

INPUT/OUTPUT DEVICES

The basic function of a peripheral device is to get data into and out of the Central Processor. Hence they are often referred to as Input/Output Devices (I/O Devices).

How can we classify peripherals?

One method of classifying peripherals is by their rate of transfer of data. In fact we talk of FAST and SLOW peripheral devices (see Student Notes on Mainframes, Minis & Micros).

eg. Some SLOW peripherals are card readers, card punches, paper tape readers, paper tape punches and line printers.

Some FAST peripherals are magnetic tape systems, magnetic discs and magnetic drums.

INPUT DEVICES

Punched Card Reader:

These readers have an electro-mechanical or optical reading head which detects the presence of holes punched in a card.

The commonest punched card is the 80 - column card, in which a single character is represented in a column by a unique pattern of holes. The card has twelve rows, a character being represented by holes punched in either one, two or three of the 12 punching positions in each column. Adjacent columns are grouped together to form a 'FIELD' of data, typical fields being: name, address, age, date of birth etc. Cards can be read at speeds of up to 2000 cards/min.

An 'INTERPRETED' card has the corresponding character printed above each column for visual inspection.

Punched Paper Tape Readers:

These read in a similar way to punched cards; a character is represented by a unique pattern of holes across one 'FRAME' of the tape. A field of data is again a set of adjacent characters. Typical reading speeds of up to 1500 characters/second. The interpretation facility is not used with paper type.

Magnetic Ink Character Recognition:

Magnetic Ink Character Recognition (MICR) devices read specially printed characters like those for example on bank cheques. Their main advantage lies in the fact that they can be read by man and machine.

There are two stages at which the magnetic ink characters may be printed on the document (ie ENCODED ON THE DOCUMENT).

- i) Pre-coding: This takes place after the document has been printed but before it is used. The information entered at this stage would be fixed information.

e.g. In the case of cheques from a bank fixed information would be CHEQUE NUMBER, BRANCH REFERENCE NUMBER and CUSTOMER ACCOUNT NUMBER.

- ii) Post-encoding: This stage would occur when VARIABLE INFORMATION is entered on the document.

e.g. Bank cheque - here customer enters the amount of money he requires on the cheque. This is then passed through a keyboard machine where the data remains visible while the operator reads it and keys it in. The subsequent characters then entered on the cheque

from this process are in magnetic ink form.

The recording method depends upon the use of a specially designed font from which the characters are printed in the normal way using a ferrous based ink which is capable of magnetisation.

Each character is made as unique as possible in order to avoid misinterpretation. In general magnetic ink characters can be overwritten with ordinary ink without affecting their legibility for the document reader. Also there is usually a restriction on the number of characters which may be encoded in one document, this limit being imposed by the capability of the document reader.

The document reader often incorporates a sorting attachment. Hence in such cases documents can be read and sorted upon a predetermined code using the magnetic ink recognition principle.

A typical sorter/reader will operate at speeds of up to 1,200 documents per minute; where the document may have as many as 75 encoded characters.

Some MICR readers have attached an add lister. This is a printing device which lists and totals each document (eg Cheque) as it is read. This facility provides a means of checking and controlling the data entered into the computer.

When the MICR document reader accepts a document it first magnetises the ink and then senses the character patterns upon which it sends the appropriate pulses to the central processor.

