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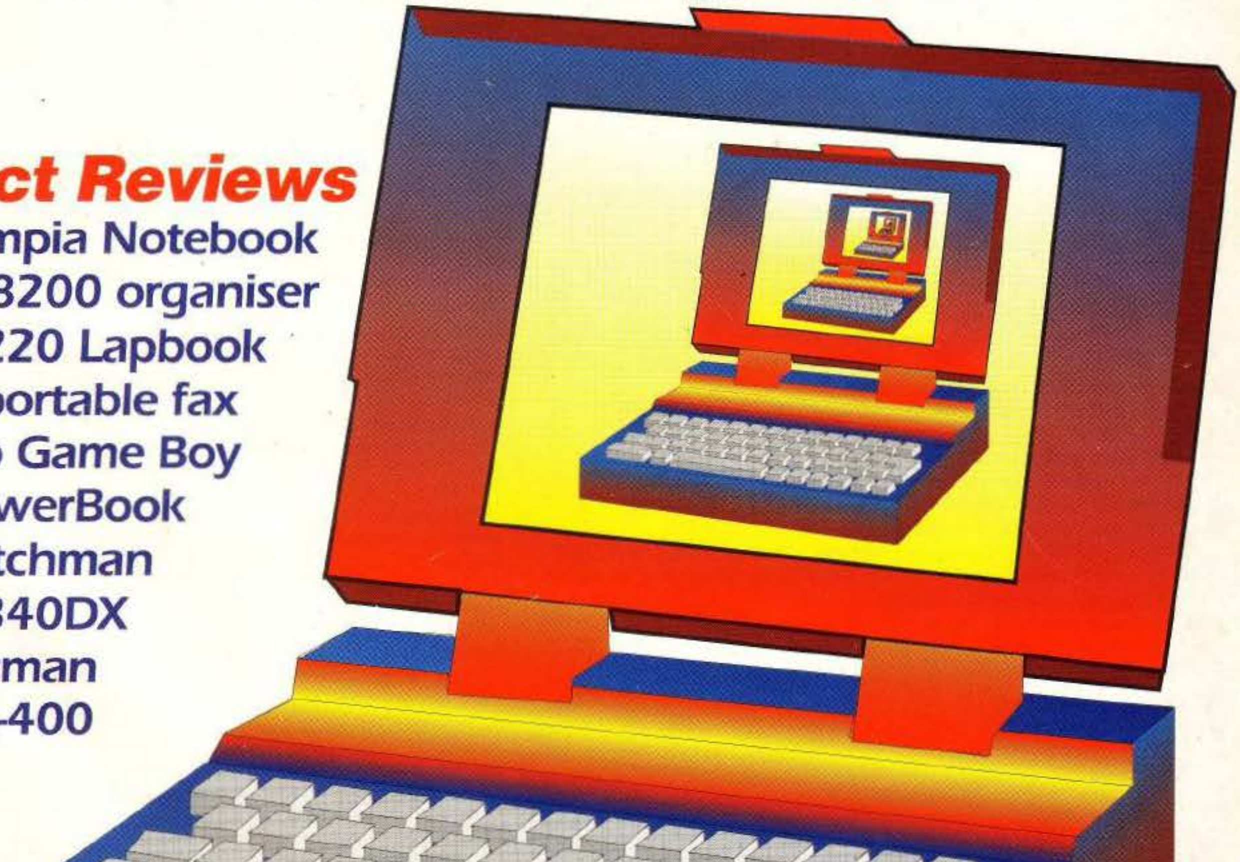
NEW PRACTICAL ELECTRONICS

SCIENCE AND TECHNOLOGY

Get Up And Go

The latest in portable electronic technology and products



Product Reviews

AEG Olympia Notebook
Sharp IQ8200 organiser
Vortec 1220 Lapbook
Comfax portable fax
Nintendo Game Boy
Apple PowerBook
Sony Watchman
Vortec 3340DX
Data Discman
Psion MC-400

Plus

Inside a walkman
Build an infra-red torch
3D TV that really works
Who needs electronic mail?
How semiconductors are made
Barry Fox on how to be a guinea pig

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This month...

The ever decreasing size of electronic components has created a whole new world of portable equipment. Not just portable computers but portable TVs, games, fax machines and electronic books. As well as looking at the practical applications of these we also take a close look at some of the enabling technologies with articles on TFT liquid crystals and semiconductors.

This month's PE also has an exclusive preview of a new development in 3DTV technology – see page 34 – and a report about electronic mail systems.

Kenn Garroch, Editor

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Next month...

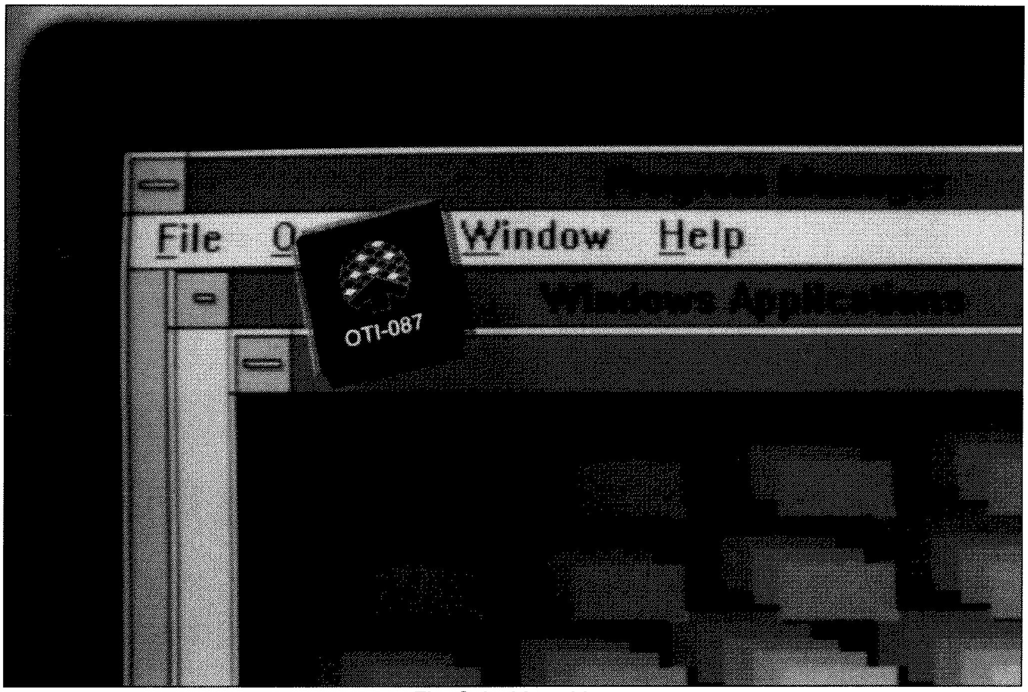
High fidelity entertainment systems, loudspeakers, amps, decks, tuners,CD, equalisers, DCC, Minidisc, plus:
Build A SubWoofer Loudspeaker System
Out On 2 April

Cover illustration: Kenn Garroch

Editor: Kenn Garroch Advertisement Manager David Bonner Production Manager: Richard Milner Publisher: Angelo Zgorelec • **Practical Electronics Intra House 193 Uxbridge Road London W12 9RA Tel: 081-743 8888 Fax: 081-743 3062 Telecom Gold: 87: SQ0567 • Advertisements** The Publishers of PE take reasonable precautions to ensure that advertisements published in the magazine are genuine, but cannot take any responsibility in respect of statements or claims made by advertisers. The Publishers also cannot accept any liability in respect of goods not being delivered or not working properly. • Practical Electronics is typeset at Intra Press on Macintosh computers using Quark Xpress. Reproduction by Circle Rule Ltd. Printing by Andover Press, St Ives plc. Distribution by Seymour Press • **ISSN 0032-6372** •

Innovations

New this month: a video edit suite for PCs and Macs, a novel mains adaptor, a fibre-optic link kit and a super fast SVGA card.



The Oak video chip.

Speedy Windows

If you think that running Microsoft Windows on the average 386 is rather slow, a solution has been presented by Qak Technologies. Its graphics chip is said to boost the performance of Windows programs by five times. Working in 24-bit colour the chip removes the bottleneck that occurs when the main microprocessor is writing graphics to the screen. The OTI-087 is basically a high quality graphics chip that attaches directly to the 32-bit local bus on the motherboard and provides high speed facilities such as bit block transfers (bit blitting) and a hard wired 64x64 pixel cursor. It conforms to the Super VGA (SVGA) standard and is should allow video boards to be built for under $500. No UK price details are available as yet but when it arrives, it should provide a good cheap way to upgrade to high speed, high quality graphics. For more information contact Oak Technology Inc, 139 Kifer Court, Sunnyvale, CA, USA, fax (408) 737 3838.

Octal Power

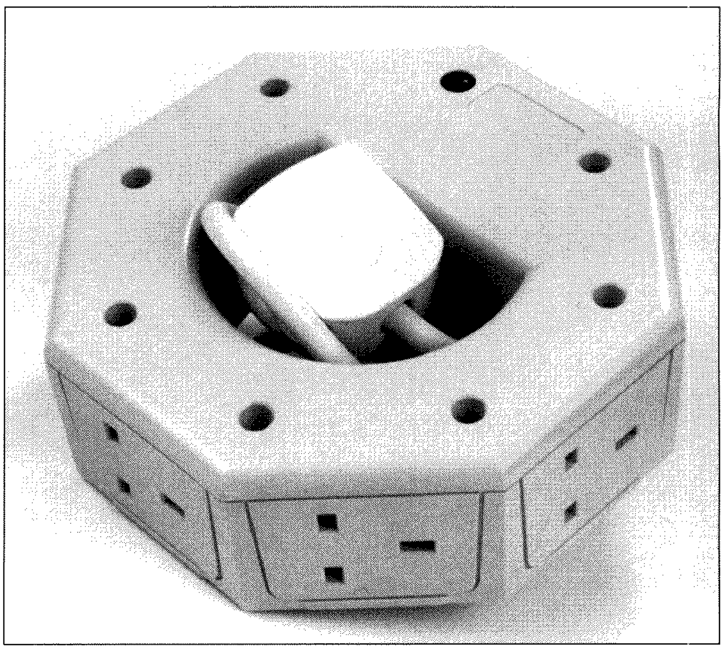
Maplin has announced a very unusual mains socket. The Carousel offers eight sockets mounted in an octagon with space in the centre for the 0.6m extension cord. Each socket is individually shuttered and a red power-on lamp shows when the unit is active. Priced at £19.95, it is available from Maplin Electronic Supplies, Tel. 0702 554161

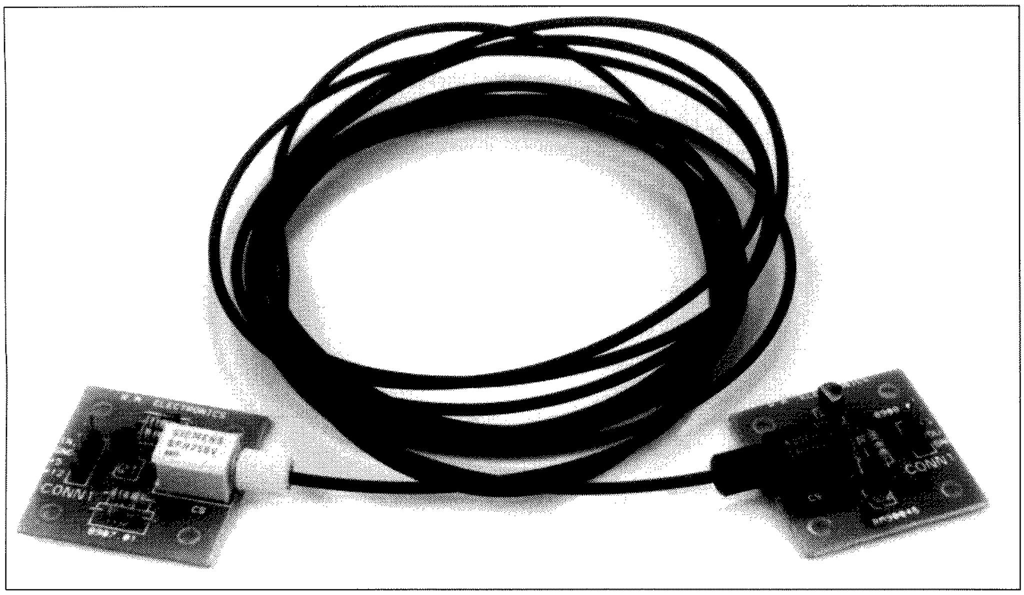
Also new from Maplin is fibre optic digital data link module. This consists of ready built transmitter and receiver modules which are connected via 3m of optical fibre. The system has been designed to be used with data transmission rates up to 20kbps – fast enough to transfer a page of PE text every two seconds. Designed to allow experimentation with optical links, the units and cable are supplied complete with full instructions and circuit diagrams and cost £22.95.

Video Control

Until very recently, computerised video editing was confined to either expensive high quality studio systems or low quality minority home computers such as the Commodore Amiga. Now, Fast Electronic has

Maplin's eight way socket.





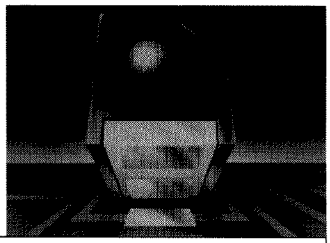
Fibre optic link kit.

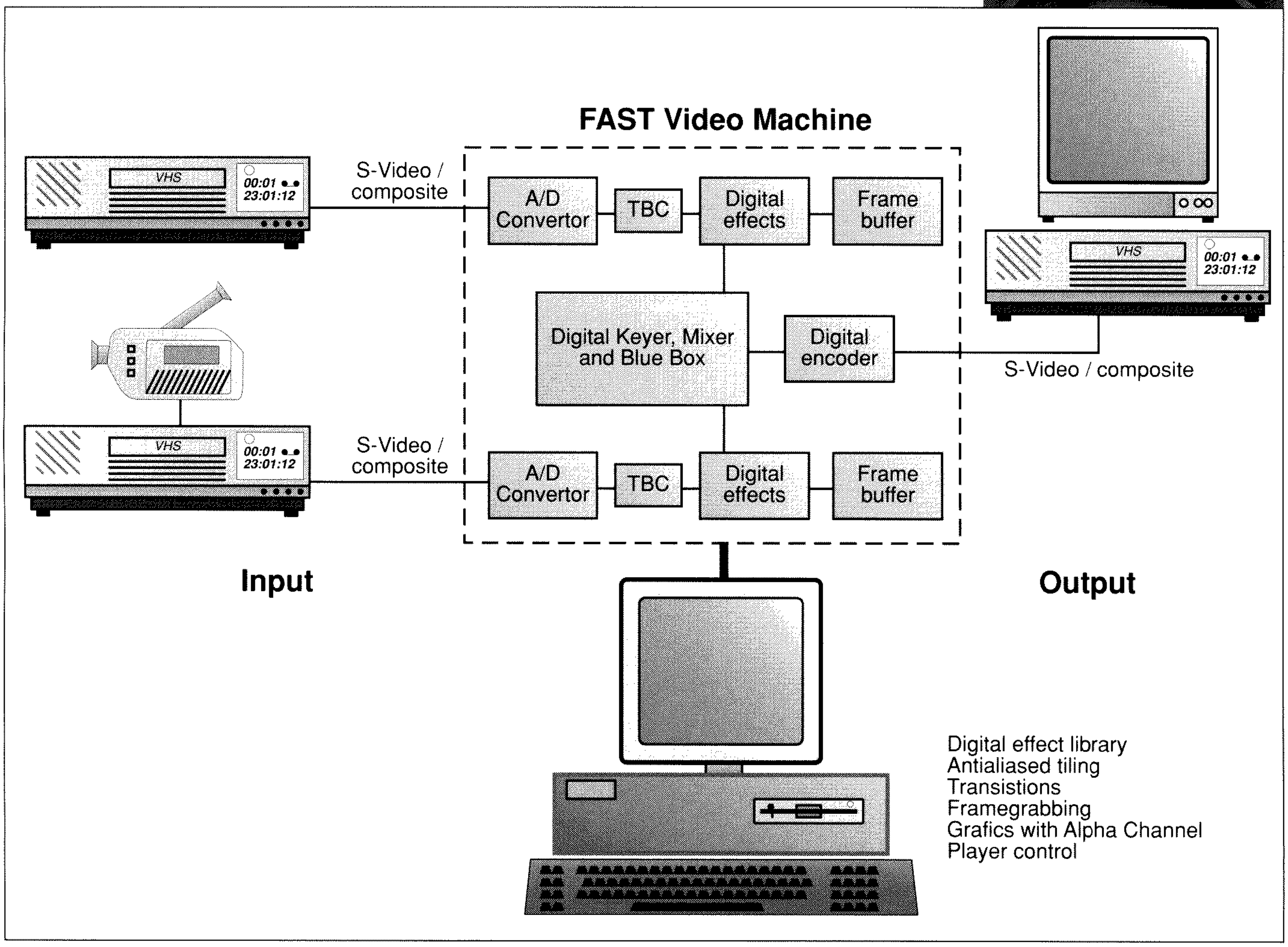
introduced a system for IBM PC compatibles and Apple Macintoshes. The Video Machine uses the graphical interface on the computer to control the video editing facilities. The video information can come from a variety of sources and can be combined with computer generated graphics including Postscript (a page description language) fonts and layouts from other sources.

Unlike other systems in the market, the Video Machine allows the user to mix two live video sources and apply effects. No additional hardware is needed and a number of effects libraries are provided with the system. These include slides, curtain effects, wipes, smooth zoom and shrink, negative and blue box effects. All processing is performed by the add-on board so that they work smoothly and in real time, not taking up any of the computers processing power.

A number of video standards can be used with the Video Machine and facilities are provided to merge PAL and NTSC. Both video in and out can be S-video or composite and a digital encoder chip makes sure that the output signal is of broadcast quality. The whole package will cost around £2000 and is available from Magnifye – Tel. 071 221 8024. ■

The World's 1st surface mount LED



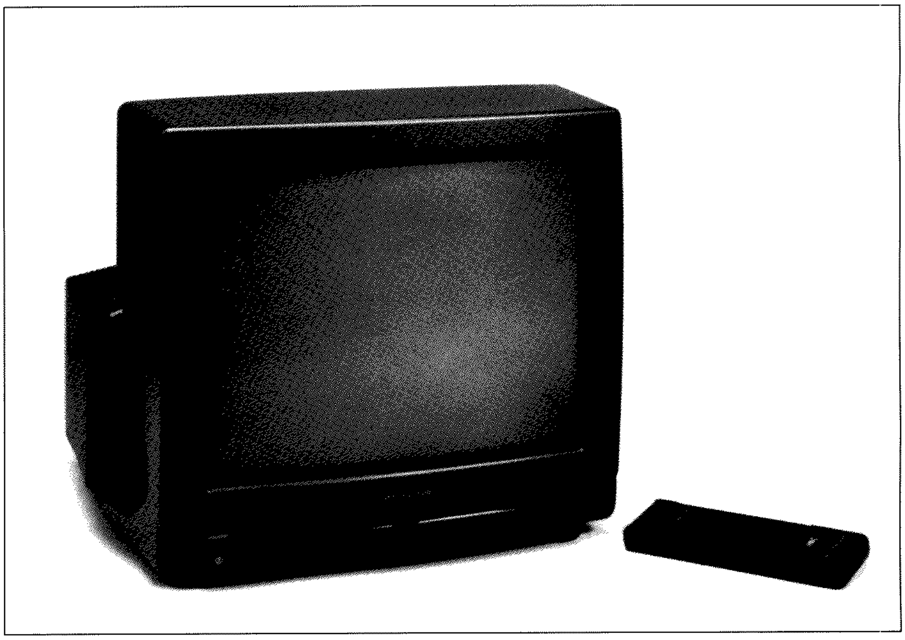


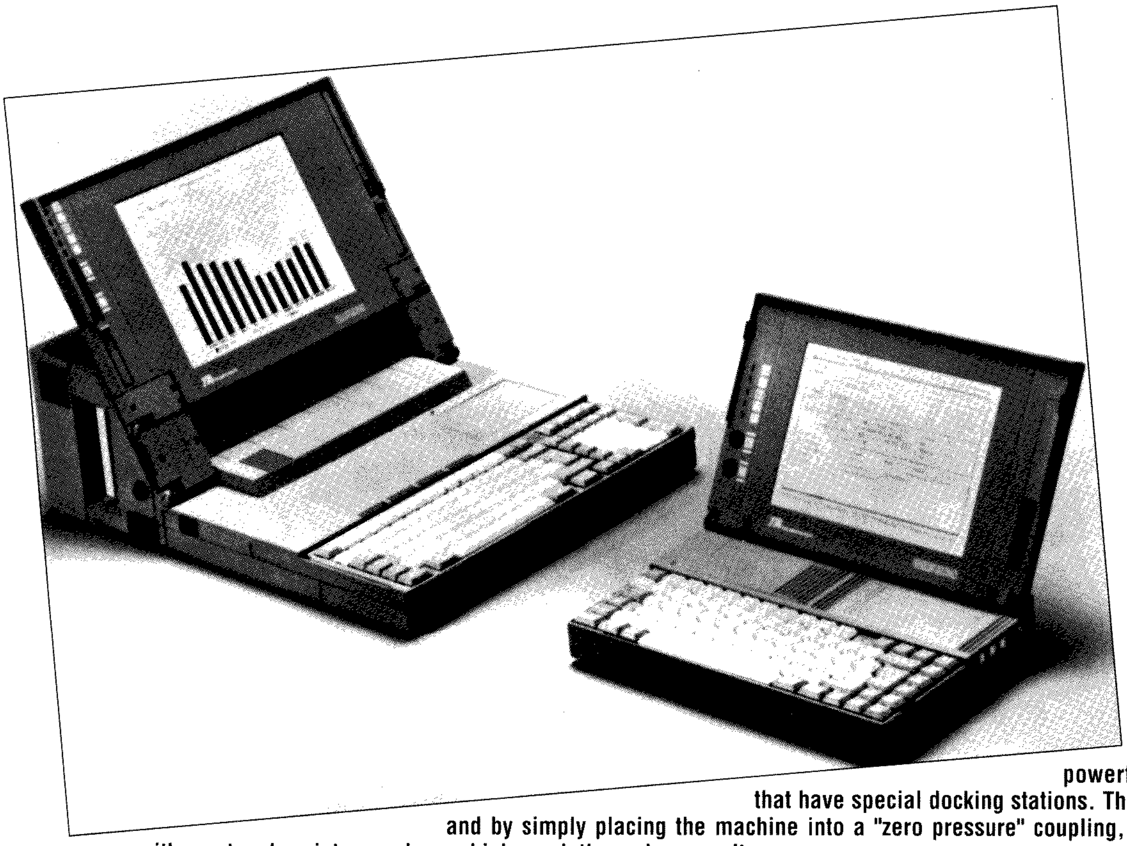
What's New

These groovy camcorders are from Fuji. At the top is the Fujix-8 F60wide 8mm which features one touch conversion from standard to wide field of view in the camera's 6x zoom lens. Other features include six speed shutter (up to 1/4000s) and the Easy Finder viewfinder which allows the user to see both the subject of the shot as well as the surrounding scenery.

On the left is the Fujix Hi8 which offers 410,000-pixel resolution for sharp images – the horizontal resolution is more than 400 lines. In addition, it sports stereo sound and an 8x power zoom lens. Both models have the dual-position Multi-Action grip which, in one position, can be used as a carry handle and in another is the stabilising handgrip with built in trigger. The handle can also be used as a tripod with built in remote control.

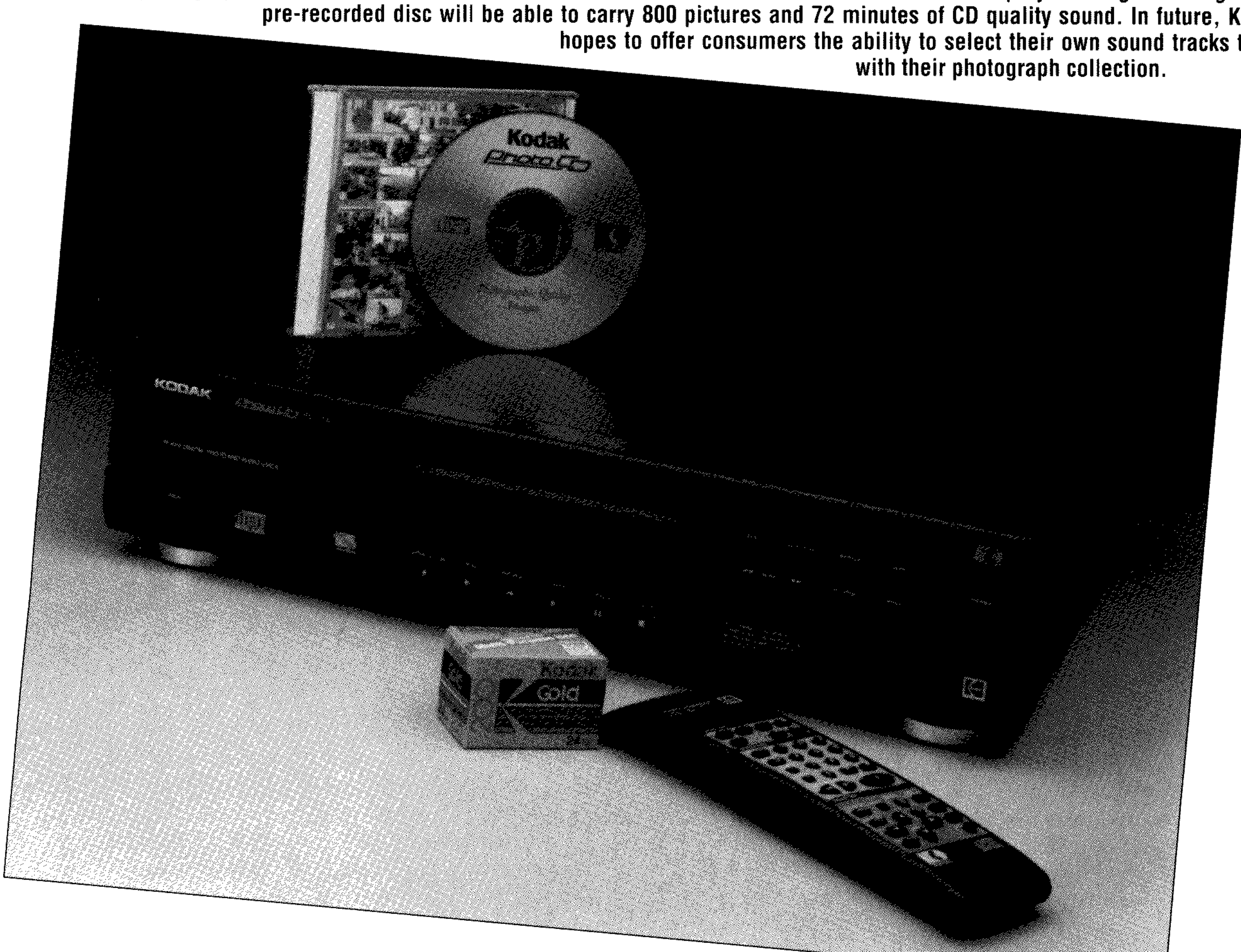
This new FST (Flat Square Tube) portable from Ferguson is one of two new models. They both offer a 15in colour screen and the A36F sports Fastext. The A36R costs £229.99 and the A36F £249.99.





