap printer and disc unit .....

## Tandy Replies:-

Dear Sir,

I would like to thank the Editor for this opportunity to reply to the interesting article on the TRS-80 by Mr. I. Sinclair.

I should like to begin by congratulating Mr. Sinclair on his excellent choice of micro-computer and thank him for the christening "Trusty-80". He has coined in this tiny phrase the feelings of thousands of other satisfied customers.

There are a few points I would like to make regarding his purchase, however, and hope to clarify one or two questions which might have arisen in the minds of our future customers.

It seems that Mr. Sinclair took some time to decide exactly which microprocessor would be best suited for his requirements and, like any sensible person would, looked around to find the best possible price. In doing so however, he appears to have overlooked Tandy Corporation, who — being the manufacturer — would be the obvious choice of supplier for most. Further, Mr. Sinclair did not purchase a 16K Level II TRS-80 as supplied by Tandy Corporation. What he did purchase was a single component part — namely, the 'Keyboard' (also known as the central processing unit) — from a computer component supplier, not an authorised Tandy agent. In terms of capital outlay he paid £399.00 (exclusive of V.A.T.) for one part of a 16K Level II System. TO COMPLETE HIS PURCHASE he would need to buy a 12" black and white video monitor and a cassette recorder with a digital tape counter.

As Mr. Sinclair was already in possession of a cassette recorder — for which he had to build an adaptor box (which led to wasted time and 'he calls himself an engineer') he only needs to purchase a video monitor.

Were it not that Mr. Sinclair had found the resultant picture on his Television receiver was inadequate (a U.H.F. modulator was included in his purchase price) this would not have been necessary. I feel bound to say that we have been advising people against the use of these modulators from the beginning.

Considering all this, we find that it is easier AND CHEAPER — AS ONE MIGHT EXPECT — to purchase the TRS-80 directly from the manufacturer, namely Tandy Corporation.

Apart from these obvious benefits, Tandy Corporation can offer an after sales service second-to-none on a national basis; but not on units imported AND CONVERTED TO U.K. STANDARDS BY UNAUTHORISED AGENTS.

I would like to recommend, therefore, that any future customers learn from Mr. Sinclair's mistakes and purchase direct from an authorised Tandy dealer. I hope that when Mr. Sinclair comes to purchasing his expansion units he will save himself the aggravation and expense he has experienced to date by buying from a Tandy retail outlet.

I should like to conclude by thanking Mr. Sinclair for his fair and kind appraisal of the TRS-80 and hope that he continues to benefit from its use.

Mr. R.A. Heller,  
Manager,  
Computer Division.



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# MPU's BY EXPERIMENT

## Our series continues with a close look at some more machine code instructions

In part 4 we came across the binary-add instruction ADI (the immediate version of binary-add, that is) and the way that the CY/L and OV status bits are used. We're not completely finished with immediate-loading instructions yet, however, and there are a few rather important ones left. The first one we'll look at this month is the DECIMAL-ADD IMMEDIATE, DAI, coded as 11101100. For decimal addition, the byte in the accumulator and the data byte added to the accumulator are both treated as two-digit BCD numbers. For example, the byte 01010011 is taken as the two BCD digits 0101 (decimal 5) and 0011 (decimal 3), making 53. Some care is needed to ensure that the numbers in the accumulator and in the memory are genuine BCD numbers; 11001010 isn't because its first four bits decode to 12 and its next four bits to 10.

### BCD Equals Good News

The ability to carry out BCD arithmetic is rather useful, because it's not the easiest thing in the world to write programs for — Fig. 1 indicates what is needed to add BCD numbers. We can try out two examples, one of which adds simply, like binary numbers, the other of which reveals some of the actions which are taking place inside the microprocessor. After the usual RESET and CANCEL, load up BCD 25 by using the steps 11000100 (LDI) PUSH 00100101 (BCD 25) PUSH. The next steps are 11101100 (DAI) PUSH 00110010 (BCD 32) PUSH. We can view the answer by the usual 11001000 PUSH 00000001 PUSH routine. This gives the answer 01010111 which is BCD 57, the correct answer. In this example, the BCD addition has been indistinguishable from binary addition, because there has been no carry from one group of four to the next.

Now try an example which differs from ordinary binary addition. RESET and CANCEL, then load in BCD 39, then add 57 to get 96. Fig. 2 shows this addition, and also shows that the BCD addition gives a very different answer from the same figures added in pure binary fashion. The practical procedure is 11000100 (LDI) PUSH 00111001 (BCD39) PUSH 11101100 (DAI) PUSH 01010111 (BCD57) PUSH 11001000 PUSH 00000001 PUSH to display. The result is 10010110 as expected, BCD 96. The carry/link bit operates on BCD additions also; it is added in the lowest order bits if the logic of the BCD arithmetic requires it, and is set by a carry out of the highest order bit.

So much for addition — what about subtraction? Binary subtraction is achieved by converting the number which is to be subtracted into a negative number, using the 2's complement form as illustrated in Fig. 3. The 2's complement is formed by complementing the number (that is, exchanging a 1 for a 0, or a 0 for a 1 in each bit) and then adding 1 to the least significant bit (lsb). If the binary numbers which are being subtracted consist of more than one byte, however, it is only the lowest order byte which needs to be 2's complemented; the higher order bytes are simply complemented and then added (Fig. 4).

### The Byting Order

Because of this distinction between lower and higher order bytes, which can be made only by the programmer, the 8060 instruction COMPLEMENT AND ADD IMMEDIATE (CAI)

is a simple complement, not a 2's complement, followed by binary addition. To form a 2's complement, an additional 1 has to be added in, and this is most easily done by making use of the CY/L bit, since this is automatically added in when the CAI instruction is used.

The subtraction routine therefore starts, after the usual RESET and CANCEL, with SET CY/L (SCL), coded as 00000011, PUSH. We can then load a number decimal 103 in this example by using the steps 11000100 PUSH 01100111 PUSH. The number to be subtracted is 32, and the steps are 11111100 (CAI) PUSH 00100000 (data 32) PUSH. The results are displayed as usual by 11001000 PUSH 00000001 PUSH, giving the result 01000111, which is

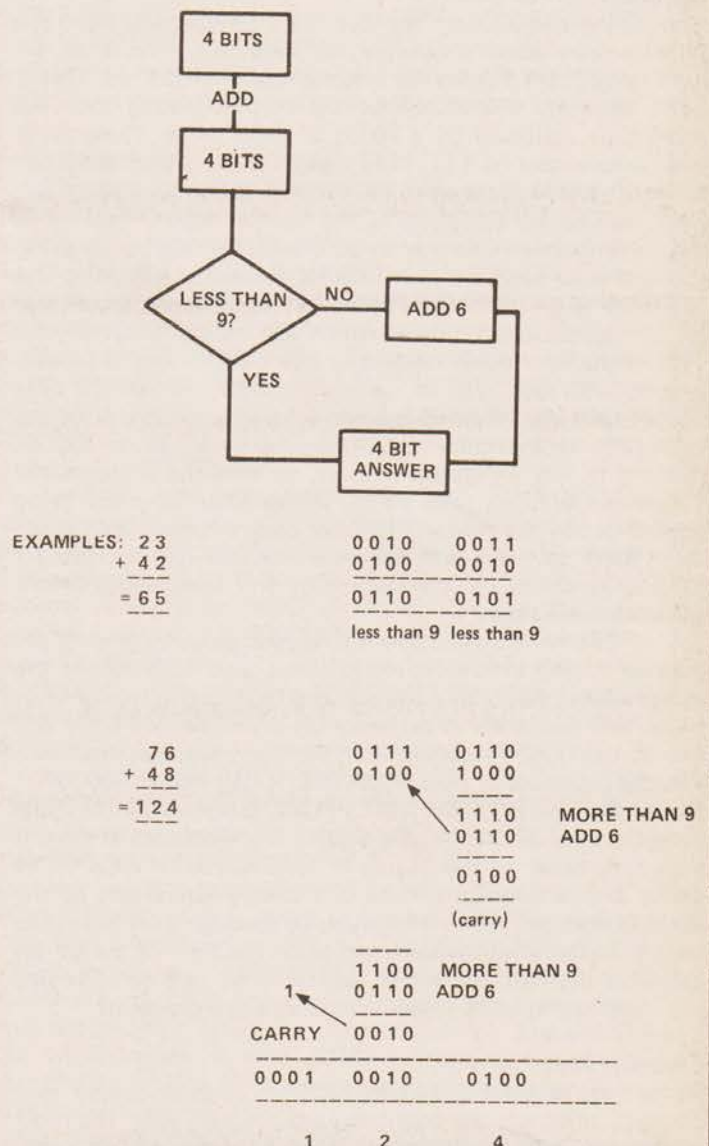


Fig.1. The rules of BCD addition. Each group of four bits is binary added, including any carry from a previous stage. If the sum of four bits is less than 9, the result is valid. If the sum is more than nine, 6 is added.



decimal 71, the correct answer. This chip knows a thing or six, doesn't it? Now find out for yourself whether the carry of overflow bits are set, using the CAS and display steps as before.

The subtraction which we've illustrated is a straightforward one, with a positive answer, indicated by a zero in the most significant place. Now try a subtraction which has a negative answer, as shown in Fig. 5. We start again with the SET CY/L instruction, and load the binary equivalent of 69. This is done using 00000011 PUSH 11000100 PUSH 01000101 PUSH. Now follow with 11111100 (CAI) PUSH 01111000 (decimal 120) PUSH, and display by using 11001000 PUSH 00000001 PUSH. The result which is displayed is 11001101, the result of straightforward binary arithmetic. We want to interpret this as a signed number, and it'll be negative because of the 1 in the msb. To find the equivalent negative decimal number, we must subtract 1 and complement, the opposite of the 2's complement procedure, giving 00110011, which is decimal -51. Can we program the microprocessor to get this binary number by itself?

### Complement Yourself

Complementing a binary number in 2's complement form is a bit of a roundabout procedure, but here goes. First of all, we have to subtract 1 from the original result, 11001101. This is itself done by a 2's complement method, using the CAI instruction followed by a string of eight zeros. These zeros will complement to 11111111, which is the 2's complement form of -1. The steps are 11111100 PUSH 00000000 PUSH. Now how do we complement the number which is stored in the accumulator? One way to do this on the 8060 is by using the extension register, a very useful feature of this chip. The extension is another single-byte register, which has a similar set of instructions to these which act on the accumulator. The instruction XAE exchanges the byte in the extension register with the byte in the accumulator, so that the data byte 11001100, formed by the subtraction, is now in the extension. If the chip was previously reset, there will be nothing in the extension register, so that the accumulator will now be filled with zeros. If this little lot were being carried out in the middle of a large program, we would probably want to clear the extension register beforehand by loading zeros into the accumulator and exchanging before the arithmetic steps.

The next instruction is CAE, which complements the number in the extension register and then adds it into the accumulator. Any carry bit will also be added in, so we must be certain that there is no carry bit set before we carry out this instruction. Assuming that the carry was not reset earlier, the sequence is now 00000010 (CCL) PUSH 00000001 (XAE) PUSH 01111000 (CAE) PUSH followed by the usual procedure for displaying the result. The whole set of steps is shown in order in Fig. 6 just to remind you of what we've done. The answer should be the binary equivalent of the decimal number. When would you go through this? When the msb is 1 after a subtraction, and when the state of the OV bit indicates that it's correct to take the msb as a genuine sign bit — could you write these instructions as a program?

### Changing Pans

So far, we've been using the program counter simply as a counter, going up one count at each program step. The most interesting and useful program steps, however, involve jumping from one program number step to another which is NOT in sequence. This means that the numbers on the address lines will also be out of sequence; remember part of the memory. Instructions which result in out-of-sequence moves

```

          0 0 1 1 1 0 0 1
BCD Add  0 1 0 1 0 1 1 1
          1 0 0 1 0 1 1 0

```

Fig.2. A BCD addition of two digits each byte.

```

1 0 0 1 1 0 1 1  NUMBER
0 1 1 0 0 1 0 0  1's COMPLEMENT
+ 1
-----
0 1 1 0 0 1 0 1  2's COMPLEMENT

```

Fig.3. Forming the 2's complement for a subtraction.

```

          upper byte      lower byte
          1 1 0 0 1 1 1 1  1 0 1 0 0 1 0 1
-          0 1 1 0 0 1 1 0  1 1 0 0 0 0 1 1
-----
is equivalent to :
          1 1 0 0 1 1 1 1  1 0 1 0 0 1 0 1
+ 1's complement - 1 0 0 1 1 0 0 1  0 0 1 1 1 1 0 1  - 2's complement
1
0 1 1 0 1 0 0 0  1 1 1 0 0 0 1 0
carry

```

Fig.4. A sixteen-bit number is 2's complemented by the usual method of forming the ones complement and then adding 1. This is the same as 2's complementing the lower byte and ones complementing the higher byte.

like this are transfer instructions, and are transfer instructions, and each microprocessor chip has a variety of types of these transfer instructions. In fact, the most marked differences between different types of microprocessors lie in the varieties of transfer instructions which they can use.

The simplest and most straightforward method of transfer is called program-relative displacement. To see how it works, we'll use the instruction JMP, which simply means JUMP TO A NEW ADDRESS; its instruction code is 10010000 on the INS8060. Start by the usual RESET and CANCEL, then set up the JMP code. This is the instruction part of a two byte code, which must be followed by a data byte, so that when PUSH is pressed, the address count goes from 0001 to 0010 and waits. Now enter the data byte 00000011, which is the binary form of decimal 3. You would expect on previous form that the next PUSH would enter this data and take the address to 0011 — try it.

Now what has happened is that the data byte which you entered just after the instruction byte has been added to the address number, it hasn't gone into the accumulator. What would go into the accumulator, if we had a fully-fledged system operating, would be the number which is stored in the memory at this new address; in this example address 0110.

That looks fine if we want to make the address shift forward — but by how much? Try again, resetting and then entering 10010000 PUSH again. Now enter the data byte 11111111 PUSH. The address might be expected to move to 0011 — does it?

The entry of 11111111 has behaved like a subtraction of one, which means that the leading 1 of the data byte has been interpreted by the microprocessor as a negative sign. The byte of 1's is, in fact, the 2's complement form of -1, so that the address can be moved backwards as well as forwards, as we might expect.

Just to be sure, enter 10010000 again, then PUSH



# MPU's BY EXPERIMENT

```

Subtraction      0 1 0 0 0 1 0 1    69
                 - 0 1 1 1 1 0 0 0   -120
                 -----
                 1 1 0 0 1 1 0 1    - 51

Converting answer
out of 2's complement
form:
      1 1 0 0 1 1 0 1
      - 1
      -----
      1 1 0 0 1 1 0 0
      0 0 1 1 0 0 1 1    complement = -51
  
```

Fig.5. A subtraction which gives a negative answer, and the method of finding the size of the answer by inverting the twos complement.

Mnemonics	Description
CAI	Complement and add 0
0	to the number in the accumulator
CCL	clear carry/link
XAE	exchange accumulator with extension register
CAE	complement extension and add to accumulator
DISPLAY	and display

Fig.6. The program steps for inverting a 2's complement.

and follow with 11111110, which is -2 in 2's complement form, and PUSH. Once again, the expected address would be 0011 — what is it?

## Jump For Joy?

The JMP operation is a clean break in address counting, and the count will then go on from the new address. Try these examples again, watching the address LEDs carefully, and following the data byte with the new instruction 00001000 (NOP), PUSH as many times as you like. This instruction is NO OPERATION, and its use lets you concentrate on what the address LEDs are doing without any data bytes needing to be entered.

Let's stop for breath. Program-relative displacement lets you shift the address, using a byte following the instruction byte as a 'displacement' number — a number which specifies how many places forward or back the address must shift. Because this byte is interpreted by the microprocessor itself as a signed number, the largest positive value must be 01111111 (which is decimal +127), and the largest negative number must be 10000000 (which is decimal - 128). This limits the range of addresses we can get to, but it's perfectly adequate for most purposes, particularly the purposes for which a Simple Cost-effective MicroProcessor might be used. The reason for using this method of transfer is straightforward — an address consists of two bytes, and if we use only one byte of address we can only change the lower byte. Some other microprocessors have a memory addressing system in which both bytes of an address can be loaded in directly, one at a time, so that there are three-byte instructions. We'll look at a less-direct variation, which allows a full address number to be loaded, in the next part.

Before we leave the JMP instruction, though, there are a few points which are worth noting. One is that the basic instruction of JMP is 100100, and the remaining two bits specify which register is used as the 'base' or 'index' address,

to which the displacement number is added. We've used 00 for these last two bits of the instruction, making the jump relative to the count number on the program-counter register — more of this later. The other point is that conditional jumps are possible. The code 100101 is the start of the JP instruction, meaning jump if positive or zero. Here again, completing the byte with 00 causes the jump to be relative to the program counter. If we use 10010100 as a jump instruction there will be no jump if the accumulator contains a negative number — that is if the most significant bit in the accumulator has the value 1. Try it — load in -127 by using the sequence (after resetting) of 11000100 PUSH 10000000 PUSH. Then use JP and watch the address LEDs carefully. With the JP instruction loaded by 10010100 PUSH, the address will now be 0100. Make the jump displacement three places by entering 00000011 PUSH. What address have we reached? Has there been a jump?

Now try again, but enter the data byte 00000001 (which is +1) instead of -127. Is there a jump this time?

There are two other lots of jump instructions. The jump-if-zero (JZ) instruction is basically 100110; if we are displacing relative to the program counter this becomes 10011000. The jump-if-not-zero (JNZ) is basically 100111 (10011100 for program-relative displacement). Try them out, with the accumulator loaded first of all with zero, then with a positive number and then with a negative number.

## Immediately Relative Programming

Before we leave program-relative address transfers for the moment, it's important to note that all of the instructions which we have used as IMMEDIATE instructions, such as LDI, ANI, ORI, XRI, DAI, ADI, CAI, have their counterparts as memory reference instructions. This means that the instruction code can be followed by a byte, the displacement byte, which causes the shift of address we have noted for the jump instruction. We've used this, in fact, as a method of displaying the quantity in the accumulator, by keying in the instruction STORE (11000100) followed by a displacement of 1 (00000001).

Let's now look at this procedure a bit more closely, watching what happens to the address LEDs rather than the data LEDs. Reset, and load up 11001000, the ST instruction. The address will be 0001 until PUSH is operated, when the address changes to 0010. Now set up the displacement number decimal 3, as 00000011 and PUSH. The next address would normally be 0011, but is in fact 0101, three steps on from 0010. Note that it's NOT three steps on from 0011. Now set up 00001000, the NOP instruction, and PUSH again. What happens to the address number now?

Unlike the JMP 3 instruction, in which the address number moves three places on from the program count, and then carries on counting from there the LOAD instruction, followed by a displacement of 3, causes the address of the first part of the instruction to jump three places, but then returns to the normal count at the next PUSH. Look at this one again, comparing JP3 (11001000 PUSH 00000011 PUSH) with LD3 (11001000 PUSH 00000011 PUSH). Another way of looking at the effect of the displacement is that the program counter is incremented by 1 in addition to the displacement on each JUMP instruction, but this increment does not take place on any of the other memory transfer instructions.

In fact that's not quite true, because we can specify what's called auto-indexing on some instruction, but we're not quite at that stage yet. Next month, another LED is added, and we take the plunge into the pointer registers of the INS8060.



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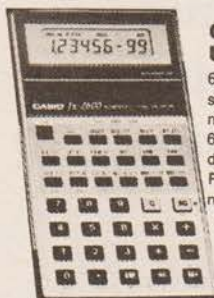
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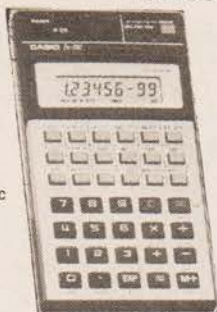
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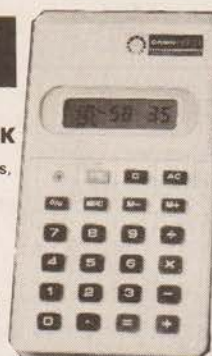


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# TEMPUS

Dept CT, Beaumont Centre, 164-167 East  
Rd., Cambridge CB1 1DB. Tel. 0223 312866



## This months feature program gives you a chance to sink the baddies in a computer version of the board game

**T**his program is written for the Research Machines 380Z and plays a simplified version of the well known game battleships. The computer draws some randomly positioned ships on the monitor and the user attempts to sink the ships with torpedoes from his submarine.