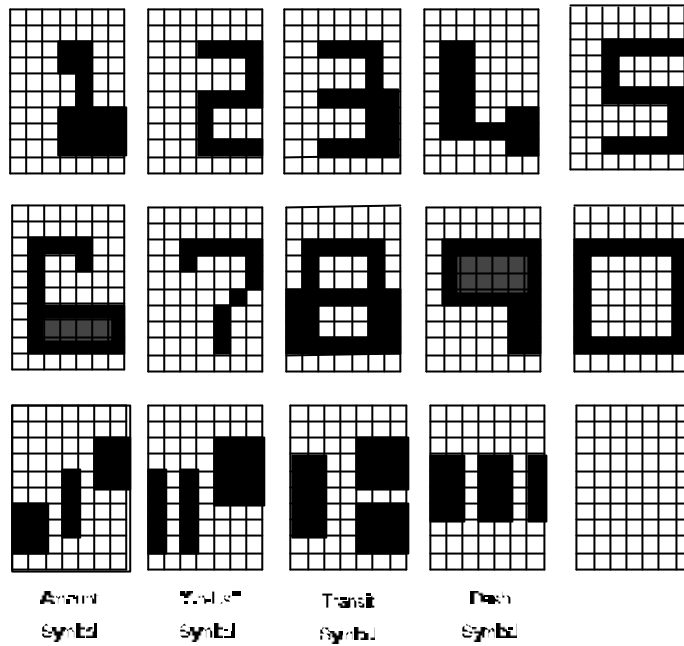
At present there are two main fonts which depend upon different recording and reading methods.

i The E.13B font

This was first used as a standard font by the American Banks Association and was subsequently adopted as standard by the British Banks.

It is limited to 10 numeric characters plus four special symbols.

The E.13B. character set:



NATIONAL 1ST BANK Plc	£						
	35-40-62						
Pay	or order						
	£						
<table style="width: 100%; border: none;"> <tr> <td style="text-align: center; width: 33%;">CREDIT</td> <td style="text-align: center; width: 33%;">Branch</td> <td style="text-align: center; width: 33%;">Amount</td> </tr> <tr> <td style="text-align: center;">000000</td> <td style="text-align: center;">35-40-62</td> <td style="text-align: center;">78350446</td> </tr> </table>	CREDIT	Branch	Amount	000000	35-40-62	78350446	
CREDIT	Branch	Amount					
000000	35-40-62	78350446					

Figure 1

As each character passes under the read head, ten data channels transfer pulses to an electronic storage device called the character matrix. The matrix has a storage location for each of the 70 character symbols. The machine will store a zero list in a storage location which corresponds to a character segment with a very small (negligible) signal as it passes under the read head. On the other hand, if there is magnetic ink in a character segment the signal given to the matrix will not be negligible and the corresponding bit in the character matrix will be made to hold 1.

ii The CMC7 (Caractere Magnetique Code) font:

This font was originally developed by the Compagnie des Machines Bull and was referred to as the CMB font. This code consists of 7 vertical lines for each character with variable thickness lines and variable distances between the lines.

The CMC7 font code was developed from the CMB font and extended to include all of the alphabet.

The CMC7 font has been accepted as standard font by the European Computer Manufacturers Association and is widely used in Europe.

Example of CMC7 font characters:

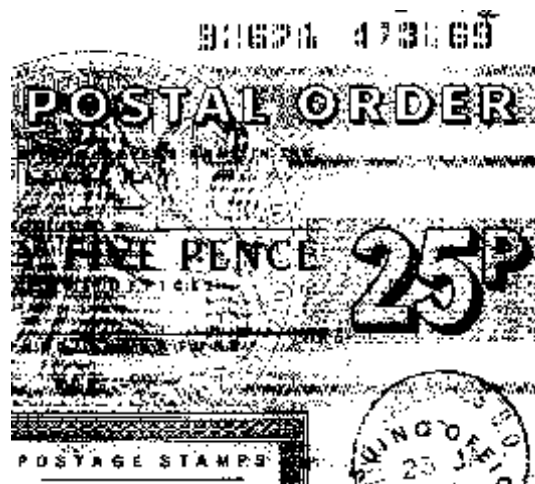


Figure 2

Optical Character Recognition:

Optical Character Recognition (OCR) devices read characters directly from documents. The Characters have to be in a special typeface, but can be produced by a wide variety of equipment, including accounting machines, cash registers, adding machines, typewriters and computer printers. Some OCR devices will even read data which has been carefully written by hand.

Data can be read from individual forms, such as gas bills, or from continuous reels of paper, such as cash register tapes. Some readers can cope with both OCR and optical marks (see below) characters.