The Walkstations from Triumph Adler are powerful portable computers that have special docking stations. These go on a user's desk and by simply placing the machine into a "zero pressure" coupling, they can communicate with a network, printers and even high resolution colour monitors.

The Kodak Photo CD model PCD870 shown below is the machine that will appear later this year, able to display home photographs on a TV. New features will be added to later models that allow sound to be played alongside images – a pre-recorded disc will be able to carry 800 pictures and 72 minutes of CD quality sound. In future, Kodak hopes to offer consumers the ability to select their own sound tracks to go with their photograph collection.



From A Twitch In A Frog's Leg...

Early experimenters detected electricity by its effect on muscles. Things have moved on a little since then as Jane Fuller explains.

Ever since the development of the transistor, the trend in electronics has been towards smaller and more powerful devices. The move from discrete devices – transistors packaged in single containers with just three leads sticking out – to integrated circuits was just another step in a continuing process. Nowadays, almost every electronic gadget relies on integrated circuits of one kind or another and most use that all-purpose device; the microprocessor.

Early Days

The computers developed in the early 1950s relied on the valve as a switching device. As soon as the transistor came along, it was snapped up by computer designers to reduce the size of their machines drastically – it also increased their reliability and speed. Again, integrated circuits were a big step forward with large numbers of transistor switches being fabricated onto one chip. The move to put the whole computer, or as much of it as possible, onto a single piece of silicon came soon afterwards and resulted in the microprocessor. With greater levels of miniaturisation and integration, more and more processing power became available until nowadays, microprocessors are as powerful if not more so that many minis and look set to leap ahead of the mainframes in the very near future.

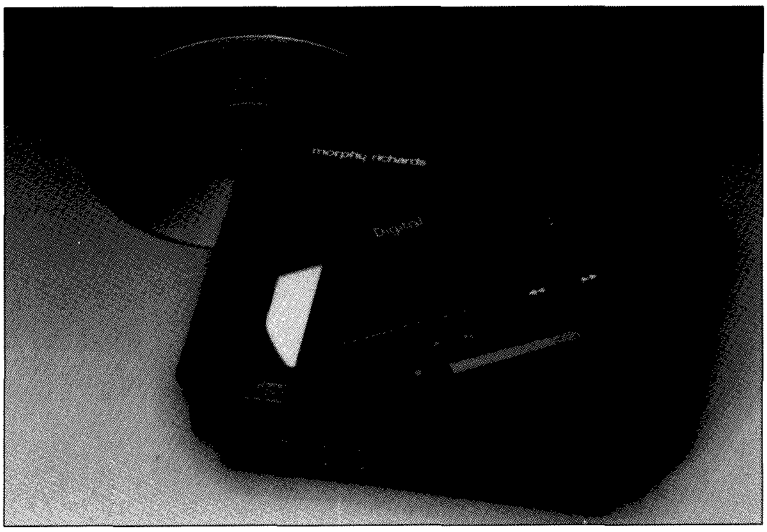
What the microprocessor is good at is taking in information, making decisions on the basis of it and then exerting control signals. It is the perfect control device whose capabilities are now limited mainly by programming.

This electronic dictionary holds over 100,000 words.

Other Technologies

While the microprocessor was under development a number of associated technologies were also improving. The techniques used to squeeze more and more transistors onto a chip were also being used for other devices. Mass storage systems increased in capacity. Specialised dedicated controllers, such as those used to drive video displays and manipulate the signals from a disk drive or from a microphone were also being thought up and then improved upon. The capabilities of electronic components were increasing dramatically while reducing in size and plummeting in cost.

The finest quality music on the move.



Electronic Gadgets

The electronics industry has now reached the stage where, demand has a tendency to create a supply. The invention of the Walkman showed the world that high quality personal stereos were possible. Now the portable

Nothing's Impossible

Although the gadget on the left may not actually exist, it shouldn't be too long before it does.

Developments in LCD screens and electronic communications encoders should enable a portable video-phone to be a reality before the end of 2010.

The limitations on such a device are less on the capabilities of the electronics than on the radio bandwidths available. Transmitting video pictures requires a huge bandwidth compared to speech.

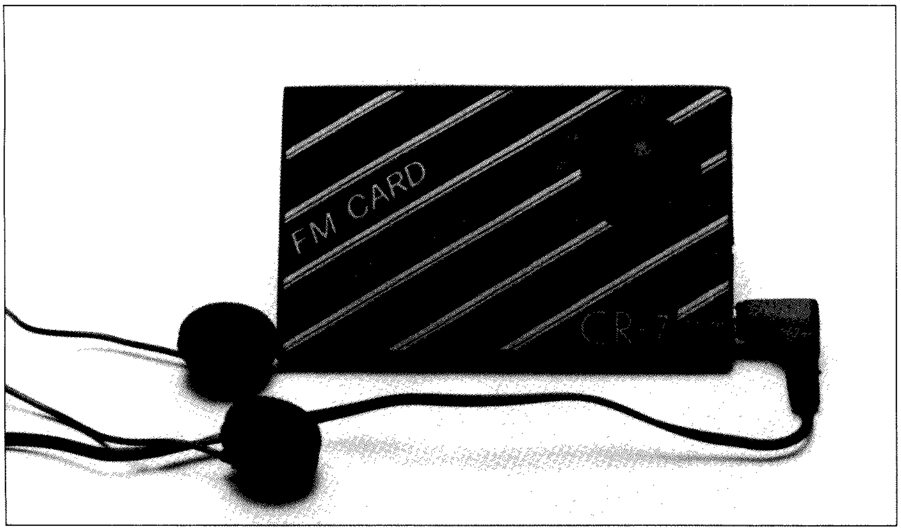
One solution is to compress the video images. Removing unnecessary information such as parts of the image that don't move and sections that have a single colour.

The ability to produce a picture such as this is a tribute to modern electronic technology. A high resolution image scanner digitised the two photographs and then a high speed microcomputer with sophisticated graphics software was used to distort and fit them together.

CD player and soon DCC and Sony Minidisc players will provide facilities never before see or heard – without the creation of the Walkman, no-one would have realised the demand for such equipment could exist. The same can be said of the portable computer and its offspring the palmtops and personal organisers. All of these are science fiction come true.

Nowadays, the consumer electronics market is growing, even in the current recession, such is the demand. Everybody expects the latest technology to be smaller, cheaper and use less power. For example, TV sets have gone from being huge beasts that dominate the corner of a room and consume considerable power, to the hand sized Watchman – the large systems still exist but they are more compact and offer almost amazing facilities such as picture within picture, teletext, remote control and so on.

Modern electronic devices are small enough to fit a radio onto a credit card.



The Near Future

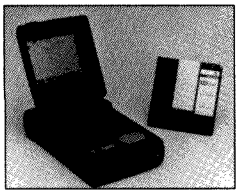
The next few years will see more and more electronic gadgets appearing. Technologies such as high resolution colour LCDs are already with us – Sharp has an exhibition in London's West End which has a number of wall hanging flat screen LCD TVs and they are working on 16in and 20in models which should be available within two years. A lot of portable electronics products relied on 5V power supplies until recently. Now manufacturers are moving to 3V systems since they reduce battery bulk and give a longer battery life.

The Next Century

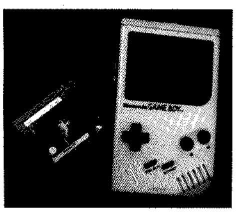
It is always hard to foresee what will happen in the future but electronics should go on getting smaller, cheaper and less power hungry. We will begin to find it in areas previously untouched and find uses for it that are now unimaginable – back at the beginning of the century the science of electricity was in its infancy and who would have dreamed what could happen in a mere hundred years. Imagine what could happen in another hundred. ■

Setting The Scene... Portable Electronics

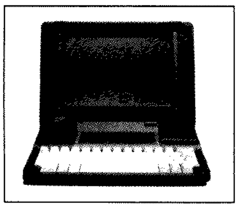
Kenn Garroch takes a quick run through the background of the machines in this month's review section.



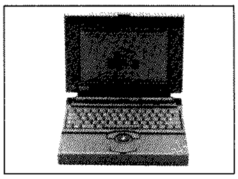
This month's special feature looks at the current state of the art in portable electronics. The first two items are from Sony, the Data Discman and Watchman. Both of these are examples of equipment that will change the way in which we live our lives. Next comes the Gameboy, possibly the most successful Christmas present of 1991/2, it easily outsold its rivals and is steadily taking over as 'the' machine to be seen with. As with the Sony products it makes good use of the liquid crystal display (LCD) screen, a technology without which most portable electronics would be impossible. The Nintendo currently has over 100 game titles available in its slot-in cartridge – another technology becoming widely used in portable systems. Both the Psion MC 400 computer and the Psion IQ8200 make good use of slot-in cards to distribute software, add memory and provide expansion capabilities.The Nintendo Gameboy also uses the ubiquitous microprocessor to control its screen, sound and run its games – many players now spend hours pitting their wits against a tiny piece of silicon which, through its programmability, has so many capabilities we have scarcely even begun to tap them. The other main use of the microprocessor is in personal computers (PCs).



Once upon a time, PCs were large desk bound boxes with hulking great monitors that lurked on the side of the office desk. Thanks to advances in integrated circuit (IC) technology, they have are now on the move en-mass.



At the bottom end of the range are the i286 based systems which run the, now old-fashioned, Intel 80286 microprocessor. The Vortec 1220 with its 1Mb of memory and 20Mb hard disk is typical of the type of machine. It can run most PC applications at a reasonable speed though it is rapidly being superseded by more powerful systems which engender more sophisticated software. The next step up is the 80386SX microprocessor which, running at 20MHz, is at the heart of most PC systems these days. The AEG Olympia is a good example of a 386SX system but in portable form. As a portable system it can be used either in an office as a fully fledged desktop machine or on the move allowing full scale computing any place, any time. Of course, if a 386SX is not fast enough then the power of the 386DX which runs at 33MHz is the next step. This is actually more powerful than many desktop only systems and when coupled with 4Mb of Memory and an 40Mb hard disk drive as in the Vortec 3340DX-4, it is truly a machine to be reckoned with.



Of course, not everyone wants to use an IBM PC compatible and its major competitor, Apple, also produces laptop computers. The PowerBook series are fully compatible Macintosh systems with large memories and hard disk plus the latest system 7 operating system that is so easy to understand and use, a 4 year old can operate it. Alternatively there is the option to get away from standardised systems completely. After all, they do tend to use rather power hungry microprocessors and their operating systems were not originally designed to be portable. The Psion MC-400 is a good example of a portable computer that offers all of the functions required of a laptop, wordprocessing, databases and so on but in a more portable form.

Yet another alternative to portable computing is the electronic organiser. At its simplest this is an electronic version of the filofax with calendars, phone books, sheduler and a calculator – all the necessities needed to lead a thoroughly modern lifestyle. At its most sophisticated the organiser can run spreadsheets, communicate with other computers, hold a dictionary, help manage new ideas and run a wide variety of specialised software. The Sharp IQ8200 with its 128kb of memory outperforms most of the home computers of 8 years ago and is small enough to fit in the average inside pocket. It can even be used with a portable fax system such as the Comfax to send information around the world from a portable cellular telephone. The Comfax is a fully functional modem again, small enough to be put in a pocket. Since it is battery powered, it can be used anywhere any time – truly the mark of a portable electronic gadget. ■

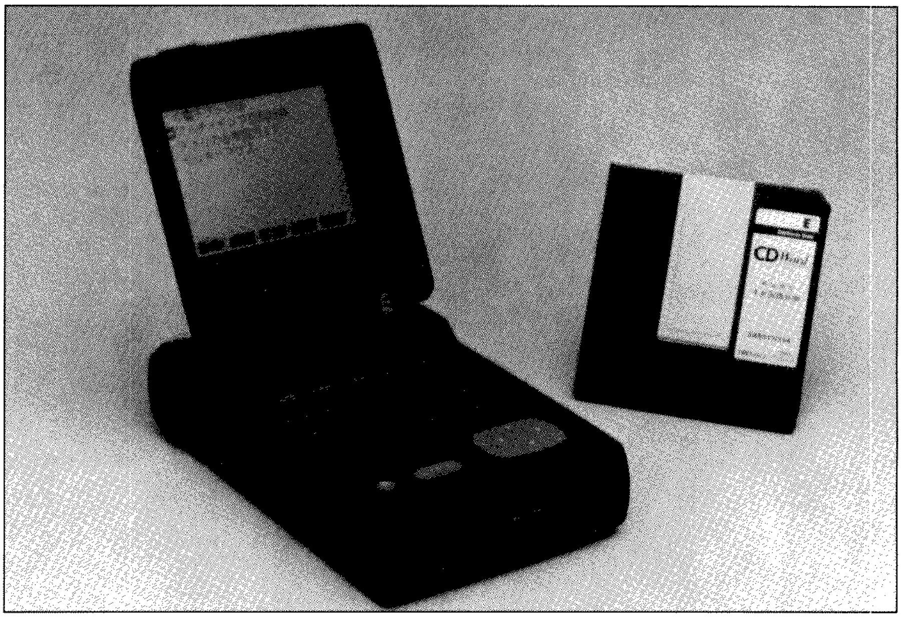
Sony Ushers In The Electronic Book

Micro-electronics has made almost everything portable, even the book. Ian Burley looks at Sony's attempt to take us ever nearer the future.

The Sony Data Discman has arrived in the UK at last. We first saw this compact portable CD ROM player two years ago and after one face-lift it has been launched in the UK as the DD-1EX with a recommended price tag of £350. Over 100,000 have already sold in Japan with an average of two "electronic book" CD ROM titles sold per Data Discman.

What you get is a unit slightly smaller in width and depth than a portable compact disc player, though slightly thicker. The DD-1EX weighs just over 700 grams. Flip up the lid and a qwerty keypad plus a 3.5" diagonal back-lit LCD screen are revealed. The screen has a 256 by 200 pixel resolution and solid text is displayed in 30 columns by 10 lines. Underneath the keypad and accessible by flipping it up is the "electronic book" bay. Data Discman "books" are 3.2in compact disks enclosed in a protective case or caddy – rather like a 3.5in floppy disk. These disks have a 200Mb capacity. Sony likens this to 100,000 pages of text, but you're not restricted to the written word – theoretically up to 32,000 illustrations could be held on one disk. If you get bored with your book you can swap it for a standard 3in audio CD single and listen via the 3.5mm stereo headphone socket.

Sony says there are a dozen UK-produced electronic books, or EBs, available right now – three of which are bundled with the player, one of which has been confirmed as the Hutchinson Encyclopædic Dictionary. It's expected that up to fifty UK EB titles will be available by the end of the year. Titles range from travel guides, dictionaries and even the Thomson Directory, to such exotica as the Michelin Restaurant Guide and a guide to the best golf courses in Europe. The Data Discman's graphics capabilities are exploited by The London Guide published by Nicholson, which features a series of maps to accompany texts on tourist information, shopping, theatres, where to stay, and so on. Prices so far range from around £40 to £60 per title. Sony is very keen to assist the compilation of new titles and prospective EB publishers are offered a complete authoring and mastering service. Currently over 85 other EB titles have already been published in Japan and America. Incidentally, full marks to Sony for not only providing the DD-1EX with a TV/Video display adaptor, but including the three main TV standards, Pal, Secam and NTSC as well – the DD-1EX is obviously aimed at jet-setters. Up to twelve languages can be supported by Data Discman too.



There is a barrage of search options to help you find the required passage to view. You can search simply by word or parts of a word, by key word for a sort of thesaurus-like search, combination searches, menu searches and graphics searches. Finally there is a hyper-card text and graphics cross-referenced search.

A lot of thought has gone into power sources for the Data Discman. Unlike some electronic devices I could mention, you would be very unlucky not to have access to either AA batteries (six alkalines give 6 hours operation), a mains electricity source, car cigar lighter socket or a 2.5 hour rechargeable battery pack.

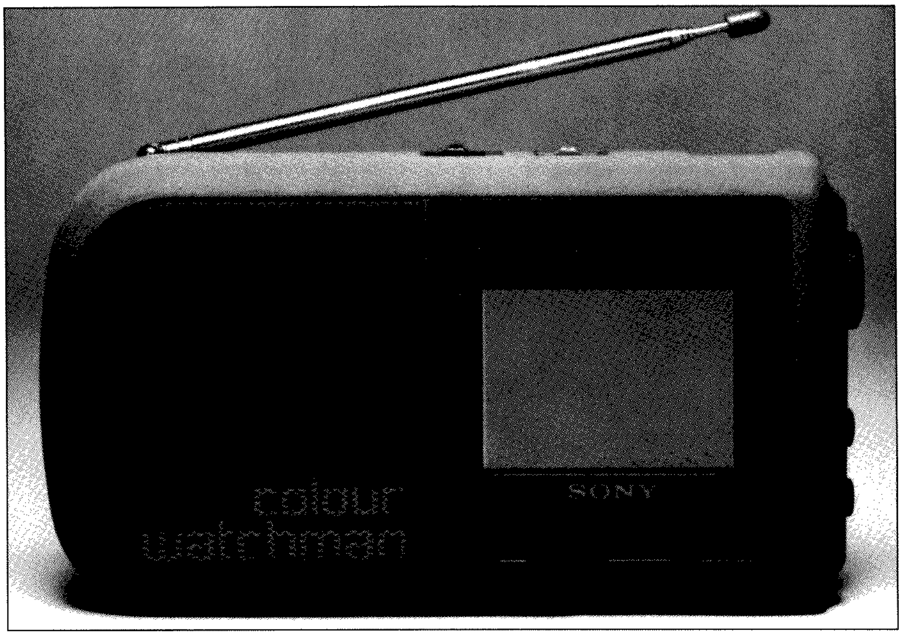
The Data Discman captures the imagination; it's another bit of that once elusive future popularised in science fiction. Whether it's a practical and genuinely useful alternative to the printed book, only time will tell. It's a pity you can't play full size 12cm audio CDs and one also wonders why Sony invented a third incompatible standard for the Mini Disc audio system. Still, it's the perfect gift for people who thought they had everything! ■

Review... Sony Colour Watchman

Andrew Armstrong wanted to buy a portable TV so after checking out the competition, he decided on the Sony Watchman.

The Sony Colour Watchman TV is a liquid crystal television which differs from the market norm. It has a three-inch screen, but is the size of a small portable radio, and is powered by six C cells instead of the more usual AA cells. This is in marked contrast to most other miniature portables on the market.

When looking to buy a portable colour TV, my initial thought was that the larger-screen models might be easier to watch. The screen size ranged from 2.2in to 4in and I found that the viewing angle was very limited. In non-ideal viewing conditions, the colour quality and contrast were lacking and I remained unsure that I wanted to spend money on one of these sets.



I then came across the Colour Watchman and was immediately impressed by the brightness and clarity of the picture and by the fact that it remained viewable over a range of angles – it also has a much larger loudspeaker giving a much better sound.

The picture is better than that on other sets because the liquid crystal screen uses a different technology. Thin film transistors (TFT), employ amorphous transistors deposited on the screen glass to drive the liquid crystal elements. This means that each dot can be driven all the time, rather than being scanned. TFT technology is described in more detail on page 30.

When I say that the set is "larger" than many other small portables, it isn't a monster. The overall dimensions are 208mm wide by 116.5mm high by 72.5mm to the back of the battery compartment. It weighs approximately 1.1 kilograms with the batteries fitted – about as much as the proverbial bag of sugar – and has a stable and reasonably ergonomic carrying handle, which doubles as a prop for desktop use. The styling is elegant in mat grey with a black surround to the screen and a fine, punched metal grille over the loudspeaker. As you might expect from the company that pioneered play-as-you-go audio, the Colour Watchman is robustly built without being overweight. Another nice touch is that the on/off and band-change switches are easily thumb-controllable from the carrying handle. The drawback is that you do pay for this quality.

As well as covering the UK UHF/PAL signals, the set can receive European PAL and VHF. It would not work in France, where SECAM is in use, but you should be able to receive German broadcasts in Germany. The set has an integral telescopic aerial and it is possible to plug an external aerial into the 3.5mm jack socket if it is necessary to boost reception. The set also has an audio/video input socket, an earphone output and an external power socket.

This is where I come to my first criticism. Though the power socket is of the concentric type, commonly used for this purpose, it is of a non-standard size. Though I have a suitable 9V regulated power supply, I cannot use it to run the television, because I cannot buy a plug of the right size to fit it. The mains adaptor is included with the set in all countries except the UK. In this country, the power adaptor is sold separately and costs the best part of £20. The controls comprise the slider-type band and on/off switches already mentioned, rotary volume, brightness and colour controls. The knobs are slightly recessed, reducing their vulnerability, have a smooth travel

Continued on page 58

Review... Nintendo Game Boy

Richard Milner is hooked on computer games and reckons, although admitting to be a little biased, that the Gameboy is tops.

Lots of people play computer games these days and they're not all kids or teenagers. Quite a lot of them are sophisticated City bankers moonlighting on their firms' PC or Unix networks outside trading hours. Nintendo in America recently stated that, to their surprise, about 40% of Game Boys were being used by players over 18 years old. But what happens when you leave the office and get on the Docklands Light Railway for the long drag back to your studio flat? You need a portable game machine to get your fix of pixel action. This is were handheld machines come in.

In my (biased) opinion the Nintendo Game Boy is the only portable worth considering. It totally fulfills the requirements and is essentially the game computer version of a Walkman. It is small enough to go into a hip or breast pocket, light enough to be held for long bursts of action without your arms getting tired, narrow enough to stop your elbows sticking out (an important consideration on a crowded tube train). It uses only four AA batteries, which is what most rechargers will do at one go (two sets of rechargeable batteries are essential equipment), and they last for hours. You can play all day on one set – a lifetime of 10-12 hours for Ni-Cads is standard.

The Nintendo has a massive selection of games – well over 100 at the last count – and the game-paks are small and sturdy, packed in individual plastic cases. The games available range from straight ahead shoot-'em-ups to complex adventure and strategy simulations. Two recent favourites of mine are

Final Fantasy Adventure, a graphic role-playing game that took about 30 hours to complete, and Nobunaga's Ambition, a historical simulation of feudal Japan of the 1560s combining elements of Risk and economic control games like the venerable Yellow River Kingdom. Apart from the standard selection you will find at Smiths and Dixons, there are plenty of import games, including original Japanese models, available from stockists in the gadget heaven of Tottenham Court Road. If you go for these you must watch out, because the on-screen instructions are often in Japanese alphabet. If you need an excuse to carry a Game Boy get the Personal Organise pack and use it as an electronic address book.

The Game Boy is a lot cheaper than its rivals at £70 including a free copy of Tetris. Individual game packs range from £20 to £35.

The main disadvantage of the Game Boy is that it has a mono screen which is not backlit. This is why the batteries last so long, but it can be difficult to see the screen in bad light. There is a lighting attachment you can get to solve this problem, as well as other gadgets like a screen magnifier and a carrying case, but with all these hanging off the Game Boy it stops being a neat handful and turns into a mutant monster. Less is more. ■

Review...
AEG Olympia Lapbook SX

Kenn Garroch gets to play with a mid-range PC compatible 386SX portable computer and finds that it does the business rather well.

Notebook computers are now available from a wide range of manufacturers – it seems that anyone who make a personal computer makes a notebook. The AEG Olympia is fairly typical of the latest crop of machines. It uses an Intel 80386SX microprocessor – this is a full power version as seen in many desktop machines – an LCD VGA screen, a full size keyboard, contains a 40Mb hard disk drive, a 3.5in floppy, 1Mb of memory and has a rechargeable battery that gives approximately 3 hours of use.

Speed wise, it is fully as capable as the average desktop machine running under a microprocessor clock of 20MHz. This allows it to run any PC compatible software, from Windows and Corel Draw, to dBase and MS-Word.

Unfortunately, there are a few drawbacks, the first being that the whole thing is fairly weighty. Partly this is the battery, but mainly it seems to be the case and disk drives. Although it comes with a smart carry bag, complete with handle and pouches for the mains adaptor and some disks, it is rather a chore to lug around.

Another drawback is the use of a full power microprocessor. This tends to reduce battery life and, whenever possible, the unit must be plugged into the mains supply to be recharged. Another drain on the battery is the hard disk, although this switches off if it hasn't been used for a moment or two – any package which does a lot of disk accessing will reduce the useful life of the machine further. A second problem with the disk powering down is that there is quite a noticeable delay when it has to spin up to speed again – slightly disconcerting in a wordprocessor and quite irritating in a database.

The keyboard is one thing that limits the size of any notebook computer. It has to be close enough to full size to allow the average fingers to hit the keys reliably. Some short-cuts are possible with half height function keys and doubling or even tripling the functions of other keys. In this respect, the Olympia is rather good. It devotes full keys to arrows, page, home, end and insert – many manufacturers have chosen to double these up. The obvious trade off in a portable is the lack of a numeric keypad. An attempt is made to get around the problem with a num-lock key that converts part of the main keyboard to numbers. The trouble with this is that qwerty keyboards have staggered rows whereas numeric keypads don't.

On the back of the Olympia, hidden away behind rather flimsy shutters, are the external connectors and ports. All of the usual facilities are available, 2xserial and a parallel port, as well as connectors for an external colour VGA monitor, external keyboard, and additional floppy disk drive.

The screen is a VGA compatible LCD which acts just like a monochrome VGA system. It works well for most applications although because of its sluggish update speed, it can blur quite a lot when trying to run fast moving computer games. Brightness and contrast controls are provided and the side lighting system means that the display is quite visible under a wide range of light conditions.

This type of portable is useful for both the commuter and the person who needs to save a little desk space. Ideally it would be recharged every night, ready for the train journey the next morning. During the day, it could be used as a desktop machine being powered from the mains. The journey home could then see more use. It is a full speed, fully fledged PC compatible with the only real drawbacks being the relatively short time between recharges and the weight.

Pricing and availability.
1Mb +MS Works+Mouse £1699
2Mb +MS Works+Mouse £1799
5Mb +MS Works+Mouse £1999
Available from:
AEG Olympia
Tel 0753 630 111 ■

Review... Vortec 3340DX

Nigel Gregory takes a liking to to this super powered notebook computer even though he finds it somewhat of an effort to lug it up the stairs to his flat.

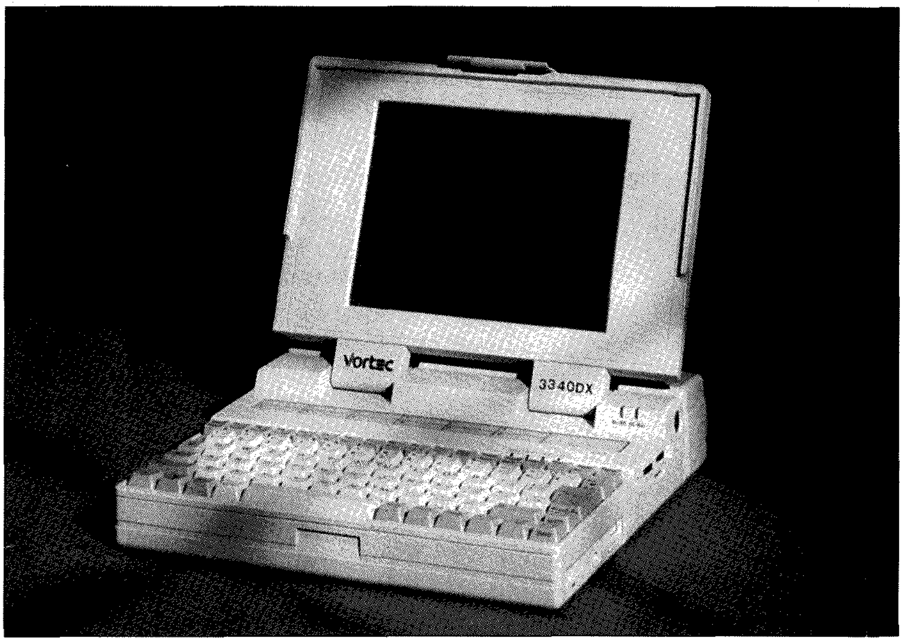
When you have recently moved house and had to lug an old PC compatible and monitor up two flights of stairs, you begin to realise the attraction of a notebook sized computer. However, potential purchasers should be warned that while a notebook PC may fit into a briefcase, it will feel like you have placed a couple of bricks in with your papers, not a notebook.