### The Program Explained

```
100 REM *****
110 REM *** BATTLESHIPS MK II ***
120 REM *****
130 REM *** INITIALISATION ***
140 WIDTH 80
150 CLEAR 100
160 GOSUB 1160
170 INPUT "HOW MANY SHIPS"; S
180 IF S > 9 OR S < 0 THEN ? "INCORRECT (1 - 10)":
    GOTO 170
190 GRAPH 1
200 H=0:G=0
```

The 'width 80' on line 140 is only there to make the format of the instructions easier. Clear 100 reserves some memory for use in string variables. Graph 1 sets most of the screen up as a piece of graph paper. H and G count the hits and the number of goes respectively.

```
210 REM *** SET TITLE ***
220 T$="BATTLESHIPS"
230 FOR I=1 TO LEN(T$)
240     PLOT 31+I*2-2,47,ASC(MID$(T$,I,1))
```





# BATTLESHIPS

```
250 NEXT
260 FOR I=30 TO 50 STEP 2
270     PLOT I,44,96
280 NEXT I
```

This portion of the program is not essential: it 'plots' the title of the game at the top of the screen. The plot statement is in the form PLOT Xco-ordinate, Yco-ordinate, ASCII code.

```
290 REM *** SET TARGET ***
300 RANDOMIZE
310 FOR I=1 TO S
320     Y=INT(RND(1)*46)
330     Y=3*(INT(Y/3))
340     X=INT(RND(1)*66)+6
350     X=2*(INT(X/2))
360     REM *** CHECK FOR SHIP OVERLAP ***
370     FOR J=1 TO S
380         IF Y<>Y(J) THEN 440
390         IF X=X(J)-8 OR X=X(J)+8 THEN 320
400         IF X=X(J)-6 OR X=X(J)+6 THEN 320
410         IF X=X(J)-4 OR X=X(J)+4 THEN 320
420         IF X=X(J)-2 OR X=X(J)+2 THEN 320
430         IF X=X(J) THEN 320
440     NEXT J
450     REM *** PLOT SHIP ***
460     PLOT X-4,Y,184
470     PLOT X-2,Y,176
480     PLOT X,Y,189
490     PLOT X+2,Y,184
500     PLOT X+4,Y,144
510     REM *** STORE CO-ORDS. OF BRIDGE ***
520     X(I)=X
530     Y(I)=Y
540 NEXT I
```

Lines 320 — 350 generate co-ordinates for the ship and round them off to make the game run better. Lines 370 — 440 compare these co-ordinates with the co-ordinates of the other ships to ensure that the ships do not overlap. Lines 460 — 500 plot the ship onto the screen and then its co-

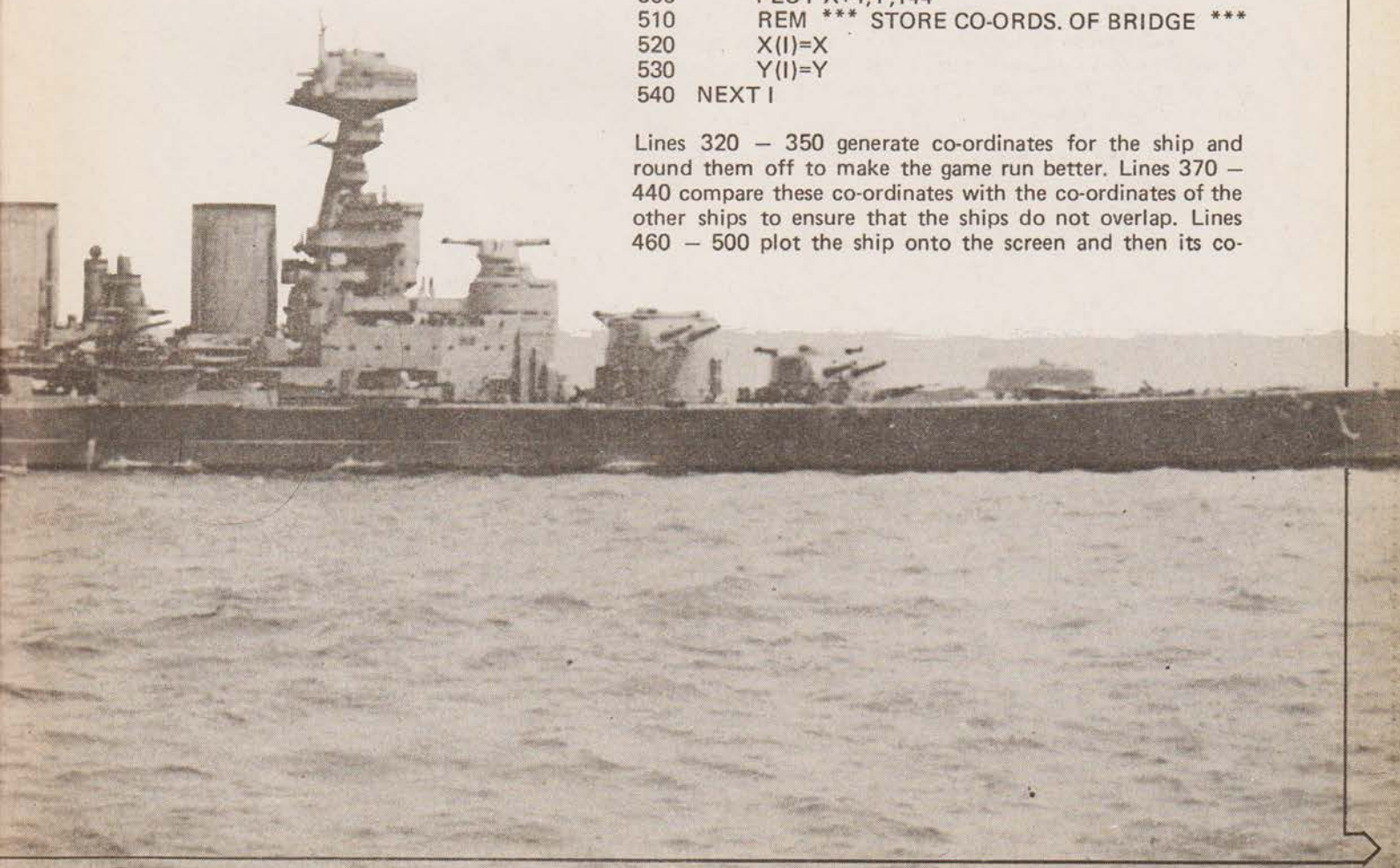
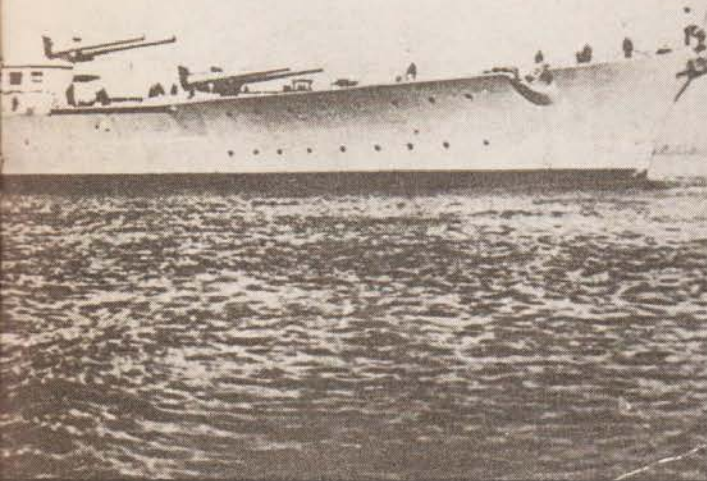
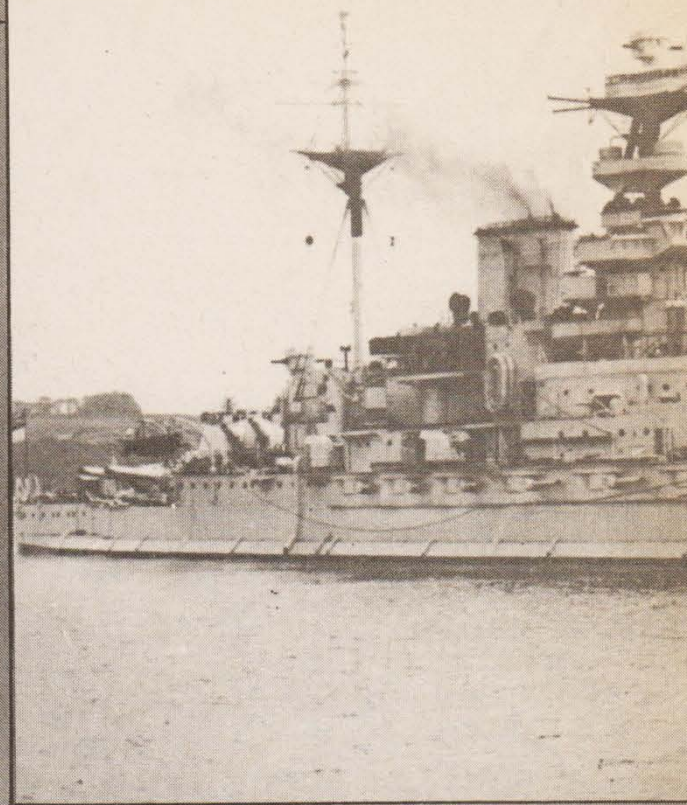
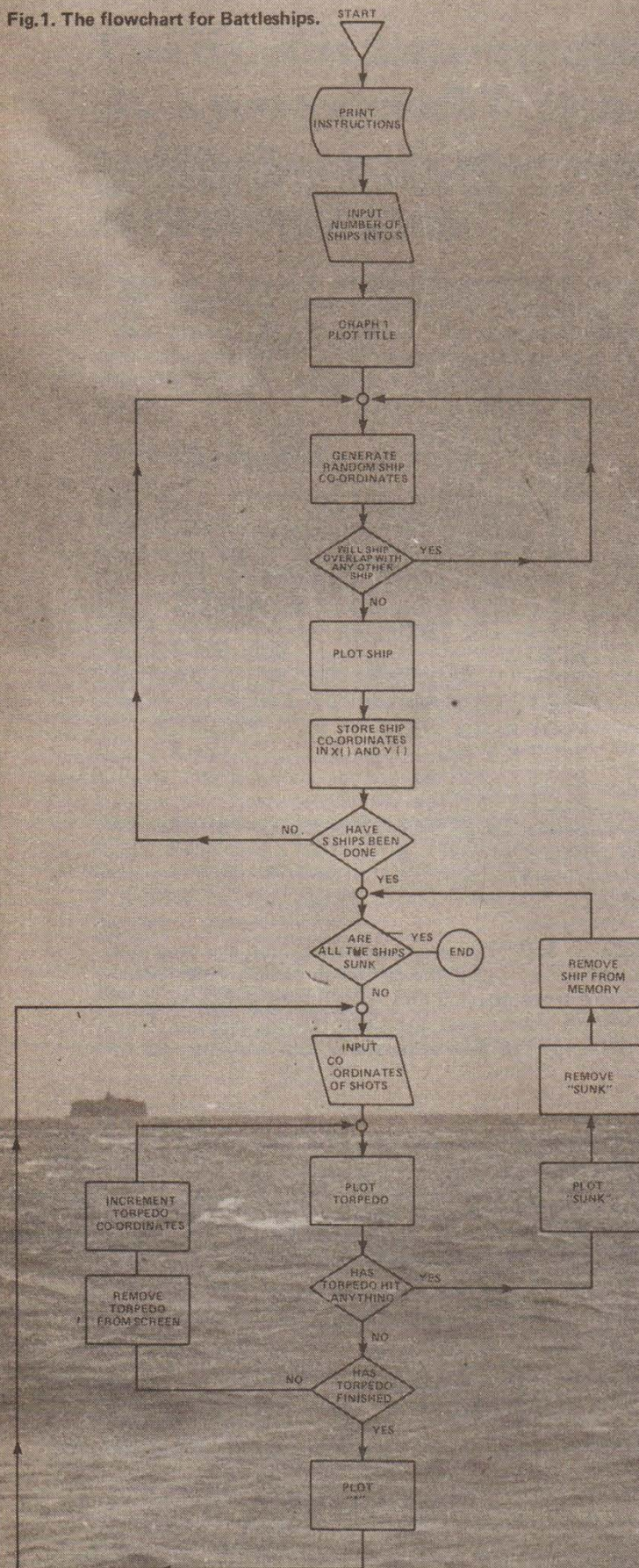




Fig.1. The flowchart for Battleships.





# BATTLESHIPS

```

570 ?"YOU HAVE HAD";G;"GOES,AND";H;"HITS"
580 INPUT"WHAT IS X CO-ORDINATE(1-79)";A
590 INPUT"WHAT IS Y CO-ORDINATE(1-46)";B
600 A=2*(INT(A/2))
610 B=3*(INT(B/3))
620 IF A > 79 OR B > 46 OR A < 0 OR B < 0 THEN
    ?"CO-ORDS. OUT OF RANGE":GOTO 580
630 G=G+1

```

The co-ordinates for the shot are input at lines 580 and 590: they are rounded off as for the ship co-ordinates. If the co-ordinates are too big or too small an error message is printed at line 620. The 'goes' counter is incremented by one.

```

640 REM *** TORPEDO ***
650 A1=0:B1=0
660 FOR I=1 TO 100:NEXT I
670 PLOT A1,B1,32
680 IF A1 < A THEN A1=A1+2
690 IF A1 > A THEN A1=A1-2
700 IF B1 < B THEN B1=B1+3
710 IF B1 > B THEN B1=B1-3
720 PLOT A1,B1,204



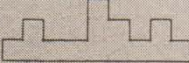

```

A1 and B1 hold the torpedo co-ordinates and are incremented or decremented as required by lines 680 - 710 such that the torpedo heads for the shot co-ordinates. ASCII code 204 is a horizontal bar.

ordinates are stored in X() and Y(). This part of the program is a loop so that the number of ships input at the beginning are generated on the screen.

The ASCII codes for the ship and the shapes they form are as follows:

```

184 : 
176 : 
189 : 
144 : 

```

They go together to form a ship which looks like this:—

## Shooting And Hitting

```

550 REM *** INPUT GUESS SHOT ***
560 IF H=S OR G=10 THEN 1060

```

```

730 REM *** CHECK FOR HIT ***
740 FOR I=1 TO S
750     X=X(I):Y=Y(I)
760     IF B1=Y THEN 770 ELSE 820
770     IF A1=X-4 THEN 870
780     IF A1=X-2 THEN 870
790     IF A1=X THEN 870
800     IF A1=X+2 THEN 870
810     IF A1=X+4 THEN 870
820 NEXT I
830 IF A1<>A OR B1<>B THEN 660
840 PLOT A,B,42
850 GOTO 570

```



Lines 760 — 810 compare the co-ordinates of the torpedo with all the stored ship co-ordinates in turn. If they agree the computer goes to line 870 for the hit routine, if not the program either loops back to move the torpedo again or it plots a star where the torpedo explodes.

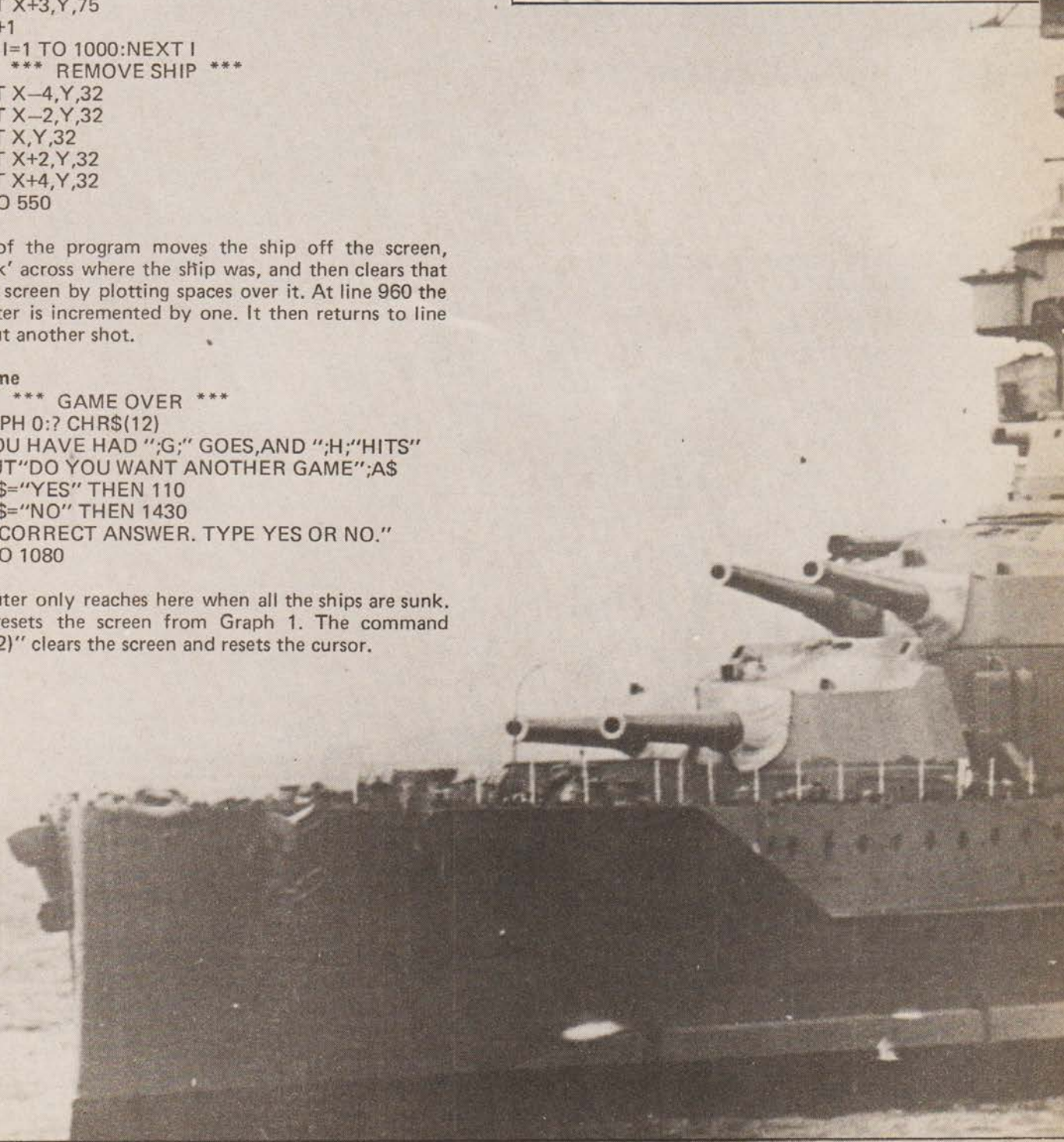
```
860 REM *** HIT ROUTINE ***
870 PLOT A1,B1,42
880 REM *** REMOVE SHIP FROM MEMORY ***
890 X(I)=-1:Y(I)=-1
900 FOR I=1 TO 900:NEXT I
910 REM *** PLOT "SUNK" ACROSS SHIP ***
920 PLOT X-4,Y,83
930 PLOT X-1,Y,85
940 PLOT X,Y,78
950 PLOT X+3,Y,75
960 H=H+1
970 FOR I=1 TO 1000:NEXT I
980 REM *** REMOVE SHIP ***
990 PLOT X-4,Y,32
1000 PLOT X-2,Y,32
1010 PLOT X,Y,32
1020 PLOT X+2,Y,32
1030 PLOT X+4,Y,32
1040 GOTO 550
```

This part of the program moves the ship off the screen, writes 'sunk' across where the ship was, and then clears that part of the screen by plotting spaces over it. At line 960 the 'hits' counter is incremented by one. It then returns to line 550 to input another shot.

#### The Endgame

```
1050 REM *** GAME OVER ***
1060 GRAPH 0: ? CHR$(12)
1070 ? "YOU HAVE HAD ";G;" GOES, AND ";H;" HITS"
1080 INPUT "DO YOU WANT ANOTHER GAME";A$
1090 IF A$="YES" THEN 110
1100 IF A$="NO" THEN 1430
1110 ? "INCORRECT ANSWER. TYPE YES OR NO."
1120 GOTO 1080
```

The computer only reaches here when all the ships are sunk. Graph 0 resets the screen from Graph 1. The command "?CHR\$(12)" clears the screen and resets the cursor.



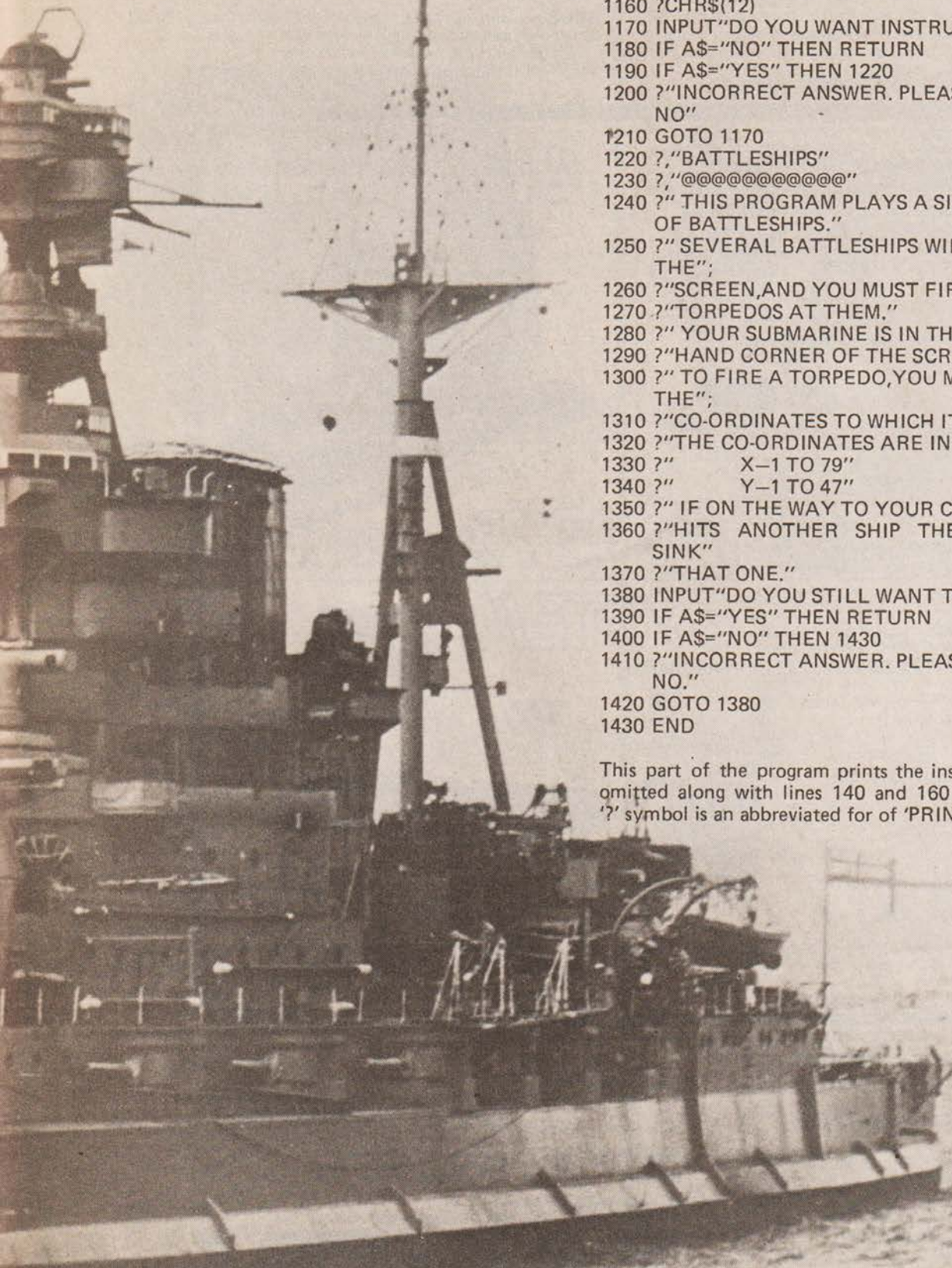


# BATTLESHIPS

## Game Instructions

```
1130 REM *****
1140 REM *** INSTRUCTION ROUTINE ***
1150 REM *****
1160 ?CHR$(12)
1170 INPUT"DO YOU WANT INSTRUCTIONS";A$
1180 IF A$="NO" THEN RETURN
1190 IF A$="YES" THEN 1220
1200 ?"INCORRECT ANSWER. PLEASE TYPE YES OR
    NO"
1210 GOTO 1170
1220 ?,"BATTLESHIPS"
1230 ?,"@@@@@@@@@@@@@"
1240 ?" THIS PROGRAM PLAYS A SIMPLIFIED GAME
    OF BATTLESHIPS."
1250 ?" SEVERAL BATTLESHIPS WILL APPEAR ON
    THE";
1260 ?"SCREEN,AND YOU MUST FIRE YOUR TEN"
1270 ?"TORPEDOS AT THEM."
1280 ?" YOUR SUBMARINE IS IN THE BOTTOM LEFT."
1290 ?"HAND CORNER OF THE SCREEN."
1300 ?" TO FIRE A TORPEDO,YOU MUST GIVE IT
    THE";
1310 ?"CO-ORDINATES TO WHICH IT WILL'HOME-IN'."
1320 ?"THE CO-ORDINATES ARE IN THE RANGES:—"
1330 ?"      X-1 TO 79"
1340 ?"      Y-1 TO 47"
1350 ?" IF ON THE WAY TO YOUR CO-ORDINATES IT"
1360 ?"HITS ANOTHER SHIP THE TORPEDO WILL
    SINK"
1370 ?"THAT ONE."
1380 INPUT"DO YOU STILL WANT TO PLAY";A$
1390 IF A$="YES" THEN RETURN
1400 IF A$="NO" THEN 1430
1410 ?"INCORRECT ANSWER. PLEASE TYPE YES OR
    NO."
1420 GOTO 1380
1430 END
```

This part of the program prints the instruction, and can be omitted along with lines 140 and 160 if not required. The '?' symbol is an abbreviated for of 'PRINT'.