One method of character recognition is carried out by a camera unit which detects the amount of illumination in different parts a character and converts this to electrical signals. A recognition unit then identifies the character and is translated into the appropriate form for the computer's CPU, where it is then stored.

One way which both character and mark recognition techniques can be used is in the production of turnround or turnaround documents.

For example, suppose that a company wants to send out invoices to customers, it could use an ordinary computer printer to create the invoices and then key in the remittance details to tape or disc for input into the machine. This would be an extremely wasteful way of doing this; an improved method would be:

- i A computer printer adapted to print OCR characters would be used to print the invoices (see figure 3). Customers would be asked to return the invoice with their remittance.
- ii When the invoices have been returned, and checked for correctness, they can be directly read into the computer, using an OCR reader.
- iii Because the document goes to a third party, 'turns around' there, and enters the computer without further preparation, the invoice is an example of a turnaround document.

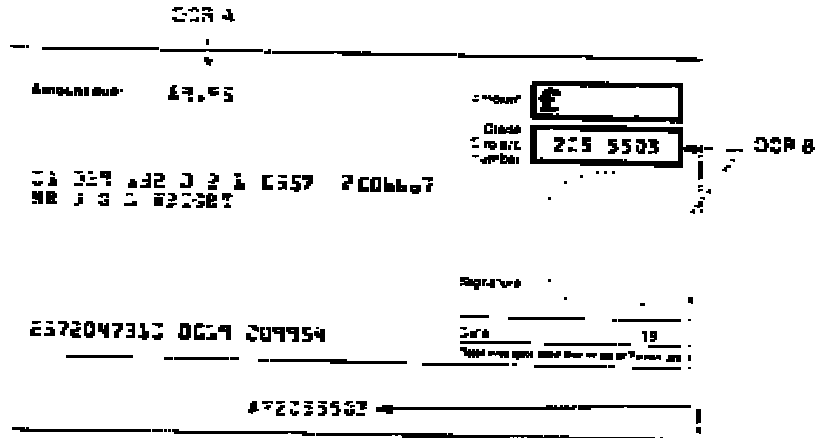


figure 3

Optical Mark Recognition:

A mark sensed card is similar in shape to a normal punched card. It is divided, as shown in the diagram below (figure 4), into columns, each of which has ten digits printed in it. Each digit is inside a pair of brackets. To enter data into the card, a soft pencil is used, and the brackets surrounding the required digit are joined. The card in figure 4 has digits 2 4 3 5 7 entered onto it for the Part Number and a stock quantity of 53 (0 0 5 3).

Part Number					Stock Quantity			
0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9

Figure 4

Later, when the card is read, the pencil mark is read by its electrical conductivity.

Mark reading is very similar to the principle of mark sensing. The major difference is that the form does not need to be completed using a pencil, as it is the presence of the mark itself that is determined

optically.

OMR documents can be read directly or converted into some other form of input for the computer. Both mark sensing and mark reading are most appropriate when each transaction is of a low volume, and where the people filling in the raw data can be trained to do the job correctly. It is often used in such situations as students tests' (multi-choice questions), recording sales and censuses.

Universal Product Code Scanning:

The development of supermarket scanning systems followed the introduction of powerful small computers in the early 1970's. Although initial development of the idea of a Laser beam scanning a barcode took place in Switzerland, it was in the USA that real progress was made. Trials were run involving manufacturers and retailers who organised the development of a code number incorporated into the product label, the equipment manufacturers who developed the scanners and wrote the computer programs and retailers who installed the system in their supermarkets.

The first European installation was in Holland in 1978 with the first UK installation in 1979. By 1988 there were more than 78,000 scanning stores world wide, 60,000 of which were in Japan, with France running second with 3,471 stores and the UK third with 2,792 stores.

The scanning system used in Tesco stores is known as the 'Checkout Plus', 'PLUS' means Price Look-Up System. The main computer in each store provides a direct link to the checkouts and to 'HOST', which is the main Head Office computer. The system has been designed to improve service to customers, and improve company productivity and profits.

