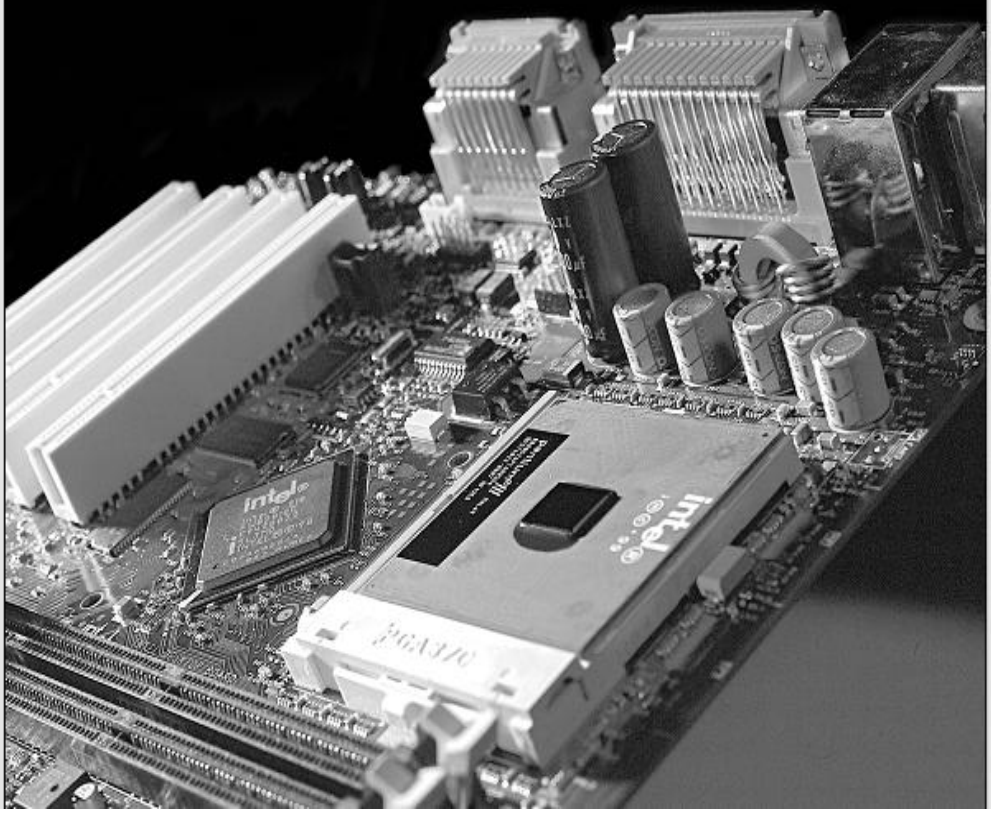
CHAPTER 4

Input and Output Devices.



Input Devices

1) KeyBoard:

Keyboard is an input device. Most of the Keyboards have between 80 and 110 keys including

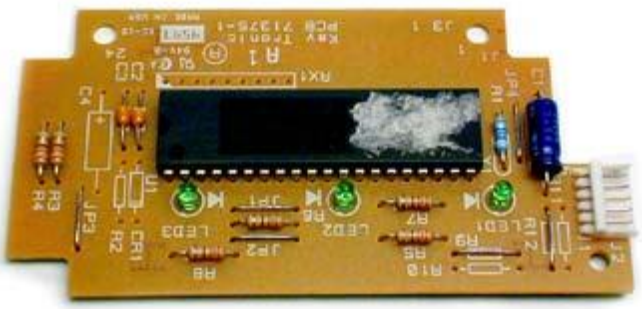
1) Typing Keys (QWERTY)
2) Numeric Keypad
3) Function Keys
4) Control Keys

It has following components:

1) Keyboard Processor or Circuitry
2) Key Matrix
3) Keyboard Switches

1) Keyboard Processor or Circuitry

- Inside of the keyboard has processor and circuitry that carries information to and from that processor.
- The Keyboard controller is a single chip micro-computer such as Intel 8042, 8048, 8049 etc.