The Vortec 3340DX is not very different from its competitors when it comes to weight and size, weighing in at 8 lbs with the battery pack connected, and measuring about the size of a thick A4 pad.

In terms of specifications the review model contained: a 3.5in 1.44 Mb floppy drive, an 80Mb hard disk, a backlit black and white LCD VGA screen, and 1Mb of memory. Various combinations of memory and hard disk size are available.

Where the Vortec differs from several of its rivals is that it uses a fully blown 386 (386DX) microprocessor, rather than its more lowly cousin the 386SX. In practice this means that it runs faster, working at 33Mhz compared to a more typical 20Mhz for an SX. While this might seem like an obvious plus, you should think carefully whether you need this extra power, a 386SX machine is quite capable of running modern applications like Windows. There may be times when the added speed would be useful, running large spreadsheets would seem an obvious example.

While size and weight might seem the most obvious considerations, there is another important factor that should be looked at – the length of time before



the battery needs recharging. For my liking the Vortec's 2hrs does not really seem long enough. If a machine is to be truly portable, then having to operate from the mains every two hours is a distinct disadvantage. With the current specification a second battery pack would seem like a worthwhile investment.

When it comes to the display, the screen is quite adequate for most portable uses, but in common with many LCD screens fast moving graphics tended to blur.

In terms of design the computer does well. The casing is of solid construction, with the added bonus of an attractively styled carrying case. The keyboard has firm response click style keys and the layout is fairly straightforward. With all notebooks the lack of space entails several keys doubling up and performing more than one function. Vortec to their credit have managed to keep this to a sensible minimum.

There are two beneficial additions included with the package.

Firstly, it comes with a one year warranty cover which is mobile. If it develops a fault, an engineer will come out to you on an eight hour basis (the next day), providing you are in the UK mainland. Secondly, it comes bundled with an up-to-date operating system DR-DOS 6. It is also nice to be able to report that the manual is readable, and even contains some pictures of actual screen messages.

With a Recommended Retail Price of £2,099 for the 2 Mb, 40 Mb hard disk version, increasing to £3,299 for the 16Mb, 80Mb hard disk version, the Vortec 3340DX seems like a serious contender in the market for powerful portable business computers. ■

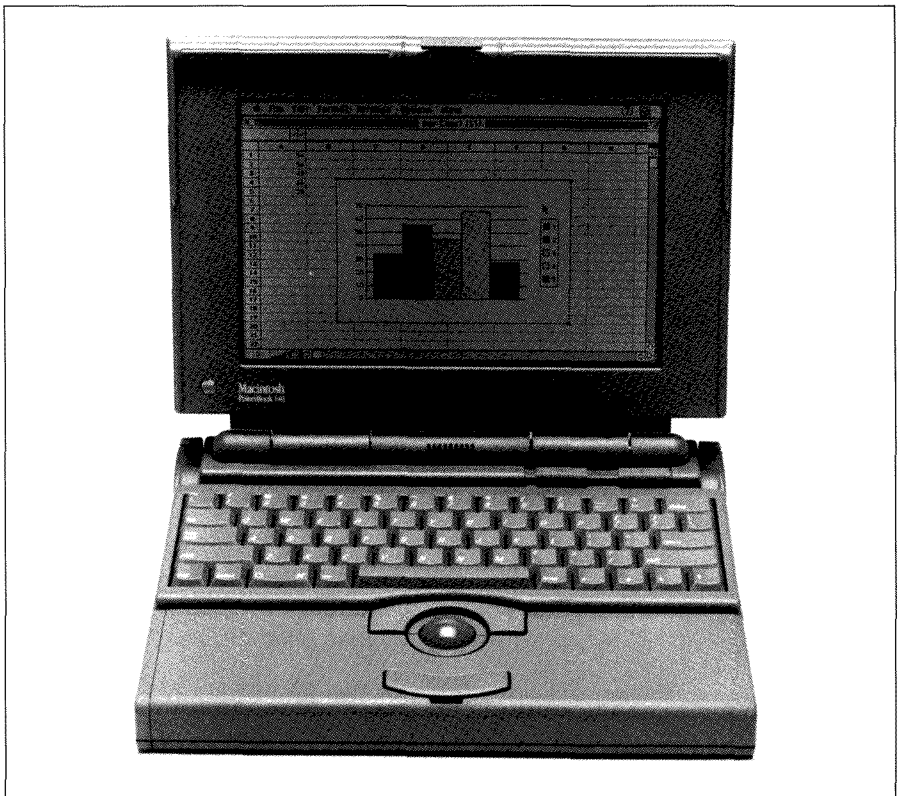
Review... Apple PowerBook 140

John Dean switches on a portable computer and falls in love with a machine that tells him bedtime stories.

Unlike most other portable computers, the Apple PowerBook series is not an IBM PC compatible. It doesn't run MS or DR DOS or MS Windows. Instead it is a completely portable Apple Macintosh. The 140 and 170 machines are actually as fast and powerful as the Mac II series and will run all the Mac software that runs on the standard machines.

On opening up the clamshell top, an number of unusual features are revealed. The first is that this portable has a built in tracker ball – a necessity since all Mac software requires a mouse in one form or another which this replaces. Above and below the ball are the mouse button switches. Both do exactly the same thing and there are two of them, presumably because the manufacturer couldn't decide which was the best position. Another unusual feature is the positioning of the keyboard. The two large blank spaces on either side of the tracker ball serve as hand rests. When using the machine in a mobile environment – say a bus or a train, the machine can be held steady on the knee with easy access to the keyboard, tracker ball and mouse buttons. This is a very ergonomic style and, although unusual to start with, soon proves its worth.

When compared to IBM PC compatibles and MS DOS machines, Apple computers seem to come bundled with lots of software. Most of this is the operating system which is a complete task sharing system that allows a number of applications to be loaded up at once. Although only the current task actually runs (with a few exceptions such as the printer driver), others are only a point and click away.



The screen is the standard LCD type and, on the Mac, has the disadvantage of smearing the mouse. The top of the range PowerBook 170 has an active matrix system which should improve on this. The size of the screen means that it is a little larger than a standard Mac Plus/Classic/SE displays and it provides a clear crisp bright display.

On the power management front, the PowerBook outperforms most of its rivals. Around 35 minutes before the battery actually runs out a message pops up on the screen to say that power is running low and mains power should be used. Ignoring this gives another 25 minutes or so of use before another message pops up to say that the machine will close down in 10 seconds which it duly does with a rather brusque "Good Night". Fortunately, all is not lost and plugging in the mains adaptor revitalises the system leaving the application in the same state at which it was stopped. Overall operation time was about 3 hours twenty minutes non-stop use.

The only real problem with the PowerBook is the price. At £1375 for the model 100, £2195 for the 140 and £3150 for the top of the range 170, they are expensive. On the other hand, they are very easy to use and fully compatible with the wide range of Macintosh software. ■

Review... Psion MC 400

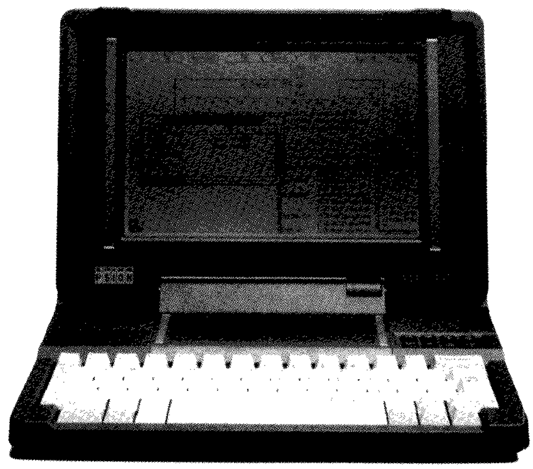
Portable computers come in all shapes, sizes and flavours. Psion's offering is definitely not vanilla as Ian Burley explains.

The PC world has laid down an unwritten specification for compact 'notebook' portable computers. Typically this means a battery life of just 2-3 hours in a 6-7lb device that must behave, as much as possible, like its desktop dinosaur ancestor and can be hidden in a slim line case . When you realise PC technology is constrained by, what is basically, a ten year old system architecture, its no surprise that portable PCs are riddled by compromise.

Psion bravely decided to look from scratch at the requirements of personal computer portability; the PC environment was simply not suitable. To run PC software you needed an expensive, heavy, unreliable and power-hungry hard disk which was out of the question. So late in 1989 the Psion MC (Mobile Computer) series was born.

There are three models in the MC line-up, the non-PC compatible 200, 400 and the PC-compatible 600. The 200 is a cheaper version of the 400 sporting a smaller and inferior screen. Its only saving grace is that it consumes even less battery power than the already outstanding 400. The 600 was supposed to be Psion's insurance policy against market reluctance towards things PC incompatible but has proved to be an even worse compromise than your average notebook PC.

That leaves the MC400, a portable modestly driven by a 10MHz PC/XT class 80C86 processor, running a proprietary multi-tasking and windowing operating system called Epoc. It has no conventional disc drives – hard or floppy, and can run for around fifty hours off one set of eight ordinary alkaline AA batteries. My example's batteries haven't been replaced for three months.



The first thing noticeable about the MC is its first-class production engineering – it looks superb. The 400 has a 640x400 pixel resolution retardation film LCD. It's unlit but razor-sharp. On both sides of the keyboard are flip-up hinged covers hiding four small memory cartridge slots. These accommodate SSDs (solid state drives) either battery- backed RAM (up to 512K) or Intel Flash Memory (up to 1Mb) cartridges. Underneath are two expansion module bays. One is usually occupied by a combined parallel and serial communications interface. The second could accommodate a diminutive 2400bps error corrected modem, a bar code reader interface or even a digital sound recorder which can be used to verbally annotate word processor documents. Unfortunately the latter doesn't appear to be actually on sale.

Another novel feature of the MC 200 and 400 (but not the 600) is a touch-pad mouse-pointer controller. It works well enough, but the pointer's position on the screen is relative to the exact position of your finger (or other convenient stylus like a biro cap) on the pad. I'd like to see the option of a "drag and leave" operation – just like a mouse.

Built in software includes a word processor, card-style free format database, calculator, communications terminal, clock/calendar and diary/time manger. File transfer capabilities are provided for PC and also Apple Mac users.

There isn't much else software to be had for the MC400 besides a Lotus 123 compatible spreadsheet, which comes on a cartridge. But what else does a portable user really need? You can write your own applications using the quirky but powerful Psion OPL language.

Despite some frustration with a rather fragile comms/modem section which I rely on a lot as a journalist, I personally think the MC400 is a brilliant piece of kit, especially as the price is now £200 cheaper at a much more realistic £495. But then my enthusiasm is unfettered by PC dogma. In reality, the MC range has not so far been a commercial success – everybody, it seems, prefers a PC-compatible, compromise and all. ■

Review... Vortec 1220

James Smith opens up a low price portable computer and finds a natty looking machine that, among other things, is an excellent wordprocessor.

The Vortec Laptec 1220 is a 12MHz 286 based laptop that comes with 1Mb of memory, a 20Mb hard disk drive plus built in floppy disk. It is a lower end machine but for the price, is pretty good value.

It is a compact system with full sized keyboard – apart from the space bar which has been shortened to make room for the insert, alt, delete and home keys. This is not really a handicap, especially if, like me, you are a two fingered typist. The main problem with the keyboard is that in a quiet room, it is rather noisy. While pounding away at the keys, a light ringing sound can be heard – presumably the key springs. Although the keys are full sized, there is no room for all those 102 keys you get on a standard PC keyboard so some of the have to be doubled up. Fortunately, this is kept to the minimum although there are a number of purely system functions placed on the keys as well. These allow the size of the screen to be altered as well as inverted – some of the normal VGA screen formats don't actually fit exactly onto the LCD layout so they have to be mapped to fit, these extra keys are a quick way to do the job. The other function on the keyboard is a quick shutdown key – function and then enter – which switches the hard disk off with an audible click and blanks the screen as well. Everything comes back at the press of a key and is just as it was when it was shut down. The system is still consuming power but not as much and gives the user time to leap off one bus and onto the next without having to leave the machine completely on.

Whilst on the subject of using the Laptec in a truly portable situation; it does have a rather natty carrying case and when packed up with its power supply/charger, the whole caboodle is rather heavy. Most of this weight is the two battery packs which slot into the top back of the case. They can be taken out and recharged separately so that by carrying two sets of batteries around, the useful portable life of the machine can be extended.

Even though the portable comes with a 3.5in floppy disk drive, there are times when large pieces of software or data files must be moved to or from its hard disk. The 1.44Mb floppy is not really up to this. The answer is to use one of the two serial ports on the back. Linking up to another machine running DR DOS 6 and invoking the Filelink command allows data to be transferred at rates up to 115,200bps – fast enough for most transfers. Alternatively, a portable modem can be hooked in allowing connection to a main phone socket or even a cell phone for real communications on the move.

On the whole the Laptec is a machine to be proud of. It has the power to run most PC software though it would be a bit slow for Windows. As a portable wordprocessor it is excellent and for running smallish databases, basic spreadsheets and the odd game, it is ideal. At £999 the only real grumble I have is that the clamshell screen does not tilt back far enough for comfortable viewing while sitting in an upright chair with it on my knee.

Vortec can be contacted on:
081 569 7513 ■

Review... Sharp IQ8200

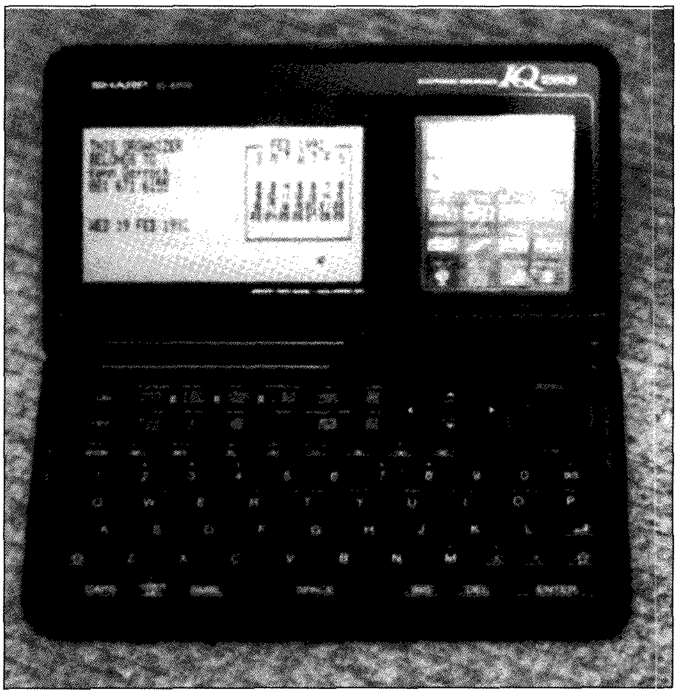
Kenn Garroch files his facts and gets organised with this high specification pocket sized machine from Sharp.

Keeping track of events, people, addresses, phone numbers and ideas is becoming more and more of a chore. Unless you are a mnemonic expert, it is difficult to remember more than several telephone numbers at once, let alone four or five addresses. The electronic personal organiser was designed to solve exactly these problems.

The Sharp IQ8200 is the latest Sharp electronic organiser and, in some ways, can be considered to be the state of the art. As well as all of the usual functions – calendar, memo pad, address book, calculator and idea outliner – it also has an almost infinite expandability via plug in cards.

Positioned to the right of the main screen is a touch sensitive area behind which the cards slot in – only one at a time. On the front of the card are small pictures that give meaning to the transparent touch switches. Applications ranging from spreadsheets, extra memory, computer programming languages, dictionaries, legal databases and even the complete King James Bible are available. Sharp has bent over backwards to enable organisations to create bespoke software that works with the IQ by making all all of the necessary information freely available. It is used on the road by salespersons, not only to keep track of appointments, but also to keep a full database of stock, orders and invoicing details.

Built in communications software operates through a standard voltage RS232 link to allow data to be uploaded and downloaded from the machine to a PC, Mac or any other compatible system.



The basic hardware of the IQ8200 is an 8 line by 40 character LCD screen, 128kB battery backed RAM built in, an 80 key keyboard which is set out in QWERTY format rather than the alphabetical (ABCDEF and so on) sequence used on other organisers. Other keys allow quick access to the main functions, memo, scheduler and so on. Some of the extra functions are accessed by a special SHIFT key – set-up functions and communications options and so on. Other keypress options are available on the touch screen for use with the slot in cards.

In use, the QWERTY keyboard makes it just about possible to type memos and idea outlines – especially if you are a two fingered typist. There is a help facility built in which gives guidance in a context sensitive manner. Unfortunately, there are a number of functions not covered by the help and there seems to be no way of searching the help files for a particular keyword. Perhaps the most annoying aspect of the built in software is that after typing something in, the enter key must be pressed if the information is to be saved. This may sound rather obvious but I managed to lose a couple of memos by hurriedly turning the IQ off when my train arrived, only to find that everything had gone when I turned it on again – quite an unnecessary fault. Another niggle was that the calculator had to be used from the number keys across the top of the keyboard, slow and inconvenient, especially when the enter key doesn't double as the '='.

Apart from a few minor faults, the IQ8200 is small and neat enough to fit in the average inside pocket. Priced at £259.99 with plug in cards ranging from £35 to £100 it is not excessively expensive. The plug in cards make the whole system very flexible – in this sense it is much more than just a personal organiser and is definitely moving towards to low end of the laptop computer market. ■

Review... DataFlex Comfax

Mobile communications is a major area of development for micro-electronics and, until now, sending faxes required a fax machine – Kenn Garroch looks at an alternative.

Miniature portable modems have been around for quite a while whereas fax machines have remained large desk bound beasts. The Comfax from Dataflex is a very flexible modem which not only allows standard telephone communications up to 2400bps but can also send faxes.

The Comfax supplied for this review came as part of a Sharp IQ8200 package. In practice, it could be used with any computer supporting RS232 communications and having appropriate communications software. Hooking up the IQ to the telephone is simple, just open the slot on the side of the machine, plug in modem cable, plug in to the telephone socket and select the number to dial. The 2400bps speed is not all that fast, especially when performing large downloads (transferring data from an online service to the IQ). However, for just sending and receiving email it works well.

All settings are made on the IQ's phone list, name, number, speed and comms information. Once set up, the number can be dialled at the touch of a button. To differentiate between normal comms numbers, such as for bulletin boards or email services, and fax numbers, the latter simply have the letter 'f' placed in front of them. As with all data communications systems, you have to know the settings of the receiving system to be able to communicate with it. The modem is very flexible and allows virtually any data format to be set up.

Up to a point, sending a fax is as simple as hooking into any other communications system – press the required button for the number and

wait for it to dial. The Comfax should connect to any fax machine and had no trouble at all with the switch box I use at home which allows me to have a fax and answer phone on one line – this is more than can be said for some fax machines which just sit and bleat at the answerphone.

Once a connection is established, a number of codes are shown which reassure the user that the system is indeed talking to a fax. The next step is to upload a memo file which is repeated back, again mainly as reassurance. Disconnection is a matter of sending a 'control Z' and that's all there is to it. At the other end, the fax machine produces a printout of the message in the same type face used in the IQ and, unlike messages sent from normal fax machines, no image scanning is involved so there is no loss of quality. The message comes out perfectly clear and more readable that the average fax. There is also a saving on fax paper since only that which is required for the lines of the message is output – very useful for short messages.

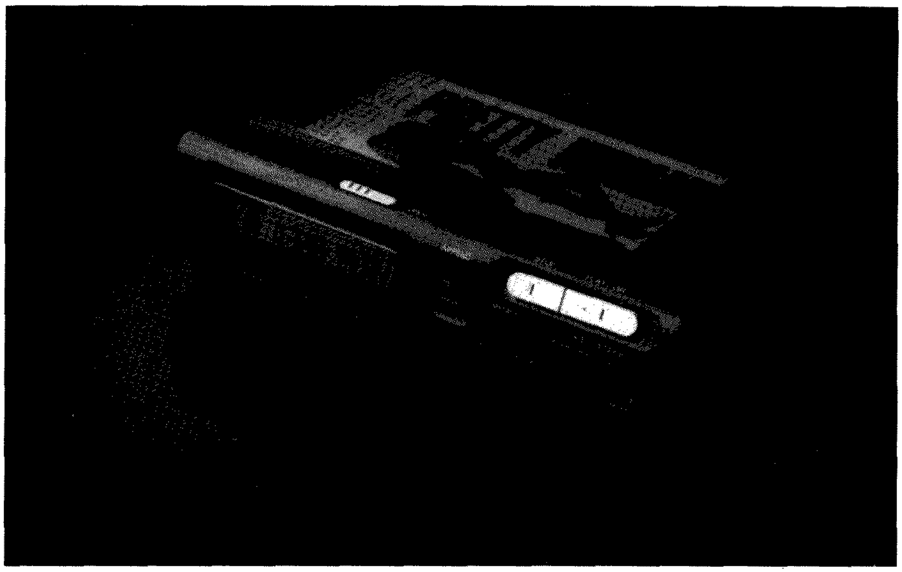
As mentioned before, the Comfax is able to operate on any computer with an RS232 serial port. The manual explains the complete Hayes AT command set which the Comfax supports. It is not something for the nervous and, fortunately, most comms packages will operate in an invisible way saving any need to 'get your hands dirty'.

As far as specifications go, the Comfax is fully Hayes compatible and supports the following communications protocols: V21, V22, V22BIS, V27TER and operates with error correction up to MNP level 5. It will run for up to four hours continuously on a single PP3 battery and a mains adaptor is included as part of the package. The whole thing costs £399 which, considering its capabilities is a pretty good deal if you're looking for communications on the move. ■

Wintering In Las Vegas

Ian Burley reports on the latest DCC machines, Toshiba with VideoPlus, a digital compass and widescreen HDTVs.

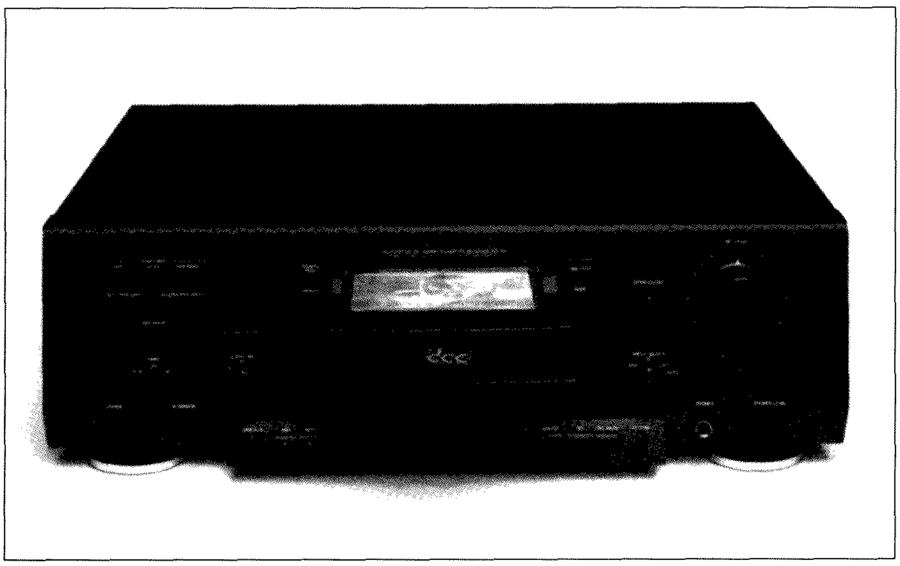
Las Vegas was once again the venue for this year's US consumer electronics industry showcase; CES. It was at last year's event that Philips, with the crucial backing of Matsushita (Panasonic/Technics) and Tandy, rocked the industry by demonstrating DCC (Digital Compact Cassette), its nomination for the replacement of the 26 year old analogue compact cassette. The prize for trying the hardest at Winter CES was probably earned by Philips again this year as the Dutch giant demonstrated its involvement in a wide range of key technology developments including DCC, Compact Disc-Interactive (CD-I), Multimedia PC (MPC), digital HiFi and Kodak's Photo CD system.



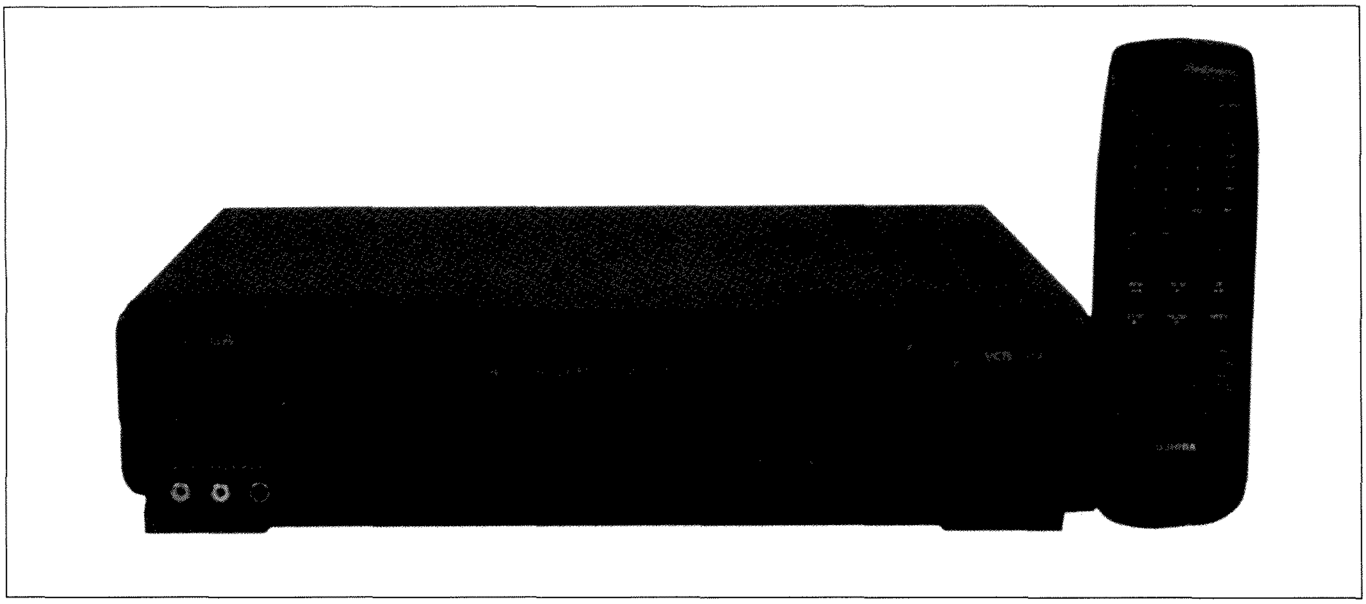
DCC in its most compact portable form.