The term scanning is used to describe the user of a Laser system to identify the Universal Product Code (Barcode) on products. The information relating to each barcode is held in a computer linked to the scanning equipment. As the barcode is passed across the scanner it is 'read' and the price and description are then obtained from the computer and the sale is registered.

Below is a typical example of a barcode and its European Article Number or EAN. This number is allocated to each product manufacturer by the Article Number Association (ANA).

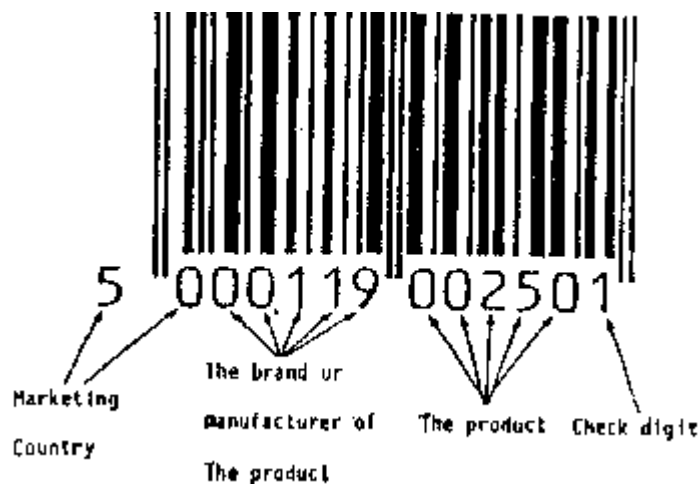


Figure 5

The EAN number of a product can be found below the barcode, as in the above illustration. It is normally thirteen digits but may only be eight on smaller products. The first two numbers represents the marketing country. The next five figures identify the supplier of the product. The following five figures identify the product. The final figure acts as a check digit to the previous twelve numbers so the computer can validate the code.

The barcode is the symbol of bars and spaces printed on a product by the manufacturer.

Kimball Tags:

In certain circumstances, it is possible to key the data about a transaction into the input medium before the transaction has taken place.

Industries such as the clothing and shoe retailers employ this approach when using punched tags.

- i For each piece of merchandise produced, a small tag is punched, containing such details as the product number, the colour, the size, the style and the price of the article. The tag is machine-readable by virtue of the holes punched into it; it is in effect a small punched card. One type of tag in common use is a Kimball Tag (see figure 6).
- ii Before an article leaves the factory, the appropriate tag is attached to it.
- iii When the merchandise is sold, its tag is removed and sent, with other tags, to the data processing centre.
- iv At the computer centre, the tags can be read by an on-line tag reader for direct input to a computer, or their data can be converted, off-line, into a medium such as magnetic tape, for subsequent reading.
- v Data thus read can be used for accounting purposes, for stock control, or for the production of sales statistics.

Multi-part tags, with the data duplicated on each, are often used and one tag is removed for processing at various stages of the sales cycle.

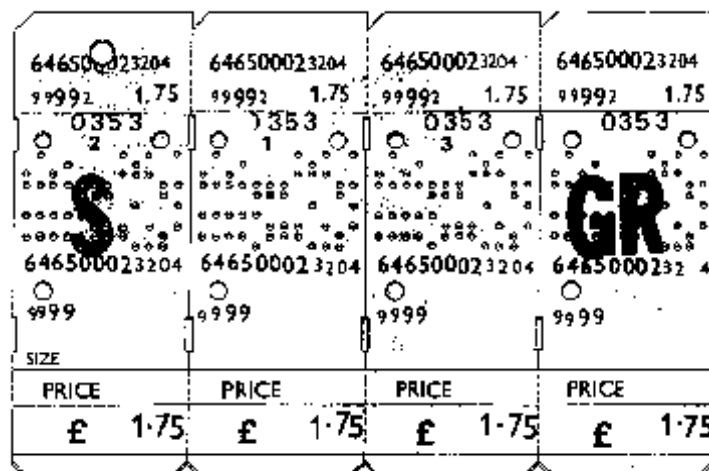


Figure 6

Direct Entry Devices:

These include teletypewriters (teletypes) and Visual Display Units (VDU's). Data is entered through a typewriter like a keyboard by an operator, thus reducing the speed of input to well below other methods. With the teletype a printed copy of the input data is produced in the same way as an ordinary typewriter, but a second copy in the form of paper tape can also be provided at low cost. The VDU is a much quieter machine with a television - type screen providing a check on the data input.