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Dear Sir,

Having entered your "Brands" program on my Pet over the weekend I found several errors which seem to spoil this otherwise superb listing.

The first group of alterations seem to be common to all Basics.

```
5 DIM A$(14)
160 DIM S(14)
180 DATA 160, 110, 51, 110, 84, 42, 75, 120, 150, 60,
    120, 98, 82, 160
230 FOR I=1 TO 14
450 PRINT "THE SAME THING HAPPENS THE FIRST
    TIME YOU EXCEED 12,000 RPM"
460 FOR MN=1 TO 10,000:NEXT MN
575 M=S(I)*((10+T5)/10)
580 PRINT A$(I)
675 IF G > 5 OR G < 1 THEN 670
690 IF B > 9 OR B < 0 THEN 680
720 IF T > 9 OR T < 0 THEN 710
740 IF B > 8 THEN IF T5 > .87 THEN 1500
905 IF R > 12000 OR Z=6 THEN 1000
```

The following alterations are for PET which has a peculiar random number generator and no "DIGITS" function.

264 deleted

```
570 T5=RND(TI)
600 PRINT "MAXIMUM SPEED ON THIS SECTION IS";
    INT(M);"MPH"
840 PRINT G; TAB(9);INT(V);TAB(17);INT(R);TAB(28);
    INT(Q5)
1300 PRINT "YOU HAVE CRASHED AT";INT(V2+2.2);
    "MPH"
2000 PRINT "YOU COMPLETED THE COURSE IN";
    INT(Q5);" SECONDS WELL DONE!!"
2020 PRINT "YOUR AVERAGE SPEED WAS";
    INT(84*60/Q5);"MPH"
```

These alterations make "Brands" a very enjoyable program to run. Now there is no need to write a rule "Concord Prohibited" as the maximum speeds (line 575) have been reduced to more earthly figures.

May I compliment you on the high run value offered by this program. Will you please advise me if you intend to publish an article on 6502 Machine Code programming.

Yours faithfully,  
A.K.Jowett (15).

197 Victoria Road East,  
Thornton-Cleveleys,  
Blackpool,  
FY5 3ST.

Dear Sir,

I would be very grateful if you could print a few lines in your Printout column to the effect that I intend to set-up a program exchange. Entitled Micro News, this would be a newsletter (of approx. 10 pages) covering programs for less publisized micros such as the Superboard, Nascom 1 & Exidy Sorcerer.

Depending on the number of enquiries, a small charge will be made. This would cover both the cost of printing, and also any postal charges. If anyone is interested, please write direct to me (Martin Black) at the given address. In this connection, an SAE would be greatly appreciated.

Thankyou for a most informative magazine.

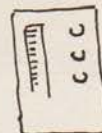
Yours sincerely,  
Martin Black.

11 Moorland Avenue,  
Crumpsall,  
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M8 6WT.

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THIS!!



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MUCH ROM TO MANOEUVRE !!



Dear Sir,

I wonder if you are familiar with the subject matter of the enclosed newspaper cutting (Observer Sunday 26th Aug). Why should owners of small computers, whether personal or commercial, pay levies to music — record companies, merely in order to record computer programs? I am sure that there are many other uses for tape — cassettes (apart from music), for example, use in the learning of a foreign language. Perhaps you can make representations to the appropriate authorities?

Yours truly,  
J.R.Camp.

48, Eastdean Avenue,  
Epsom,  
Surrey.  
KT18 7SN

Ed: We have spoken to the BPI and they assure us that steps will be taken to prevent the levy being charged on tapes used for "legitimate" purposes. The levy is only a proposal, nothing is definite yet.



Dear Sir,

## TRITON V5.1 BASIC

I must write to congratulate you on getting my name on one of my articles at last. Unfortunately because of the number of printing mistakes in it, I would have preferred to have my name omitted.

For those who want to read it, I suggest they take the following route. Start at the beginning on page 14 and read to the end of page 15 making the following corrections. At the end of page 14 the line should read:  
Now type in 123456 Return following by LIST  
and the line 130 of the example on page 15 should read:  
130 PRINT ' ,

Now the difficult bit. The example at the end of page 15 is continued at the end of page 16 and the article continues from here onto page 17 and down to the heading Intercept Jumps. From here it returns to the top of page 16 and continues over the remainder of this page. It then jumps to the last section on page 17.

The following corrections should be made while reading this part of the article.

Line 40 of the example on page 16 should read:

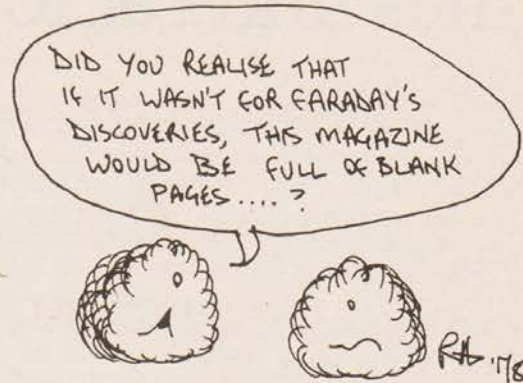
40 IF B=0 PRINT #1,A, 'IS DIVISIBLE BY',I

and the end of the WRITE description should read:

The data is also the least significant byte of a numeric constant, a variable or an expression.

Yours faithfully,  
D.M. Scales.

43, Knighton Road,  
Oxford,  
Kent. TN14 SLD



Dear Sir,

Mr A Stephenson's article "APPRECIATING MPUs" CT July 79, is one of the best ones on the subject, at this level, that I have read.

The following are some points which may be relevant to the scope of his article, including some which I originally found not immediately obvious.

### P64. Memories

Battery standby can be used to retain programs in otherwise volatile semi-conductor memories.

### Bi-directional Data Bus

Earlier busses such as the S100 are not Bi-directional but require a second set of 8 lines for READING.

Also some versions use positive logic (a digital '1' is + 5V) and others may use negative logic, (a digital '1' is + 0V) for the various bus signals.

### RESET

End of paragraph — a special address "provided for program restart uses". Reset is also used by the interface circuits, to clear-out any registers that may contain incorrect data, perhaps left from a previous interrupted sequence.

### INTERRUPT REQUEST

End of paragraph — (Which is programmable "to provide means by which a maskable interrupt can be 'held off' under program control).

### P66. CHIP SELECTS

The Address line decoding provided in each chip is restricted to the number necessary to access the functions of that chip only (ie. for 10 lines). To selectively access other chips in the system it is necessary to provide external decoding of the other 6 lines of the Address Bus. This is then used to Enable the CHIP SELECT of the particular chip to provide virtually an ON/OFF switch action for each chip.

### P70. FETCH AND EXECUTE PHASES

It is impossible to differentiate between successive FETCHED Bytes as to which are the instructions and which are operands. However as the CPU 'Unwinds' them strictly in the sequence that the ASSEMBLER originally generated them, a Data operand should never get acted on as an Instruction. Also, as a general point, LSI peripheral chips (PIAs and so on, which can cost almost as much as the CPU chip) are not mandatory for use with any CPU chip.

For many straightforward purposes, discrete TTL or CMOS is adequate for the necessary address decoding and buffering circuitry and can be simpler to use and program.

Yours sincerely,  
G.R.Barry.

25 Pelican Road,  
Pamber Heath,  
Hants.

Dear Sir,

Not knowing the 'PET' BASIC at all, I do not know whether it supports the 'ON . . . GO TO' function. Assuming it does (or for those planning to run the program on BASICs which do) the program 'Hangman' by M.J. Coates (CT, Sept, P.48) would surely run more efficiently were lines 480 to 730 replaced by this:

475 on (ASC (Y\$) - 17) \* 10) GOTO 480, 490, 500, . . . 730

480 M = 0

490 M = 2

500

—

—

—

730 M = 104

Yours sincerely,  
Nick Beard.

High Street,  
Braithwell,  
Rotherham,  
South Yorkshire.

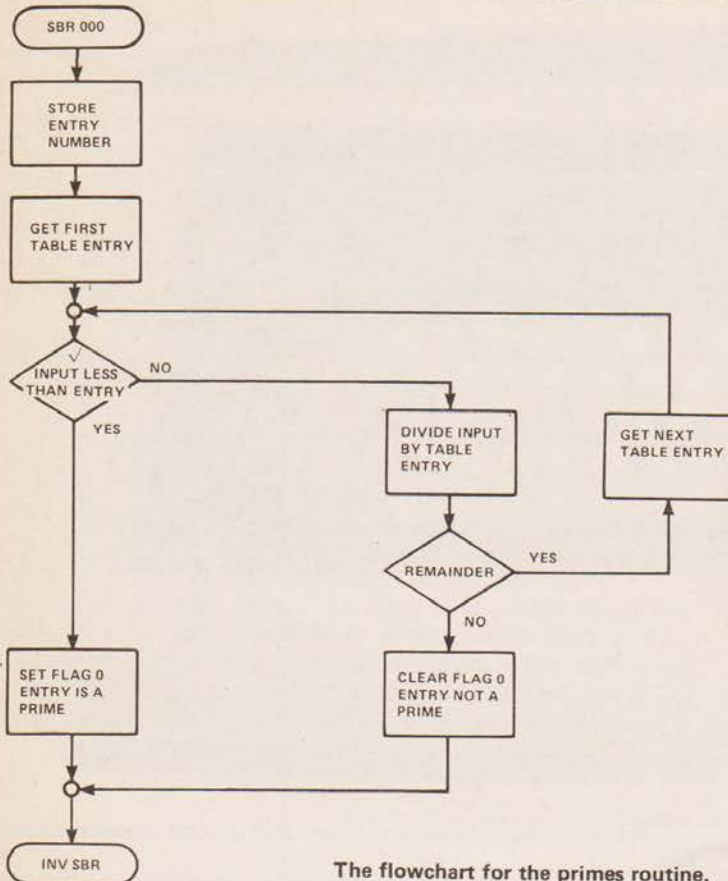


# Primes and Factors

000	42	STD	051	00	00	102	87	IFF
001	02	02	052	87	IFF	103	00	00
002	05	5	053	00	00	104	01	01
003	42	STD	054	00	00	105	13	13
004	00	00	055	36	36	106	69	DP
005	73	RC*	056	73	RC*	107	21	21
006	00	00	057	00	00	108	43	RCL
007	32	XIT	058	66	PAU	109	02	02
008	43	RCL	059	87	IFF	110	66	PAU
009	02	02	060	01	01	111	72	ST*
010	34	FX	061	00	00	112	01	01
011	22	INV	062	73	73	113	43	RCL
012	77	GE	063	99	PRT	114	03	03
013	00	00	064	22	INV	115	32	XIT
014	33	33	065	49	PRD	116	43	RCL
015	53	(	066	02	02	117	01	01
016	43	RCL	067	71	SBR	118	77	GE
017	02	02	068	00	00	119	00	00
018	55	+	069	05	05	120	36	36
019	00	0	070	61	GTD	121	02	2
020	32	XIT	071	00	00	122	44	SUM
021	54	)	072	52	52	123	02	02
022	22	INV	073	02	2	124	71	SBR
023	59	INT	074	44	SUM	125	00	00
024	67	EQ	075	02	02	126	02	02
025	00	00	076	71	SBR	127	61	GTD
026	32	32	077	00	00	128	01	01
027	69	DP	078	02	02	129	01	01
028	20	20	079	61	GTD	130	76	LBL
029	61	GTD	080	00	00	131	11	A
030	00	00	081	52	52	132	43	RCL
031	05	05	082	76	LBL	133	03	03
032	22	INV	083	15	E	134	32	XIT
033	86	STF	084	68	NOP	135	04	4
034	00	00	085	01	1	136	42	STD
035	92	RTN	086	42	STD	137	01	01
036	43	RCL	087	04	04	138	73	RC*
037	02	02	088	02	2	139	01	01
038	99	PRT	089	42	STD	140	66	PAU
039	22	INV	090	05	05	141	43	RCL
040	86	STF	091	03	3	142	01	01
041	01	01	092	42	STD	143	22	INV
042	92	RTN	093	06	06	144	77	GE
043	76	LBL	094	06	6	145	01	01
044	12	B	095	42	STD	146	48	48
045	86	STF	096	01	01	147	92	RTN
046	01	01	097	05	5	148	69	DP
047	76	LBL	098	71	SBR	149	21	21
048	13	C	099	00	00	150	61	GTD
049	71	SBR	100	00	00	151	01	01
050	00	00	101	22	INV	152	38	38
						153		

The primes and factors program listing. Don't forget to load STO 03.





The flowchart for the primes routine.

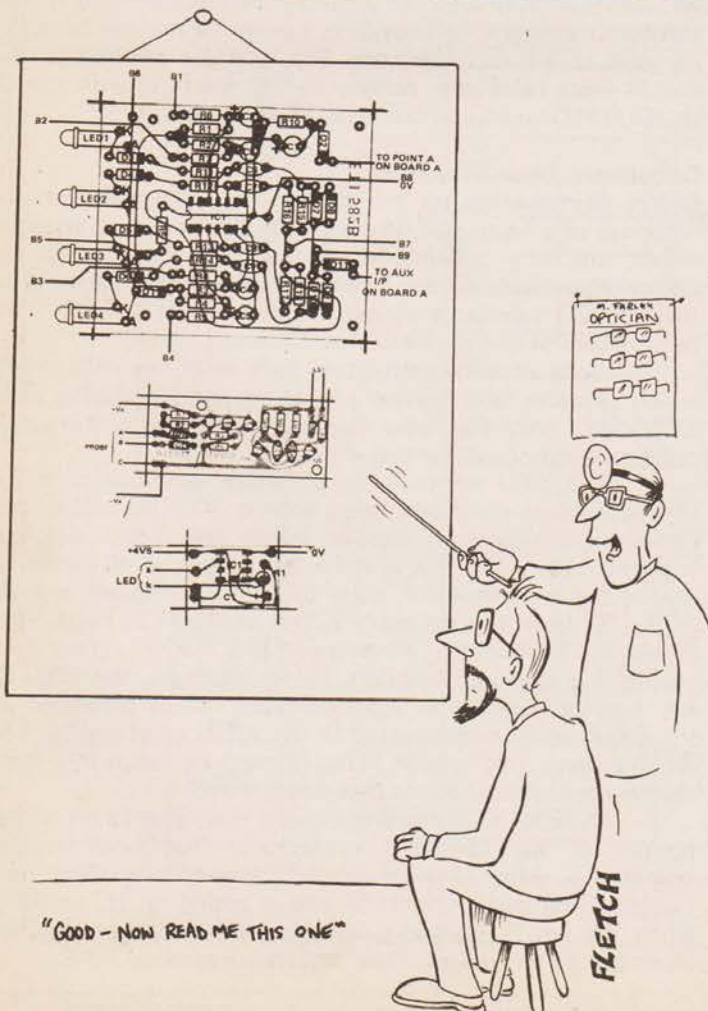
The TI 59 programmable calculator can be used to study numbers up to 249001 (22201 for the TI 58) using available memory capacity. Initially the program at Label E calculates and stores the first 96 primes. These can then be used to factorise an input entry up to the limiting number, or to determine the intermediate primes. The initial store procedure takes about 25 minutes and the program at Label A can be used to view the table contents.

The flowchart illustrates the mathematics involved, and since there is only one even prime (2) the "next" prime entry at Label B requires an odd number entry to look for an answer.

Obviously the magnetic card facility of the TI 59 and the print facility of the PC100B can be used to advantage but the same program using only 40 stores and the TI 58 should prove an interesting diversion.

### Program Use

Enter the desired table length (max 99 for TI 59, 39 for TI 58) in STO 3. Press E, program takes 25 minutes to run. Now press A to display the table, B to find the next prime from an entered odd number or C to factorise an entered number. The program includes print commands for use with the PC100B print cradle.



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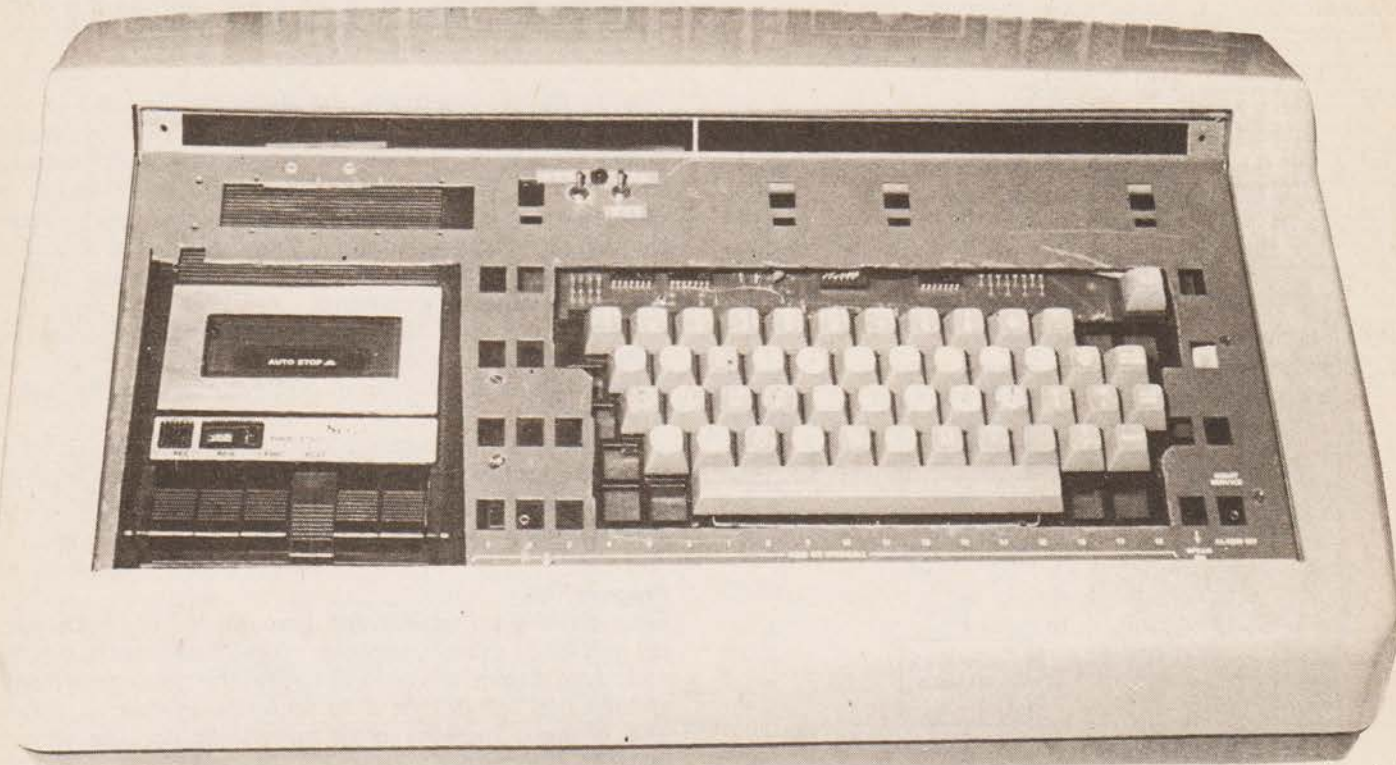
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## If you want to perform complex arithmetical operations with your micro this project will make life easy

Over the last two decades we have witnessed a revolution in number processing which has been unsurpassed since the invention of the abacus. Gone is the abacus, gone is the slide rule, even our junior school children are demanding electronic aids that do more than 4 functions at 7 digit accuracy. Now we have the all singing, all dancing microprocessor based home computer, heralded as the salvation to all our domestic problems. The anomaly is the number processing capability of these machines, ranging from very poor to average. If the arguments are in favour of calculators with full scientific or financial facilities encompassing a range of numbers from  $1E-99$  to  $1E99$  then those arguments hold good for computers also.