A year on, Philips has not yet started to ship DCC, but production prototypes were on display for the first time. Philips admits they are behind schedule, but the initial trickle of DCC units should start shipping around mid-summer, well in time for Christmas when production should be in full swing. Philips DCC models will be joined by examples from Panasonic, Tandy, Demon, Sanyo and others. Philips itself showed the DCC900 deck at CES. This has a projected price of about \$700 (£390) – reasonably competitive with up-market analogue cassette decks and right in the DAT ball-park. The DCC900 will exploit some of DCC's advanced features like a karaoke-style recorded text display as well as playback-only capability for conventional analogue cassettes. Bitstream digital to analogue sound shaping is standard. Another prototype, the DCC180 walkman, was also on show. Philips claims the DCC180 is impervious to shock and vibration in normal use.

DCC for the HiFi system.



Initial DCC decks are unlikely to be as cheap as Philips was projecting last year. The reason is that the all-important PASC sound coding electronics still consumes nine chips. Mass-market affordable DCC equipment should start to appear once PASC integration has reduced the chip-set count to two

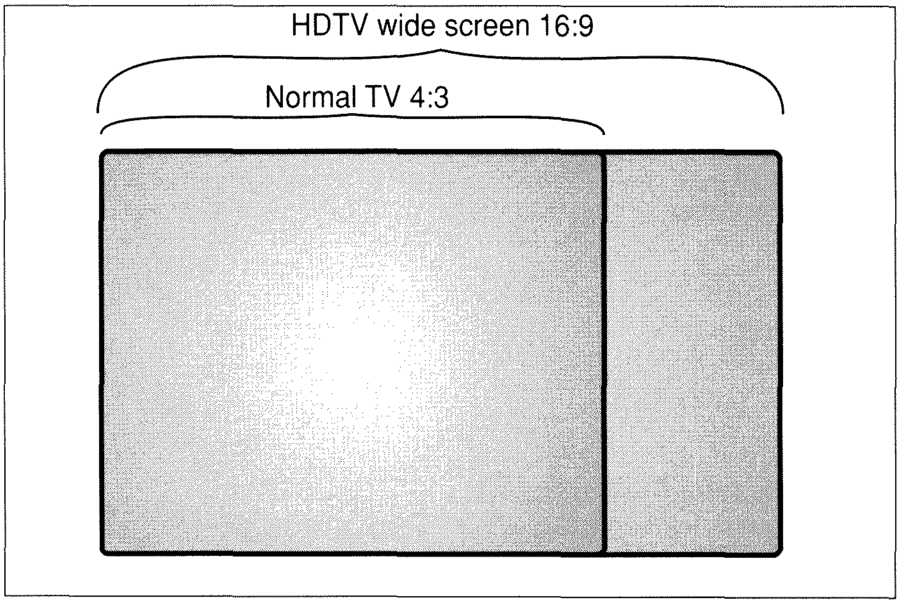


Video Plus has been taken on-board by big names such as Toshiba.

or three and ultimately one. When this has been achieved, the relative mechanical simplicity of DCC will see pricing dramatically below equivalent DAT units.

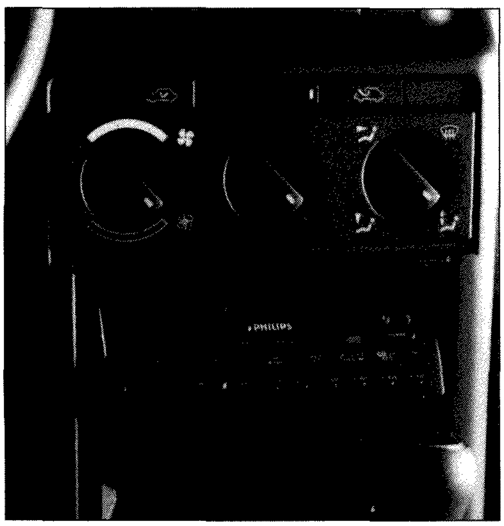
Toshiba And Video Plus

There was considerable demand during Christmas for the newly introduced Video Plus programmable timer/remote for video and satellite TV receivers and stocks quickly ran out (see last month's PE). At CES Toshiba demonstrated the logical evolution of Video Plus application by building the device into one of its video recorders. No longer does a Video Plus user have to ensure nobody moves the infra-red transmitter inadvertently before the desired programme has been successfully recorded. Video Plus has been a huge success in the States and Toshiba's move is bound to be followed by others.



The difference between normal and wide screen TV at a glance.

DCC in the car.



Wide-Screen TVs

Wide screen (16:9 aspect ratio) TV is well established at CES shows. JVC (absent from this year's event), RCA (owned by the French Thompson group), Panasonic, Sharp, Goldstar, and others have all demonstrated either full-blown HDTV systems or wide-screen sets for normal 4:3 aspect ratio broadcasts in the past. This year both RCA and Philips exhibited HDTV ready 16:9 'monitors' – as soon as HDTV services start and the relevant decoders are available, users will be able to upgrade their sets conveniently to full HDTV operation. Until then, we will have to be content with viewing wide-screen (standard resolution) home videos, a feature now offered by an increasing number of camcorders, or banishing the letterbox effect typical of some broadcast wide-screen movies.

Sharp On HDTV

Meanwhile, just a couple of weeks after CES finished, Sharp dropped a bomb-shell in Japan by announcing a 36in HDTV set for well below £5,000. That price is roughly a quarter the cost of rival HDTV sets in Japan. Sharp says it has succeeded in slashing its manufacturing costs through further decoder integration – only six chips are now needed. The price is under the threshold analysts had predicted would send Japanese consumers dashing for their first HDTV. Cynics point out that the announcement is perfectly timed for this year's Olympic games; Sharp could be gambling on relatively high volume sales. At press-time there was considerable scepticism that Sharp had avoided cutting quality. Japan currently enjoys 8 hours of HDTV broadcasting daily, which is set to rise during the Olympics. It's predicted that Sharp's rivals will be working over-time to match Sharp's achievement.

Hand-held Video Projector

Fuji, better known for its photographic products, showed a pocket-sized video projector at CES. The P40 device has a single colour LCD projection panel. Conventional cathode ray projectors have three image sources, one for each primary colour, as do most professional standard LCD video projectors. The P40 weighs less than one pound and can be optionally powered by a camcorder NiCd rechargeable battery. The projected image can reach 40 inches across. provisional pricing is $800 or about £450.

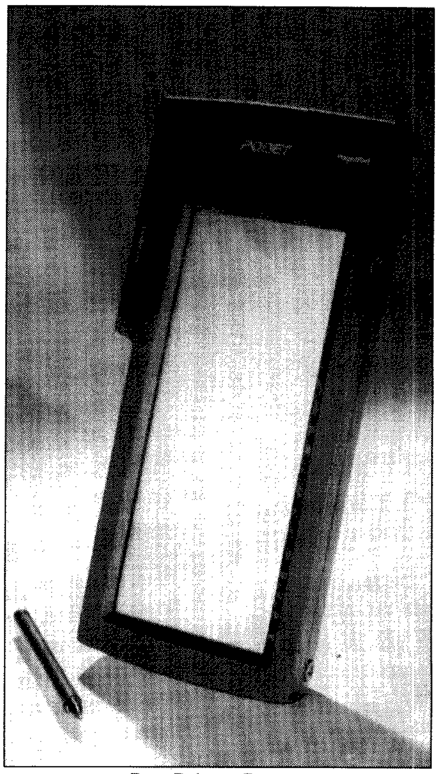
Portable CD-I From Sanyo

Sony first demonstrated a prototype portable CD-I player almost two years ago, but at CES Sanyo looked like being the first to bring such a device to market – though it's not expected to go on sale until the latter end of this year. Sanyo's new baby has a four inch colour LCD screen and there are plans to introduce a kids version with a built in graphics tablet next year. Sanyo also demonstrated another hi-tech device aimed at kids, a portable CD+G player ideal for karaoke which Sanyo expects to ship for less than £200.

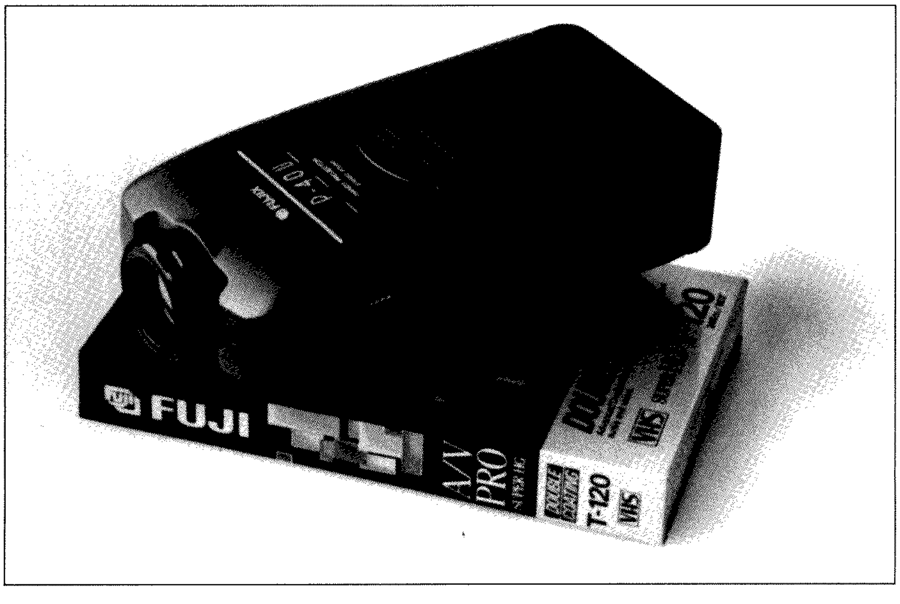
A Pen For Your Poqet

Poqet Computer, best known for its diminutive pocket-sized Poqet PC, has announced a pocket-sized pen-PC, the PoqetPad. The 1.2lb device closely resembles another compact pocket computer unveiled by Epson at the Comdex expo in the States last October. There is no keyboard and most of the top surface of the device is occupied by a 7.25in diagonal 640x200 pixel supertwist LCD screen. Dimensions are 9.65in by 4.59in by 1.26in. Just two AA batteries will provide up to 48 hours operating time. The operating system is MS-DOS 3.30 in 1Mb of ROM and there is 640K of system memory with room for two PCMCIA mass storage cards. The pen-centric interface has been borrowed from Tandy and handwriting recognition is provided by NestorWriter. Textual input is via telescoping stylus and the pen-sensitive screen is good for a writing resolution of 200 dots per inch.

PoqetPad is not aimed at the flashy executive; it's a serious attempt to get into the portable data acquisition market which the likes of Husky, Psion and others currently dominate. A full PC-based applications development package is available. US Pricing is around the $2,000 mark (£1,115). PoqetPad may not be a consumer product itself but it demonstrates that all the right ingredients are there to produce an advanced, compact, pen-based personal computer – just what Apple has been hinting hard that it is currently working on.



Pen Driven Poqet.



Those LED Blues

When was the last time you saw a blue LED, and I don't mean a gas plasma or other fluorescent device? Well, the chances are you have never seen one. Blue LEDs do exist, based either on silicon carbide or gallium nitride, but they have not been commercially popular as they are extremely inefficient or difficult to make. At last, however, the standard red and green LEDs may eventually be joined by bright new blue LEDs, if experimental results from various researchers around the world are verified. The primary colour set in LEDs would then be complete. The significance of this is that blue LEDs could open up a whole new range of applications, including large display colour TVs and signs.

Two research teams in Austria and Japan have come up with completely different ideas in the quest for the elusive blue LED. The Austrians at the Technical University of Graz have used semiconducting organic polymers to successfully construct a blue light diode. It has potential because they should be very easy to make commercially. The only drawback is that they remain very inefficient. In Japan researchers at Nagoya University have produced a blue LED which is almost a hundred times more efficient through refinement of the original gallium nitride process. We're still a long way from blue LEDs being featured in Maplin Magazine for a few pence each, but there is hope.

The Solid State Compass

Another survivor of the mechanical age has finally succumbed to the solid state age; this time it's the magnetic compass. A Plymouth-based team at the Polytechnic of the South West has come up with a magnetic field sensor which could be used as an electronic compass small enough to fit into a wrist watch. The key to the technology is a special substance which, in conjunction with an electric field, changes its current resistance according to the presence and magnitude of a magnetic field. Tiny stripes of the special ferric-nickel material are printed on to glass and this enables a magnetic field perpendicular to the stripes to be detected. A pair of these devices can be used to find the actual direction of the magnetic field. Apparently the prototypes work extremely well, with high sensitivity and the researchers are now working on miniaturising the technology in chip form. Since modern wrist watches can monitor your heart beat, check your blood pressure, calculate, measure altitude, record and play back sound and so on, a compass function might almost seem routine.

Picture The Action

Still life on your PC is now old hat and that's official. This is because Apple has launched QuickTime for its Macintosh computers. QuickTime lets you replace static illustrations in desktop applications with sequences of motion video. There are obvious specialist multimedia uses for such a facility, but the beauty of QuickTime is that it has been designed to be used, 'cut and paste' fashion, in ordinary applications like word processors and even spreadsheets. For the latter, for example, you could have a pre-recorded clip showing a factory floor scene next to a spreadsheet graph showing its productivity – complete with audio commentary. The idea is that users would digitise fairly short sequences of video, perhaps shot on amateur equipment or sourced from high quality libraries or broadcast TV. These sequences, or "movies" in Apple parlance, can then be pasted into an application of your choice. Computer generated animation can also be incorporated. Watch out for a new growth area; CD ROM QuickTime "clip art." By using advanced data compression techniques, QuickTime movies can be viewed on even the least powerful Mac Classic models and Apple has revealed that a QuickTime replay package compatible with Microsoft Windows on IBM PC compatibles is to be made available later in the year. There is also a sign that QuickTime technology could be used in a mass-market consumer multimedia product, perhaps to rival Commodore's CDTV and Philips' CD-I.

QuickTime is a great idea, but there are critics of its quality and none more vociferous than Acorn Computers which revealed its full motion video system based, called Replay, at the same time as Apple. QuickTime movies can be played on any Mac, but there is a trade off in terms of frames per second rate and picture size on the screen. Critics say that QuickTime is too flickery and jerky as well as being displayed too small on the commonest Apple Macs like the LC and Classic models. Acorn's Replay, which runs on the firm's Archimedes RISC workstation, plays movies on relatively large windows and at a constant 25 frames per second. Acorn is big in the education market in the UK, but it has little hope of dislodging QuickTime from the world PC market especially with the prospect of MS Windows compatibility.

However, there may be a twist to this little story. Apple has bought into Acorn's RISC processor technology, now managed by the spin-off ARM Ltd company. Apple has also confirmed it will use these RISC processors in its as-yet secret new range of consumer products. One could speculate that a consumer version of QuickTime will eventually be Acorn powered. ■

Multimedia on the Archimedes.

TFT Liquid Crystal Technology

Andrew Armstrong explains how the technology behind the latest hand-held TV colour screens works.

Most liquid crystal colour televisions use a passive matrix liquid crystal screen. This gives a picture of limited contrast and poor sharpness. The Sony Colour Watchman reviewed elsewhere in this issue uses an active drive technology with a transistor to drive each display element in an arrangement somewhat like a dynamic ram. This gives clearer and brighter pictures.

To explain how it works, we must first look at the principles on which a liquid crystal display operates.

Twisted Nematic

A liquid crystal is a liquid in which the array of molecules is crystallised. It has some of the characteristics of both crystal and liquid and is usually an organic chemical made up from cigar-shaped (nematic) arrays of molecules.

To make a display using liquid crystals, a thin layer of the liquid crystal is sandwiched between two glass plates, each having a metallised layer in contact with the liquid crystal. The direction in which the molecules lie is determined by the surface finish, and, in the twisted nematic display, the two plates are arranged so that the molecules in contact with each face like at right angles to those in contact with the other face, as shown in Fig. 1.

Polarised light entering from one side has its plane of polarisation rotated through 90° as it passes through the rotated array of molecules. However, as shown in Fig. 2, if a suitable voltage is applied across the two plates, the crystals line up end to end and have no effect upon the polarisation of light. If crossed polarisers are fitted on either side of the glass plates, as illustrated in Fig. 3, the application of a voltage prevents the liquid crystal from rotating the plane of polarisation and hence prevents the light passing through the entire sandwich.

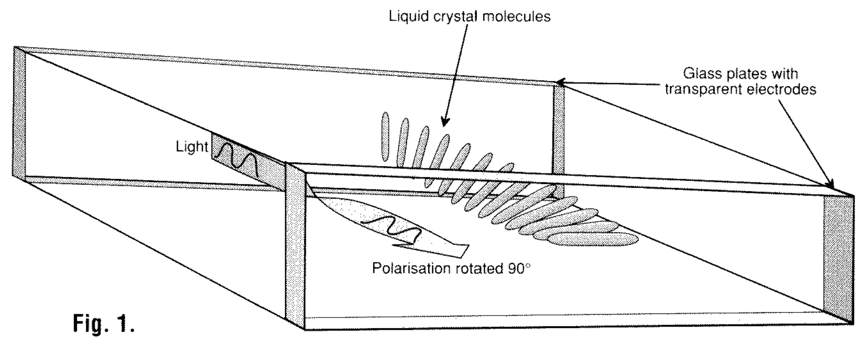


Fig. 1.

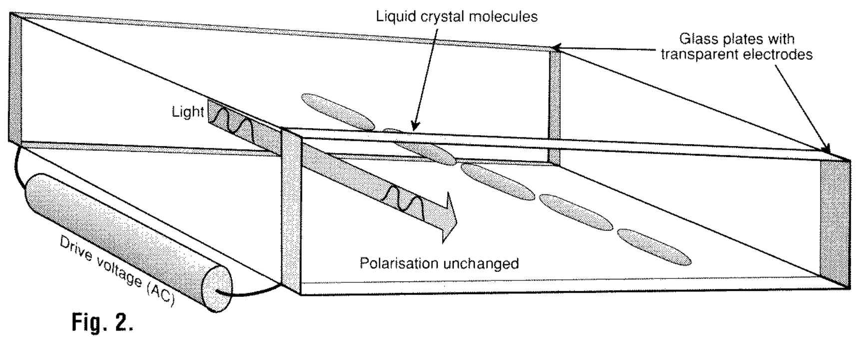


Fig. 2.

A passive liquid crystal dot matrix display, illustrated in Fig. 4, works by addressing each picture element in turn. The chemistry of the liquid crystal must be designed so that it will remain in its non-polarisation-rotating state in the intervals between being addressed. It must also return to its inactivated state rapidly enough to avoid picture streaking. These constraints result in low contrast and a limited range of viewing angles.

Clearly, in order to produce an analogue television image, rather than te pixellation used on the screen of a computer, a proportional response is required. The extent to which the picture element rotates the light, and hence the brightness of the element, depends upon the drive voltage.

Most LCD televisions use a fluorescent lamp behind the display to illuminate the pixels, which have red, green, and blue coloured filters. Thus the displays are transmissive rather than reflective, but similar principles apply to reflective displays as used in calculators and some computers.

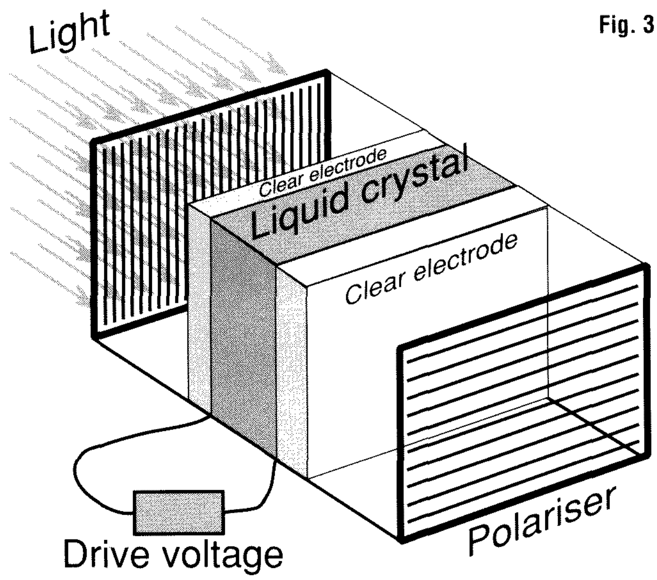


Fig. 3.

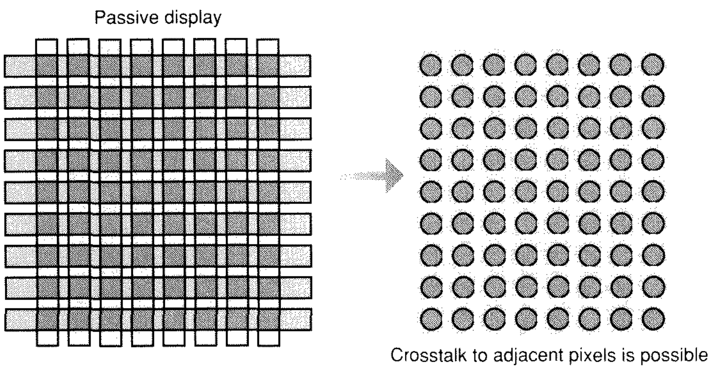


Fig. 4.

Active Drive

With active liquid crystal displays, there is one thin-film transistor (TFT), as shown in Fig.5. When the TFT gate is energised, the capacitor is charged to the voltage present on the data line. This sets the brightness of the element.

Fig. 6 shows the pixel layout of an active TFT display. The picture elements cover most of the screen area, with a small cutout in the bottom right corner where the thin film transistor is deposited. The loss of light due to this cutout is insignificant compared with the advantages conferred by TFT technology.

Thin film transistors are made by depositing amorphous silicon on glass. Until about a decade ago, it used to be necessary to make transistors from high quality crystalline silicon. Amorphous silicon layers, though pure, had too many unattached bonds giving rise to energy-wells, which trapped charge carriers. Amorphous silicon semiconductors were made practical by attaching hydrogen to the spare bonds.

The technique was first applied to amorphous solar cells, which are used in many of the calculators now on sale. The amorphous silicon solar cells which these employ are only about half as efficient as crystalline cells, but they are very cheap to mass-produce.

Further developments of the amorphous technology have made it possible to produce amorphous transistors. These do not have the performance of transistors made from crystalline silicon, but they are adequate for the purpose of driving liquid crystals, and can be economically deposited onto the glass plates.

According to news reports about five years ago, the means of using thin film transistors was first devised by a British engineer. He could not get funding to develop this in Britain or elsewhere in the European Community, so by default the technology is now Japanese, who have put it to good use in a number of innovative products. ■

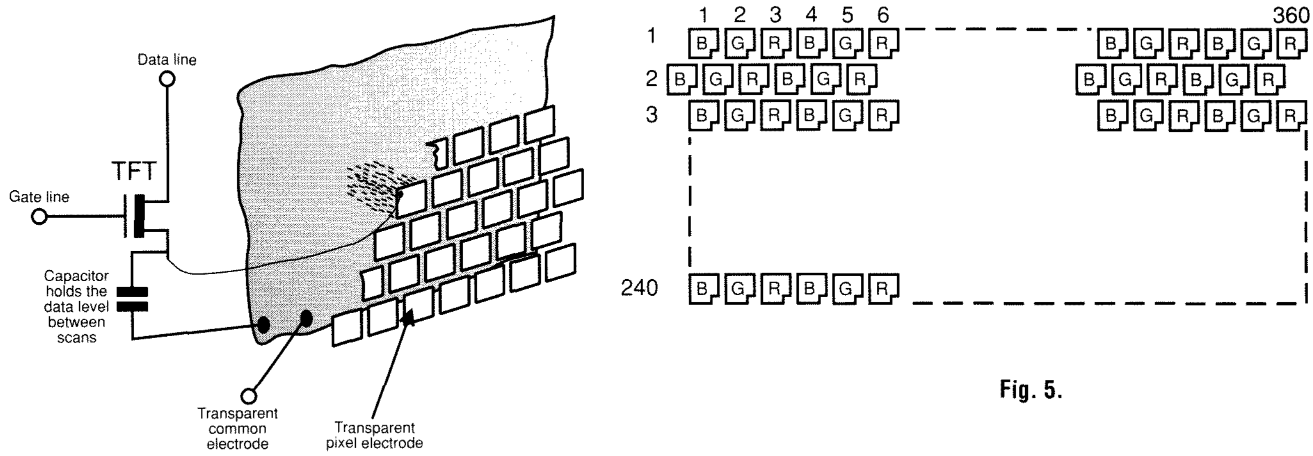


Fig. 5.

How It Works...
The Personal Stereo

Jim Haskins' mission this month is to take apart a walkman. With great care and the aid of some miniature screwdrivers he succeeds – this is his report...

The original Sony Walkman has inspired numerous imitations and personal stereo's now come in a wide variety of shapes and sizes. The idea of a pocket sized tape playing system able to play standard audio compact cassettes through miniature headphones at HiFi quality was originally developed by Sony in Japan.

The main components of a personal stereo cassette player are the tape transport, electronics, headphones and the power supply. All of this, apart from the headphones, is compressed into a case hardly larger than the cassette itself. A standard 3.5mm (sometimes 2.5mm) stereo jack plug and socket are used to connect the headphones to the main unit allowing the player to be placed conveniently in a pocket with just a cable going to the headphones.

Apart from the basic ability to play back stereo audio cassettes, most modern players come with a number of extra features. Almost standard are such things as Dolby noise reduction circuits, balance control, fast forward, rewind and repeat play. Other features can include four channel equalisation, built in stereo FM radio, metal tape capabilities and built in microphone allowing the unit to record as well as playback although this also requires an extra tape erase head.

The main limitation on the size of a personal stereo is the set size of audio compact cassettes. Some of the latest machines are actually smaller than this and simply clip onto the outside of the cassette case. More commonly, the units allow the cassettes to slot in and provide protection for the electronics – some models are even splash-proof.

The other limitations on size are the need for a power supply that will give a reasonable playing time, the motors, batteries and tape playback head, all of which have minimum sizes. Power usually comes from two or more batteries which must be of a commonly available variety, such as AA or AAA. The more batteries there are, the longer the unit will operate but, the heavier and larger it will be.

Most of the machinery inside the casing is used to move the tape from one reel to another past a head which picks up the magnetic fluctuations. These are amplified to produce the sounds heard in the headphones. To maintain as constant a speed as possible a pinch and flywheel system is used. In addition, more advanced designs use electronic feedback sensors to lock the speed of the motor. This can be vital in a portable system since any movement of the flywheels and motor will tend to cause changes in the tape speed causing the sound to "wow".