Both devices can also receive output from the computer, and are used in locations remote from the computer room, the characters being carried along telephone lines or coaxial cables in the form of electronic pulses.

OUTPUT DEVICES:

The main form of output apart from the VDU is via a printer. Several different types of printers are available for use with computers to-day. These different types can be categorised under two main headings, Non-Impact and Impact printers. Impact printers can be further classified into Line and Character printers. The full spectrum is summarised below.

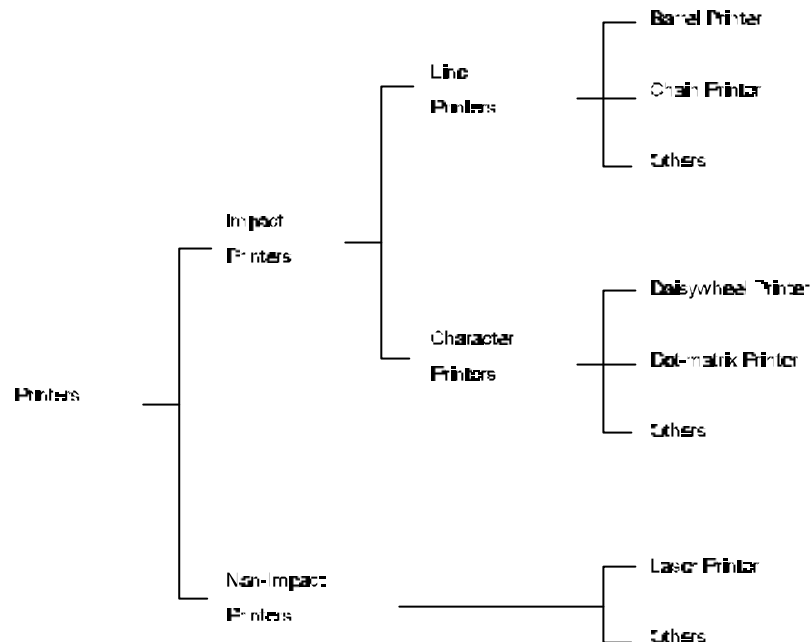


Figure 7

Impact Printers:

Impact printers create images by physical contact on the paper through a ribbon (on the top copy) and via carbon sheets interleaved or treated non-carbon paper for the other copies. The physical impact creates noise - a major nuisance and even a health hazard. Many different ways of handling the print heads are found; on continuous chains, on a revolving sphere ('golfball'), on spokes around the hub of a wheel ('daisy-wheel') or as a combination of retractable pins, with appropriate ways of impelling the print heads on to the ribbon.

Line Printers:

Output by line printer is one of the most commonly used methods of output for a computer system. Its chief characteristic is that instead of printing one character at a time it prints a whole line (THE 'PRINT LINE'). There are a number of different types of line printers of which the CHAIN PRINTER and BARREL (or DRUM) PRINTER are most generally used for on-line computer work.

A printer would, in general, have the following basic units:

- i) Hopper
- ii) Print Unit - ie printing mechanism, row of print hammers and an ink ribbon
- iii) Stacker

iv) Buffer Store

In chain and barrel printers the type faces are moving continuously even whilst printing is taking place.

The basic operation of a printer takes the following form:

- i) Continuous stationery is loaded into the Hopper
- ii) This is then passed through the print unit where printing takes place.
- iii) Finally, after printing the printed documents (still in continuous form) are stacked by the stacker. From there they are removed for separating.