The number handling facilities have been badly neglected by 'chip' manufacturers and software houses have been left to fill the gap. Tiny BASIC gives a range of interger -32767 to 32767 and Extended BASIC's are limited to typically 6 digit mantissa  $E-38$  to  $E38$  and are very limited on arithmetic functions.

To obtain the greater accuracy and flexibility of the calculator age it would seem sensible to interface a calculator module to the home computer. Many such modules can be obtained from either scrap calculators or some of the inexpensive models now available.

One chip manufacturer (National Semiconductors) is marketing a NCU chip, the MM57109, which is little more than a calculator chip disguised. None of the interface

requirements have been simplified and it costs approximately £15.

The circuit and description detailed below shows the way the author tackled the problem and gives the circuit and software necessary for providing a powerful number processing unit on a home computer. The interface can be used to couple most calculator designs to any machine with one 8 bit 'OUTPUT' port and one 8 bit 'INPUT' port.

### Calculators: How They Work

Before commencing on this project it is essential that the workings of a calculator, in particular the keyboard arrangements, are fully understood. To assist in the explanation Commodore Systems have kindly permitted the publishing of their 6120R calculator circuit diagram shown in Fig.1. The peculiarities of this device will be discussed later.

Many modern calculators have only one chip inside which provides both central processing and interfacing with LED's etc, they still have the same keyboard and display output conditions as the one shown.

The CPU contains an oscillator which is slow by microcomputer standards, being approx 300KHz, and all the circuitry necessary to decode inputs and carry out the required functions. This is done by using time division and sequencing techniques. A pulse of 450uS is applied to each of the 'D' leads in turn every 7.2mS as shown in Fig.2. This allows the keyboard to be arranged as a matrix, rather than having one lead per function. If, for example, the 'digit 9' key was depressed then a 450uS pulse will be presented to the pulse would be presented to the K3 input at time slot 5. At this point two special features must be taken into consideration, contact bounce and repeat entry.

In order to prevent erroneous entry due to the initial bounce of the keyboard contacts or 'fumbling' by the operator a delay is incorporated between the CPU first receiving the input condition and it acting on it, similarly when the key is released a delay is provided before another input can be recognised. These delays are approx 14mS.



## NUMBER CRUNCHER

The authors Nascom 1.

The display consists of a number 7 segment LED's which are sequentially illuminated under the control of the CPU 'D' leads. Each lead connects a digit display to the 8 output leads labelled A—G and DP which are coded by the CPU to light the correct segments for the value of that digit. The digits associated with each time slot are shown in the box beneath the display. IC's 3—4 are drivers which may be incorporated in the CPU.

## Interface Requirements

The requirements of the interface are as follows:—

1. To buffer the TTL Programmable Input/Output port (P10) of the MPU to the CMOS devices on the calculator board.
2. To extend the instruction from the MPU O/P port to the calculator CPU during the correct time slot.
3. To present to the MPU I/P port the seven segment digit data as specified by the MPU O/P Port.

The circuit diagram of the interface is shown in Fig.3 together with its connection to an 8-bit Output Port and an 8-bit Input Port. One prime consideration is the difference in working voltages between CMOS (6V2) and the TTL (5V0). Some published circuits provide both supplies and

buffer or zener down the interconnections. I have chosen to run the CMOS devices at +5V and provide buffering solely to limit drain on the CMOS input leads.

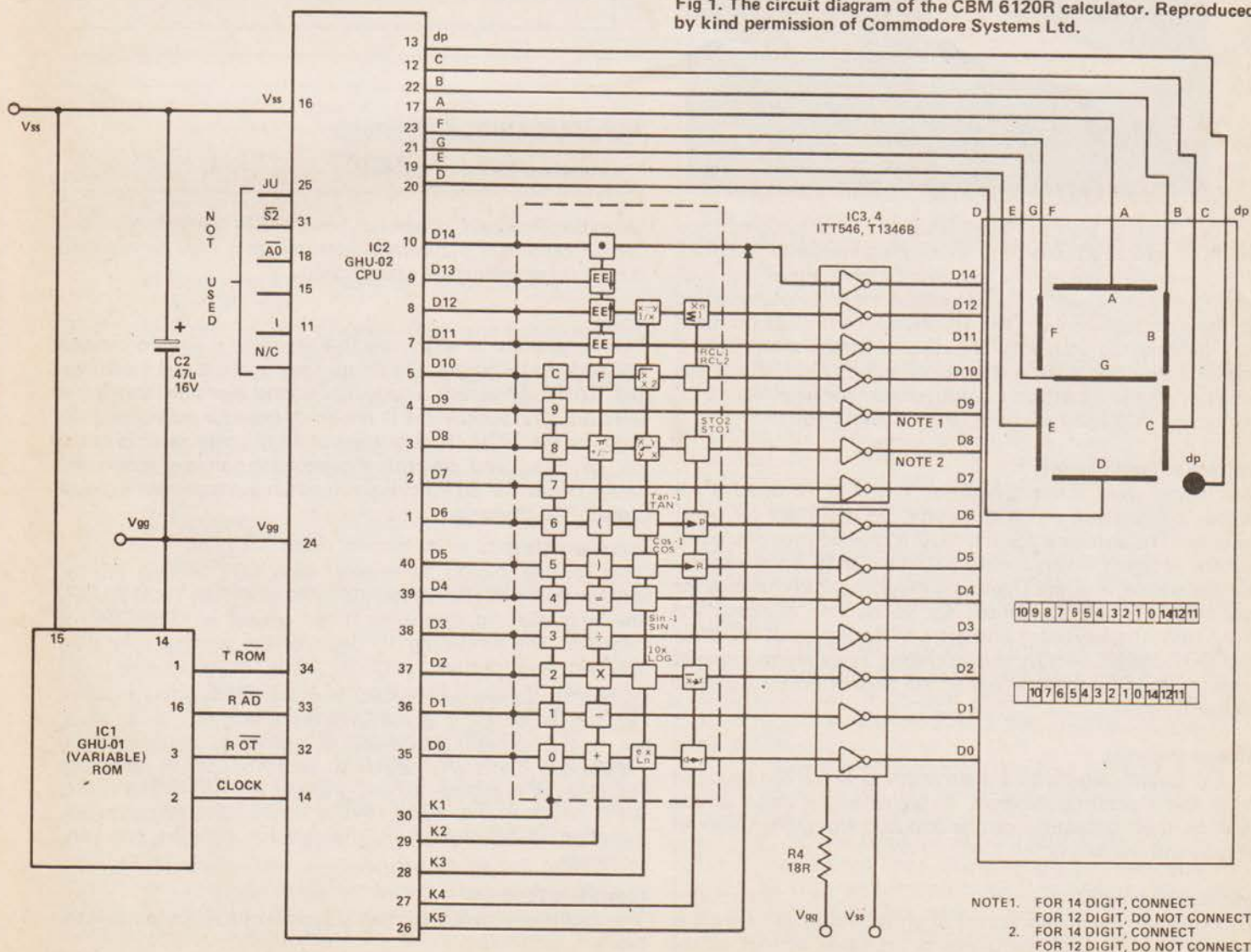
### Construction Notes

This circuit can be simply built on VERO board or a home made PCB if desired, the positioning of components is not critical, although at least three decoupling capacitors should be strategically placed across the +5V supply. The power requirements are low but it is essential that the board be fed direct from the PSU and not via the power output on the Port otherwise noise interference may upset the workings of the calculator. It is also strongly advised that the circuit of the calculator being used is obtained, or at least the key matrix format determined, before being dismantled. Once the display has been removed you are working blind.

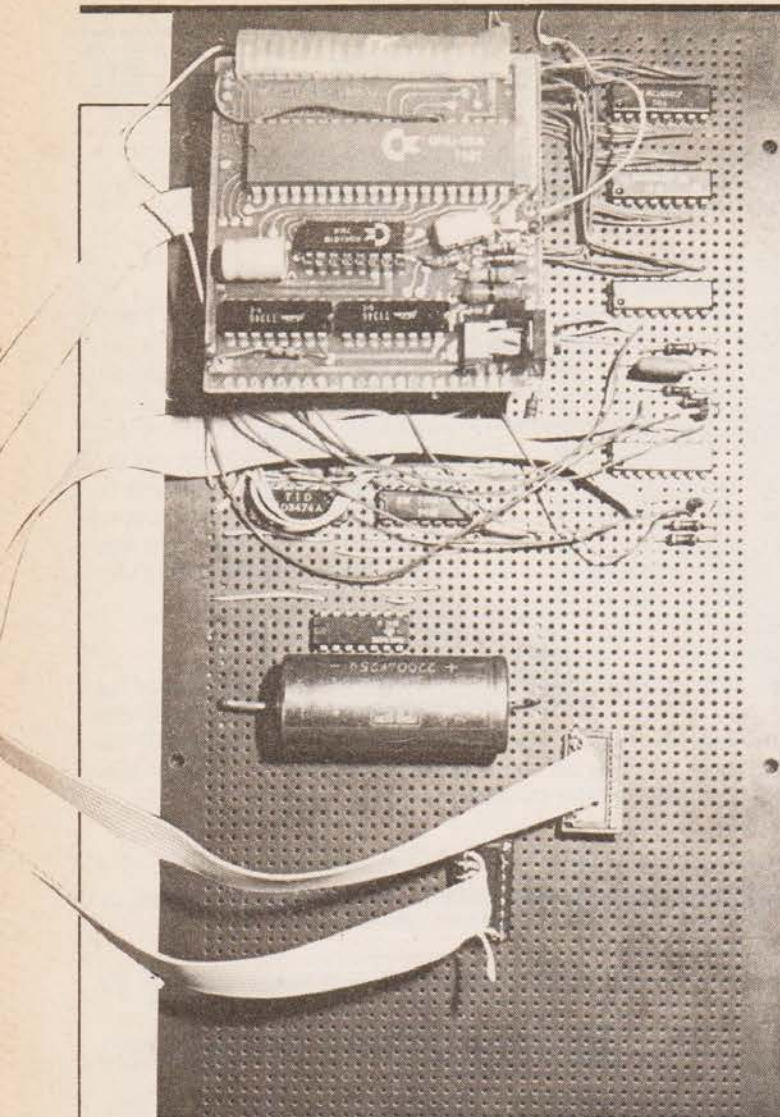
### Using A Commodore 6120R Calculator

The author chose the CBM Commodore 6120R calculator for two main reasons:— 1) It is a 48 function scientific machine which could easily be adapted for computer use, and 2) He had one! A guide to the changes necessary for other machines is given in a later paragraph.

Fig 1. The circuit diagram of the CBM 6120R calculator. Reproduced by kind permission of Commodore Systems Ltd.







The red, blue and black leads can be unsoldered from the PCB and the power and battery components removed. Now carefully remove the keyboard ribbon from the keyboard end as this can be used to connect the calculator board to the interface board. (The insulation of the ribbon melts very quickly, be warned!) The display ribbon should be removed from the PCB end and discarded. Fig.4 shows the location of the inputs and outputs from the calculator PCB (Note: the PCB itself may not be fully annotated).

#### Software Requirements

The listing given is for a Nascom 1 with a T2 monitor. It could, without too much difficulty, be modified for other systems. The software for the NCU is divided into two parts; Service Program which contains all the interface software for the calculator, and the Operating Program which handles the operator interface equipment e.g. to be able to access the NCU from the keyboard and get a VDU display of the problem and answer. Whilst the operating program can change from application to application, the Service Program should always be used.

#### Service Program

This program consists of 3 main routines which can be called from the Operating Program. Explanation of these will be brief as their operation can be deduced from the flowchart (Fig.5) and the listing.

#### Initialisation (INIT)

This routine, designates Port 4 as an O/P port and Port 5 as an I/P port. If preferred it can be included as part of the

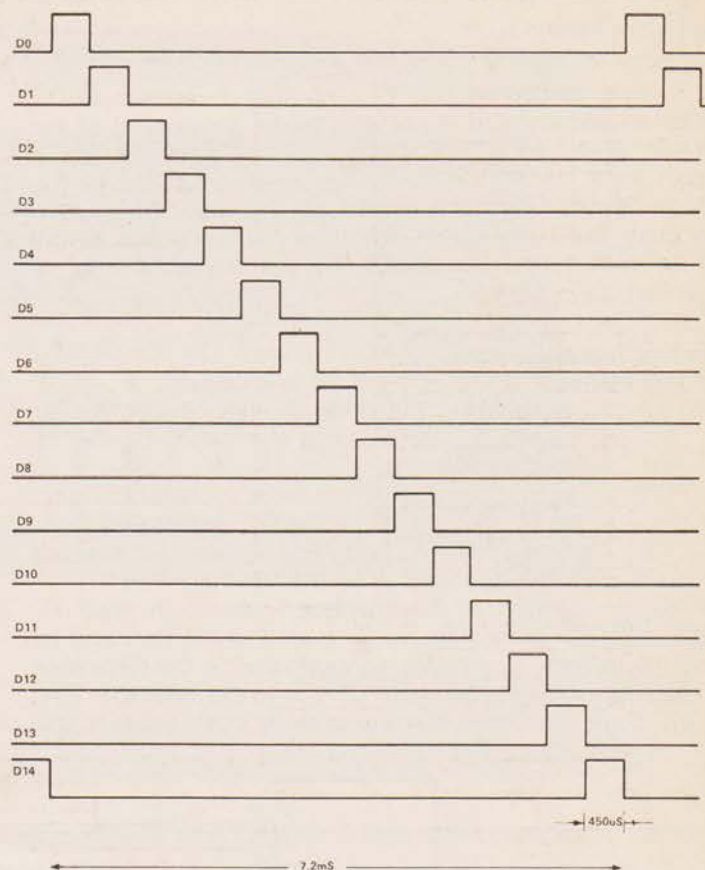


Fig 2. The data select timing diagram.

The prototype NCU on Veroboard.

Operating Program. Space has been left in the listing for any special calculator stabilising sequence that may be required if start-up problems are experienced.

#### Input

The conditions of entry are that Register A should contain the code to be output. On return the HL register is incremented. This routine tests a code for 'second function' status and executes that subroutine if required, prior to outputting the digit to the NCU. It also waits until the calculator is ready for an input and controls the necessary timing sequences. Input codes for all calculator functions are shown in locations 0F00 onwards.

#### Answer (ANS)

This routine should be entered with CRT address for the answer string in HL register pair. On entry, the routine scans the first digit to determine if the answer is "ERROR" or negative. The remaining 10 digits of the argument are then scanned and printed, with all blank digits ignored. The exponent, if any, is then scanned and printed with the prefix 'E' (e.g.  $6.25 \times 10^{-12}$  will be displayed as 6.25E-12).

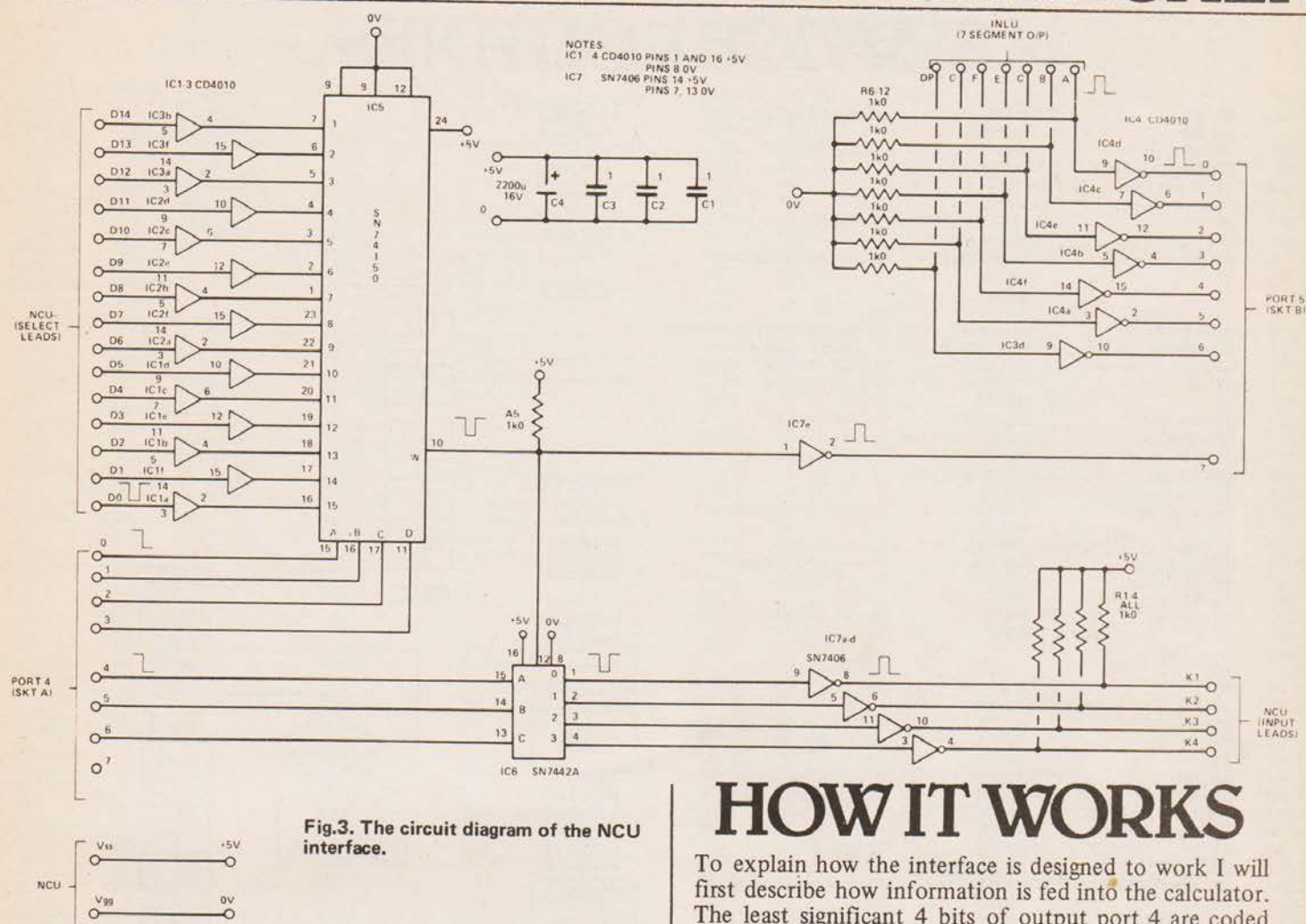
The 6120R calculator can also operate in radians. When this mode of operation is used 'rads' is displayed following the answer. In the event of an 'ERROR' the program jumps to the 'error' routine in the operating program. Location 0CAB should be changed for differing operating programs.

#### Operating Program

The facilities offered by this suggested program are as follows:—



## NUMBER CRUNCHER



**Fig.3. The circuit diagram of the NCU interface.**

- Operating instructions and error statements on the top CRT line.
- Entry of the problem from the computer keyboard, spaces ignored.
- Arithmetic language — i.e. as used by a calculator. 'Sin 90' should be entered as '90 Sin =', and '-1' as '1CHS'
- Backspace error correction.
- Line overflow operational at any time during entry by depressing N/L key.
- Termination of data indicated by '?' being entered.
- Display of result commencing at the location of the '?'

For detailed explanation of this program see Fig. 6 and the listing.

## Conclusion

As stated at the beginning of this article, the use of a calculator is only an expedient until some enlightened manufacturer produces an NCU chip that is both fast, running off the computer clock, and fully computable with the address bus structure. Only then can the amount of operating software be drastically reduced.

To use other types of calculators the interface board can be left as standard or expanded to its full capacity of 16 'D' leads and 6 'K' leads if required. The software changes should be limited to the tables giving the input codes, locations marked \*, which detail the display addresses and the timing loops.

## HOW IT WORKS

To explain how the interface is designed to work I will first describe how information is fed into the calculator. The least significant 4 bits of output port 4 are coded with the time slot information and fed direct into a data selector (IC5). This looks at the buffered 'D' Select leads from the calculator chip so that when the select lead corresponding to the binary input on the A-D leads goes high the output 'W' goes low. Bits 4, 5 and 6 of Port 4 are binary coded to indicate which of the three 'K' input leads is to be marked during the time slot for the required entry to the calculator. These two binary codings are brought together in a 4 Line-to-10 Line decoder (IC6). With the 'W' output of IC5 high, any input from Port 4 will select outputs 8 or 9 of IC6, which are both unused, but when the 'W' output goes low (i.e. during the required time slot) outputs 0-4 will go low as specified by Port 4 bits 4-6. This pulse is inverted by IC7 and pulled up by R1-4, thereby pulsing the required 'K' input lead high during the specified time slot.

To read the display the time slot associated with the required digit is binary coded onto Port 4 bits 0–3 as before. The 'W' output pulse of IC5 is inverted by IC7e to give a pulse on Port 5 pin 7 during the required time slot.

The condition present on Port 5 bits 0–6 are a buffered copy of the 7-segment outputs from the calculator CPU, note that only 6 of the 7 are required to give full decoding of digits (only 5 are required if the '6' has no top line). The program is so arranged that only the data present when bit 7 is high is considered as the valid digit. No attempt has been made at hardware decoding of the display as this is more economically carried out in software.