The headphones of a personal stereo range now come in three main sizes, all of which take advantage of high power permanent magnets to produce high quality sound. At their smallest, headphones are lodged inside the ears which, unfortunately reduces the quality of the sound – a lot of fidelity is picked up by the outer portions of the ear. Medium size headphones sit just outside the ears and produce better sound – they also have the drawback of producing high frequency noise to people who aren't listening to the music. Full size headhones have become more popular with personal stereos quite recently. Since they cover most of the ear, they give very good sound reproduction. They can also have muffling built in to that noise pollution is limited. ■

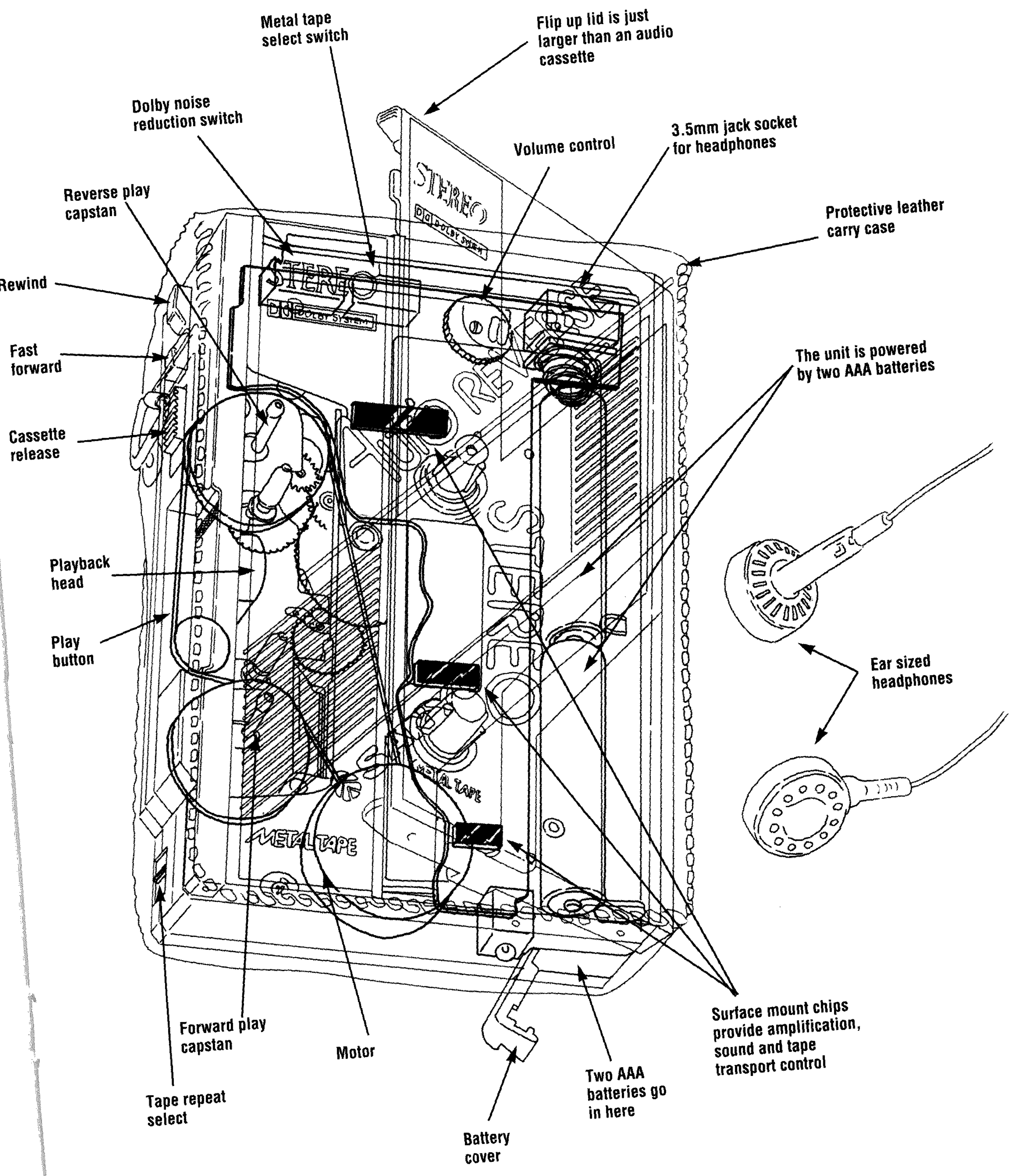


Illustration: Derek Gooding

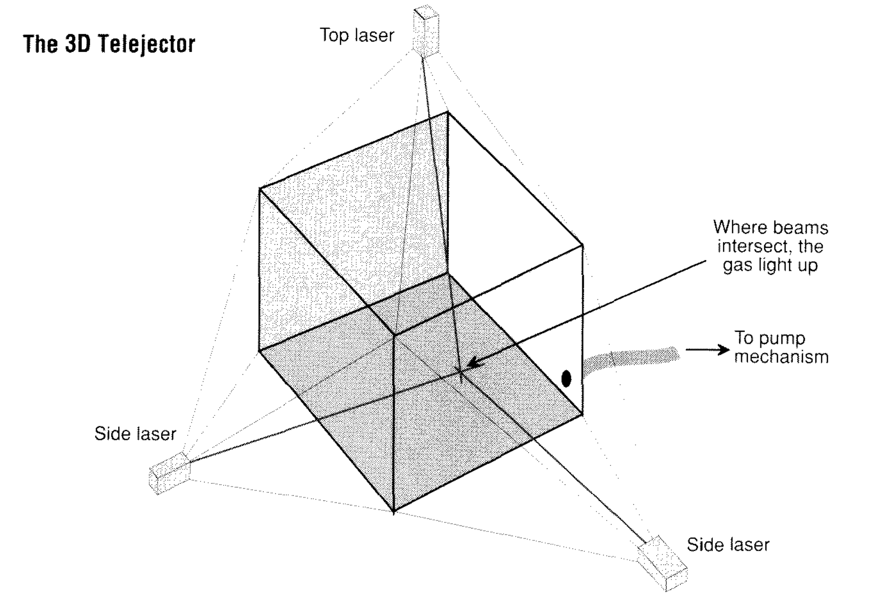
Taking A Three Dimensional View

The 50 year old dream of three solid television looks set to become reality with this new idea from a British inventor. Adam Forth looks at the details.

Three dimensional television has been the dream of inventors since John Logie Baird first showed that moving pictures could be transmitted electrically. Until recently, all 3D systems have attempted to fool the eyes and brain into thinking that the flat image it was seeing actually had depth. However, a recent invention by a British amateur electronics enthusiast looks set to take the world by storm.

The new system, designed by Alan Frith, produces a solid moving image in a tank. The viewer is able to see the picture by looking through one of three sides and gets the impression of a completely solid image.

The 3D Telejector



Underground Ideas

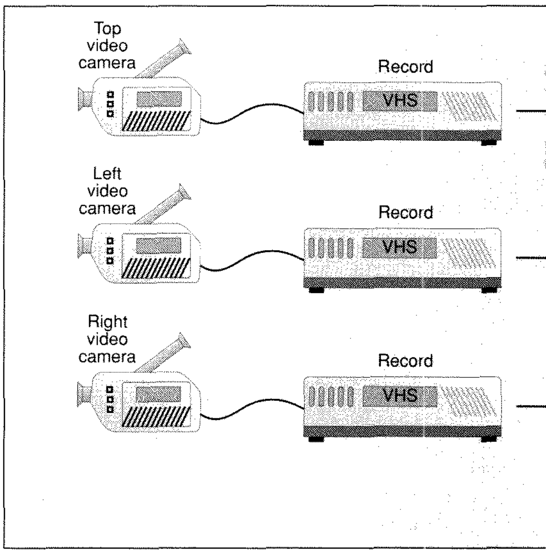
The idea for the invention, according to the designer, came one day while travelling on the London Tube. An advert showed two old age pensioners looking at a solid, three dimensional football match, all in miniature with the viewers able to move around to see different aspects of the playing field. After thinking about the idea for a while, Alan Frith decided to have a go at designing a real system to produce the same effect. Ten years later, he has a working machine which, although it is only black and white, produces three dimensional moving images.

How It Works

The solid Video system uses three laser beams mounted at right angles around a tank of special gas. The secret lies in the way in which the gas fluoresces when the three beams hit it together. Its special atomic structure causes electrons to move from orbit to orbit when energised by three particular wavelengths. If only one or two beams hit it then nothing happens and the gas remains transparent. Where three three beams intersect, however, the gas emits a number of photons of light.

Unfortunately, the amount of light emitted from a particular gas molecule is constant so some method had to be devised to allow the light spots to vary in brightness. The solution was to vibrate the scanning beams at high frequency so that a 'cloud' of molecules are illuminated producing more light – similar to the dither patterns used in printing. Here a patch of black dots can be made to simulate a single dot having various shades of grey by changing their number and pattern. The loss in resolution in the solid Video is completely unnoticeable due to the fine control over the laser beams and their focussing mechanisms.

To obtain a three dimensional image, the laser beams scan across each of the three faces of the cubic gas tank in the same way as a

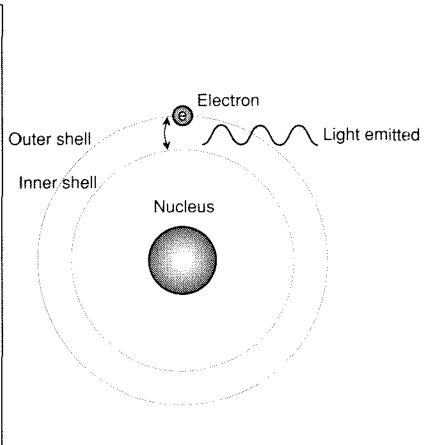


normal TV. This raster scan builds up the light dots that make the picture from the back, bottom corner of the tank to the front, top. This makes sure that portions of the picture at the front of the cube are not obscured by those at the back. The scanning also has the advantage that moving images can be sourced from three standard video recorders.

Seeing Exited Atoms

Atoms are made up from a core of neutrons and protons surrounded by a series of shells of electrons. Due to the quantum nature of very small structures, electrons can only sit in shells at specific levels – there are no 'in-between' states. When the atom is exited, either by heating it up or by pumping photons into it, the outer electrons move from one shell to another to absorb the energy and then move back again to release it. As an electron moves it creates an electromagnetic wave. Different atoms have different numbers of electron shells with possible shells existing at higher energy states. The distance that the electron moves determines the wavelength of the electromagnetic radiation so, by using the right type of atom and method of making its electrons jump, a specific wavelength of radiation can be created.

At its simplest level, an incandescent light bulb heats the atoms in its filament so that the electrons move up and down in a random manner creating white light. In a more controlled and sophisticated way, a laser is energised to produce an exact wavelength of light. The gas in Alan Frith's Solid Video reacts to three specific wavelengths which combine to excite the electrons to produce light.



Record And Playback

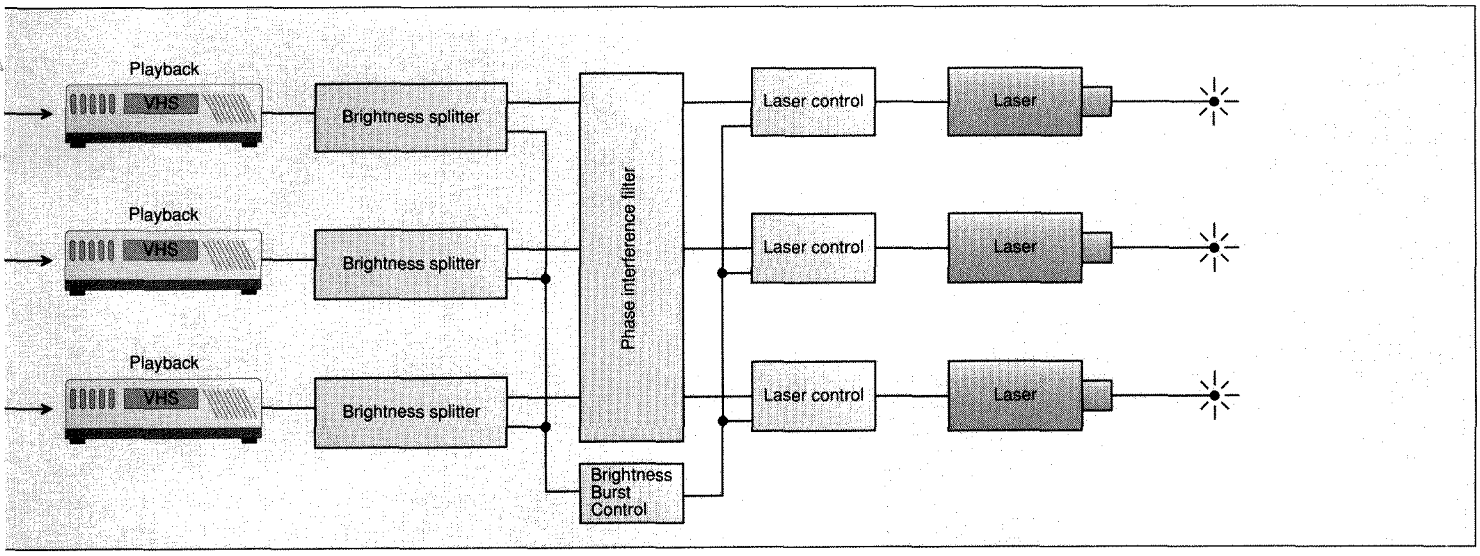
Because of the way in which the solid image is viewed, the 3-D system works best for staged events – at the moment the is no way to process all sides of a possible image. Three standard video cameras are positioned at right angles, top the left, right and above the stage area. The action is then filmed and stored on three VCRs – these are cross linked to provide perfect synchronisation. This is a simple approach to the problem of how to film in three dimensions and all of the interpretation and interpolation needed to produce the final solid projected image is performed by the electronics that controls the lasers.

The basic operation of the system is shown in Fig. 1. The three images from the synchronised VCRs are fed into the three laser drivers. These are cross linked in such a way that interference between the three images removes unwanted parts of the picture. The lines of each aspect (from each camera) are then split into pixels – standard analogue TV signals are not actually pixelated until they hit the shadow mask behind the TV screen. The brightness of each pixel is fed to the laser vibration burst units and the scanning position information derived from the combination of the three video synch signals. The lasers then scan across the inside of the cube and where they intersect they produce small bursts of light which eventually build up the picture.

A critical part of the system is the way in which the gas is made reactive to the laser light. It must be kept at a specific temperature and pressure. This is maintained by a special pump and conditioning unit connected to the base and both sides of the display cube. The current temperature and pressure are sensed from within the system and feedback control is used to keep the whole thing stable. The formula for the gas is still a secret although it is believed to based around C^{60} Buckminsterfullerine and was originally been developed in the USA as part of a particle beam weapon research project.

The working model of the Solid Video has had a patent granted and is currently being shown to a number of possible manufacturers both in the UK, Japan and USA. The inventor believes that with a little development work, it could be the next big thing after HDTV.

Future improvements to the system will include full colour, using a mixture of three gases and three excitation lasers, and the development of the idea for use as a computer display. With Solid Video, the dream of 3DTV seems to have finally materialised. ■



The Campaign For Real Time

Eamon Fitzpatrick wants to make time decimal but will anyone accept such a radical change to a centuries old tradition?

I read "The Naming Of Names" by Ashley Jones in the February issue of PE with great interest. The information contained in it regarding the System International d'Unites is extremely useful, especially for those who were brought up on the 'old' Imperial Units of measurement. I can recall how apprehensive we all were when Ireland (and Great Britain) decided to "go metric" in the 1970's. I was in my final years as a student of Medical Laboratory Sciences at the time and can still feel the anxieties as we prepared to cope with the new units. There were chapters included in most textbooks at the time reminding us of the impending change and giving tables of conversion factors for converting Imperial to SI units. The two systems lived side by side for several years before full transition occurred and, indeed, many examination questions which were set using the older units ended with the dreaded warning that "all answers must be expressed in SI Units!" In some cases the necessary conversion tables were supplied (if you knew how to read and apply them!) but in many subjects you were expected to know, for example, that the gas constant (R), which we all knew was 1.987 calories per mole per degree centigrade, was now 8.3144 Jmol-1K-1

There was, however, one thing that always puzzled me about the SI system and Ashley Jones' article came tantalisingly close to discussing it before it ran out of space. It is this: why should a metric and decimal system use such an un-decimal unit of time as the second? It was my ambition, together with some of my colleagues, to develop and establish a decimal clock. Some of us were convinced that if such a decimal time system were introduced, it would eventually replace the old system. Remember how apprehensive we all were when Ireland and Britain decided to decimalise their currency? How were we going to work out the decimal equivalent of 13s.9d? How much would it cost to buy our copy of Practical Electronics in the 'new money'? Well, whatever happened, we managed because we had to.

Is it not reasonable to suggest that a decimal clock, while having some opposition to begin with, would eventually be accepted and become commonplace. Obviously there would have to be some thought given to the exact way in which the new clock would be structured.

We can do little about the length of the day. However, into how many units would it be divided? Would there be, for example, 10 hours per day, giving us 2.4 'old' hours to the 'new hour'? Would each hour be divided into 100 minutes and each minute into 100 seconds? This conversion would appear to be a step in the right direction at least, as it would shorten the value of the second, a unit which appears to be getting too big to be really useful. One reads every month in this magazine of the advances being made in the processing speed of CPU's or the number of bits of information that can be optically transmitted per second, and more and more it appears that nano, pico, femto and attoseconds are the order of the day in expressing the time taken for one event to happen.Why not just start all over again with a smaller base unit?

Consider also the complex divisions which must be electronically performed to provide clock pulses for atomic time. Instead of saying that Ce^{133} has 9,192,631,770 transitions per second, why not use this natural resonance or that of some more convenient isotope and base the new time constant on a multiple of its period?

Even if the decimal clock is not acceptable to the world at large, could the scientific community nevertheless adopt it? For instance, the 'person in the street' still refers to car speeds in miles per hour and even the car manufacturers talk of consumption in terms of miles per gallon. There are many other such examples in common use – so much for decimalisation and metrication.

Well, whether or not decimalisation of our clock ever takes place, one thing is certain: time will fly just as fast as it does at present.

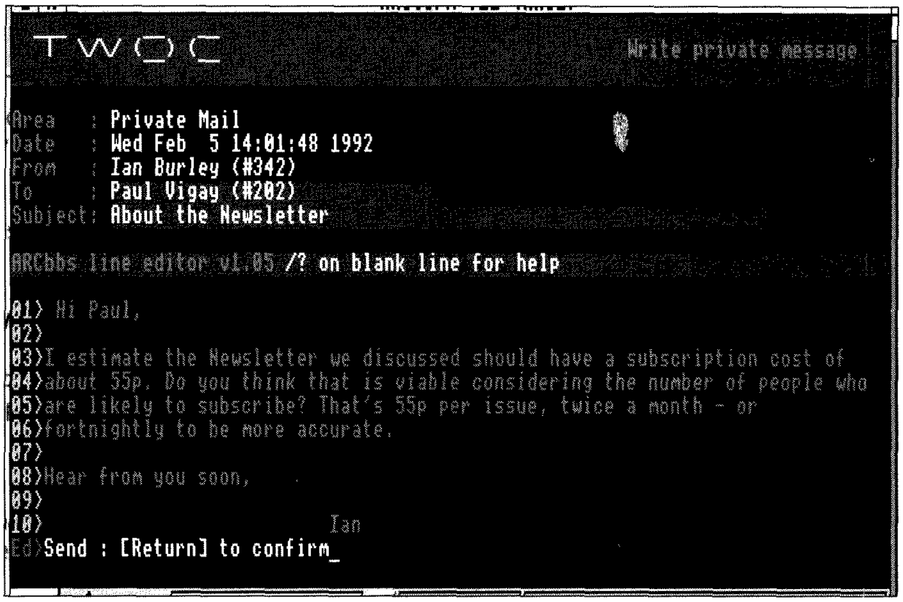
Eamon S Fitzpatrick
Dublin
Ireland

In practice, the second like the metre and ampere is an SI base unit. All calculations are performed with and result in multiples of seconds – kiloseconds, megaseconds, µseconds. There is really no need to convert to minutes, days, weeks and so on for scientific purposes and I don't suppose anybody else really cares. On the other hand, just think of the boost for the clock and watch industry... Kenn. ■

Growing Pains... The Email Dilemma

Arthur King ponders the future of electronic mail. Why hasn't it replaced the Royal Mail and why are faxes so popular yet so un-green?

Technology has always been the key to better communications. Over the last few years the postal service has reached new heights of efficiency. The fax machine boom means words and pictures can be transmitted to the other side of the globe in seconds. Billions of pounds are shunted electronically between banks every day. More and more firms carry out their business with the help of paperless electronic trading. But whatever happened to electronic mail? It's estimated that the users of public electronic mail networks number a mere hundred thousand or so in the UK. Email is still a long way from achieving critical mass.

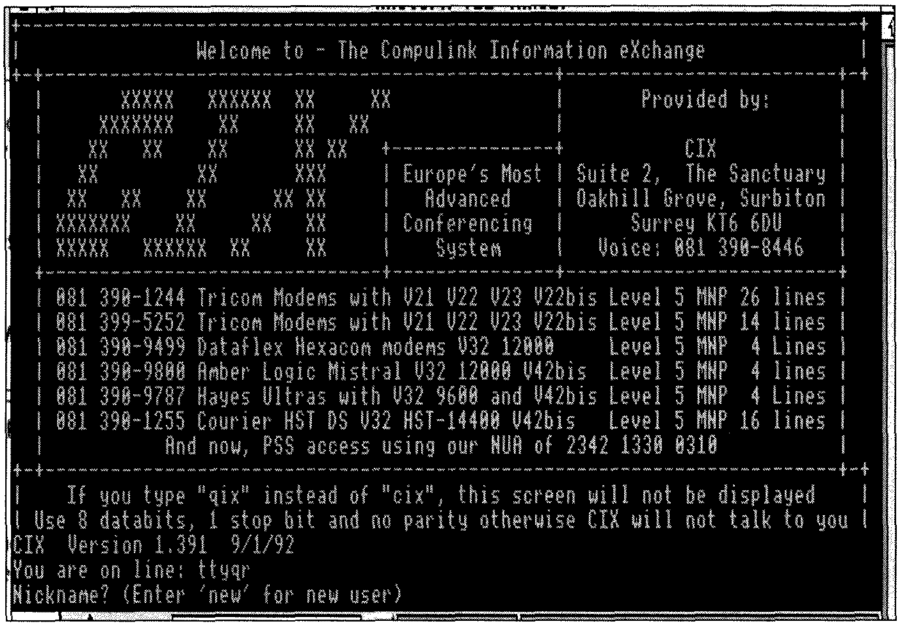


Over the last ten years, the most advanced electronic sorting machinery in Europe has endowed the Royal Mail with productivity and efficiency improvements of 50%. Nine out of ten first class letters now reach their destination the next day. But electronic mail usually gets to its destination within a few minutes, seconds even. You don't need to find an envelope, a stamp or a post box. There's no need for a postman to lug sacks of paper to a sorting office, no need to burn vast quantities of fossil fuels in transporting your letter to another sorting office at the other end. On reflection the logistics of posting a letter conventionally are an eye-opener, but we take it for granted. Parcels and personalised stationery will always need a postal service, but so much ordinary written or typed correspondence would be more suitably sent via electronic mail.

So what about fax? There are now approaching one million fax machines in the UK, another triumph of technology in the quest for convenient global communications. A fax machine is just like a photo copier. It's so easy anybody can use one. In the USA a fax machine often complements a phone in the home and it isn't unknown to order 'pizzas to go' via fax. That a fax requires paper originals and transmissions are vulnerable to line noise glitches seems to be tolerated by most.

But faxing documents is daft, especially if the original is computer generated. Electronic mail lets you transmit a PC document without the strange need to convert it into that wasteful and relatively useless printed paper form. Your average PC with a typical modem could transmit a ten page word processed document via email in roughly two minutes. The transmission would be crystal clear, error free and no precious paper would be involved at all. It's also secure – only authorised eyes would have access to the message store at the other end. In this age of the word processor, do we need scraps of fax paper which somebody might have to re-type? To view an email message once it has been received, all you need to do is load it into a word processor. Once there you can do anything you like with the text.

What about PC documents with graphics? The pretty graphics generated by spreadsheets and CAD drawing systems, for example, are nothing but compact arithmetic codes. Pages of solid graphics could total megabytes of data and so tie up a fax machine for ages. The spectre of line noise ruining it all will be ever present and the result will always be limited to 200 dots per inch resolution. Colour? -forget it unless you have a very large wallet. Those same graphics could be transmitted



with virgin clarity, retaining colour attributes, via email in seconds. Even bit-image data, pre-drawn images, can be squirted across an email link with retained resolution faster than a fax by using file compression. Take the screen shots for this article; six pictures in all were sent, each 16 colour original 70K long. Compression reduced over 400K of data to just 27K, which took less than two minutes to send. PE Editor Kenn Garroch at the PE office quickly de-compressed the images on his Apple Mac and pasted a selection directly into the pages you are reading now.

Neither the pictures or the text you are looking at used up a single fibre of paper in getting from me at home to Kenn at the office. The telephone time used was a mere three minutes or so, just a few pence at off-peak rates. Compare that with the cost of a stamp and envelope, finding the post-box and then the 24 hour delay before the bits of paper arrive at the other end – assuming you're not the one out of ten who suffers and extra day's delay or worse still, whose mail gets lost. And then what rigmarole would have to be performed at the office to make use of posted information...? Fax may be instantaneous, cheap even, but what comes out the other end is hardly presentable. Imagine pasting a faxed graph into a report; it's just not done.

While the fax machine was undoubtedly a major force keeping the lid on email, the email network providers themselves must also share part of the blame. It is still difficult to send a message from one network to another and without access to everybody else's mailboxes, the point of email is severely restricted. It's like having incompatible rival phone systems. The attraction of an email service is directly related to the number of people you would want to communicate with on that system. With a few exceptions in the US, most email services turned out to be relatively small, exclusive communities of users. These started off as public email services for enthusiasts, education and some forward looking businesses. Then email of a form took off in the corporate world through PC networking. Suddenly everybody in a company had email access to each other. But networked companies simply became newer islands in an expanding sea which was desperately short of ships. Electronic bulletin board systems devised their own inter-mail systems, like Fidonet while Unix system users enjoyed the Usenet system-linker. Basically these systems involved one location dialling the next and exchanging batches mail several times a day. Public notices could end up in Hawaii at the end of the day after first being posted in Swindon that morning! But these were still proprietary solutions. It was recognised ten years ago that all these 'islands' needed to talk to each other via an internationally agreed protocol and the result was the introduction in 1984 of X.400. However X.400 took a long time to be widely adopted. The good news is that the implementation of the X.400 specification is gaining pace. But even with X.400 users still have to struggle against the complexities of finding the right mail address for the recipient.

Email addresses, or IDs, are usually very compact. The Telecom Gold email ID for Intra Press, publishers of PE, is 87:SQQ567. On the Compulink Information Exchange (CIX) it's simply 'PROGNOW' – the condensed title of one of PE's sister titles, 'Program Now'. X.400 returns to the original concept of a postal address; you need to the recipients name, a country code, a public system name and a whole host of optional parameters. But you need only establish the details once per

recipient.

So can we assume that by giving a PC users some insight into the advantages of email and providing universal inter-system compatibility, that email will become an overnight success? Possibly, but not until it's cheap and easy enough. Online services mostly require registration and a standing charge plus usage charges, just like the telephone. The beauty of the postal system is that it's pay as you go. It's arguable that electronic mail is just that, an electronic version of the post, not an alternative to, say, the phone even if the phone network happens to be used as the carrier. As email use is nowhere near critical mass, public network providers have to rely on premium charges. It's a vicious circle typical of an emerging service technology; charges will remain high until demand driven discounts can be triggered, yet the inherently high cost of the facility stunts that crucial growth. Old-fashioned 'snail mail' and the rough and ready fax machine are unhindered by the kinds of growing pains experienced by electronic mail.