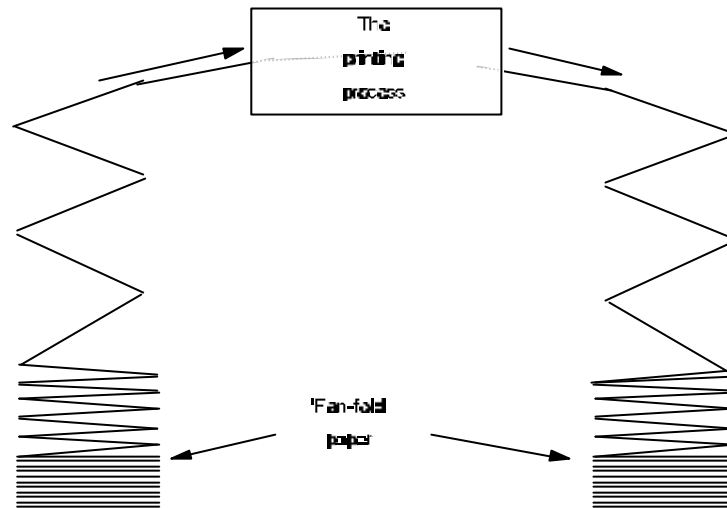


Figure 8

Chain printers:

Here the printing mechanism consists of a closed metal loop or chain. This chain contains the type faces and revolves continuously parallel to the print line.

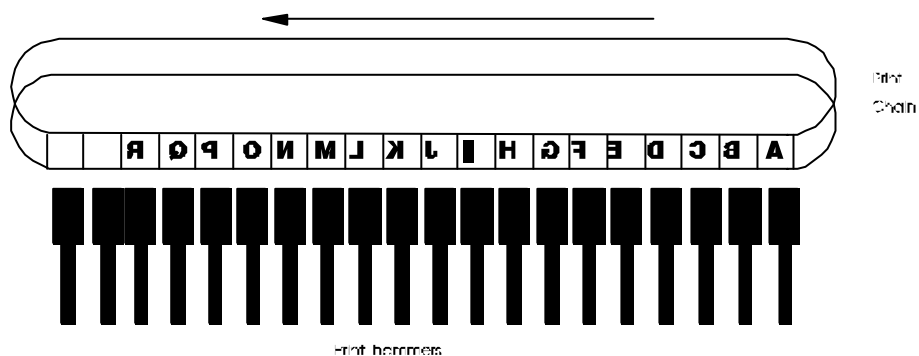


Figure 9

Behind the paper is a row of hammers which are released individually when required characters on

the chain reach their printing positions. In fact as one hammer may be printing an 'A', another hammer 25 positions away could be printing a 'Z' at the same time. The speed of the hammer strike is designed such that clear impressions of characters are made on the paper even though the type face is moving at high speed (although the possibility of smudging is not completely eliminated).

To increase the speed of this type of printer, sets of characters are often repeated along the length of the chain (perhaps 4 or 5 complete sets).

The usual way of ensuring that the hammers are activated at the correct moment is to scan the data once for every character in the character set just before that character comes opposite to the hammers. This means either that the whole line of information must be transmitted to the printer as many times as there are characters in the character set (usually 64), or the printer must have a buffer store capable of holding one line of information, which can then be scanned as many times as necessary.

Barrel Printers:

- a) Continuous stationery loaded into the hopper (this is often a drawer located beneath the printer)
- b) This is passed through the print unit. The stationery and ink ribbon are located between the barrel and the row of print hammers. If the printer contains a buffer store the line of characters is held in it for printing purposes which allows the CPU to carry out further processing during printing.
- c) The continuous stationery is then passed to the stacker.