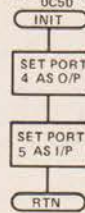


# SERVICE ROUTINES

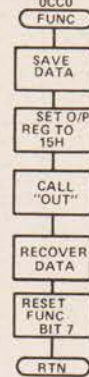
INIT  
 0C50 3E 4F  
 0C52 D3 07  
 0C54 3E 0F  
 0C56 D3 06  
 0C58 C9  
 'INPUT'  
 0C65 CB 7F  
 0C67 C4 C0 0C  
 0C6A CD 98 0C  
 0C6D 23  
 0C6E C9  
 ANS\*  
 0C70 01 45 0B  
 0C73 CD D0 0C  
 0C76 E5  
 0C77 E5  
 0C78 23  
 0C79\* 01 41 01  
 0C7C CD D0 0C  
 0C7F\* 01 43 02  
 0C82 CD D0 0C  
 0C85 37  
 0C86 C1  
 0C87 ED 42  
 0C89 28 05  
 0C8B E1  
 0C8C 36 45  
 0C8E 18 01  
 0C90 C1  
 0C91 C9  
 Subroutines  
 'OUT'  
 0C98 F5  
 0C99\* 3E 4F  
 0C9B D3 04  
 0C9D DB 05  
 0C9F FE 81  
 0CA1 30 0D  
 0CA3\* 3E 45  
 0CA5 D3 04  
 0CA7 DB 05  
 0CA9 FE B9  
 0CAB CA E0 0E  
 0CAE 18 E9  
 0CB0 FF  
 0CB1 F1  
 0CB2 D3 04  
 0CB4 FF  
 0CB5 FF  
 0CB6 FF  
 0CB7 C9  
 'FUNC'  
 0CC0 F5  
 0CC1 3E 15  
 0CC3 CD 98 0C  
 0CC6 F1  
 0CC7 CB BF  
 0CC9 C9

A=0F Initialise P4 as O/P  
 OUT 6,A  
 A=4F Initialise P5 as I/P  
 OUT 7,A  
 TEST B7 ?Function  
 CNZ 'FUNC' Pass inst. to calculator  
 CALL 'OUT' INC HL  
 RTN  
 BC = 0B45 Display digit and answer length  
 CALL 'DISPLAY' Read out 11 digit display  
 PUSH HL Save CRT address  
 PUSH HL Save CRT address  
 INC HL Inc. CRT  
 BC = 0141 Exponent sign  
 CALL 'DISPLAY' Exponent value  
 BC = 0243  
 CALL 'DISPLAY'  
 SCF  
 POP BC Was there an exponent—  
 SBC BC  
 JRZ 'A1' If no go to 'A1'  
 POP HL Recover CRT address  
 (HL), 45 Print 'E'  
 JR 'A2'  
 POP BC Waste CRT address  
 RTN  
 'A1'  
 'A2'  
 PUSH AF Save Data  
 A = 4F  
 OUT 4,A Test LSB to await calculator  
 IN A, 5 to be ready  
 CP = 81  
 JNC 'OUT 2' If not blank go to 'out 2'  
 A = 45 Otherwise test for error  
 OUT 4,A  
 IN A, 5  
 CP = B9 Test Error  
 JZ - 'ERROR' JR 'OUT' If still blank do again  
 RST 56 Delay  
 POP AF Recover Data  
 OUT 4,A Pass data to calculator  
 RST '56'  
 RST '56'  
 RST '56'  
 RTN  
 Delay > 14m Sec for contact bounce etc.  
 PUSH AF Save data  
 A = 15 Code for 'func'  
 CALL 'OUT' Output function data  
 POP AF Recover data  
 R/S B7 Reset function bit  
 RTN

## INITIALISATION (INIT)



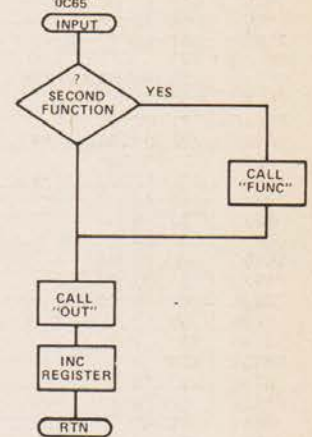
## FUNCTION (FUNC)



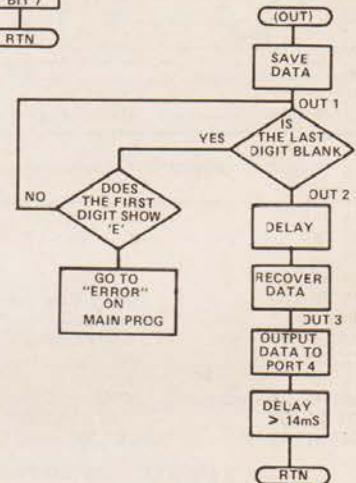
## ANSWER (ANS)



## INPUT



## OUTPUT



The various Service Routine flowcharts.

# DISPLAY

0CD0 79  
 0CD1 D3 04  
 0CD3 DB 05  
 0CD5 CB 7F  
 0CD7 28 FA  
 0CD9 DB 05  
 0CDB FE 80  
 0CDD 38 F1  
 0CDF 20 04  
 0CE1 0C  
 0CE2 10 EC  
 0CE4 C9  
 0CE5 FE C0  
 0CE7 28 22  
 0CE9 CB B7  
 0CEB D9  
 0CEC 01 15 00  
 0CEF 21 20 0D  
 0CF2 ED B1  
 0CF4 C2 E0 0E  
 0CF7 7E  
 0CF8 D9  
 0CF9 77

'D1' A,C Load digit number/time slot  
 OUT 4, A Output time slot  
 'D2' IN A, 5 Input display  
 TEST A7 ? Correct time slot  
 JRZ 'D2' If no do again  
 IN A, 5 Double check input  
 CP = 80  
 JRC 'D' If cleared do again  
 JRNZ 'D4' If not blank jump to 'D4'  
 INC C Step to next digit and do again  
 DJNZ 'D1' if not finished  
 RTN Return if finished  
 'D3' CP = C0 Set carry if no dec. pt  
 JRE - D6 If blank - d.p. jump to 'D6'  
 R/S A6 Reset dp bit (bit 6)  
 EXX  
 BC = 0015  
 HL = 0D20 Search table for match  
 CP1R  
 JNZ 'ERROR' If match not found  
 A, (HL) Load translation  
 EXX  
 (HL), A Print digit

0CFA 23  
 0CFB 38 E4  
 0CFD 3E 01  
 0CFF B8  
 0D00 28 05  
 0D02 36 2E  
 0D04 23  
 0D05 18 DA  
 0D07 79  
 0D08 FE C4  
 0D0A C0  
 0D0B E5  
 0D0C 22 18 0C  
 0D0F EF 20 20 72 61 64 73 00  
 0D17 E1  
 0D18 C9  
 DIGIT DISPLAY TABLE  
 0D20 9F 30 86 31  
 0D24 AB 32 A7 33  
 0D28 B6 34 B5 35  
 0D2C BD 36 87 37  
 0D30 BF 38 B7 39  
 0D34 A0 2D

INC HL Step to next CRT locn  
 JRC 'D3' If no dp go for next digit  
 A = 01  
 CP B If last digit suppress decimal point  
 JRZ 'D5' Print dp.  
 (HL), 2E Step to next CRT locn.  
 INC HL Go for next digit  
 JR 'D3' Does point follow the LSD of exponent?  
 A, C RTN if no.  
 CP = C1 If yes save CRT address  
 RNZ  
 PUSH HL (DCH18), HL  
 POP HL  
 RTN  
 Print 'Rads'  
 Recover CRT address  
 Return



# NUMBER CRUNCHER

## OPERATING PROGRAM

0E00	CD 50 0C	CALL 'S/INIT'	Initialise	0E86	FE 45	'F7'	CP = 45	CP = 'E'
0E03	EF 1E 00		Clear CRT	0E88	28 0F		JRZ - 'F9'	
0E06	DD 21 00 0B	1X = 0BD0		0E8A	FE 41		CP41	? Numerical
0E0A	DD 22 18 0C	(0C18), (1X)	Set cursor	0E8C	38 0B		JRC - 'F9'	If yes go to F9
0E0E	EF	PRINT		0E8E	23		INC HL	Step to next CRT point
	ENTER DATA NOW	TEXT		0E8F	86		ADD (HL)	Add 2nd letter to first
0E1D	00			0E90	F5		PUSH AF	Save resultant data
0E1E	21 10 09	HL = 0910	Set CRT address	0E91	3E 41		A = 41	
0E21	22 00 08	(0800), (HL)	Save line address in temp reg.	0E93	23	'F8'	INC HL	Search for end of
0E24	22 18 0C	(0C18), (HL)	Set cursor	0E94	BE		CP (HL)	word string
0E27	CD 3E 00	CALL 'CHIN'	Get entry	0E95	38 FC		JRC 'F8'	
0E2A	FE 1F	CP = 1F	? N/L	0E97	2B		DEC HL	
0E2C	20 10	JRNZ 'F3'	If not a new line F3	0E98	F1		POP AF	Recover data
0E2E	3E 09	A = 09		0E99	E5	'F9'	PUSH HL	Save CRT address
0E30	CD 3B 01	CALL 'CRT'	Print ' '	0E9A	21 FE 0E		HL = EFE	Table address - 2
0E33	2A 00 08	(HL), (0800)	Recover line address	0E9D	0E 31		C = 31	Table length
0E36	01 7F 00	BC = 007F	Set HL to next but one	0E9F	23	'F10'	INC HL	Step to next pair of
0E39	09	ADD HL, BC	line - 1 place	0EA0	23		INC HL	data
0E3A	77	(HL), A	Print ' '	0EA1	BE		CP (HL)	Is there a match?
0E3B	23	INC HL	Step CRT	0EA2	28 05	'F11'	JRZ 'F12'	If yes go to F12
0E3C	18 E3	JR 'F1'	Go for next digit	0EA4	0D		DEC C	Decrement couple
0E3E	CD 3B 01	CALL 'CRT'	Print the digit	0EA5	20 F8		JRNZ 'F10'	Repeat till match found
0E41	FE 3F	CP = 3F	CP = '?' End of data	0EA7	18 37		JR 'ERROR'	If not found error
0E43	20 E2	JRNZ 'F2'	If no go for next digit	0EA9	23		INC HL	Load translation
0E45	2A 18 0C	HL, (0C18)	Load cursor address into HL	0EAA	7E		A, (HL)	
0E48	2B	DEC HL,	Decrement to cover '?'	0EAB	CD 65 0C		CALL 'S/INPUT'	Enter into NCU
0E49	DD 22 18 0C	(0C18), (1X)	Set CRT address	0EAE	E1		POP HL	Recover CRT address
0E4D	EF	PRINT		0EAF	18 B5		JR F4	Do for next entry
	CALCULATING	TEXT		0EB1	DD 22 18 0C		(0C 18 1X)	Set cursor
	NOW			0EB5	EF	'E1'	'PRINT'	
0E5D	00			0EB6	PUSH BAR		TEXT	
0E5E	21 10 09	HL = 0910	Reset line address store to		TO RE-ENTER			
0E61	22 00 08	(0800), (HL)	the first line	0ECA	00			
0E64	18 01	JR 01	Miss the next locn.	0ECB	CD 3E 00	'E2'	CALL 'CHIN'	
0E66	23	INC HL	Step to next CRT locn.	0ECE	FE 20		CP = 20	Wait for entry
0E67	7E	A, (HL)	Load data into A	0ED0	20 F9		JRNZ 'E2'	
0E68	FE 20	CP = 20		0ED2	31 00 10		SP = 0100	Reset stack point
0E6A	28 FA	JRZ 'F4'	Ignore spaces	0ED5	21 03 0E		HL = 0E00	Enter return address
0E6C	FE 09	CP = 09	? N/L	0ED8	E5		PUSH HL	onto top of stack
0E6E	20 0C	JRNZ - 'F6'	If no go to F7	0ED9	3E 05		A = 05	Load clear data
0E70	2A 00 08	HL, (0800)	Record line address	0EDB	C3 B2 0C		JP 'S/OUT 3'	Jp to execute the clear
0E73	01 80 00	BC = 0075	Step to next line and					
0E76	09	ADD HL, BC	store					
0E77	22 00 08	0800, (HL)						
0E7A	18 EB	JR 'F5'						
0E7C	FE 3F	CP = 3F	? All data entered	ERROR				
0E7E	20 06	JRNZ - 'F7'	If no jump	0EE0	DD 22 18 0C		(0C18), (1X)	Set cursor
0E80	CD 70 0C	CALL 'S/ANS'	Call service program	0EE4	EF		'PRINT'	
0E83	C3 B1 0E	JP 'END'		0EE5	ERROR!!!			Print ERROR!! + 2 spaces
				0EEE	00			
				0EEF	18 C4		JR 'E1'	

## TABLE

F00				A1 A7	ROOT	$x\sqrt{y}$
TO				99 97	Pi	$\pi$
F5F	30 0F	0		B1 A3	XY	$X <> Y$
	31 0E	1		96 3F	DR	Deg $<>$ Rads
	32 0D	2		8B 17	CHS	Change sign
	33 0C	3		9C 2B	SIN	
	34 0B	4		94 AB	ASIN	$\sin^{-1}$
	35 0A	5		92 2A	COS	
	36 09	6		84 AA	ACOS	$\cos^{-1}$
	37 08	7		A2 29	TN	Tangent
	37 07	8		95 A9	ATN	$\tan^{-1}$
	39 06	9		93 2D	Lg.	$\log^{10}$
	2B 1F	+		8D AD	AL	Antilog
	2D 1E	-		9A 2F	LN	Logn
	2A 1D	*	Multiply	8F AF	AN	$e^x$
	2F 1C	/	Divide	A6 B3	XN	Statistic data entry
	3D 1B	=		97 3D	AV	Average
	29 1A	)		7D 3A	P-R	Polar to rectangular
	28 19	(		7F 39	R-P	Rectangular to Polar
	2E 11	.	Decimal point	7A 37	I1	In memory 1
	45 14	E	Exponent	7B B7	I2	In memory 2
	40 1D	@		80 35	O1	Out memory 1
	27 27	"	$x^y$	81 B5	O2	Out memory 2
	22 25	"	$x^2$	8E 33	E1	Sum in memory 1
	2C 23	,	$1/x$	A5 05	RST	Reset
	A4 A5	SQR	$\sqrt{x}$			



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# computing today

WHAT TO LOOK FOR  
IN THE NOVEMBER ISSUE.  
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## PET IMPRESSIONS

Like the TRS-80 article in this issue we present another "first time" buyers look at the Commodore PET. Written by Mr Stephenson (of D2 programming fame) it investigates the pro's and con's of buying a home micro and the impressions it has created. An article not to be missed if you are considering buying a PET.

A graphics project for your Nascom is this months offering. Requiring the minimum disruption to the processor card it is a simple project to build and uses pixels rather than pre-determined characters. These give greater flexibility to the system and allow you to easily program it. Grab your soldering iron and stand by for this one.

## GRAPHICALLY PROJECTED

## LIVING WITH A GAME

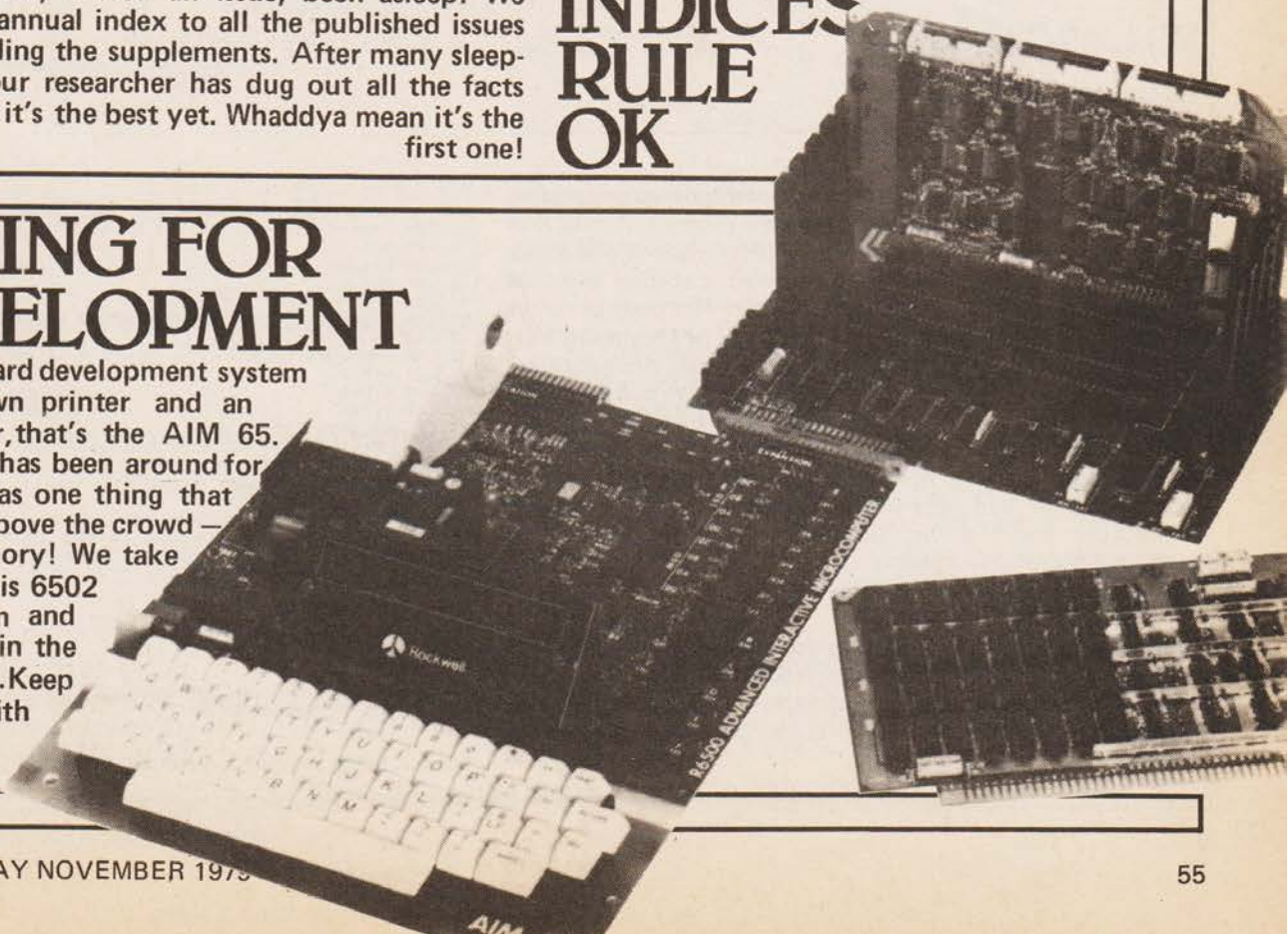
The famous game of Life, developed by Conway — presented by Kuczinski, will have you racking your brains for the ultimate pattern in the struggle to survive. A complete object code listing for the Nascom 1 is supplied along with a sample run to show game in action. Will you survive the wait till next months issue?

Lost an article, missed an issue, been asleep? We present our annual index to all the published issues of CT including the supplements. After many sleepless nights our researcher has dug out all the facts and reckons it's the best yet. Whaddya mean it's the first one!

## INDICES RULE OK

## AIMING FOR DEVELOPMENT

A single board development system with it's own printer and an 8K monitor, that's the AIM 65. Although it has been around for a while it has one thing that elevates it above the crowd — bubble memory! We take a look at this 6502 based system and its position in the marketplace. Keep on target with our system review.





## We improve last months trial solution in a variety of ways, and give you a new one to ponder

Last month, the problem was to find a house number in a row of odd numbered houses, such that the sum of the house numbers on one side equalled the sum on the other side. A possible solution was given but, although it gives a correct answer, the program (listing 1) is a rather poor attempt.

```

100 REM ***** MY UNCLE LIVES IN HOUSE - N *****
120 LET N=1
130 LET N=N+2
140 REM ***** SUM HOUSE NUMBERS ON LEFT IN - L *****
150 LET L=0
160 FOR I=1 TO N-2 STEP 2
170 LET L=L+I
180 NEXT I
190 REM ***** SUM HOUSE NUMBERS ON RIGHT IN - R *****
200 REM ***** STARTING AT HOUSE NUMBER - H *****
210 LET H=N
220 LET R=0
230 LET H=H+2
240 LET R=R+H
250 REM ***** DOES THE LEFT SUM EQUAL THE RIGHT SUM ? *****
260 IF L=R THEN 300
270 IF L>R THEN 230
280 GOTO 130
290 REM ***** HOW MANY HOUSES ? *****
300 LET T=(H+1)/2
310 IF T>100 THEN 330
320 GOTO 130
330 PRINT "THERE ARE";T;"HOUSES IN THE ROAD"
340 PRINT "UNCLE LIVES AT HOUSE NUMBER";N
350 END

```

THERE ARE 169 HOUSES IN THE ROAD  
UNCLE LIVES AT HOUSE NUMBER 239

Fig. 1. Last months solution.

### What Is Better?

Before we can 'improve' a program, we must ask ourselves just what we mean by 'better'. An ideal program should find the correct solution and execute quickly without ridiculous storage requirements. The given program is correct and uses little storage, so better here means faster! The program takes 76 seconds to execute on a PET. This may not seem too bad, but for longer roads the time required increases dramatically.

A small, but significant, improvement can be achieved by tidying up the given program. The first thing to note is that, in lines 260 and 270, the left sum — 'L' is more likely to be greater than the right sum — 'R' than equal to it. Thus reversing these two lines means that the  $L = R$  test is not carried out unnecessarily. Another small improvement is to eliminate the GOTO statements.

eg. 310 IF  $T > 100$  THEN 330

320 GOTO 130

may be replaced by the single statement:—

310 IF  $T \leq 100$  THEN 130

With these improvements, the program (listing 2) takes 68 seconds to execute — this is 10.5% faster than the original version.

```

100 REM ***** MY UNCLE LIVES IN HOUSE - N *****
120 LET N=1
130 LET N=N+2
140 REM ***** SUM HOUSE NUMBERS ON LEFT IN - L *****
150 LET L=0
160 FOR I=1 TO N-2 STEP 2
170 LET L=L+I
180 NEXT I
190 REM ***** SUM HOUSE NUMBERS ON RIGHT IN - R *****
200 REM ***** STARTING AT HOUSE NUMBER - H *****
210 LET H=N
220 LET R=0
230 LET H=H+2
240 LET R=R+H
250 REM ***** DOES THE LEFT SUM EQUAL THE RIGHT SUM ? *****
260 IF L>R THEN 230
270 IF L<R THEN 130
290 REM ***** HOW MANY HOUSES ? *****
300 LET T=(H+1)/2
310 IF T<=100 THEN 130
330 PRINT "THERE ARE";T;"HOUSES IN THE ROAD"
340 PRINT "UNCLE LIVES AT HOUSE NUMBER";N
350 END

```

THERE ARE 169 HOUSES IN THE ROAD  
UNCLE LIVES AT HOUSE NUMBER 239

Fig. 2. A slightly improved version.