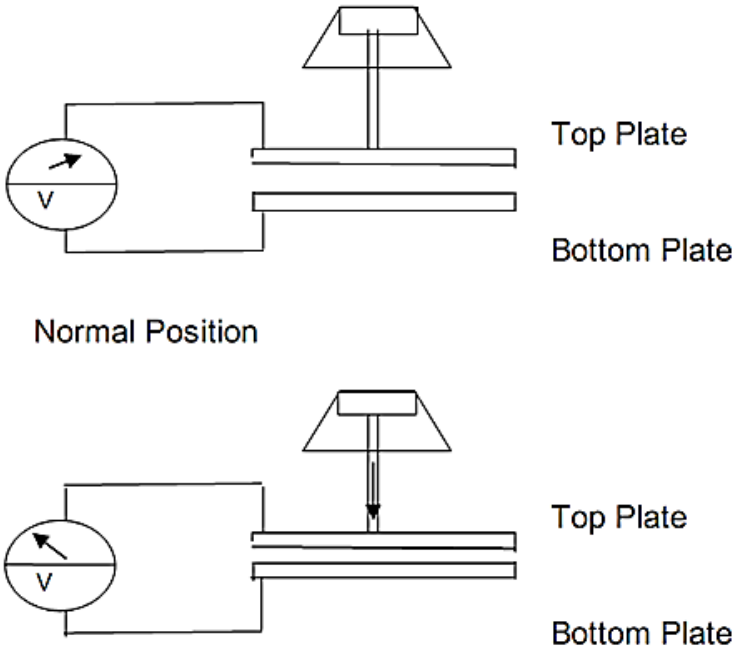
- These chips consists of processor, RAM and ROM memory inside a single chip.
- The ROM of this chip is programmed to control different operations of the keyboard

2) Key Matrix

- Keyboards use a matrix with the rows and columns made up of wires.
- Each key acts like a switch.
- The Key Matrix is nothing but a grid of circuits
- When a key is pressed a column wire makes contact with a row wire and completes a circuit.
- Key Matrix passes electronic current to circuit then pass it to the keyboard controller.
- The keyboard controller detects position of this closed circuit and registers it as a key press and the controller read the key pressed.

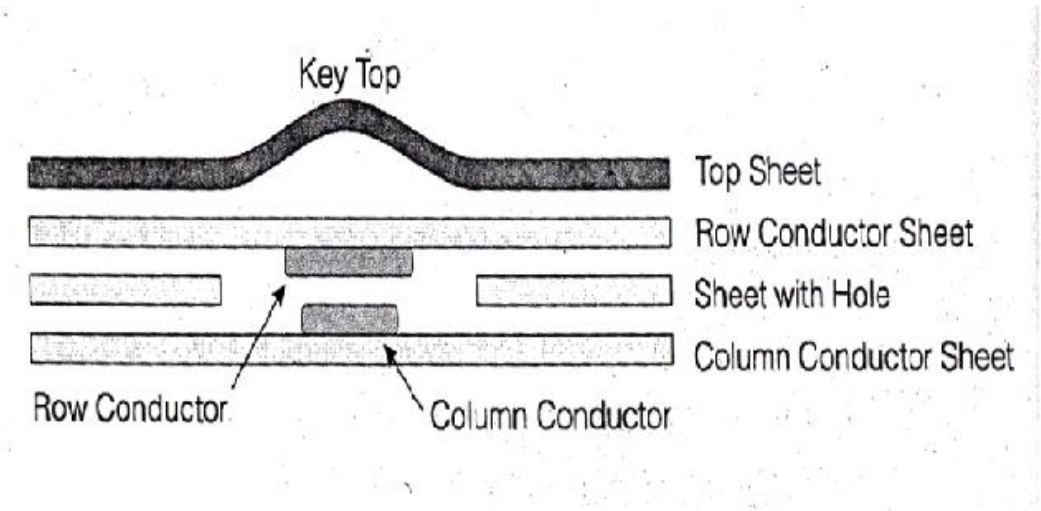
3) Key Switches:

i) <u>Capacitive Keyboard Switch</u>



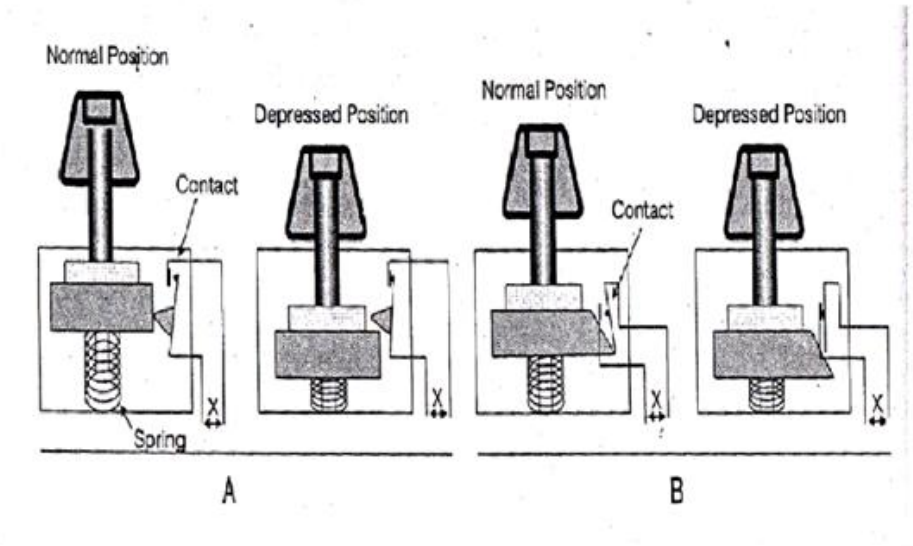
- **In this type of switches, two plates of capacitor are brought closer when the key is pressed.**
- **When the plates are brought closer or moved away, the capacitance of the switch is changed and this change can be detected by measuring the voltage change across the switch using some sense amplifier.**
- **The sense amplifier will receive one voltage when the switch is in open position and another voltage when the switch is in close position. These voltages are converted into proper logic signals to inform the computer about the open or close position of switch.**
- **These switches have a normal life span of 20 million keystrokes.**

ii) <u>Membrane Keyboard Switch</u>



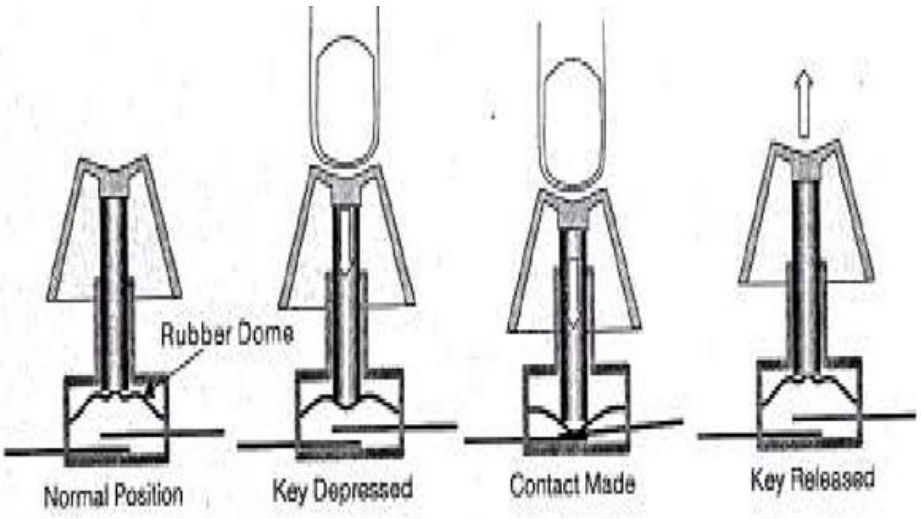
- Rubber or plastic sheets are used as row conductor and column conductor sheet.
- These sheets are separated by another sheet with holes at the key top position
- When key top is pressed it forces the row conductor sheet through hole to touch the column conductor sheet.
- When the row conductor lines on the row conductor sheet touches column line on column conductor sheet, key contact is made. This is interpreted by the keyboard interface as key closure.

iii) Mechanical Keyboard Switch



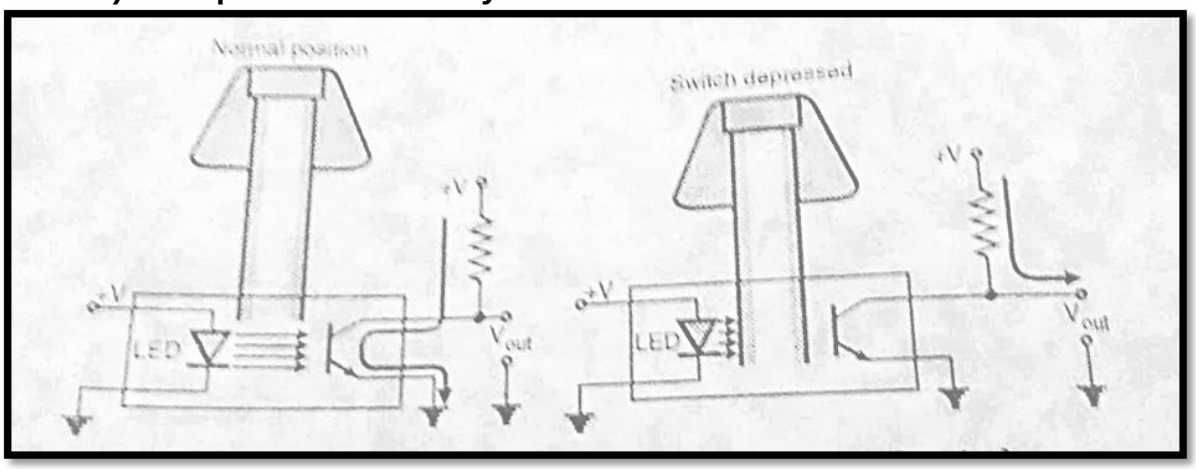
- These are one of the most common type of keyboard switches.
- In this type of switches, two metal pieces or contacts are kept in open position and moved into close position when switch is depressed.
- This type of switches works when contact closed, these contact becomes oxidized or dirty and make the switch useless. Most f the manufacturers provide good plating on this contact to improve the switch's lifespan.
- The life of these high quality switches are around 20 million keystrokes**.**