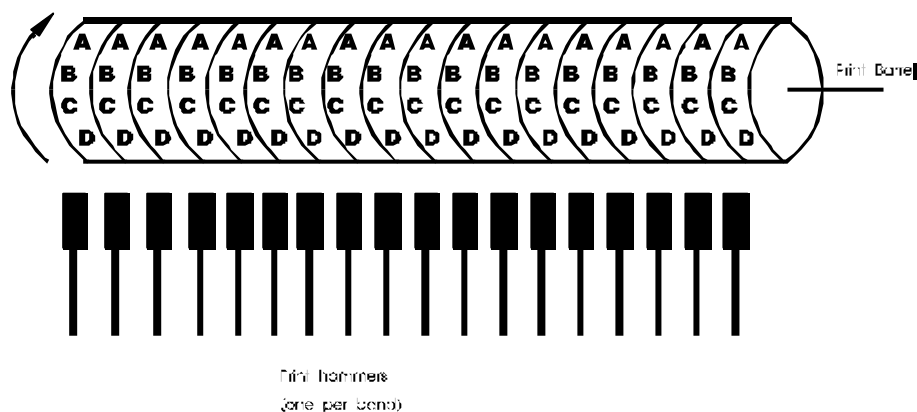


Figure 10

Here the characters are embossed on the surface of the metal drum. Each character is repeated along the length of the barrel and as it rotates each of the characters from the character set are presented to the Print Line in turn. When for example, the row of 'D's is presented to the Print Line, hammers are released simultaneously at all positions in the line where the letter D is required.

After this the next character row is moved into position and this is printed etc. In this way a line of information is built up character by character, during one revolution of the barrel.

The horizontal spacing of characters is usually of the order 10 characters per inch. The vertical spacing is 6 or 8 lines to the inch.

It is possible to obtain multiple copies of the printed information by using interleaved carbon paper or N.C.R (ie no carbon required) paper.

A disadvantage of the barrel type printer is that slight maladjustment of the hammers can give misalignment of the print in a vertical direction. Also it can have vertical smudging of characters.

Printing speeds for line printers are expressed in terms of the number of lines printed in a unit of time.

Although the absolute speed of printing depends on the number of characters printed on each line, the number of lines on each document and the spacing requirements between documents, printing speeds of chain and barrel printers can be very high.

Typically line printer speeds are of the order 600, or 1350 lines per minute. However, machines now exist which can operate at a much greater speed than these.

Character Printers:

Dot Matrix:

Character printers print one character at a time in the same way as a typewriter except that they have facilities for printing from left to right and right to left. The 'dot-matrix' or needle printer forms characters by using a series of needles in the print head. The needles protrude and, via the print ribbon, create a number of small dots which make up the required character. The matrix may consist of 7 by 5 needles, more may be used. Modern dot-matrix printers use a single column of 9 needles or pins moving the head one pin width each time to form the matrix. Even higher quality can be gained from a 24 pin printer which has its needles arranged in two columns of 12, offset against each other.



Figures 11 and 11a

The standard seven or nine pin printers may well produce poorer quality output. Now-a-days most dot-matrix printers will print in draft mode or 'near-letter-quality' (NLQ) mode. The draft mode being quicker, can be used when a document is in the preparation stage. A 'near-letter-quality' document, requiring two passes of the print head, would be produced for sending to the ultimate recipient of the output.

The typical printing speeds can be as high as 200 cps in draft mode and as low as 45 cps in NLQ mode. The high speed is accomplished because the printer is designed to print 'on the fly', that is whilst in motion, with the print-head moving at a uniform horizontal velocity and also bi-directionally.

Daisy Wheel:

The so-called 'daisy wheel' printer uses an interchangeable print head which resembles a flower, with each spoke on the daisy wheel holding one character. The wheel rotates until the correct character is positioned in front of a hammer which strikes the spoke against a carbon ribbon to produce an image of the character. The daisy wheel printer is slower than the dot matrix printer mainly because the daisy wheel is momentarily stationary for each character to be positioned and printed. The typical speed of this type of printer is 40/50 cps, the print quality however is superior to that of the dot matrix printer and produces letter quality print at all times.

Non-Impact Printers:

Non-impact printers create images only on one copy, by various processes including ink-jets, thermal effect on treated heat sensitive paper or ribbons, xerographic and laser beam printing. They are much quieter than impact printers.