### Improving The Method

For further improvements we must look at the algorithm. The method used requires that we calculate the left sum and the right sum from scratch for each new value of N. This is totally unnecessary — when we move the test house, the new left sum is merely increased by adding on the old test value. Similarly, the right sum must be decreased by the new test value.

eg. Imagine that the test for house 11 has just failed. The next test is set up as follows:—

Left Sum	Test Value	Right Sum
25 = 1+3+5+7+9	11	13+15 = 28
36 = 1+3+5+7+9+11	13	15 = 15
		15+17 = 32
		15+17+19 = 51

```

100 REM ***** MY UNCLE LIVES IN HOUSE - N *****
120 LET N=1
130 LET L=0
140 LET R=3
145 LET H=3
150 REM ***** MOVE HOUSE AND CHANGE LEFT AND RIGHT SUMS *****
160 LET L=L+N
170 LET N=N+2
180 LET R=R-N
230 LET H=H+2
240 LET R=R+H
245 IF L>R THEN 230
250 REM ***** DOES THE LEFT SUM EQUAL THE RIGHT SUM ? *****
270 IF L<>R THEN 160
290 REM ***** HOW MANY HOUSES ? *****
300 LET T=(H+1)/2
310 IF T<=100 THEN 160
330 PRINT "THERE ARE";T;"HOUSES IN THE ROAD"
340 PRINT "UNCLE LIVES AT HOUSE NUMBER";N
350 END

```

THERE ARE 169 HOUSES IN THE ROAD  
UNCLE LIVES AT HOUSE NUMBER 239

Fig. 3. A better solution but still not the best.



# PROBLEM PAGE

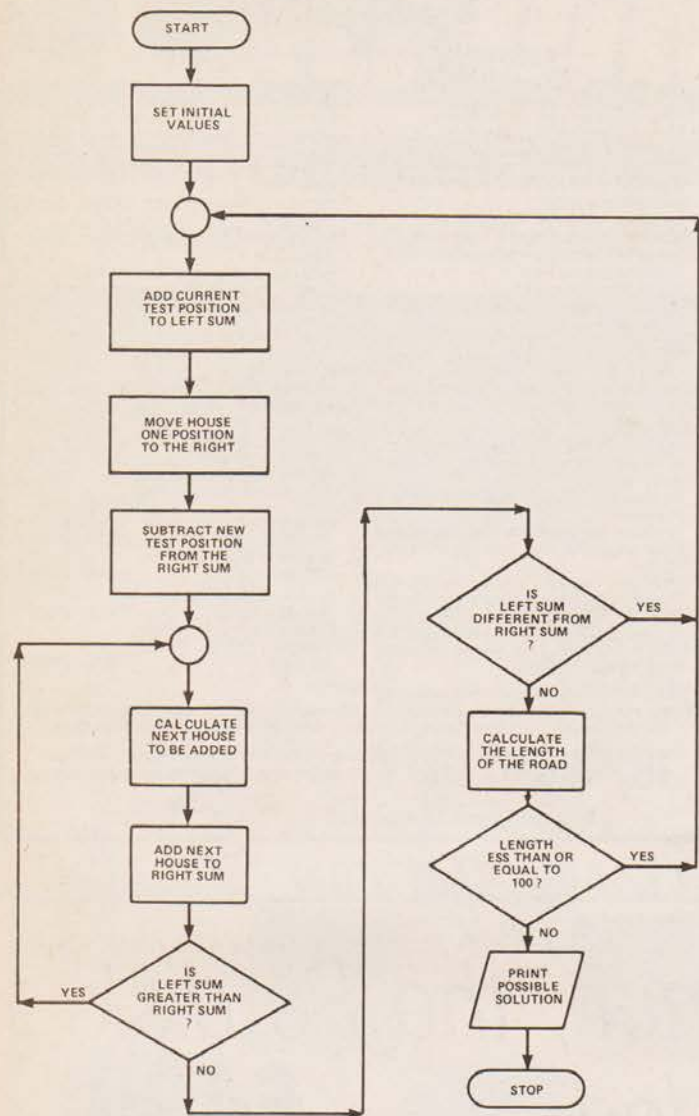


Fig.4. The flowchart for the best solution to the problem.

```

10 REM *****
20 REM *
30 REM * PROGRAM --- 'WHAT-HOUSE' *
35 REM * BY RECURRENCE FORMULA *
40 REM *
50 REM * PROGRAMMED IN 'PET' BASIC *
60 REM *
70 REM * TREVOR L LUSTY 12/8/79. *
80 REM *
90 REM *****
95 REM
2000 REM ***** SET INITIAL VALUES *****
2020 LET M1 = 1
2040 LET M2 = 7
2060 REM ***** COMPUTE NEXT VALUE *****
2080 LET N = 6*M2 - M1
2100 REM ***** MOVE VALUES *****
2120 LET M1 = M2
2140 LET M2 = N
2160 REM ***** COMPUTE LENGTH OF ROAD *****
2180 LET L = INT(SQR((N*N+1)/2)+.5)
2200 REM ***** PRINT POSSIBLE SOLUTION *****
2220 PRINT
2240 PRINT
2260 PRINT "THERE ARE";L;"HOUSES"
2280 PRINT "UNCLE LIVES IN NUMBER";N
2300 REM ***** IS IT TIME TO STOP ? *****
2320 IF N<10000000 THEN 2080
2340 END
  
```

THERE ARE 29 HOUSES  
UNCLE LIVES IN NUMBER 41

THERE ARE 169 HOUSES  
UNCLE LIVES IN NUMBER 239

THERE ARE 985 HOUSES  
UNCLE LIVES IN NUMBER 1393

THERE ARE 5741 HOUSES  
UNCLE LIVES IN NUMBER 8119

THERE ARE 33461 HOUSES  
UNCLE LIVES IN NUMBER 47321

THERE ARE 195025 HOUSES  
UNCLE LIVES IN NUMBER 275007

THERE ARE 1136689 HOUSES  
UNCLE LIVES IN NUMBER 1607521

THERE ARE 6625109 HOUSES  
UNCLE LIVES IN NUMBER 9369319

THERE ARE 38613965 HOUSES  
UNCLE LIVES IN NUMBER 54608393

Fig.5. The best solution to the problem.

The program for this method is given in listing 3 and a dry run through the associated flowchart should clarify the procedure.

When this method is programmed it takes only 5 seconds to execute — an improvement of 93.4%. It is sufficiently fast to allow more values to be computed within a reasonable time, but it's still not the best solution.

## Leading From Behind!

When we look at a number of solutions we find that they are connected by a recurrence formula. (A recurrence formula is a way of finding the next value in a sequence from the preceding values.) In this case, the formula for the middle house is:—

$$(NEXT\ VALUE) = 6\ times\ (THIS\ VALUE) - (LAST\ VALUE)$$

or, in more normal mathematical notation:—

$$R_{n+1} = 6R_n - R_{n-1}$$

Given that the first solution is 1 — zero sum on either side, and the second solution is 7 —  $1+3+5 = 9$ . The next may be calculated from  $6 \times 7 - 1 = 41$ .

The solution we found is calculated next  $6 \times 41 - 7 = 239$ . The program for this method is given in listing 4 and, as the values are printed immediately, it might be said to represent almost 100% improvement on the original program. As this is a computing magazine and not a mathematical one, an algebraic proof of the recurrence formula would be out of place. However, if any reader can find a geometric proof I would be pleased to see it.

## Problem Of The Month

Write a BASIC program (it can even be done in integer BASIC) to divide one number by another and printout the answer correct to any specified (unlimited) number of decimal places.



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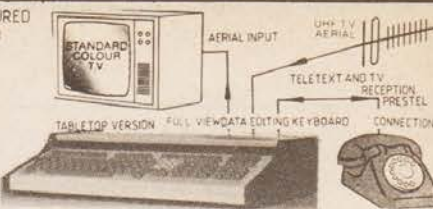
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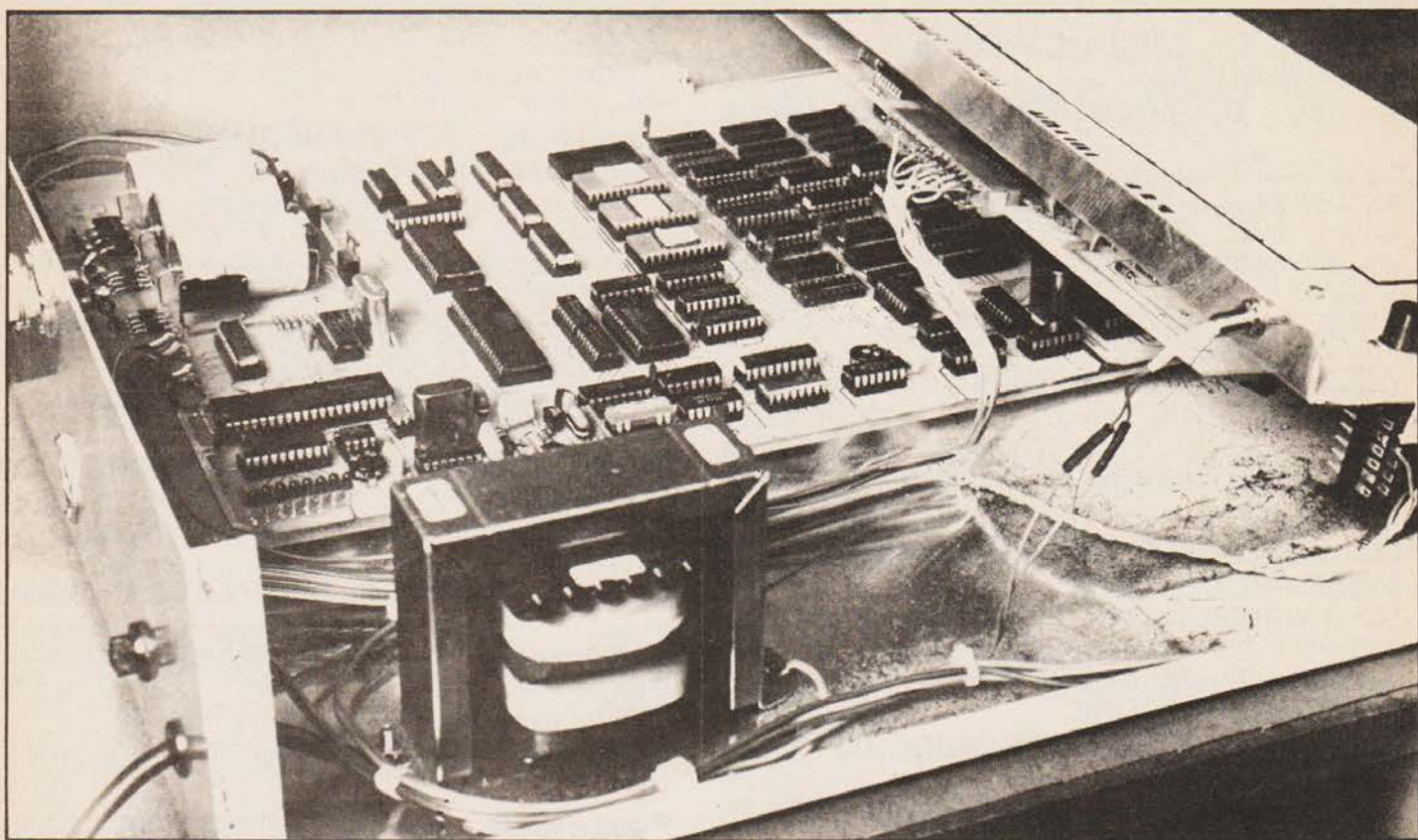
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## Interface your Triton to a cheap printer unit with this feature. Much more besides

**T**he program described in this article, with its simple interface, will allow you to use a surplus GPO teleprinter on a TRITON. These machines, the author used a CREED 7B, can be purchased relatively cheaply from electronic brokers and because of the typewriter style of output are suitable for letters. Another advantage is that they use cheap roll type paper, rather than continuous forms.

They do have drawbacks in that they are slow and noisy but this will probably not worry too many people on a tight budget. The program contains an ASCII to Baudot conversion routine, a miniscule letter editor and a Hex dump routine to print out any section of TRITONS memory. Flow charts of the program are given to make the listing understandable.

### Typewriter Operation

To use the Mini Editor simply hit G 1602. The cursor will now step to a new line. You may now enter a page, or pages, of text up to an amount limited by the available on-board RAM. With a full set of RAM you may store up to 2000 characters but this includes spaces etc. To create a new line you must use RETURN and then line feed (Roll screen or ESC) as simply going over the edge of the screen will not create a new printer line.

To correct errors within a line Control H will backspace over characters, but do not try to backspace over lines other than the current one as this may look OK on the screen but not to the RAM. Other cursor controls should NOT be

used as they are not handled by the program.

Any characters which are not recognised, or are not contained in the Baudot code are printed as a space. When you have finished composing your text on the screen, don't be afraid to overtype any scrolled lines, hit Control D. The message 'HOW MANY? 1 TO 9' will be displayed and the input of any number in that range will start the printer and output the required number of copies. After printing is completed you are asked if you want more, if not the screen will be cleaned for more text input.

### Further Facilities

To use the Hex dump facility hit P 1681 and enter the starting address of the section you want dumped, low order byte first. Keying in G 1680 will cause the printer to output a line of Hex code until it finds an address ending in 0H, where upon it executes a carriage return and stops. Hitting any key at this point will cause the next line of 16 bytes to be output.

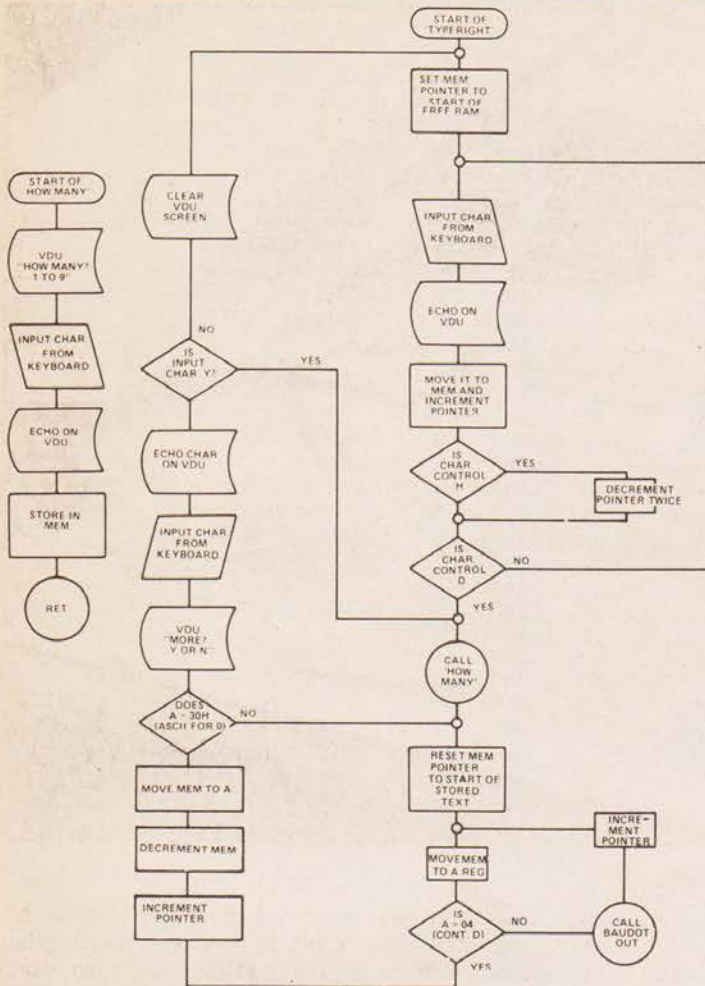
The Baudot code conversion may be used on its own with a program written between 1600 and 16E3, calling 16E3 will cause the accumulator contents to be dumped. It should be noted that the teleprinters being used always print one letter behind the code received as they use a mechanical decode, hence you should always leave a space or line feed at the end.

### Cost And Implementation

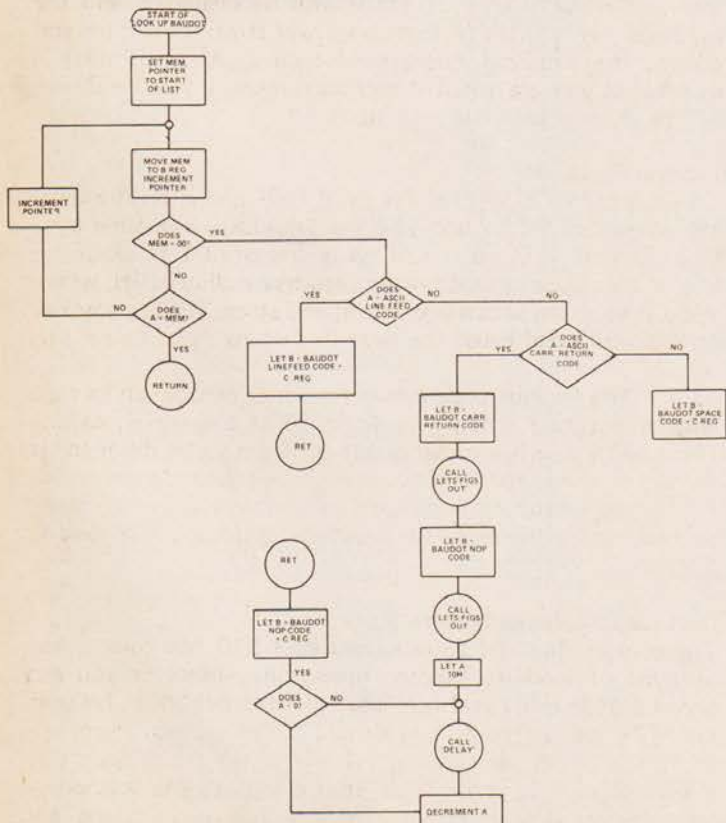
The printer that the author used cost £20 and took a fair amount of work to become operational, however you can spend a little more and buy one that runs off 240V, his uses two 12V car batteries. You should try to extract a promise from the dealer to make good any missing bits (pun not intended) as it is difficult to ensure that all the mechanics are present. The interface circuitry and connections are shown in Fig 1.



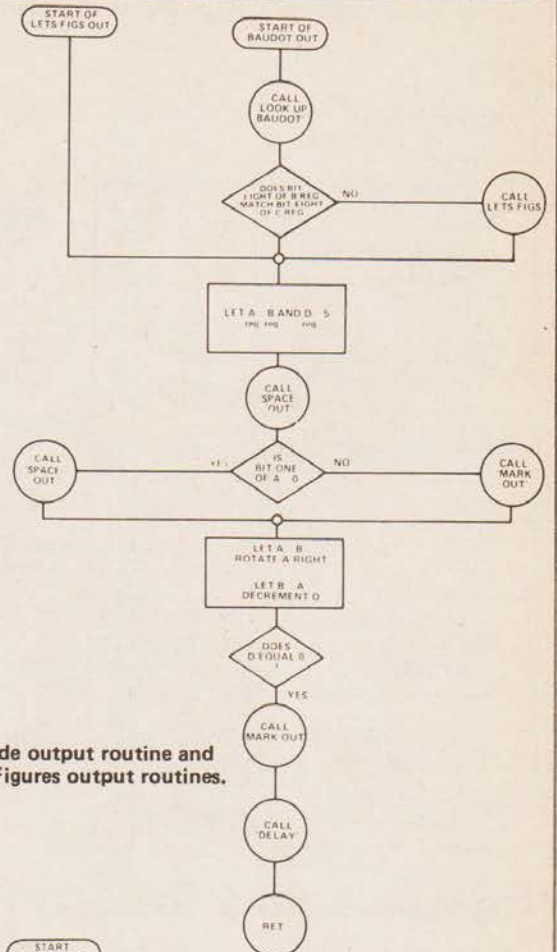
# TRITON TYPECAST



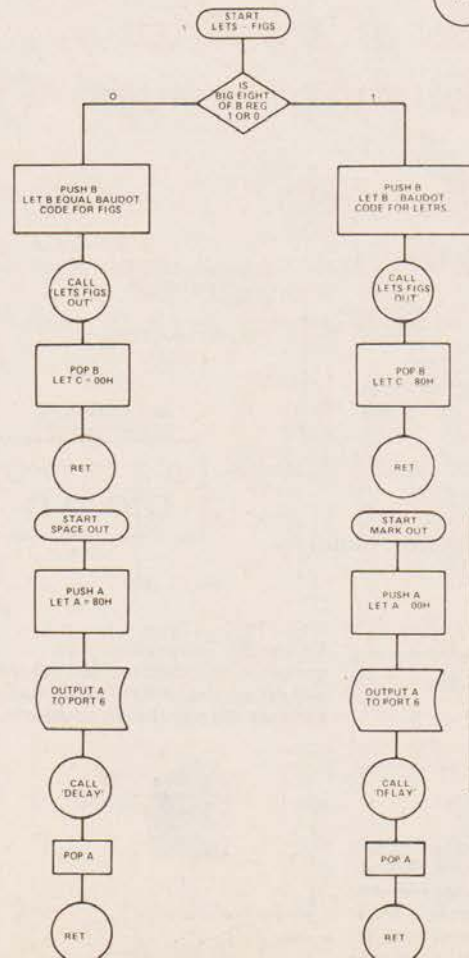
The main routine flowchart.