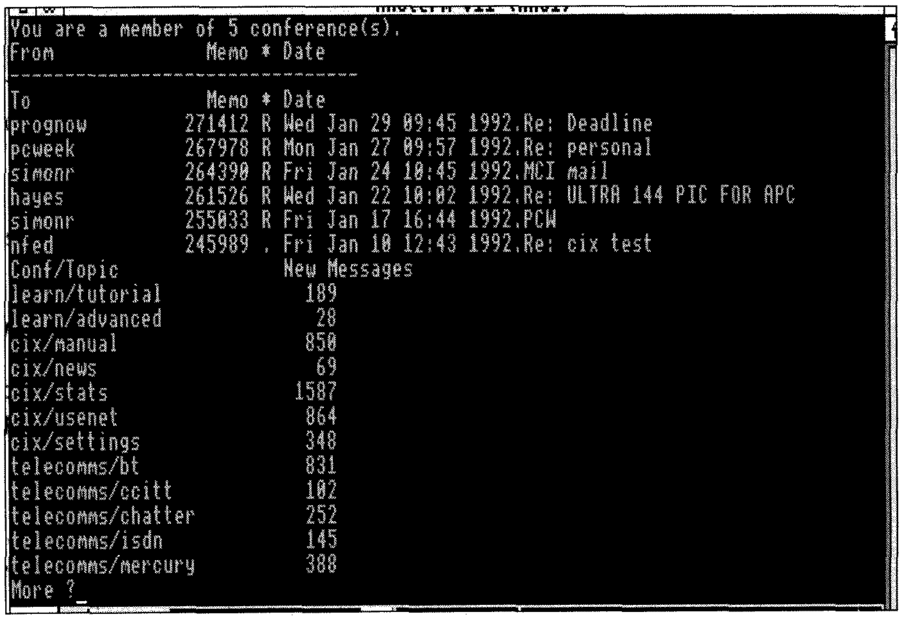
The cost of hardware has also been a problem. There is no great outlay involved in posting a letter and even a fax machine can be had for less than £300 – hardly a luxury these days, especially for businesses. Only recently have PC modem prices started to fall. An error corrected (MNP standard) modem offering 2400 bits per second transmission speed now typically sells for between £200 and £300. This is still expensive compared to the relatively complex fax machine with all its moving parts, but increased demand and improved modem chip technology will continue to drive prices down. In the USA, where demand is higher, the same modem typically costs $150. Many online services now offer 9600 and even 14.4K bps links, useful for large document transfers or big graphics files. Don't forget that many electronic bulletin boards offer downloadable public domain or shareware software, which can involve lengthy downloads.

Ease of use is an area in which the fax machine, for all its weaknesses, has email beat, for the time being at least. Fax is as easy to use as boiling a kettle while email is as difficult to use as your PC. But PC operating systems are getting better all the time. Windows-type user interfaces have already made a considerable impact on the user friendliness of communications programs. Once users had to contend with stark online prompts and meaningless command syntaxes, but now there are comms packages which can shield the user from these horrors and to a large degree automate the business of logging on, fetching and delivering mail and logging off.

So what ever became of the paperless office ideal? More letters are posted today than ever and offices have never used more paper. All this is despite the introduction of various forms of electronic information interchange like EDI (Electronic Data Interchange for paperless trading), BACS (direct wages payment) and EFTPOS (Electronic Funds Transfer at the Point Of Sale), etc.

Electronic mail is such an obvious solution to deficiencies in established communications methods like letter post, fax and even telex. Hand delivered mail may one day become robotised, but we will always expect packages and other bits of paper delivered this way. I can see the time when email will take over from fax. Indeed, fax and email are already moving closer together. PC-dedicated fax modems, which enable paperless fax transmission and reception are already gaining popularity, as are models which combine fax and email capability.

The chances are that if you aren't using email yet, you will be sooner or later. ■



The Making Of Semiconductors

Mike Sanders tells you all you need to know about the technology behind the semiconductor industry.

All materials consist of atoms which have a nucleus surrounded by electrons. This nucleus is made up from protons (positively charged particles) and neutrons (particles with no electric charge) – Fig. 1. The electrons move in various orbits or shells surrounding the atom.

For the atom to have a neutral charge, the number of electrons must equal the number of protons. Increasing the number of electrons ionises the atom giving it a negative charge. The gain or loss of electrons usually occurs in the outermost orbits since, being further away, they have weaker electric bonds to the positively charged nucleus.

Fig. 2 shows the periodic table of elements based on the arrangement of electrons around the nucleus. Orbits close to the nucleus contain fewer electrons than orbits further away with inner orbits being filled before outer orbits. The orbits correspond to the rows of the periodic table and when one is filled, a new one starts.

Elements with the same number of electrons in the outermost shell are placed in the same column. The number of electrons in the outermost shell is indicated by the group number. For example, all the elements in column one have one electron in their outermost shell.

The Russian chemist Dimitri Ivanovich Mendeléev observed that chemically inert elements have eight electrons in the outermost shell. This goes some way to explaining why group seven elements will readily react with those in group one – stealing the single electron to make eight and fill and empty the shells respectively to form an ionic or electric bond.

Similarly, a group six element will react with a group two. However, the electric field will not be strong enough to steal two electrons so these are shared to

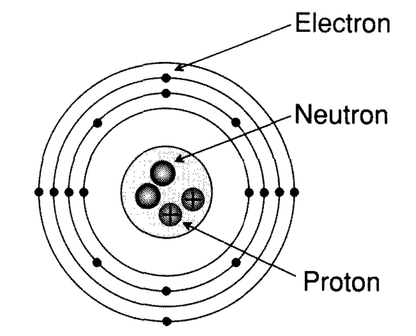


Fig. 1. The structure of the atom.

Fig. 2. The Periodic Table Of Elements.

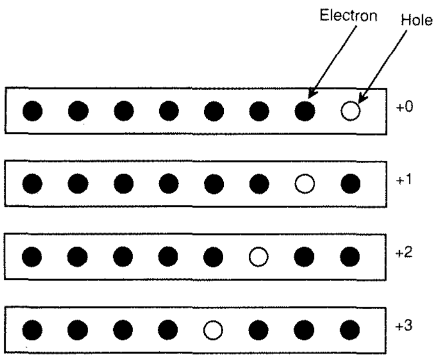
Group →

Atomic number, Symbol

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VII	Inert gases
1 H Hydrogen																	2 He Helium
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium											13 Al Aluminium	14 Si Silicon	15 P Phosphorous	16 S Sulphur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Z Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
55 Cs Caesium	56 Ba Barium	57 La Lanthanum	72 Hf Hafnium	73 Ta Tantalum	74 W Wolfram	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 As Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89 Ac Actinium															

Lanthanides	58 Ce Cerium	59 Pr Preseodynium	60 Nd Neodynium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
Actinides	90 Th Thorium	91 Pa Prolectinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americum	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 Nobelium	103 Lawrencium

Fig. 3. Hole movement from right to left.



form a covalent (sharing) bond. Other groups that will combine are three with five and four with four.

Top Of The Class

There are a number of ways to classify materials, one of which is by the ability to conduct electricity. Materials grouped in this way are classed as insulators, conductors or semiconductors. Insulators have all their electrons bound tightly to the atoms so that none are able to move around and conduct electricity. Conductors have many free electrons enabling them to carry current. Semiconductors are in-between having just a few free electrons.

In semiconductors, the absence of an electron is called a hole and has an effective positive charge (the opposite to an electron). The hole is a vacancy and can move around the material as electrons move into it – the vacancy thus moves in the opposite direction – Fig. 3.

Starting with pure silicon, various impurities or dopants can be added to produce either a shortage (holes) or surplus of electrons. Silicon has four electrons in its outermost orbit and doping it with group IIIA elements like boron, aluminium or gallium produces holes. Similarly, doping silicon with group VA elements produces a surplus of electrons.

Elements that provide holes are called acceptor impurities and produce P-type (positively charged) materials. Those that provide excess electrons are called donor impurities and produce N-type (negatively charged) materials. Commonly used group VA elements are arsenic, phosphorous and antimony.

The carriers within a semiconductor, the holes and electrons, move by two methods, drift and diffusion, and determine the total current flowing within the material. Drift is the movement of the carriers under the influence of an electric field. Without this the carriers would move about randomly instead of in a fixed direction. Diffusion is the movement of carriers from a region of high concentration to a region of low concentration – rather like a squirt of dye in water. At first only the immediate area is coloured, then fingers of colour spread out until finally all the water is more or less uniformly coloured.

Purification

Silicon makes up about a quarter of the earth's crust and is found mainly as silicon dioxide (SiO_2) – more commonly known as sand. This is the starting point of a process that consists of three main steps:

First of all, sand (SiO_2) and carbon (C) are brought together in an electric arc furnace to produce the following reaction:

$$SiO_2 + 2C = Si + 2CO$$

The silicon dioxide is reduced to 99% pure silicon (metallurgical grade) and carbon monoxide gas.

Next, the silicon is purified further by converting it to trichlorosilane ($SiHCl_3$) by adding hydrochloric acid and heating to 1260C:

$$Si + 3HCl = SiHCl_3 + H_2$$

Trichlorosilane is a liquid at room temperature and is purified by distilling (fractionation). This gets rid of many chlorides such as those of copper, iron, phosphorous and boron as well as silicon tetrachloride ($SiCl_4$).

The final stage is to take the purified trichlorosilane and heat it in the presence of hydrogen to produce pure silicon and hydrochloric acid again. The reaction takes place in a chemical vapour deposition reactor (Fig. 4). The silicon is deposited on pieces of pure silicon called 'slim rods' which are heated resistively.

The resulting silicon bars are 2m to 3m in length, up to 20cm in diameter and are now ready for growing crystals. The complete purification process takes several hours.

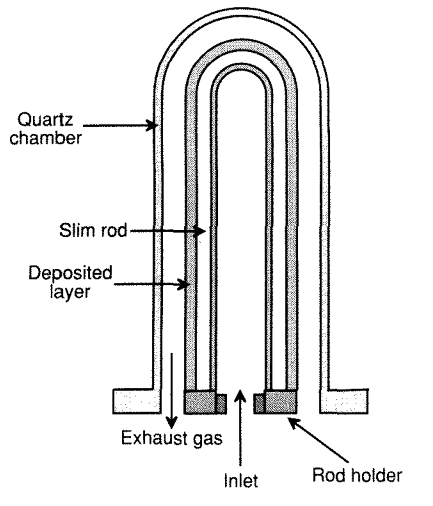


Fig. 4. CVD reactor.

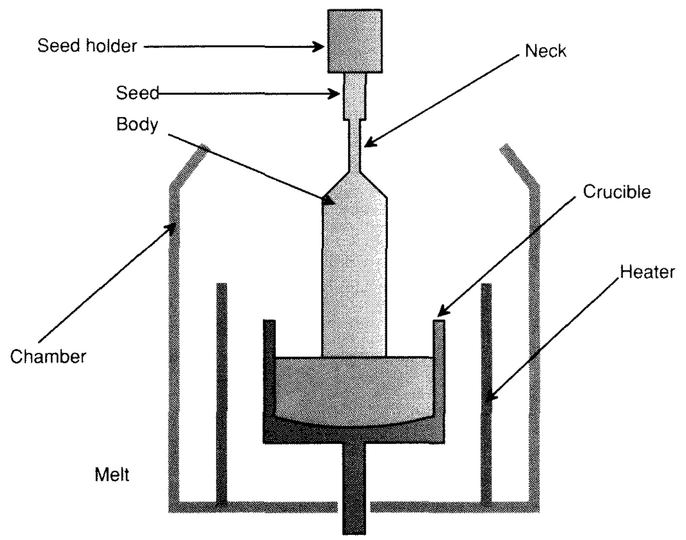


Fig. 5. The Czochralsku process.

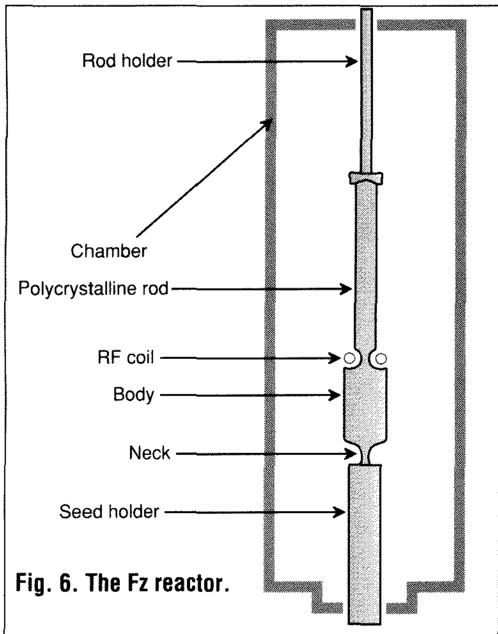


Fig. 6. The Fz reactor.

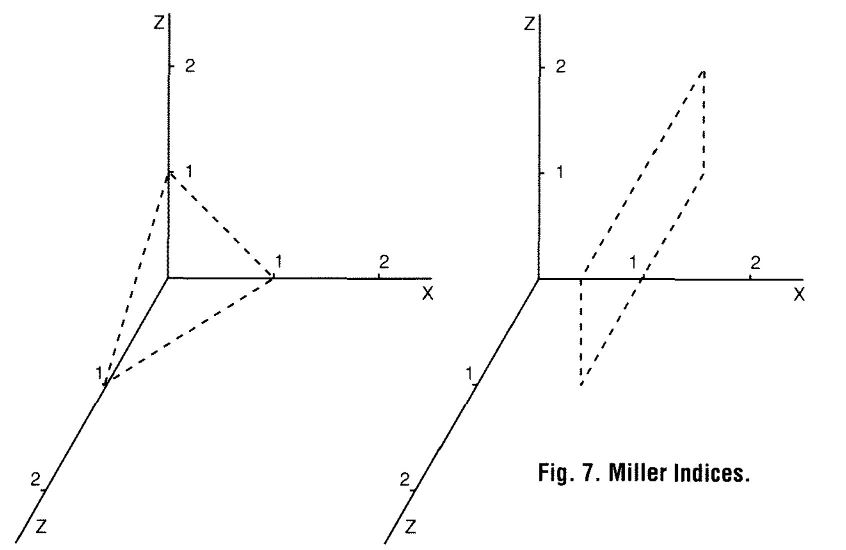


Fig. 7. Miller Indices.

Growing Crystals

The two methods used for growing single crystal silicon for semiconductors are the float zone and Czochralski method – usually abbreviated to Fz and Cz respectively.

Up to 90% of the crystals are grown by the Cz method which uses a crucible made from pure silicon dioxide (quartz) as shown in Fig. 5. Pieces of silicon crystal, called the charge, are placed in the crucible and heated to a temperature of 1415C, their melting point. The heating is carried out either thermally or by induction using radio frequency (RF) energy.

A seed crystal with the desired lattice structure is dipped into the melt and withdrawn slowly, pulling out the melt which solidifies as it leaves the crucible. If the pull rate is correct, a crystal of the same structure as the seed is grown.

In practice, the pull rate runs at different speeds varying between five and 12in per hour at the beginning and two to four inches per hour at the end. The initial narrow part is called the neck and is withdrawn at a faster rate to avoid crystal dislocations. The neck is followed by the shoulder and body as shown in Fig. 5.

To keep the melt at a constant temperature, it is stirred by rotating the seed holder at six to eight revs per minute (rpm) while rotating the crucible in the opposite direction at 12 to 14 rpm. The gas used to cloak the crystal during the process is argon – a very un-reactive element which will not produce any impurities.

The eventual diameter of the crystal depends on the pulling rate, rotation speeds and the temperature of the melt. The diameter is controlled automatically by means of an optical pyrometer which measures the temperature of the crystal. This is connected to a closed loop system that makes corrections to the temperature, rotation and pulling speeds.

Since the level of the melt drops as the wafer is grown, the crucible is lifted slowly to keep the melt level within the hot area of the furnace. If impurities are required in the wafer, they are added to the melt before the crystal is grown.

The float zone method does not use a crucible so there is no oxygen contamination from it. The high resistivity materials produced by the Fz method are used in SCRs (Silicon controlled rectifiers), power diodes and transistors.

In the Fz method a rod of crystal silicon is placed in a chamber with a seed crystal attached to one end – Fig. 6. The chamber is filled with an inert gas and the heating process

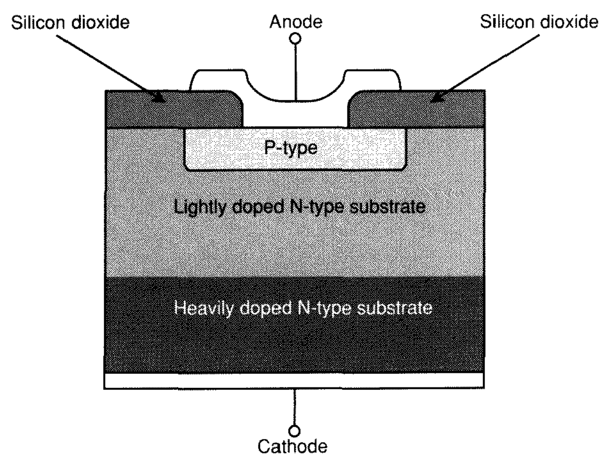


Fig. 8. Epitaxial deposition of a diode.

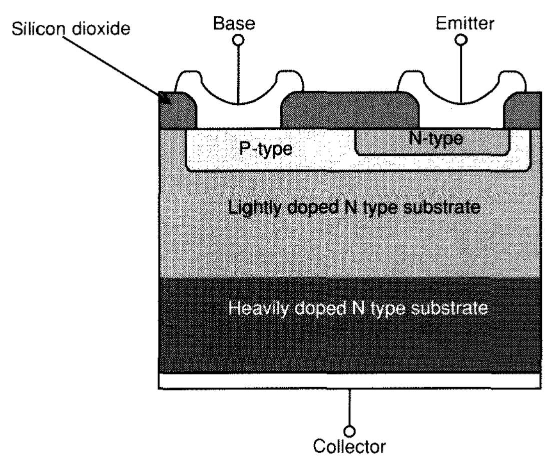


Fig. 9. Transistor using an epitaxial collector.

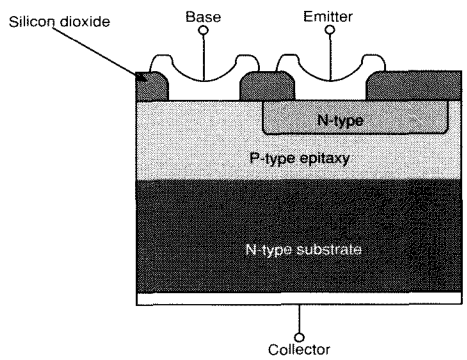


Fig. 10. Transistor using an epitaxial base.

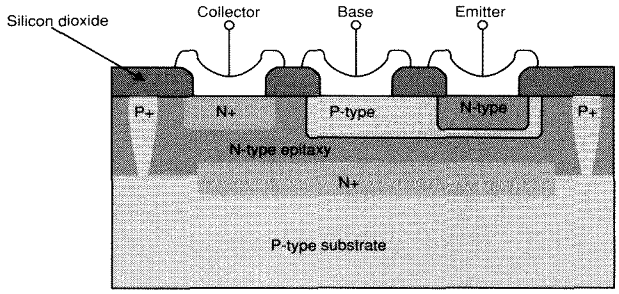


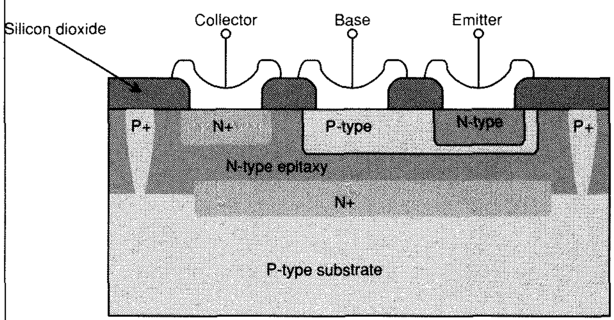
Fig. 11. Bipolar integrated circuit.

begins. An induction coil is used, starting at the seed crystal end, melting a portion of the seed and the rod. The radio frequency coil then moves upwards giving the rod the same structure as the seed crystal. The crystal diameter depends on the speed of movement of the induction coil with the diameter being limited to about 7.5cm because of the danger of collapsing the rod.

Boron or phosphorous are used as impurities in the Fz process. These are introduced as a gas and produce uniform resistivity throughout the length.

By contrast, in the Cz method as the crystal solidifies, impurities (dopants) are injected back into the melt, making it richer as the level gets lower. This makes the tail end of the crystal more heavily doped than the seed end.

Fig. 11. Bipolar integrated circuit.



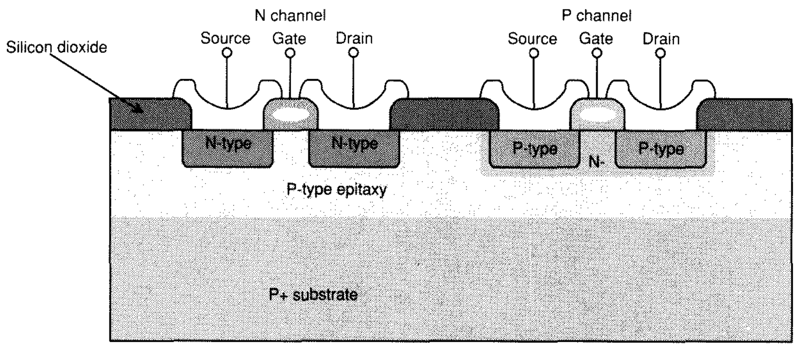


Fig. 12. CMOS integrated circuit.

Two common defects in crystals are dislocations and planar slips. Dislocations are due to irregular heating or cooling and slips occur when one part of the crystal shears. Defects can be detected by etching and staining the wafer. The two manufacturing techniques have been sufficiently perfected to prevent defects but these can arise in subsequent handling.

Cut Up

The cut or a silicon wafer is defined by the orientation of the crystal to the x, y and z axes. These are called Miler indices and are defined as:

$$X_{index} = \frac{1}{X_{intersection}}$$

$$Y_{index} = \frac{1}{Y_{intersection}}$$

$$Z_{index} = \frac{1}{Z_{intersection}}$$

If the crystal intersects the axes at x=1, y=1 and z=1 then the orientation is 111 as shown in Fig 7a. If the crystal does not intersect a particular plane then it is said to intersect that plane at infinity – since and parallel lines are said to meet at infinity.

Fig 7b shows a crystal that intersects the x axis at 1 but doesn't intersect either of the y or z axes and thus has a Millar index of 100.

Manufacture Of Wafers

The crystal is ground into a disk and the orientation determined. Which crystal face will be presented on the surface is decided by the seed crystal but the outer axes are decided by the rotational orientation of the crystal rod. The crystal has axes along which it is easier to break it into smaller pieces. This has to be taken into account before building circuits onto it. To make a reference plane, a flat surface is ground onto the crystal and then etched to remove any rough surfaces.

The crystal orientation is detected by an x-ray diffraction process, ground with one or more flat areas, then sawed into thin slices called wafers by the inner edge of a ring shaped saw. Diamond powder is sprinkled onto the saw blade to assist cutting. At this stage care is taken not to chip or flake the crystal and saw marks are removed from the wafer by etching.

Unfortunately, the wafer is still not flat enough for processing and must be polished on both sides by a process known as lapping. Any damage caused by this is removed by etching with acid which can take between 10μm and 30μm from each side of the wafer.

A mixture of ascetic, nitric and hydroflouric acid is used for etching. Alternatively, hot caustic etching using sodium or potassium hydroxide can be used – at temperatures between 70C and

130C. Acid is faster but more hazardous, less friendly to the environment and gives a less uniform finish than caustic etching.

The wafers are checked for resistivity, flatness and thickness and then mounted onto a polisher to give one side a mirror finish. The wafers are then cleaned and examined for again for resistivity, flatness and contamination.

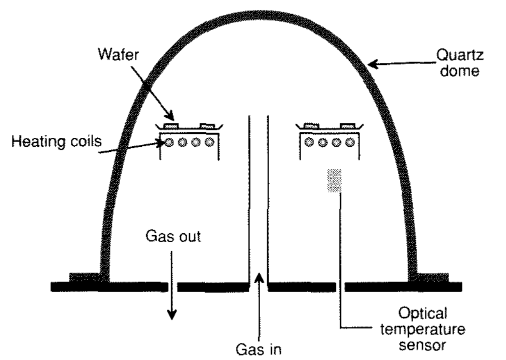


Fig. 14. Vertical chamber.

Growing Layers

The chemical vapour deposition (CVD) process decomposes a gas compound and deposits a stable layer on a heated substrate. Growing epitaxial layers is a particular kind of CVD where the structure of the deposited layer is the same as the substrate. All CVD processes require:

- A reaction chamber
- A means of controlling the gas flow
- A method of controlling the sequence and timing of events
- A means of heating the substrates
- An arrangement for handling waste gases

The reaction chamber itself may be made of stainless steel, quartz, aluminium or even a cloak of nitrogen.

Epitaxial growth is a special case and is used for producing both integrated circuits as well as discreet components based on silicon. Epitaxial growth, together with high temperature diffusion, are also used in manufacturing light emitting diodes.

Expitaxial growth produces devices with higher speeds and breakdown voltages as well as being able to handle higher current. In manufacturing diodes, the silicon substrate is heavily doped to provide low resistance which lowers the reverse junction breakdown voltage. To counter this a lightly doped epitaxial layer is deposited on the substrate as shown in Fig. 8.

Transistors can be manufactured either by starting with an epitaxial layer to form the collector and diffusing the emitter and base (Fig. 9), or by starting with an epitaxial layer to form the base and then diffusing the emitter as in Fig. 10.

Bipolar integrated circuits as well as MOS and CMOS (complementary metal oxide semiconductor) devices are manufactured using highly doped epitaxial layer on a more heavily doped substrate, Fig. 11 and 12.

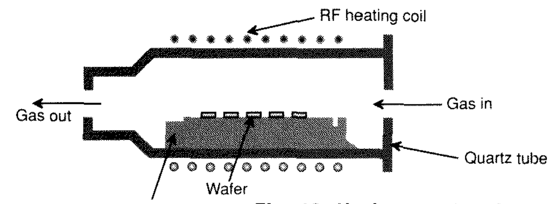


Fig. 13. Horizontal chamber.

The Reaction Chamber

Three types of chamber are used, horizontal, vertical and barrel. In the first (Fig. 13), the gases enter at one end and exit at the other. They pass over the wafers which lie flat – the wafer bed slopes to compensate for the low concentrations of gas towards the exit.

In the vertical chamber, the gases enter an exit vertically (Fig 14). The wafers still lie flat and the wafer bed, called the susceptor, rotates within the chamber to encourage the gas to circulate and hence produce a more uniform deposit.

In the barrel chamber the wafers are mounted on the vertical faces of a rotating susceptor, Fig. 15. The gas enters at the top of the chamber and leaves at the bottom.

The susceptor is made of graphite coated with a thin film of silicon carbide. The wafer board is called a susceptor because it is susceptible to heating by RF waves. The carbon atoms in the graphite are made to vibrate by the RF energy producing heat and the silicon carbide film prevents carbon contamination of the wafers.

The horizontal and vertical reactors both employ RF heating with temperature monitoring by optical techniques. Both the colour and intensity are monitored against known values and corrective action is applied to the RF energy. For example a white colour indicates a higher temperature than red. Metallic sensors cannot be used since the RF energy will couple with the sensor.

The barrel reactor employs quartz lamps for heating and therefore a thermocouple may be used. The epitaxial process is called a cold wall process because the walls of the chamber are cooler than the susceptor and the rate of deposition is faster on the hotter surfaces.