Ink-Jet:

Ink-jet printers use a relatively simple technology to force small bubbles of ink on to the paper to form small dots in much the same way as a dot-matrix printer uses its needles. This type of printer provides a compromise between the noise and poorer quality of a dot-matrix printer and the silence and high quality of a laser printer.

The principle of an ink-jet or bubble jet printer is shown in figure 12.

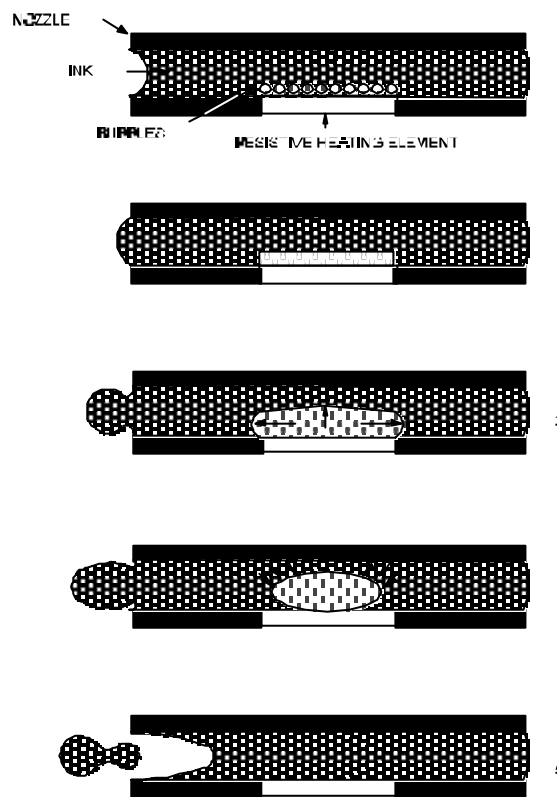


Figure 12

As the resistive heating element is energised (1), a series of bubbles form almost instantly. They quickly coalesce (2) into one bubble covering the whole of the element. As heating continues (3), the pressure exerted by the bubble forces ink out of the end of the nozzle. When the heater is deactivated (4), the vaporised ink turns back to liquid and reduces rapidly in volume. By the time the bubble disappears (5), the droplet is heading towards the paper and the vacuum left by the bubble sucks more ink from the print head reservoir.

Thermal Printers:

a piece of paper of fixed size is laid on a flat bed. A gantry moves up and down above this paper, when vertical movement is required. A moveable pen mounted in the gantry travels horizontally in the other dimension.

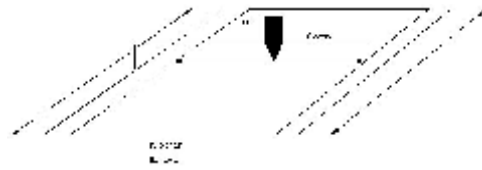


Figure 15

Plotters can be used to produce drawings, charts, maps, graphs and a host of other printed output.

Amongst many uses, they are employed in cartography for the production of contour maps, in the textile business for the drawing of designs, in meteorology when weather maps are required, for engineering and architectural drawings, such as pipe work diagrams, and in medical work. Computer systems which provide information for managers in commercial organisations may employ graph plotters to produce graphs showing sales statistics or financial analyses, and critical path networks lend themselves admirably to these devices.

In the aircraft industry, huge plotters, perhaps 50 feet across, are used to draw aircraft wings.

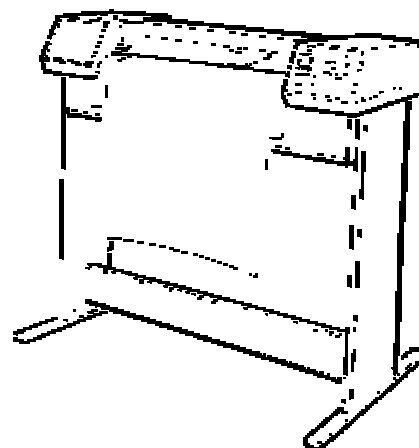


Figure 16
Large Drafting Plotter