The Baudot look-up routine.

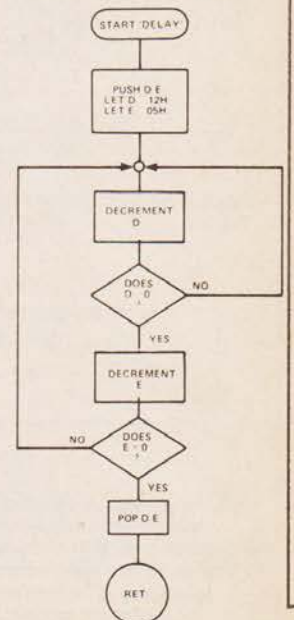


The Baudot Code output routine and the Letters or Figures output routines.



The output code check routines.

The delay subroutine.









# TRITON TYPECAST

1640 00		1696 0F		16E0 00	
164C CD	CALL ECHOCH	1697 FE	COMPARE TO-	16E1 00	
164D 30		1698 00		16E2 00	
164E 00		1699 CA	JUMP IF MATCH	16E3 CD	CALL 'LOOK UP
164F FE	COMPARE TO-	169A A4	TO SUBR.	16E4 52	BAUDOT'
		169B 16	'END LINE'	16E5 17	
1650 59	CODE FOR Y	169C 3E	LOAD ACC. WITH-	16E6 78	MOVE B TO ACC.
1651 CA	JUMP IF MATCH	169D 20	CODE FOR SPACE	16E7 E6	AND ACC. WITH-
1652 17	TO SUBR.	169E CD	CALL 'BAUDOT OUT'	16E8 80	80H
1653 16	'HOW MANY?'	169F E3		16E9 09	COMPARE WITH- C
1654 3E	LOAD ACC. WITH-			16EA 04	CALL IF NO MATCH
1655 0C	CODE FOR CNT. L			16EB 35	'LETS-FIGS'
1656 CD	CALL OUTCH	16A0 16		16EC 17	
1657 13		16A1 C3	JUMP BACK FOR	16ED D5	PUSH DE
1658 00		16A2 83	NEXT BYTE	16EE 1E	LOAD E WITH-
1659 C3	JUMP BACK	16A3 16		16EF 05	05H
165A 02	TO START	16A4 3E	LOAD ACC. WITH-		
165B 16		16A5 0D	CODE FOR CARR.RETURN	16F0 CD	CALL 'SPACE OUT'
165C 00		16A6 CD	CALL 'BAUDOT OUT'	16F1 2A	
165D 00		16A7 E3		16F2 17	
165E 00		16A8 16		16F3 78	MOVE B TO ACC.
165F 00		16A9 3E	LOAD ACC. WITH-	16F4 E6	AND WITH-
1660 48	START OF STRING	16AA 1B	CODE FOR ROLL SCREEN	16F5 01	01H
1661 4F	'HOW MANY'	16AB CD	CALL 'BAUDOT OUT'	16F6 CC	CALL IF ZERO
1662 57		16AC E3		16F7 2A	'SPACE OUT'
1663 20		16AD 16		16F8 17	
1664 4D		16AE CD	CALL INCH	16F9 C4	CALL IF NOT ZERO
1665 41		16AF 0B		16FA 22	'MARK OUT'
1666 4E				16FB 17	
1667 59		16B0 00		16FC 1D	DECREMENT E
1668 3F		16B1 C3	JUMP BACK TO	16FD CA	JUMP IF ZERO
1669 20		16B2 83	PRINT NEXT LINE	16FE 06	'CHARACTER ENDS'
166A 31		16B3 16		16FF 17	
166B 20		16B4 00			
166C 54		16B5 00		1700 78	MOVE B TO ACC.
166D 4F		16B6 00		1701 1F	ROTATE RIGHT
166E 20		16B7 E5	PUSH HL	1702 47	MOVE ACC. TO B
166F 39		16B8 21	LOAD HL WITH	1703 C3	JUMP BACK FOR
		16B9 D0	START OF TABLE	1704 F4	NEXT BIT
1670 20		16BA 16		1705 16	
1671 04		16BB FE	COMPARE ACC. WITH-	1706 CD	CALL 'MARK OUT'
1672 4D	START OF STRING	16BC 00	ZERO	1707 22	
1673 4F	'MORE?'	16BD CA	JUMP IF MATCH TO	1708 17	
1674 52		16BE C5	SUBR. 'OUTPUT CODE'	1709 CD	CALL 'DELAY'
1675 45		16BF 16		170A 11	
1676 3F				170B 17	
1677 20		16C0 3D	DECREMENT ACC.	170C D1	POP DE
1678 59		16C1 23	INCREMENT HL	170D C9	RETURN
1679 20		16C2 C3	JUMP BACK TO	170E 00	
167A 4F		16C3 BB	COMPARE TO ZERO	170F 00	
167B 52		16C4 16			
167C 20		16C5 7E	MOVE MEM. TO ACC.	1710 00	
167D 4E		16C6 E1	POP HL	1711 D5	PUSH DE
167E 20		16C7 CD	CALL 'BAUDOT OUT'	1712 11	LOAD DE PAIR
167F 04	EOT	16C8 E3		1713 05	
		16C9 16		1714 12	
1680 21	LOAD HL PAIR	16CA C9	RETURN	1715 15	DECRMENT D
1681 --	ENTER ADDRESS FOR START	16CB 00		1716 C2	JUMP IF NOT ZERO
1682 --	OF HEX DUMP	16CC 00		1717 15	
1683 7E	MOVE MEM. TO ACC.	16CD 00		1718 17	
1684 E6	AND ACC. WITH-	16CE 00		1719 1D	DECREMENT C
1685 F0		16CF 00		171A C2	JUMP IF NOT ZERO
1686 0F	ROTATE ACC.RIGHT	16D0 30	START OF LOOK UP	171B 15	
1687 0F	FOUR TIMES	16D1 31	TABLE FOR 'HEX DUMP'	171C 17	
1688 0F		16D2 32		171D D1	POP DE
1689 0F		16D3 33		171E C9	RETURN
168A CD	CALL SUBROUTINE	16D4 34		171F 00	
168B B7	'LOOK UP AND	16D5 35			
168C 16	OUTPUT CODE'	16D6 36		1720 00	
168D 7E	MOVE MEM. TO ACC.	16D7 37		1721 00	
168E E6	AND ACC. WITH-	16D8 38		1722 3E	LOAD A WITH-
168F 0F		16D9 39		1723 00	00H
1690 CD	CALL SUBR.	16DA 41		1724 D3	OUTPUT A TO PORT-
1691 B7	'LOOK UP AND	16DB 42		1725 06	06H
1692 16	OUTPUT CODE'	16DC 43		1726 CD	CALL 'DLAY'
1693 23	INCREMENT HL	16DD 44		1727 11	
1694 7D	MOVE L TO ACC.	16DE 45		1728 17	
1695 E6	AND ACC. WITH-	16DF 46		1729 C9	RETURN



172A 3E	LOAD A WITH-	1773 F1	POP PSW	17ED 50
172B 80	80H	1774 C8	RETURN IF ROLL SCREEN	17EE 37
172C D3	OUTPUT A TO PORT-	1775 FE	COMPARE A TO-	17EF 51
172D 06	06H	1776 0D	CODE FOR CARR. RETURN	
172E CD	CALL 'DELAY'	1777 C2	JUMP IF NOT TO-	17F0 8A
172F 11		1778 96	SUBR. 'PRINT SPACE'	17F1 52
		1779 17		17F2 85
1730 17		177A 00		17F3 53
1731 C9	RETURN	177B 00		17F4 30
1732 00		177C 00		17F5 54
1733 00		177D 3E	LOAD A WITH-	17F6 87
1734 00		177E 08	BAUDOT FOR CARR. RETURN	17F7 55
1735 FE	COMPARE A TO-	177F 81	ADD C	17F8 3E
1736 80	80H			17F9 56
1737 CA	JUMP IF MATCH TO-	1780 47	MOVE A TO B	17FA 33
1738 45	SUBR. 'LETS'	1781 CD	CALL 'LETS-FIGS OUT'	17FB 57
1739 17		1782 ED		17FC 3D
173A 00	NOP	1783 16		17FD 58
173B C5	PUSH B	1784 41	MOVE C TO B	17FE 35
173C 06	LOAD B WITH-	1785 CD	CALL 'LETS-FIGS OUT'	17FF 59
173D 1B	BAUDOT FOR FIGS	1786 ED		
173E CD	CALL 'LETS-FIGS OUT'	1787 16		17D0 31
173F ED		1788 3E	LOAD A WITH-	17D1 5A
		1789 10	10H	17D2 17
7740 16		178A CD	CALL 'DELAY'	17D3 31
1741 C1	POP B	178B 11		17D4 13
1742 0E	LOAD C WITH-	178C 17		17D5 32
1743 00	00H	178D 3D	DECRMENT A	17D6 01
1744 C9	RETURN	178E C2	JUMP IF NOT ZERO	17D7 33
1745 C5	PUSH B	178F 8A	BACK FOR MORE DELAY	17D8 0A
1746 06	LOAD B WITH-			17D9 34
1747 1F	BAUDOT FOR LETS	1790 17		17DA 10
1748 CD	CALL 'LETS-FIGS OUT'	1791 41	MOVE C TO B	17DB 35
1749 ED		1792 C9	RETURN	17DC 15
174A 16		1793 00		17DD 36
174B C1	POP B	1794 00		17DE 07
174C 0E	LOAD C WITH-	1795 00		17DF 37
174D 80	80H	1796 79	MOVE C TO A	
174E C9	RETURN	1797 C6	ADD TO A-	17E0 06
174F 00		1798 04	BAUDOT FOR SPACE	17E1 38
		1799 47	MOVE A TO B	17E2 18
1750 00		179A C9	RETURN	17E3 39
1751 00		179B 00		17E4 16
1752 E5	PUSH HL	179C 00		17E5 30
1753 21	LOAD HL WITH-	179D 00		17E6 19
1754 9E	START OF	179E 83	START OF LOOK UP	17E7 3F
1755 17	BAUDOT TABLES	179F 41	TABLE, BAUDOT CODE	17E8 03
1756 46	MOVE MEM. TO B			17E9 2D
1757 23	INCREMENT HL	17A0 99	IN FIRST BYTE,	17EA 0E
1758 BE	COMPARE A TO MEM.	17A1 42	ASCII CODE IN NEXT	17EB 3A
1759 23	INCREMENT HL	17A2 8E	AND SO ON.	17EC 0D
175A C2	JUMP IF NO MATCH TO-	17A3 43	BAUDOT LETTERS AND	17ED 25
175B 5F	SKIP RETURN	17A4 89	FIGURES ARE	17EE 1A
175C 17		17A5 44	DIFFERENTIATED	17EF 40
175D E1	POP HL	17A6 81	BY ADDING 80H	
175E C8	RETURN IF MATCH	17A7 45	TO THE LETTERS.	17F0 14
175F F5	PUSH PSW	17A8 8D		17F1 24
		17A9 46		17F2 0F
1760 7E	MOVE MEM. TO A	17AA 9A		17F3 28
1761 FE	COMPARE TO-	17AB 47		17F4 12
1762 00	00H	17AC 94		17F5 29
1763 CA	JUMP IF MATCH TO-	17AD 48		17F6 1C
1764 6A	SUBR. 'NOT	17AE 86		17F7 2E
1765 17	IN TABLE'	17AF 49		17F8 0C
1766 F1	POP PSW			17F9 2C
1767 C3	JUMP BACK TO LOOK	17B0 8B		17FA 05
1768 56	AT NEXT LOCATION	17B1 4A		17FB 27
1769 17	IN TABLE	17B2 8F		17FC 1E
176A F1	POP PSW	17B3 4B		17FD 3D
176B E1	POP HL	17B4 92		17FE 1D
176C FE	COMPARE A TO-	17B5 4C		17FF 2F
176D 1B	ROLL SCREEN CODE	17B6 9C		
176E F5	PUSH PSW	17B7 4D		1800 11
176F 79	MOVE C TO A	17B8 8C		1801 2B
		17B9 4E		1802 00
1770 C6	ADD TO A-	17BA 98		1803 00
1771 02	BAUDOT FOR LINE FEED	17BB 4F		1804 00
1772 47	MOVE A TO B	17BC 9B		1805 00

00 MUST BE IN  
THESE LOCATIONS  
TO RETURN  
FROM TABLES



# TRITON TYPECAST

1806 -- START OF FREE RAM  
TEXT ENTERED FROM  
HERE ON

'TYPERIGHT'

START ADDRESSES FOR SUBROUTINES

```

1602  MINI-EDITOR (TO PRINT TEXT)
161A  START PRINTOUT
1630  HOW MANY?
1646  MORE?
1660  STRING 'HOW MANY'
1672  STRING 'MORE?'
1680  HEX DUMP (ENTER START IN 1681-1682)
16A4  END LINE
16B7  LOOK UP AND OUTPUT CODE
16C5  OUTPUT CODE
16D3  START OF LOOK UP TABLE FOR HEX DUMP
16E3  BAUDOT OUT (MAY BE USED WITHOUT ABOVE
      ROUTINES. CONVERTS CODE IN ACC. TO
      BAUDOT AND SENDS IT OUT PORT 06H, THEN
      RETURNS)
16ED  LETS-FIGS OUT (OUTPUTS CONTROL CODES)
1711  DELAY (1713-1714 MAY BE ALTERED TO CHANGE
      TRANSMISSION SPEED)
1722  MARK OUT
172A  SPACE OUT
1735  LETS-FIGS
1752  LOOK UP BAUDOT
177D  SPECIAL ROUTINE FOR CARRIAGE RETURN
1789  MAY BE ALTERED FOR DIFFERENT DELAY
      AFTER CARRIAGE RETURN
1796  PRINT SPACE
179E  START OF LOOK UP BAUDOT TABLES
1806  START OF FREE RAM FOR TEXT STORAGE
    
```

EXAMPLE OF HEX DUMP FUNCTION  
PROGRAM DUMPS ITSELF  
(LOAD 1681-2 WITH  
START ADDRESS 1600)

```

06 18 21 06 18 CD 3B 00 77 23 FE 08 C2 12 16 2B
2B 00 FE 04 C2 05 16 CD 30 16 21 06 18 7E FE 04
CA 3E 16 CD E3 16 23 C3 1D 16 00 00 00 00 00 00
11 60 16 CD 2B 00 CD 3B 00 77 C9 00 00 00 23 35
7E FE 30 C2 1A 16 11 72 16 CD 2B 00 CD 3B 00 FE
59 CA 17 16 3E 0C CD 13 00 C3 02 16 00 00 00 00
48 4F 57 20 4D 41 4E 59 3F 20 31 20 54 4F 20 39
20 04 4D 4F 52 45 3F 20 59 20 4F 52 20 4E 20 04
21 00 16 7E E6 F0 0F 0F 0F 0F 0F 16 7E E6 0F
CD B7 16 23 7D E6 0F FE 00 CA A4 16 3E 20 CD E3
16 C3 83 16 3E 0D CD E3 16 3E 16 CD E3 16 CD 0B
00 C3 83 16 00 00 00 E5 21 D0 16 FE 00 CA C5 16
3D 23 C3 B5 16 7E E1 CD E3 16 C9 00 00 00 00 00
30 31 32 33 34 35 36 37 38 39 41 42 43 44 45 46
00 00 00 CD 52 17 78 E6 80 C9 C4 35 17 05 1E 05
CD 2A 17 78 E6 01 CC 2A 17 C4 22 17 1D CA 06 17
78 1F 47 C3 F4 16 CD 22 17 CD 11 17 D1 C9 00 00
00 D5 11 05 12 15 C2 15 17 1D C2 15 17 D1 C9 00
00 00 3E 00 D3 06 CD 11 17 C9 3E 80 D3 06 CD 11
17 C9 00 00 00 FE 80 CA 45 17 00 C5 06 16 CD ED
16 C1 0E 00 C9 C5 06 1F CD ED 16 C1 0E 80 C9 00
00 00 E5 21 9E 17 46 23 BE 23 C2 5F 17 E1 C8 F5
7E FE 00 CA 6A 17 F1 C3 56 17 F1 E1 FE 16 F5 79
C6 02 47 F1 C8 FE 0D C2 96 17 00 00 00 3E 08 81
47 CD ED 16 41 CD ED 16 3E 10 CD 11 17 3D C2 8A
17 41 C9 00 00 00 79 C6 04 47 C9 00 00 00 33 41
99 42 8E 43 89 44 81 45 8D 46 9A 47 94 48 86 49
8B 4A 8F 4B 92 4C 9C 4D 8C 4E 98 4F 9B 50 97 51
8A 52 85 53 90 54 87 55 9E 56 93 57 9D 58 95 59
91 5A 17 31 13 32 01 33 0A 34 10 35 15 36 07 37
06 38 18 39 16 30 19 3F 03 2D 0E 3A 0D 25 1A 40
14 24 0F 28 12 29 1C 2E 0C 2C 05 27 1E 3D 1D 2F
11 26 00 00 00 00 20 2D 20 20 20 20 20 20 20
    
```

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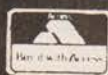
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4050 (200ns)	2.88	MM5303	5.29	7492	.33	74196		.79
4050 (350ns)	2.71	MM5307	9.08	7493	.28	74197	.85	
4060 (300ns)	2.88			7495	.72	74198		.99
		<b>74 series TTL</b>		7496	.48	74221	.96	1.05
<b>Static RAMs</b>		LS	N	74107	.22	74247		1.35
2102A - 2	1.21	7400	.17	74121	.23	74251		.81
4035 (1000ns)	1.14	7401	.17	74122	.33	74253	1.20	
2111A - 1	1.96	7402	.11	74126	.35	74273		1.27
2114	6.90	7403	.13	74141	.46	74279	.55	
4045 (250ns)	6.56	7404	.18	74145	.46	74283	.65	1.13
5257 - 4044	7.66	7405	.20	74150	.58	74293	.80	
6810	3.11	7408	.20	74151	.51	74348	1.31	
		7409	.15	74153	.43	74365	.50	.57
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81LS98	.66	7454	.14	74175	.58	75108AN	1.03	
8728	1.61	7460	.12	74180	.43	75452B	.29	
8795	1.44	7470	.22	74181	1.44			
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## This month we present the solution to the sort problem and take a look at Binary searches

**L**ast month we left you with a program to solve about the workings of our two list merge program. As we are about to give you the answer to that problem, it would help if you had last month's article in front of you.

You may remember that the program was to take two lists of numbers, A(X) and B(X), each containing 4 items in ascending numerical order and produce from these a single list, C(X), of 8 items which was to have been the result of merging the two lists together in such a way that the resulting list was also in ascending order. A simple algorithm was given to solve the problem and you were expected to dry run the program listing produced from this algorithm. The best way to try to understand the operation of a program like this is to draw a near flowchart. (See Fig.1).

As far as possible, the flowchart boxes have been numbered to correspond with the relevant program line numbers given last month. The shaded area in Fig.1 corresponds to lines 120-210 of the program. The flowchart boxes labelled 15, 20 & 25 allow you to input the two number lists A(X) and B(X). Note that these must be in ascending numerical order. Flowchart box 35 sets up initial values for A, B and C which will be used as pointers in lists A(X), B(X) and C(X) respectively. Box 50 now compares the next two items in lists A(X) and B(X) using pointers A and B to see which of A(A) and B(B) is larger (to start off with, both A and B have the value 1 so we are comparing A(1) with B(1)). If A(A) is larger than B(B) then we branch to box 90 and put the contents of B(B) into C(C). So here we make C(1) equal to B(1) (because B(1) was the smaller of A(1) or B(1)) and then we increment both pointers B and C by 1. A and B are now tested to see if either of them has reached 5. In this case they have not and so we branch back to box 50 to compare A(A) with the new value of B(B). (Here A(1) and B(2)). We will suppose this time that A(1) is smaller than B(2) (though, of course, this need not be the case) so we branch to box 60 and put A(A) into C(C) (Here A(1) into C(2)). We then execute boxes 70 and 110 thus incrementing A and C by one (so now A=2, B=2, C=3). A and B are now both tested again to see if either has reached 5 and as they have not, we branch back to box 50 to compare A(2) and B(2) etc. You should see that this process is repeated until one of the lists A(X) or B(X) has been exhausted so that either A or B has the value 5. When this occurs, we encounter the programs line 120-210 mentioned last month (shaded area of flowchart Fig.1) and the process changes slightly. In box 20, originally, we only entered 4 items in each list so that when A or B equals 5 (say A) we will try to compare the next item in list B with the non-existent value A(5) unless something happens to change the flow of the program. This is in fact done. When A=5 any items that are left in list B must all be larger than any of the items that were in list A and they must also be in ascending numerical order so that all that is required to complete list C is to transfer the remaining items in list B directly onto the end of list C without any comparisons being necessary. This is done in boxes 150-170 (If B=5 and A=5 then the same argument applies as before and the transfer of the last items of list A to the end of list C is dealt with by flowchart boxes 190-210).

The last few flowchart boxes form a FOR NEXT loop which is used to print out the merged list C.