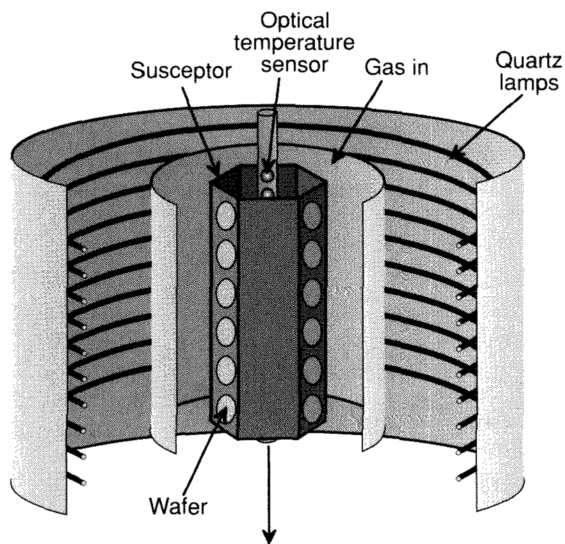


Fig. 15. Barrel chamber.

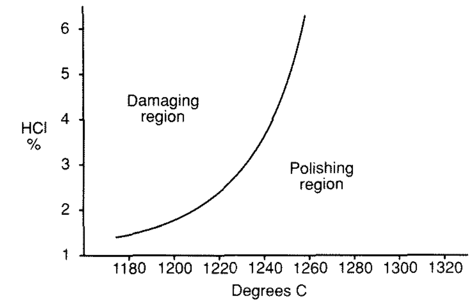


Fig. 16. Wafer etching with HCl.

Going With The Flow

Various gases are used to flush the chamber, etch the wafer, coat the wafer and carry dopants.

Before heating up the reactor, air must be flushed out with a neutral gas such as nitrogen. Similarly, during cooling down, after the epitaxial layer has been deposited, the remaining gas must be flushed out.

During the etching and doping processes, hydrogen is used as a carrier gas to maintain a steady flow and uniform conditions. Nitrogen cannot be used at these temperatures since it will react with the silicon. Helium can be used instead of hydrogen.

The gases used for doping must be compatible with the gases already present in the reactor. Compounds of hydrogen are used and, since they are only carried in small percentages (highly diluted) of the carrier (hydrogen), it is easy to control the flow and hence the dopant. Diborane (B_2H_6) gives P-type material, arsine (AsH3) and phosphine (PH_3) produce N-type.

Before the epitaxial layer is deposited, the surface is prepared by etching. Hydrochloric acid (HCl) gas is used at a concentration of 1% to 4% in hydrogen to give a fairly linear etching rate. About 0.25µm to 1µm of surface is removed. The difference between a nicely polished surface and a pitted surface depends both in the concentration of the HCl as well as the temperature (Fig. 16).

For depositing the epitaxial layer a compound containing silicon and hydrogen or silicon and chlorine or both hydrogen and chlorine is used – Fig. 17. Silicon tetrachloride is a liquid at room temperature but the others are gases. Fig. 17 shows the rate of deposition as well as the required temperature.

Considering the number of gases that have to flow in and out of the chamber, flow meters as well as timers are required. In the early days, operators used stop watches whereas today, most of the processes are automatic,. The operator simply watches the dials and loads and unloads the wafers.

Two of the most common methods of controlling the flow of gas are to measure the cooling effect of the gas on a heated wire or to float a sphere in the stream. The exhaust gases need to be made safe to discharge into the environment. The equipment that does this is called a scrubber and adds large amounts of nitrogen to cool and dilute the gases. The gases then pass through long curtains of water to cool and dissolve and gases further.

The Epitaxial Process

The wafer is cleaned with solvent to remove grease then with acids and dried. The acids used in sequence are sulphuric, nitric and hydrochloric. The wafer is also scrubbed to remove particles.

Once the wafers are clean they are not handled by the front surfaces. Instead suction is applied to the back by means of vacuum wands to load the wafers onto the susceptor. The susceptor heats up and nitrogen flushes the chamber. When 500C is reached, hydrogen is used as the carrier gas to transport HCl acid to etch the surface.

As silane requires the lowest operating temperature and silicon tetrachloride the highest temperature, we can examine these two sources for epitaxial growth.

Silane is diluted with hydrogen when stored in a tank since it ignites on contact with air. The low temperature (950C to 1050C) used for processing silane means that the doped regions of the wafer are less affected by migration of impurities than in higher temperature processes. The reactions are:

$SiH_4=Si+2H_2$

Silicon tetrachloride is kept in the liquid state in a container near 0C and hydrogen passed over it to pick up the vapour. The amount it picks up depends on the temperatures of the container and the rate of flow of the hydrogen carrier. The reaction is:

$SiCL_4+2H_2=Si+4HCl$

If the concentration of $SiCL_4$ is too high, far from depositing an epitaxial layer, etching takes place and silicon is removed. The reaction is:

$Si + SiCl_4 = 2SiCl_2$

Also, at this temperature (1150C to 1225C) the diffusion profile of doped regions could alter as the dopants migrate.

When the epitaxial growth is complete, the temperature is reduced and at 500C, hydrogen is replaced with nitrogen for flushing and further cooling. The wafer surfaces are oxidised to protect them against contamination and they are unloaded with care.

Non-epitaxial Processes

The three types of reactor used for epitaxial processes can also be used in non-epitaxial processes. In addition, the reactions can also take place in a blanket of inert gas like nitrogen – Fig. 18.

In cold wall systems, the walls are only cold when compared to the

Material	Required temperature in C	Rate of deposition in µm/min
Silane (SiH_4)	950 - 1050	0.1 - 0.25
Dichlorosilane ($S1H_2Cl_2$)	1025 - 1100	0.1 - 1.0
Trichlorosilane ($S1HCl_3$)	1100 - 1175	0.2 - 2.0
Silicon tetrachloride ($SiCl_4$)	1150 - 1225	0.2 - 1.0

Fig. 17. Wafer etching with HCl.

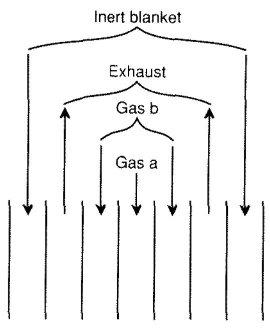


Fig. 18. Gas blanket reactor.

	Temperature in C	Material deposited	Film
Plasma enhanced CVD	100-300	SiO_2 SiN	Poor
Atmospheric CVD	300-500	SiO_2 Phosphorous glass	Good
Low temperature LPCVD	300-500	SiO_2 Phosphorous glass	Good
Medium temperature LPCVD	500-900	SiO_2 Phosphorous glass Si_3N_4 Polysilicon	Very good

Fig. 19. CVD at different pressures and temperatures.

wafers and such systems employ RF or ultraviolet heating. Systems using thermal resistance heating are hot wall systems. Cold wall systems can be heated and cooled rapidly because of the small mass that needs heating. This is also assisted by the large volume of gas flowing.

CVD processes must guard against contamination from leakage of oxygen or water vapour and the key to successful processing is good gas flow control, a uniform temperature and an optimum position for the substrate in the chamber.

Low temperature CVD is popular for depositing silicon nitride and phosphorous glass for creating passive layers directly over metal layers. However, the disadvantage is that the layer is not uniform and processes in the higher temperature range 500C to 900C provide better insulation between layers.

Low pressure CVD processes are becoming popular because of their more uniform coverage and Fig. 19 shows the materials deposited and the film quality by suing a combination of pressure and temperature.

Most low pressure CVD processes use a horizontal reactor with the wafers placed vertically as in Fig. 20. A resistance heater covers the length of the quartz chamber which has a vacuum pump at one end and a gas flow control at the other.

Although the horizontal chamber can handle a large number of wafers, there is the old problem of depleting the gas of reactive elements. One method of overcoming this is to have a temperature gradient along the reactor but this could increase the thickness of the film at higher temperatures. Another method would be to maintain a constant temperature but inject the gas through several slits along the reactor. The barrel reactor produces a more even gas distribution but cannot handle as many wafers.

Many different materials can be deposited using the CVD process but in processing semiconductors, the materials commonly deposited are:

- Silicon nitride
- Silicon dioxide, dope or pure
- Polycrystalline silicon

Silicon nitride is deposited to form a dielectric. If nitrogen is used as carrier, at a temperature of 600C to 700C, the reaction is:

$$3SiH_4 + 4NH_3 = Si_3N_4 + 12H_2$$

Alternatively, using hydrogen as a carrier and a temperature of 900C to 1100C the same reaction is obtained.

Silicon dioxide can be deposited doped with boron, arsenic or phosphorous and is usually deposited at temperatures below 450C to prevent damage to existing metal layers. It is usually deposited to guard against scratches and can be deposited at temperatures of 200C to 500C using nitrogen as a carrier to give the reaction:

$$SiH_4 + 2O_2 = SiO_2 + 2H_2O$$

Or at a temperature of 500C to 800C and still using nitrogen as a carrier a different reaction occurs:

$$SiH_4 + 4CO_2 = SiO_2 + 4CO + 2H2O$$

At the higher temperature of 800C to 1000C, hydrogen must be used as a carrier to give:

$$2H_2 + SiCl_4 + CO_2 = SiO_2 + 4HCl + C$$

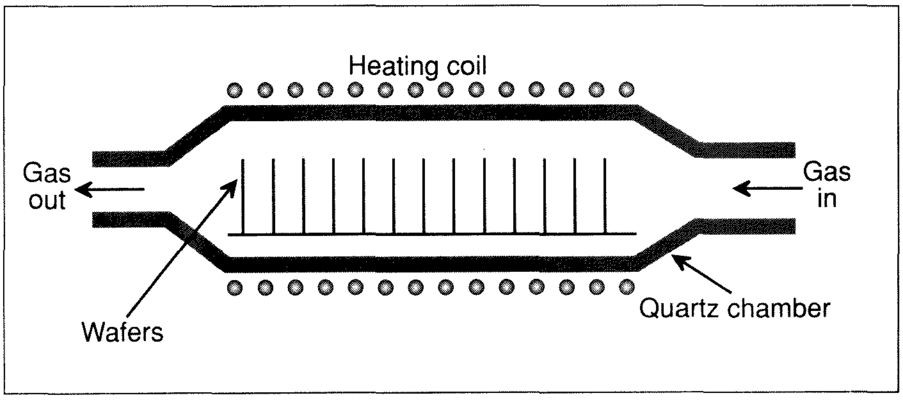
In the semiconductor industry, it can be seen from the above reactions that many hazardous chemicals and gases such as carbon monoxide, arsenic and various acids are used. This demands the most stringent precautions as some acids even appear as exhaust gases.

A layer of silicon dioxide doped with phosphorous is sometimes used to prevent the migration of impurities. Unfortunately, if the phosphorous content is mote than 5%, the metal layer is etched when a voltage and moisture are present. To prevent this a layer of undoped silicon dioxide can be used between the phosphorous doped layer and the metal.

Silicon crystal which does not have a structure extending throughout is called polycrystalline or poly. It is deposited using nitrogen as a carrier and a temperature of 600C to 700C or hydrogen at a temperature of 850C to 1000C. At both temperatures the reaction is:

$$SiH_4 = Si + 2H_2$$

Polycrystalline deposition is used if the deposition temperature is below that used for growing a single crystal. It is also used in the rate of deposition is higher if the substrate lacks a crystal structure. Poly can be deposited doped or undoped and us usually the latter. It is doped later to provide a conducting layer. ■



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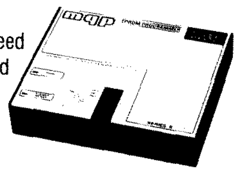

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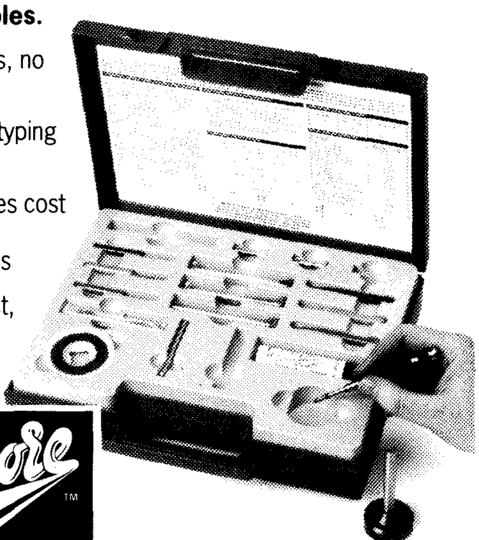

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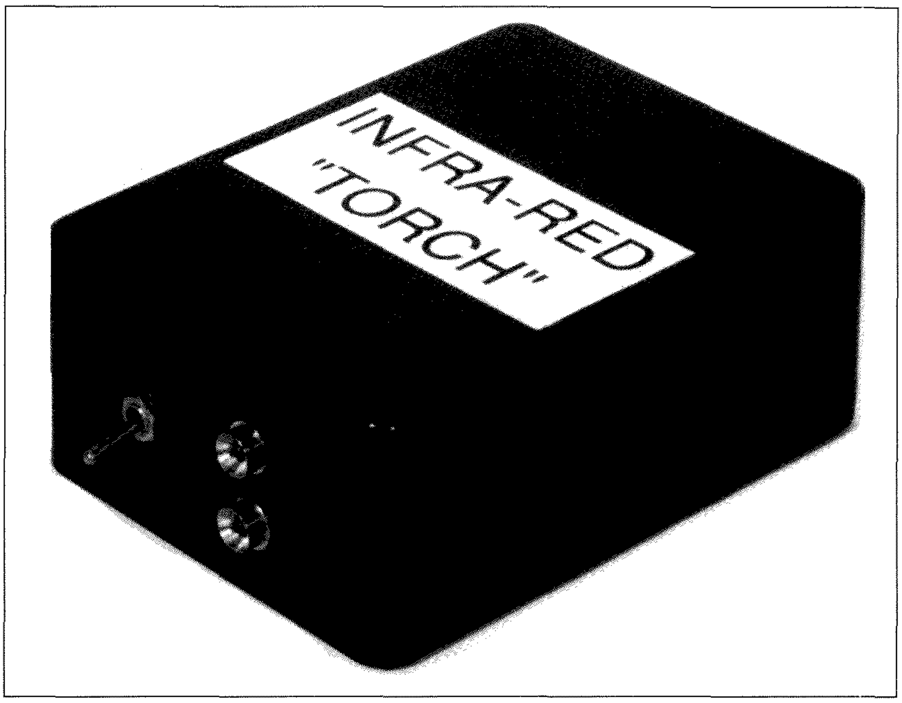
Looking Into The Darker Corners

Robert Penfold describes how to build a hand held infra-red scanning device that takes over where your eyes leave off.

This security device is basically much the same as a standard passive infra-red detector, but with the general setup reversed. Normally the infra-red sensor remains fixed and the person being detected moves. If the "target" does not move, then it is not detected. The infra-detector unit featured here is a hand-held device which is used much like a torch. You slowly scan the unit across an area, and two LEDs "blink" if an infra-red source is detected. The movement is provided by the detector, and it will detect any "targets" within the scanned zone whether they are moving or stationary.

Perhaps of more importance in security applications, anyone detected by the unit will be unaware of this fact. The unit is a passive detector, which does not require a beam of light or infra-red to be shone at the "target". It responds to body heat. Consequently, unless you tell them, there is no way that someone detected using the unit will know that they have been discovered. They would presumably not even know that you were using some form of night vision device. The unit operates at ranges of up to about 30 metres incidentally.



System Operation

The block diagram of Fig. 1 helps to explain the way in which this unit functions. The pyro sensor detects the heat from the "target", but it has a wide angle of response and a very limited range if used unaided. In an application of this type we require an angle of view of just a few degrees and a range of many metres. This is achieved by adding a plano-convex lens in front of the pyro sensor. This gives an angle of view of only about two degrees. By gathering up the infra-red radiation over a relatively large area and concentrating it on the elements of the pyro sensor the lens greatly boosts the maximum operating range of the unit.

It must be emphasised here that not just any convex lens will work in this application. With infra-red projects that use infra-red LEDs and photo-diodes the choice of lens is not critical. However, in a system such as this it is much longer wavelengths that are involved. Whereas infra-red LEDs have peak output at about 900 to 950nm (not far from the visible red part of the spectrum), passive infra-red detectors operate at around 1 to 20μm. At around 950nm most lenses have a slight shift in their effective focal length, but nothing more drastic than this. At about 10μm (10000nm) most lenses seem to be more or less opaque! They fail to provide any significant focusing of the infra-red energy. Therefore, it is important to use the special lens specified in the components list. The unit is unlikely to work at all using other lenses.

On the electronic side of things the unit is pretty simple. The output swing from the pyro sensor will often be no more than a few millivolts peak to peak, and with distant targets it could be under one millivolt. Two high gain amplifiers are therefore used to boost the voltage swing to a more useful figure of a few volts peak to peak. Bandpass filtering helps to avoid spurious output signals due to noise and drift in the pyro sensor.

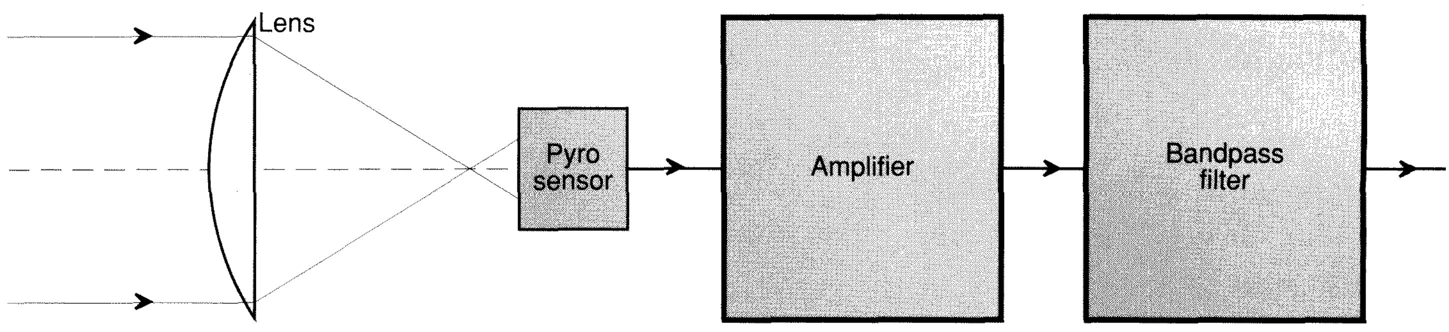


Fig. 1. The infra-red torch block diagram.

The frequencies involved in this application are sub-audio at about 0.2Hz to 3Hz. The slow innate response of the pyro-sensor precludes a wider bandwidth at the high frequency end. The practical result of this is that the "torch" must be scanned fairly slowly if it is to operate at maximum sensitivity. Swishing it around all over the place in a sword-like fashion will render it largely ineffective.

In the original design a LED indicator was driven from the output of the amplifier via a trigger circuit. In practice this did not work very well. With the gain ahead of the trigger set high, the unit gave good range but tended to give confusing results. The apparently random flashing from the LED was impossible to interpret reliably even after gaining some experience with the unit. Using lower gain gave more clear results, but at the expense of much reduced range.

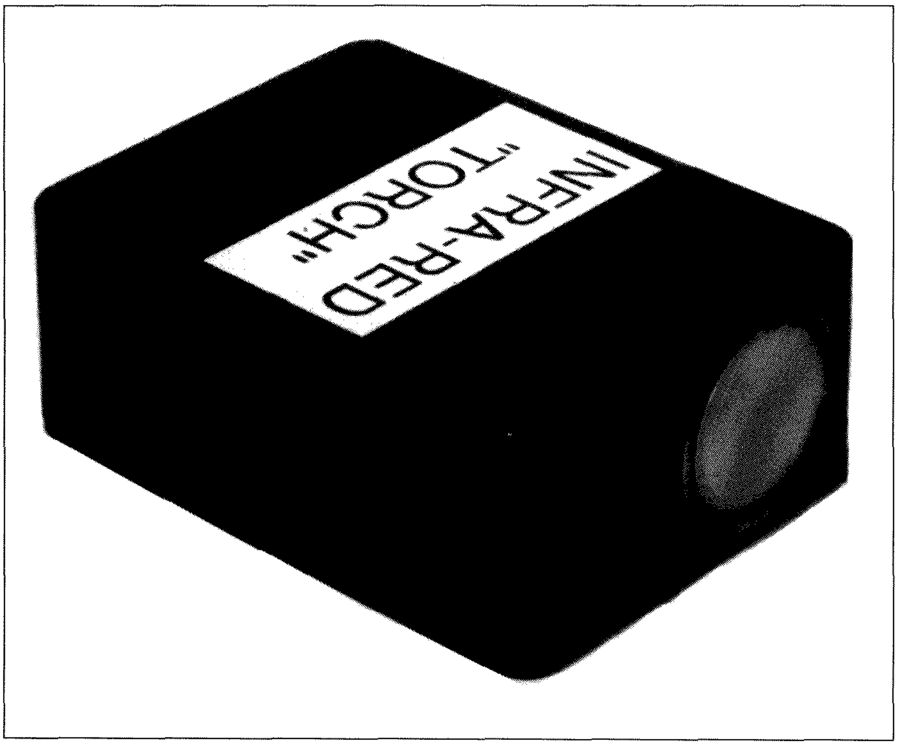
Simply driving two LEDs connected to operate out-of- phase seems to give much better results. As one LED gets brighter, the other grows dimmer. This helps to emphasise any change in brightness, giving clearer indications than if a single LED was used. Results are easy to interpret because you can see whether you are getting a small or a large response from the unit. This makes it easy to ignore any minor background responses, and to concentrate on any strong responses.

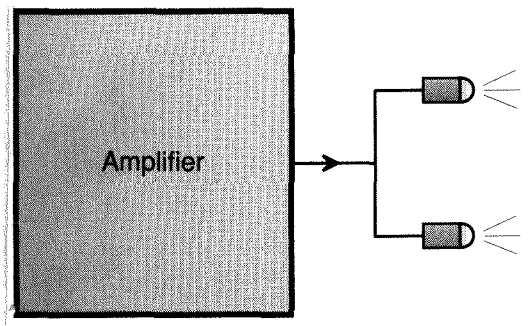
Pyro Sensor

The pyro-sensor used in this design is actually something more than just a simple sensing device. Firstly, it actually contains two sensing elements. Secondly, in common with most pyro sensors, it contains an FET pre-amplifier. The circuit of the sensor is shown in Fig. 2 and, as will be seen from this, the two sensing elements are connected in series and out-of-phase. On the face of it, the two sensors cancel out each other's output signals, always giving zero output from the unit. As far as any changes in the general background infra-red level are concerned, this is true.

The main point of using twin element sensors is to obtain this immunity to changes in the ambient infra-red level. Although it might seem as though the sensor will not respond to the infra-red signal from "targets", this is not so. Remember that the unit is not designed to pick up static infra-red signals, but should respond to moving signals. This movement causes an infra-red signal to pass across the sensor elements. In doing so the energy activates the first sensor, then both sensors, then only the second sensor. This gives a strong output pulse of one polarity, followed shortly afterwards by a pulse of the opposite polarity.

A slight problem with most twin element sensors is that they must be orientated correctly. If they are fitted with the wrong orientation the infra-red radiation is swept across them simultaneously, and no significant output signal is produced. In the present application this would mean having to hold the torch the right way up, or it would not work efficiently. This is undesirable, since there is no way of telling how someone will hold a unit of this type. There is no problem with the specified sensor





(an SBA04) as it is a new type which has special sensing elements which render it omni-directional. The elements are of the "69" variety (that is, shaped like the figures "6" and "9", and suitably entwined). This ensures that a strong output signal is produced regardless of how the infra-red signal is swept across the sensing elements.

The preamplifier is a simple source follower type which requires a discrete load resistor. The source impedance of the sensors is very high and the FET preamplifier ensures that a suitably extended low frequency response is obtained.

Circuit Operation

Fig. 3 shows the circuit diagram for the infra-red torch. IC1 is the pyro sensor and R1 is the external source load resistor for its FET preamplifier. IC2 acts as the basis of the first amplifier stage, which is a form of non- inverting amplifier. IC3 is used in the second amplifier, and this is an inverting amplifier having a relatively low voltage gain figure. C5 and C7 roll-off the frequency response of the circuit at frequencies of more than a few Hertz. Highpass filtering is provided by using coupling capacitors which provide a suitable cut-off frequency at the low frequency end of the response.

D1 and D2 are the LED indicators, with current limiting provided by R10 and R11. These set the LED current at only a few milliamps but, as the unit will be used in something approaching total darkness, this gives more than adequate LED brightness. The current consumption of the circuit is only about 6 milliamps, and a PP3 size battery is therefore adequate to power the unit.

Construction

Details of the printed circuit board are provided in Fig. 4 (component overlay) and Figure 5 (copper track pattern). Construction of the board is fairly straightforward but, due to its small size, it is essential that small resistors and capacitors should be used. The electrolytic capacitors are miniature radial (vertical mounting) types and the other capacitors are all printed circuit mounting polyester types having 7.5 millimetre lead spacing. Do not overlook the two short link wires (one above C5 and the other between C6 and IC3).

None of the semiconductors are static sensitive types incidentally, but I would still recommend the use of holders for IC2 and IC3. Be careful not to leave finger marks on the pyro sensor's "window". If you should get finger marks on it, clean them off with a soft cloth or the range of the unit might be seriously impaired. Fit double-sided pins to the board at the points where connections to the off-board components will be made.

The printed circuit board has been designed to fit a Maplin ABS box type MB2. This has built-in

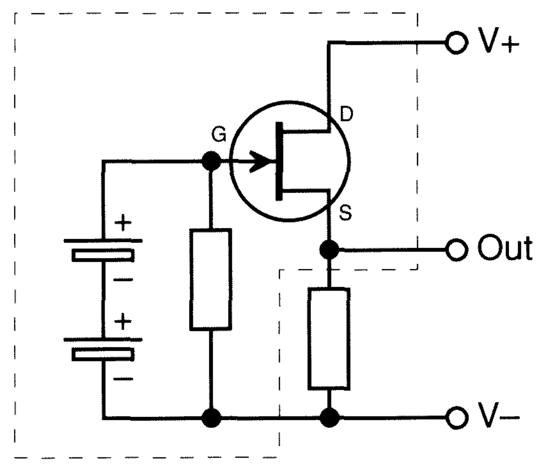
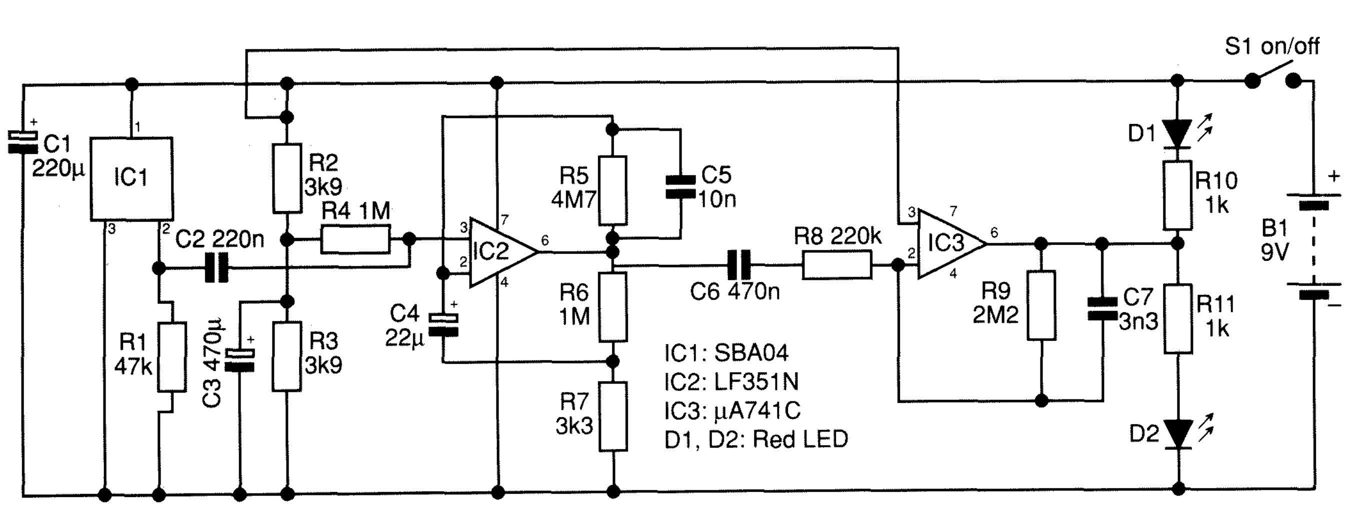
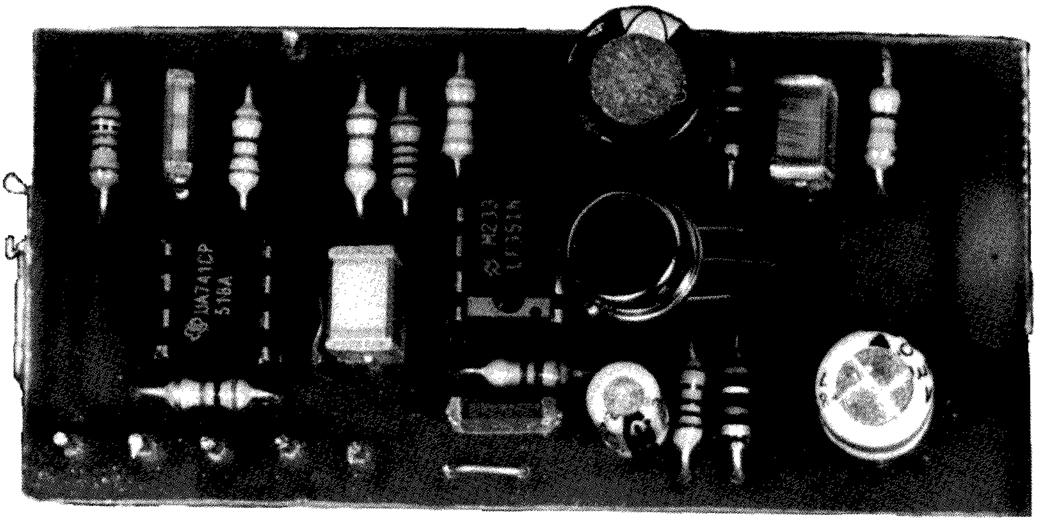


Fig. 2. The circuit for the pyro sensor contains the components shown within the dashed lines – a separate load resistor is needed for the FET.



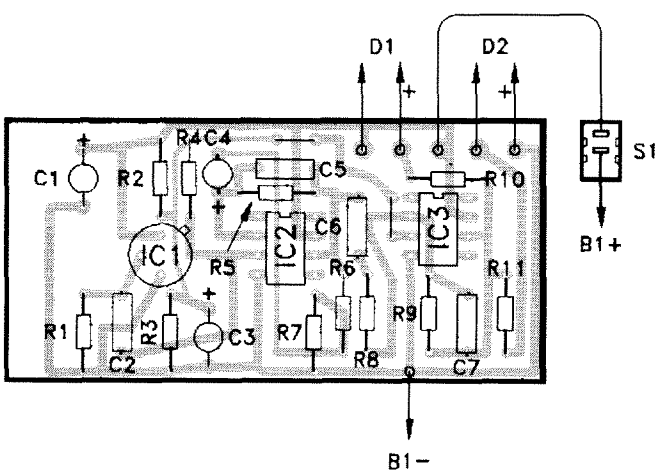


The finished circuit board.

printed circuit guide-rails, and the board slots into the middle set of rails. If a different case is used it will almost certainly be necessary to modify the board slightly in order to mount it in the case. Life is likely to be much easier if the specified case is used. The board will prevent the lid of the case from fitting properly, as it will obstruct the ridge around the underside of the lid. To avoid this it is merely necessary to file a couple of notches in the ridge at the appropriate points.

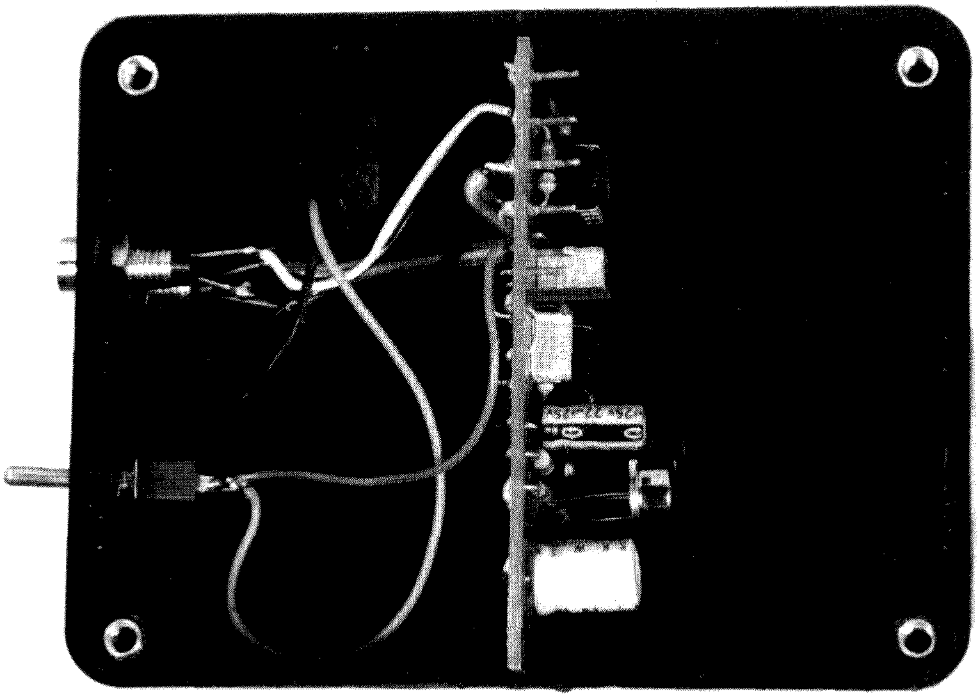
A 30mm diameter hole must be made in the case directly in front of the pyro-sensor. I found that a suitable hole could be made by first drilling one of about 12mm in diameter and then enlarging this using a reamer. The lens must be glued in place over this cut-out. The lens has an outer rim about 3mm wide for fixing purposes. I think that the lens is designed to operate with the plain surface facing away from the sensor but it seems to give much the same results either way round. As the case and the lens are both made from softish plastics, not all adhesives will stick them together reliably. In particular, most "super-glues" are not effective with materials of this type. An epoxy adhesive seems to be a good choice for this type of thing. Be careful not to smear adhesive over the main part of the lens, which could greatly reduce its efficiency.

Fig. 4. Printed circuit board component layout and wiring.



The two LEDs and on/off switch S1 are mounted at the rear of the unit (that is, the end one opposite the one on which the lens is mounted). The final wiring-up can them be completed. The cathode (+) terminals of the LEDs will probably be indicated by "flats" on their bodies, or by shorter leads. There is plenty of space for the PP3 size battery in the rear section of the case. A double-sided adhesive pad or tape can be used to hold it in place.

The focal length of the lens is 30mm which means that the pyro sensor should be positioned 30mm behind the lens in order to obtain maximum sensitivity and the narrowest possible angle of view. With the suggested layout and the pyro sensor's leadouts left full length, the sensor will probably be slightly too far back. This slight defocussing of the optics will reduce the range somewhat but will broaden out the "beam" slightly making the unit easier to use. However, if you wish to optimise the range, simply mount the sensor on pins so that it is brought forward slightly. The sensor should be positioned centrally behind the lens, or the "beam" will not be in quite the same direction as you aim the unit.



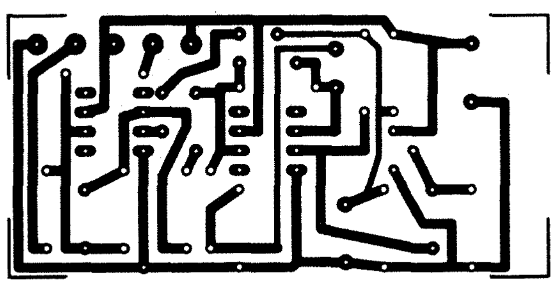
Inside the box.

Testing And Use

At switch-on you will probably notice that one LED switches on, followed by the other LED switching on as well. After several seconds the LEDs will "blink" and then both switch on again. At this stage the unit is ready for use. This so-called "warm-up" period is due to the extended low frequency response and high gain of the amplifier stages. It takes some time for the capacitors in the circuit to settle down at their normal operating voltages. If the "warm-up" period is very long indeed, or never ends, it would suggest that C4 has too high a leakage level. This should be a high quality electrolytic capacitor, or even a tantalum type, if the unit is to function properly.

The unit is easily tested out with the aid of a helper, or even using passers-by as test "targets". There is no need to wait for darkness in order to test it – the unit functions perfectly well in daylight. In fact it is better to test it in daylight as this makes it easier to assess results. Bear in mind that the unit is not, strictly speaking, a person detector, and that it will respond to anything that is warm (a radiator for example). If in use it seems to give a false alarm, it is likely that it has detected something warm that you have not noticed. For optimum sensitivity scan with the unit quite slowly. Scanning rapidly massively reduces the effective sensitivity of the unit, and can give very limited range. ■

Fig. 5. The PCB copper track pattern (1:1) – mirror image.



Components

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R1	47k
R2, R3	3k9
R4, R6	1M
R5	4M7
R7	3k3
R8	220k
R9	2M2
R10, R11	1k

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Semiconductors

IC1	SBA04
IC2	LF351N
IC3	µA741C
D1, D2	Red panel LED

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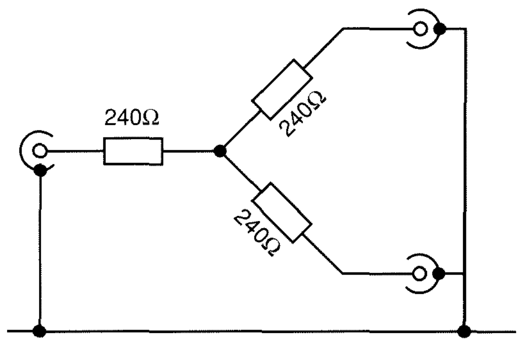
Wanted: Does anyone have a

Advertising Index

Techniques

Having trouble with your TV picture? Andrew Armstrong suggests a few solutions.



$$\frac{R+75\Omega}{2}+R=75\Omega$$
$$37.5+1.5R=75$$
$$\Rightarrow 1.5R=37.5$$
$$\Rightarrow R=25\Omega$$

So choose 24Ω though 22Ω should work okay if 24Ω is not available

Fig. 1. Aerial "Y" connector.

Colin McTavish of Sutton Coldfield writes to ask how he can run two televisions in widely separate locations from one aerial. He writes: I have tried simply joining two pieces of coax together and connecting them both to the aerial outlet in the living room, but the picture ends up blurred. Using a television Y adaptor solved the clarity problems, but there must have been too much attenuation, because the pictures became rather noisy, and teletext did not work. I imagine that a TV aerial booster with two outlets would solve the problem, but they are rather expensive. Has PE recently published a design for one?

Taking things in order: it is never a good idea to star-connect several coaxial cables carrying RF or video. This sort of connection can work at audio frequencies because the cable is not matched. Television aerials use 75 ohm coax, and if several lengths are to be joined at one point, then the impedance looking in at any point must be 75 ohms if reflections are to be avoided. The blurring of the picture, which you noticed, was probably a very short interval ghosting caused by reflections from the cable junction. Fig. 1 shows a resistive Y connection suitable for three cables to be joined, Clearly the calculations for the resistor values could be extended to more cables, but more signal would be lost.

You are right that an aerial amplifier would improve the situation, and now that you already have a Y connector (which almost certainly is connected as shown in Fig. 1) an ordinary aerial amplifier would do the job.

There are two main ways of designing aerial amplifiers: one is to use a transistor to provide the gain, the other is to use a hybrid circuit. Fig. 2 shows a transistor design. This should provide slightly more gain than is required to compensate for the loss in the Y connector, without having so much gain as to be vulnerable to interference by local amateur radio or CB transmitters. should such interference occur, the filter shown in Fig. 3 could be added to the input.

Little needs to be said about the circuit. Connections to decoupling capacitors should be kept very short and the unit should be built on an earth plane. L1, L2, and L3 should be made by winding six turns of 0.5mm to 1mm diameter

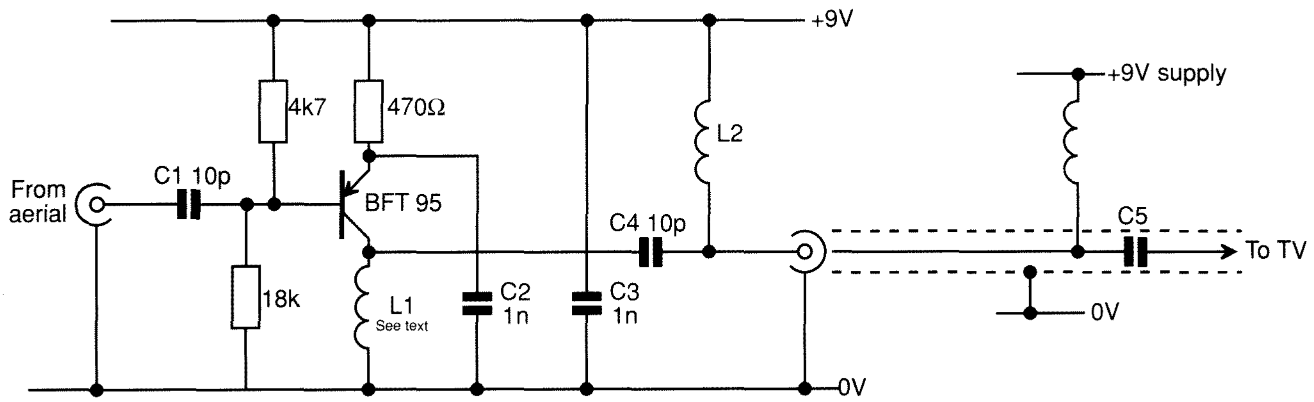


Fig. 2. Aerial amplifier.

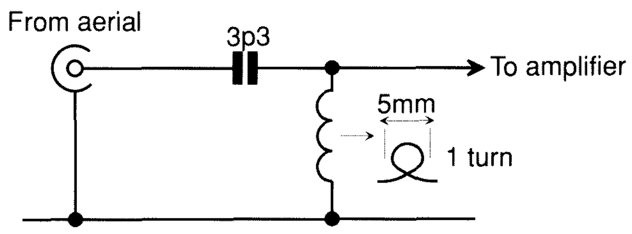
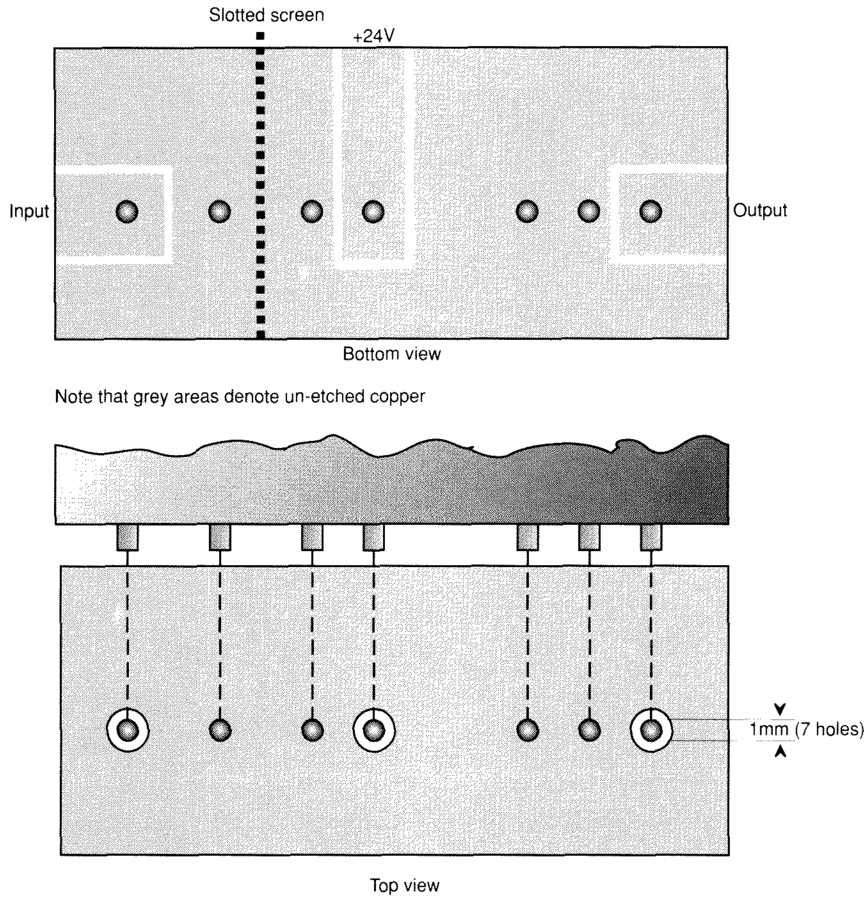


Fig. 3. High pass filter.

Fig. 4. Layout of hybrid aerial amplifier.



wire on a pencil. A screen between input and output may be necessary.

The power connections shown are to power the circuit remotely from its power source, for example if it is mounted on the masthead. If this is not necessary, L2, L3, and C5 can be omitted and the power connected directly.

Hybrid

Fig. 4 shows the design of a hybrid TV aerial amplifier. All the necessary circuitry is in the hybrid IC and all that is needed to make it work is a board to mount it on and a power supply. Note, however, that a screen must be fitted between input and output, with as narrow a slot as possible to accommodate the IC. If this is not done, some samples of the IC will oscillate in the television band, due to capacitance across the IC itself. This circuit provides in excess of 20dB of gain and is more likely to be vulnerable to interference. The filter circuit of Fig. 3 is still suitable for this, but in severe cases a commercially available in-line CB filter may be required.

The top and bottom earth planes should be joined together, either by a series of pin-throughs next to the hybrid circuit, or by thin wires inserted in each earth hole and soldered top and bottom before the hybrid is inserted. The latter method is better, if practical.

The high frequency transistor for the design in Fig. 2 is available from Cirkit, and the OM335 hybrid is available from Electromail. An aerial amplifier kit using the OM335 hybrid is available from Specialist Semiconductors. ■

Continued from page 15

and a useful adjustment range. I would have preferred to have had a contrast control available, as well. The ability to reduce the contrast very slightly on occasions would be an advantage. On the rear of the set is a signal sensitivity switch.

The people in the Sony shop tell me that one of the reasons why the picture has less noise on it is because the Sony Watchman incorporates a switched signal booster. On the high sensitivity setting, this gives more gain than usual. In practice, I have not yet found anywhere where the signal is strong enough for me to want to switch to low sensitivity.

The display is specified as a twisted nematic liquid crystal with TFT active matrix drive. There are 89,505 picture elements, and better than 99.99% of them are specified to work effectively.

In use, there is only one picture defect (it is in the middle area of the screen) which is noticeable under normal viewing conditions with the slightly noisy signal available in my area. Two more defects are visible on some picture material, and with a really good signal and the sort of picture that shows up the faults, in total four or five can be seen. The other defects would not be noticeable if you were not looking for them; only the worst one might catch the eye of the viewer not looking for it.

The instruction sheet is clear and adequate, but modelled on the lines of the type of hikers' map that can only be refolded by an expert. Fortunately, the Watchman is easy to operate.

The Sony Colour Watchman costs £229.95 from most dealers, including the specialist Sony outlets which are now springing up. ■

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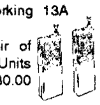

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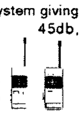

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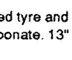

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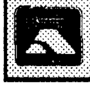

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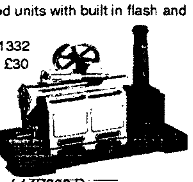

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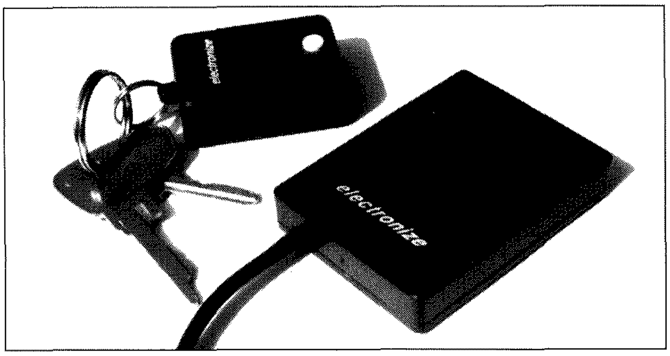

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The lucky winners the car alarm kits are:
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S M Cording, Broxbourne, Herts
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I Moore, Belfast

The answers were:

1: IR radiation ranges from 10^{12}Hz to 10^{14}Hz
2: The max speed for cars in the UK is 70mph
3: Modern cars are negative earth

Continued from page 62

convert, without first having to transcode every file to ASCII. Automating transfer via ASCII is impractical because it involves stepping through files, all with different names and creating new files with matching names.

The "convert" program which comes with WordPerfect only handles a few well-known old word processing packages. The instructions which purport to advise on other conversions will be gibberish to all but a very few of the most skilled computer literates. I sent Godwin a floppy disk containing files in Quill and asked the simple question surely it would not be difficult for WP to ignore everything except carriage returns, and double carriage returns for paragraphs, to make conversion quick and easy.

It took two months and many nagging phone calls and faxes from me to get a completely useless answer. "There are indeed some software programs which are now obsolete and are not supported by WordPerfect's conversion program. Unfortunately this creates a problem for people in your position who would like to switch to WordPerfect or LetterPerfect but have too much material stored in another format", writes Godwin, simply re-stating my question and confirming that would-be new users must go to third party software companies which specialise in document conversion – inevitably at far too high a price for anyone with a large number of files.

I never got my disk back and there is no reason to suppose that anyone at WP UK even bothered to check it. ■

Tried And Tested... By Pigs

Barry plays with CDTV, MS-DOS 5.0 and WordPerfect and realises that he is being used as a Guinea Pig – in fact we all, unwittingly, provide free testing for new products.

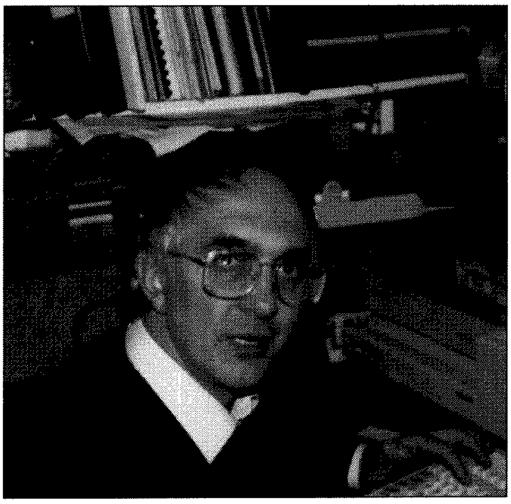
Commodore is now turning about face on CDTV. The interactive CD system, launched last April, was targeted at the consumer "brown goods" market with the emphasis on worthy "entertainment" software, developed especially for CDTV.

Consumer sales of CDTV players have been pitifully slow and Commodore now admits it made a hash of the launch. CDTV has already been renamed Amiga CDTV and reduced in price, but that hasn't worked. So this spring the 2.7 million owners of Amiga 500 computers in Europe will be offered a £300 CD-ROM add-on drive which plays CDTV discs. The software emphasis will shift from encyclopædias to games, ported from Amiga floppies to CDTV optical discs.

I finally got to try a CDTV player, nine months later than promised. Access times were terribly slow, without advice signs on screen. There was horribly distorted sound on the demo disc. Poorly thought-out software kept locking and crashing the system.

Only a computer company could make the mistake of trying to foist this on the public as a consumer product. History will judge it a miracle that the computer industry has, so far, managed to grow fat on using its customers as paying guinea pigs.

We are now up to Version 5 of the MS-DOS operating system, the de facto standard for non-Mac computers. DOS became the standard only because IBM chose it ten years ago. The decision was taken in a hurry by IBMers who knew nothing about the consumer computer business. Bill Gates and



his company Microsoft were in the right place at the right time. Gates was recently named America's richest man, worth $6.4 billion at the age of thirty-six.

Thanks to Gates PC users must struggle to identify files with a maximum of eight letters and buy bolt-on software like Norton's Utilities to undo the damage DOS can do with commands like Delete, Format and Recover – which have all the subtlety of thermonuclear devices.

When Microsoft released DOS version 5.0, there was the usual glossy demonstration for the press who were able to see the system working cleanly on rows of computers set up for the occasion. As usual, I refused to write a review on the strength of any such pre-packaged glitz and tried a copy for myself. Exactly as I feared, DOS-5 is a lot less neat and tidy than Microsoft would have you believe.

Ver 5 soaks up hard disk space by duplicating Norton's rescue tools. It claims better memory management but lacks any facility to optimise memory settings automatically, as for instance routinely offered by Quarterdeck's Optimise program that comes with QEMM/Desqview. Manual optimisation is a tricky, time-consuming job which – as the DOS 5 manual neatly proves – defies simple description.

Microsoft have already made what it tactfully calls a "silent upgrade". DOS 5A should lack some of the bugs which those who bought DOS 5 have found. But there is still no automated memory optimisation. Presumably we shall have the chance to buy this with DOS 6.

For my money, the best feature of DOS 5 is the "uninstall" program which returns the PC to its original state, in my case running DOS 3.3. This, like the old Morris Minor, has now been tested on enough paying pigs to have become a working tool.

Many offices now use WordPerfect word processing software with their DOS PCs. I do not particularly like WP, but am all for a quiet life and was quite happy to switch from my now obsolete word processing software (Psion's Xchange/Quill) for the sake of consistency. This is quite a commitment because the commands of any wordprocessing package become second nature and must be unlearned. More to the point, I have literally hundreds of disks and thousands of files stored in the old format.

So, when I saw an article written by David Godwin, Director of Marketing at WordPerfect UK, about "document compatibility" I wrote to him suggesting that if he wants to win over people with old software, WP must make it easy to

Barry continues on page 61

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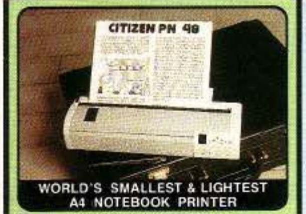

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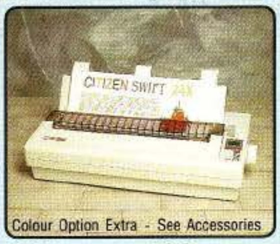

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