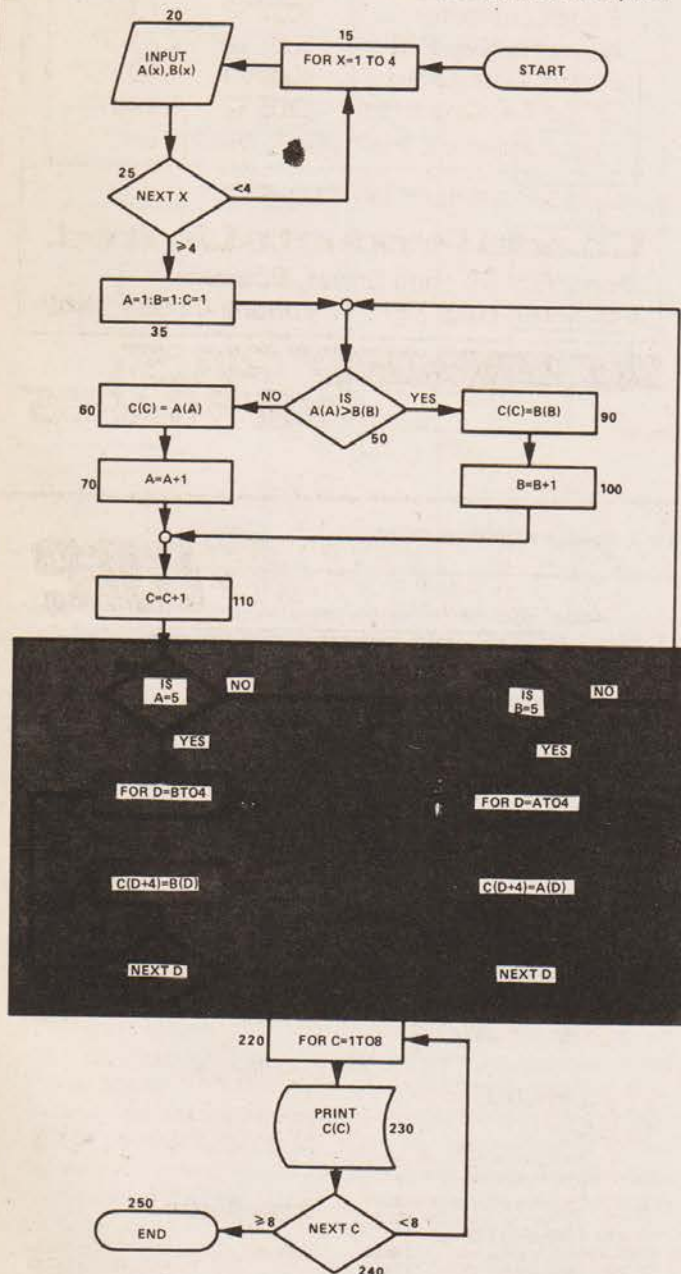


Fig.1. The flowchart for last month's problem, the shaded area represents lines 120 to 210.

### Sorting The Algorithm

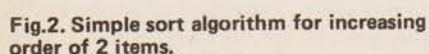
The object of the problem was to try to decide what lines 120-210 of the two list merge program were included for.



The last part of last month's homework asked you to see if you could think of a way of simplifying the program by replacing lines 120-210 with something else. The program listing given below is one possible solution — I leave you to work out how it operates.

[illegible]

So far we have examined a simple search algorithm and a merge algorithm, before we go on to consider anything more complex in either of these directions, we will take a look at a simple sorting algorithm and program.



```

graph TD
    START([START]) --> INPUT[/INPUT  
L(1), L(2), L(3)/]
    INPUT --> J1(( ))
    J1 --> D1{IS  
L(1) > L(2)}
    D1 -- YES --> E1[E = L(1)]
    E1 --> L1[L(1) = L(2)]
    L1 --> L2[E = L(2)]
    L2 --> J2(( ))
    D1 -- NO --> J2
    J2 --> D2{IS  
L(2) > L(3)}
    D2 -- YES --> E2[E = L(2)]
    E2 --> L2[L(2) = L(3)]
    L2 --> L3[E = L(3)]
    L3 --> J1
    D2 -- NO --> STOP([STOP])
  
```

You should begin to see a general algorithm appearing from all of this which can be used for any length of list (N). For P=1 to N, compare L(P) with L(P+1) and reverse these if necessary, then go on to the next value of P. This FOR NEXT loop should be repeated until we manage to go once completely through the FOR NEXT loop without having to reverse any pair of numbers L(P) and L(P+1). See Fig.4 and the following program.

I leave you to work out the details of the operation of this program. One unusual point you will notice is that part of the work of a FOR NEXT loop in this program is carried on in a part of the program that is physically outside the loop. This is perfectly acceptable even though we have not met it before.



# BEGINNING BASIC

This may sound a little complex when compared with the previous search algorithm but when we look at how much more efficient this algorithm is than the previous one, we will certainly see that for any reasonable length list the extra complexity is more than justified.

Before we can compare the efficiency of the two algorithms we must find a criterion that we can reasonably consider as a measure of efficiency for a search algorithm. Such a criterion may, for example, be measured as follows:— Every time we look at one of the locations in the list and compare it's contents with our chosen number we will call this operation one comparison. Our criterion will then be the number of comparisons we have to make before we find our chosen number or prove it is not contained within the list. We will make this measure less random by ensuring that our chosen number is in the worst possible position as far as location is concerned and we should now have quite a good test. For a list of say 1000 items our first algorithm could take up to 1000 comparisons whereas the binary search can not take more than 10 or 11 comparisons — almost 100 times as fast.

## Try This Yourself

For homework this month you might try to draw a flowchart to illustrate the operation of the binary search. Next month we look at a very efficient sort algorithm which makes our binary search even more attractive.

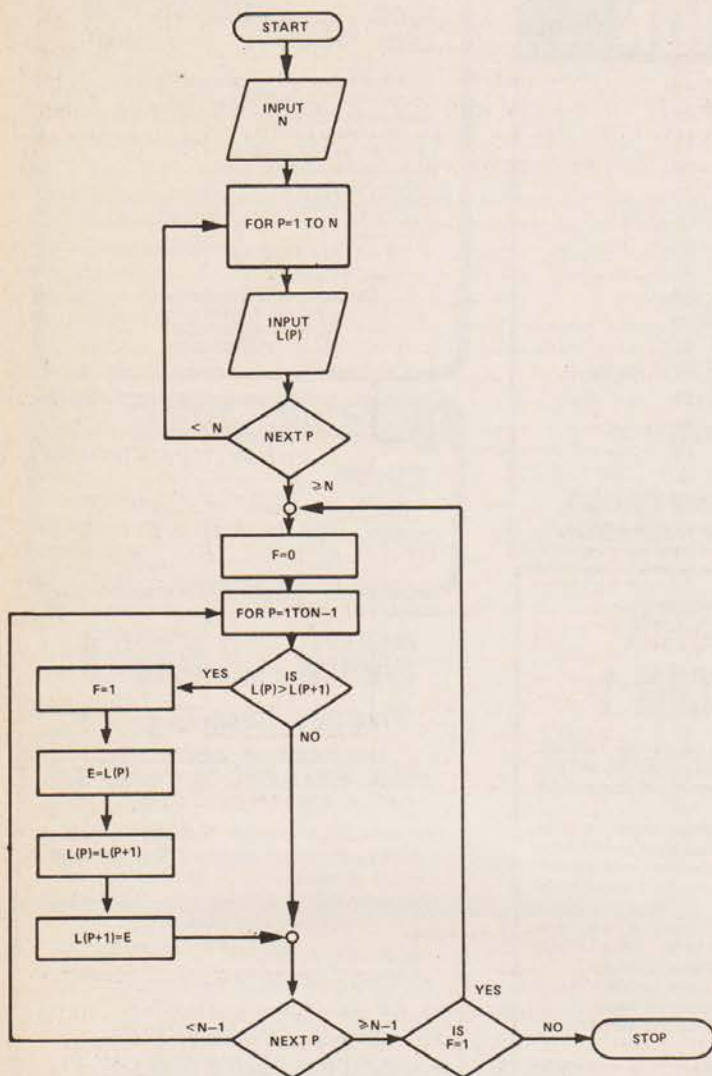


Fig.4. Flowchart for the program to perform a simple sort on any number of entries.

## The Binary Search

Now we have a sort algorithm of sorts (ouch!) there is a far more efficient search algorithm that we can use that depends for its operation upon the fact that the list of items we are to search are in numerical order. This is called "The Binary Search" for reasons that will become more obvious as we describe it. If we take any list of numbers in any numerical order and try to find one particular number in the list, then if we divide the list into two equal halves, we can say for sure that if the number exists at all in the list it must reside in one of the two halves, though we would not know which. This may seem very obvious, but if we now specify that the list is numerically ordered, then we can say which half of the list contains our chosen number simply by comparing the contents of the halfway location with our chosen numbers. If these contents are larger than our number then our number must be contained in the lower half of the list and vice versa. Having eliminated half the list, we can now consider the remaining half as a complete list and split this into two and test again, and so on until we either find the item we are searching for, or prove it not to be contained in the list.

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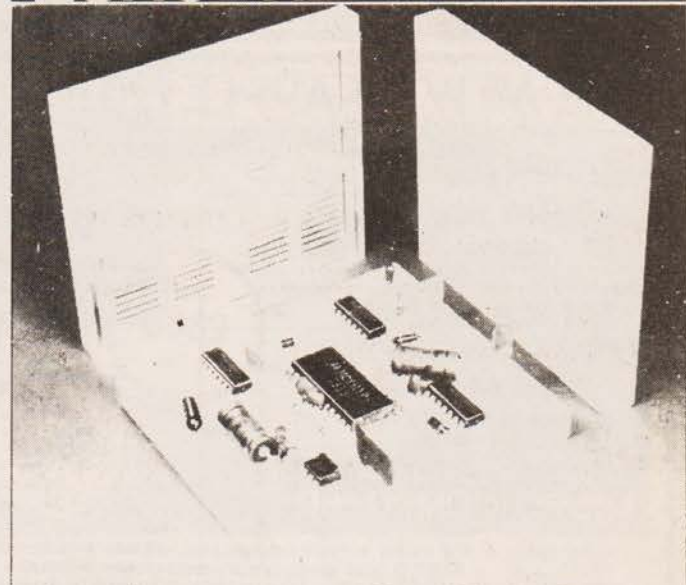
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Compucare is a company that has been set up to provide servicing and maintenance for the popular makes of micro-computers i.e. Sorcerer, Pet, Apple, TRS80, Nascom, CompuKit. Our charges are £7 per hour plus parts. Because of the extensive range of spare parts stocked you can usually expect your micro to be repaired within 10 days for an average charge of £14 labour. Emergency 24 hour repairs can be handled for a £10 surcharge where possible. CompuKits and Nascoms unsuccessfully constructed will be charged a standard £25. Maintenance contracts for these machines are available, see your local dealer for a Compucare Maintenance Application Form.

## THE TRS80 (Special Scoop) Low Priced, Ready to Go!



15K  
£399  
+ VAT

EXTENDED  
WARRANTY BY  
COMPUCARE

PLUGS INTO YOUR OWN TV  
Use your own cassette

LEVEL II BASIC WITH 16K USER RAM provides you with possibly the most powerful micro around. All our TRS80s are fully converted to English Television Standard and include a U.K. Power Supply, Cassette Leads, Sample Tape, Level I & Level II programming manuals, and special lead that enables you to connect direct into your own television.

Special features of Level II Basic enable you to:  
— Set or reset any point on the screen — Test for the presence of a point on the screen (these features enable easy animation) — Save or load data from cassette under program control — File handling capabilities on cassette using named files. — Graphics blocks as standard — design your own pictures and many many more features for only £399 + VAT

## PET COSTS LESS AT COMP and it's a pedigree

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COMPUCARE

8K — Comes complete with integral cassette deck. Full manuals supplied. Powerful 8K Microsoft Basic in ROM. Masses of software available — £499 + VAT

16K — Same as above but with new improved keyboard and cassette supplied as extra. Machine code monitor on board so you can program in 6502 machine code — £590 + VAT

32K — for a little extra get 32K memory providing greater storage capacity for programs or data — £690 + VAT

External Cassette deck for 8K, 16K or 32K — £55 + VAT complete with cable and connector.



## SORCERER SPEAKS YOUR LANGUAGE

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For personal or business use. The best value for money around.

★ 512 by 256 point screen resolution ★ 16K or 32K User RAM ★ Centronics Parallel Port ★ RS232C Serial Port ★ Composite IV peak to peak video output T.V. output supplied as extra. ★ 64 programmable graphics + 64 standard PET graphics ★ 79 key keyboard including 16 key numeric keypad. ★ Expansion bus for connection to S100 Expansion Box.

Word Processing Pac and Development Pac now available.

16K Sorcerer — £690.00 + VAT  
32K Sorcerer — £790.00 + VAT  
S100 Expansion Box — £210 + VAT

Word Processing Pac — £70 Development Pac — £70

## Break the language barrier £138 ONLY + VAT



At a price equivalent to learning one language, LEXICON offers you, English, Spanish, French, German, Italian and Greek. The LK3000 comes to you with the person to person module which contains 6 languages, de-luxe carrying case and a charger adaptor using its own power source which will give you 4-5 hours continuous use, and can easily be re-charged from the mains supply, wherever you may be in the world. Every additional module carries a concise and understandable instruction book. Your deluxe carrying case has room for two additional modules.

Please add VAT to all prices — Delivery at cost, will be advised at time of purchase. Please make cheques and postal orders payable to COMP, or phone your order quoting BARCLAYCARD, ACCESS, DINERS CLUB or AMERICAN EXPRESS number. OPEN — 10am to 7pm — Monday to Saturday CREDIT FACILITIES ARRANGED



JUST COMPARE OUR CASH AND CARRY PRICES!



EUROPE'S FASTEST SELLING ONE BOARD COMPUTER —  
JUST CHECK THE SPEC'S.

AS SEEN IN  
P.E. AUGUST, SEPTEMBER  
OCTOBER 1979

# COMPUKIT UK101

SAMPLE TAPE  
WITH EXTENDED  
MACHINE CODE MONITOR  
AND DISSASSEMBLER  
INCLUDED FREE

## LOW COST SUPERBOARD IN KIT FORM

The CompuKit UK101 has everything a one board 'superboard' should have.

- ★ Uses ultra-powerful 6502 microprocessor.
- ★ 50Hz Frame refresh for steady clear picture (U.S.A. products with 60Hz frame refresh always results in jittery displays)
- ★ 48 chars by 16 lines — 1K memory mapped video system providing high speed access to screen display enabling animated games and graphs.
- ★ Extensive 256 character set which includes full upper and lower case alphanumerics, Greek symbols for mathematical constants and numerous graphic characters enabling you to form almost any shape you desire anywhere on the screen.
- ★ Video output and UHF Highgrade modulator (8Mz Bandwidth) which connects direct to the aerial socket of your T.V. Channel 36 UHF.
- ★ Fully stabilised 5V power supply including transformer on board.
- ★ Standard KANSAS city tape interface providing high reliability program storage — use on any standard domestic tape or cassette recorder.
- ★ 4K user RAM expandable to 8K on board £49 extra.
- ★ 40 line expansion interface socket on board for attachment of extender card containing 24K RAM and disk controller. (Ohio Scientific compatible).
- ★ 6502 machine code accessible through powerful 2K machine code monitor on board.
- ★ High quality thru plated P.C.B. with all I.C.'s mounted on sockets.
- ★ Professional 52 Key keyboard in 3 colours — software polled meaning that all debouncing and key decoding done in software.

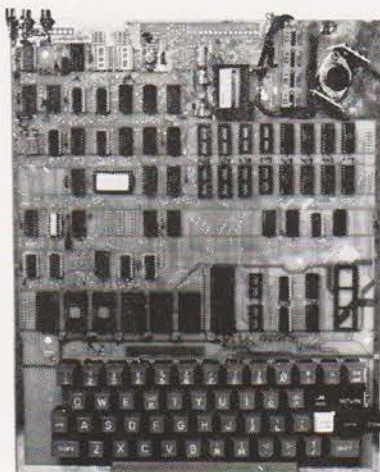
**COMMANDS**  
CONT LIST NEW NULL RUN  
STATEMENTS  
CLEAR DATA DEF DIM END FOR  
GOTO GOSUB IF GOTO IF THEN INPUT LET  
NEXT ON GOTO ON GOSUB POKE PRINT READ  
REM RESTORE RETURN STOP

### EXPRESSIONS

**OPERATORS**  
+ \* / % NOT AND OR > < <> >= <= RANGE 10<sup>32</sup> to 10 + 32

### VARIABLES

A.B.C. ...Z and two letter variables  
The above can all be subscripted when used in an array. String variables use above names plus \$ e.g. AS\$



\*8K Microsoft Basic means conversion to and from Pet, Apple and Sorcerer easy. Many compatible programs already in print.  
**SPECIAL CHARACTERS**  
@ Erases line being typed, then provides carriage return, line feed.  
Erases last character typed.  
CR Carriage Return — must be at the end of each line.  
; Separates statements on a line.  
CONTROL/C Execution or printing of a list is interrupted at the end of a line.  
"BREAK IN LINE XXXX" is printed, indicating line number of next statement to be executed or printed.  
CONTROL/O No outputs occur until return made to command mode. If an Input statement is encountered, either another CONTROL/O is typed, or an error occurs.  
? Equivalent to PRINT

Simple Soldering due to clear and concise instructions compiled by  
Dr. A.A. Berk, BSc.PhD

NO EXTRAS NEEDED JUST HIT  
'RETURN' AND GO.

Build, understand, and program your  
own computer for only a small  
outlay.

KIT ONLY **£219** + VAT  
including RF Modulator & Power  
supply.  
Absolutely no extras.

Available ready assembled and  
tested, ready to go for  
**£269** + VAT

### FUNCTIONS

ABS(X)	ATN(X)	COS(X)	EXP(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)
FRE(X)	INT(X)		
SGN(X)	SIN(X)		
USR(I)			

### STRING FUNCTIONS

ASC(X\$)	CHR\$(I)	FRE(X\$)	LEFT\$(X\$,I)
RIGHT\$(X\$,I)		STR\$(X)	
LEN(X\$)	MID\$(X\$,I,J)		
VAL(X\$)			

## EXTRAS AVAILABLE SOON

**COLOUR ADD-ON** enables you to choose your foreground and background colour anywhere on the screen. Flash any character on the screen at will. Full documentation and parts in kit form.

**AD-A-RAM EXTENDER CARD** provides up to 32K Dynamic RAM Expansion, 8 Eeprom sockets for 2708's or 2716's. Parallel Port (centronics compatible) and an RS232C serial port.

## WIN YOURSELF AN ANADEx DP8000 LINE PRINTER

There's never enough good software around. That's why **COMPUKIT LTD.** are sponsoring a software contest. There are 2 categories:

- 1) **Business and Education**
- 2) **Fun and Games**

One lineprinter will be awarded to the winner of each category.

Send or bring along to the address shown below the following:

- 1) The program on cassette in the format used by the **COMPUKIT UK101**
- 2) Any documentation that you have for the program (source listing not necessary)
- 3) This coupon signed by you accepting the rules and conditions of the competition.

### RULES:

- 1) Entries, including documentation, must be printed by computer or typed double spaced, with your name on every page.
  - 2) Send or bring your entries to the address shown below.
  - 3) Entries must be received by midnight on 29/2/80, any received after this time are void.
- Winners will be notified by post before 31/3/80.
- 4) You warrant by your signature that all programs and documentation material included is entirely your own creation, and that no rights to it have been given or sold to any other party, and you agree to allow **COMPUKIT LTD.** to use, publish, distribute, modify, and edit it as it sees fit.

- 5) All entries become the property of **COMPUKIT LTD.** No entries will be returned nor any questions answered regarding individual entries.
- 6) Judging will be by a selected panel chosen by, and including representatives of **COMPUKIT LTD.** Judges may assign programs to any of the categories as they see fit. Decision of the judges is final.
- 7) Employees of **COMPUKIT LTD.**, its dealers, distributors, advertising agencies and media are not eligible to enter.

Name \_\_\_\_\_

Address \_\_\_\_\_

I agree to abide by the above mentioned rules.

Signature \_\_\_\_\_

**COMP** COMPUTER  
COMPONENTS

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# New Bear



## UPGRADE KITS

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TRS 80 . . . . .	16K . . . . .	£69.50
SORCERER . . . . .	16K . . . . .	£69.50

- ★ SIMPLE TO FIT
- ★ LIFETIME GUARANTEE

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☆ 5¼" SINGLE-SIDED	
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34 way Cable per foot . . . . .	£ 0.80

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50 way Socket . . . . .	£ 2.90
50 way Plug . . . . .	£ 4.10
50 way Cable per foot . . . . .	£ 1.20

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5¼" Diskettes, Soft/Hard sectored	
Single Disk . . . . .	£ 4.00
Box of 10 . . . . .	£ 35.00
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Single Disk . . . . .	£ 4.00
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8" Boxes . . . . .	£ 2.50
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EACH BOX HOLDS 10 DISKETTES	

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PE14	Erases up to 6 chips, takes approx. 19 mins.	£ 56.00
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\*Includes a 60 min. Timer.

## ACORN

microcomputer on Standard Eurocard Modules

KIT £65

6502 based

## SYM-1

- ★ 6502 Based
- ★ 4K Monitor
- ★ £160.00
- ★ Fast Cassette Interface

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### WIREWRAP CENTRE

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JWK-6 . . . . .	Hand Wirewrap Kit	
	(inc. sparewire & unwrap tool) . . . . .	£19.13
JUW-1 . . . . .	Unwrap Tool . . . . .	£ 2.67
RHW-BLUE . . . . .	15 metre wirewrap spools . . . . .	£ 2.28

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R30.B-0050 . . . . .	15 metre roll AWG-30 BLUE . . . . .	£ 1.38
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### WIRE WRAP SOCKETS

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16 way . . . . .	£ 0.40
24 way . . . . .	£ 0.79
40 way . . . . .	£ 1.25

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WWT-1 . . . . .	Slotted Terminal Pack of 25 . . . . .	£ 3.46
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WWT-3 . . . . .	IC Socket Terminal Pack of 25 . . . . .	£ 3.46
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## VERO

SEND FOR LIST OF VEROBOARDS, BOXES AND INTERCONNECTING SYSTEM.

NEWBEAR SYSTEMS FOR APPLE II AND HORIZON

## JIM PAK

FOR RESISTORS, CAPACITORS, CMOS REGULATORS ETC. See Catalogue for list.

## TERMS AND CONDITIONS

All Mail Order to Newbury. Please add 15% VAT to all Hardware prices. Official Orders (minimum £10), Barclaycard & Access welcome.

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