iv) Rubber Dome Keyboard Switch



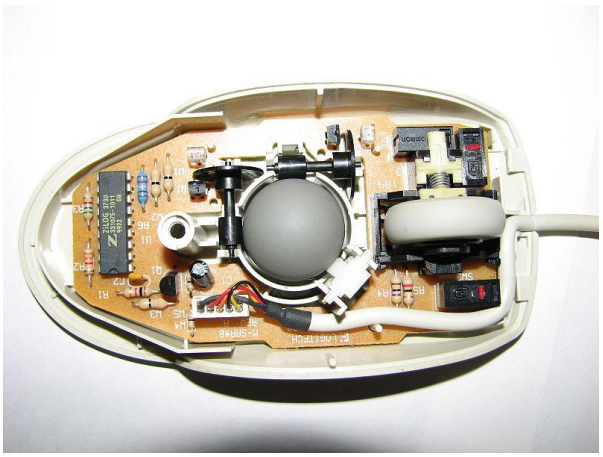
Rubber dome switches use small, flexible rubber domes each with a hard carbon center because it resists corrosion and has a self cleaning action on the metal contacts below.
When you press a key, a plunger on the bottom of the key pushes down against the dome and carbon center passes against a hard, flat surface beneath the key matrix. As long as the key is held, the carbon center completes the circuit.
When the key is released, the rubber dome springs back to its original shape, forcing the key back up to its at rest position
Rubber dome switch keyboards are inexpensive have pretty good tactle response and are fairly resistant to spills and corrosion because of rubber layer covering the key matrix.

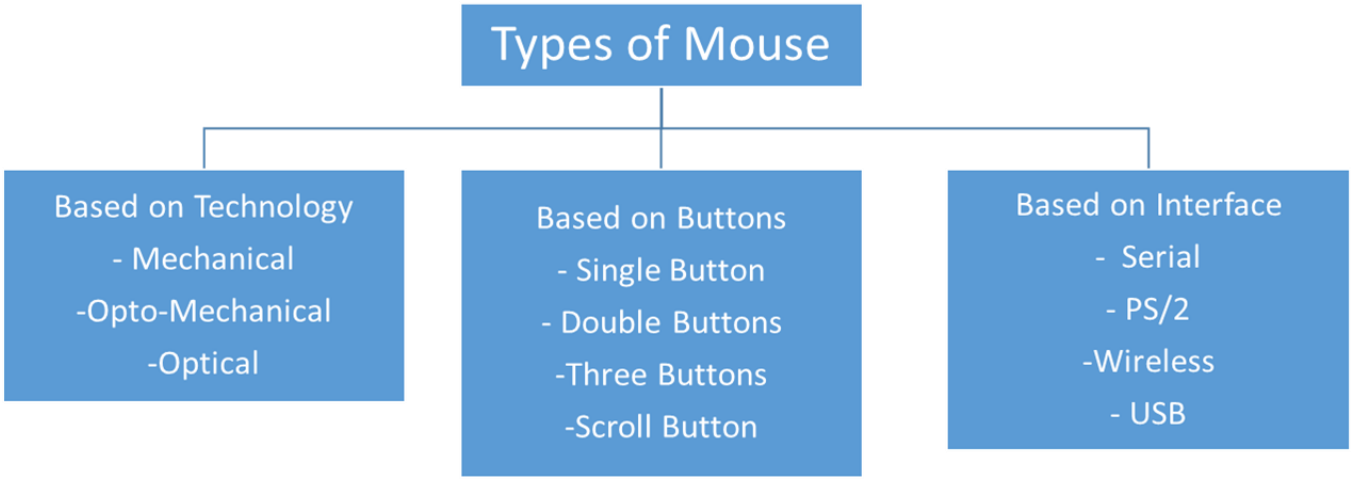
v) Opto-Electronic Keyboard Switch



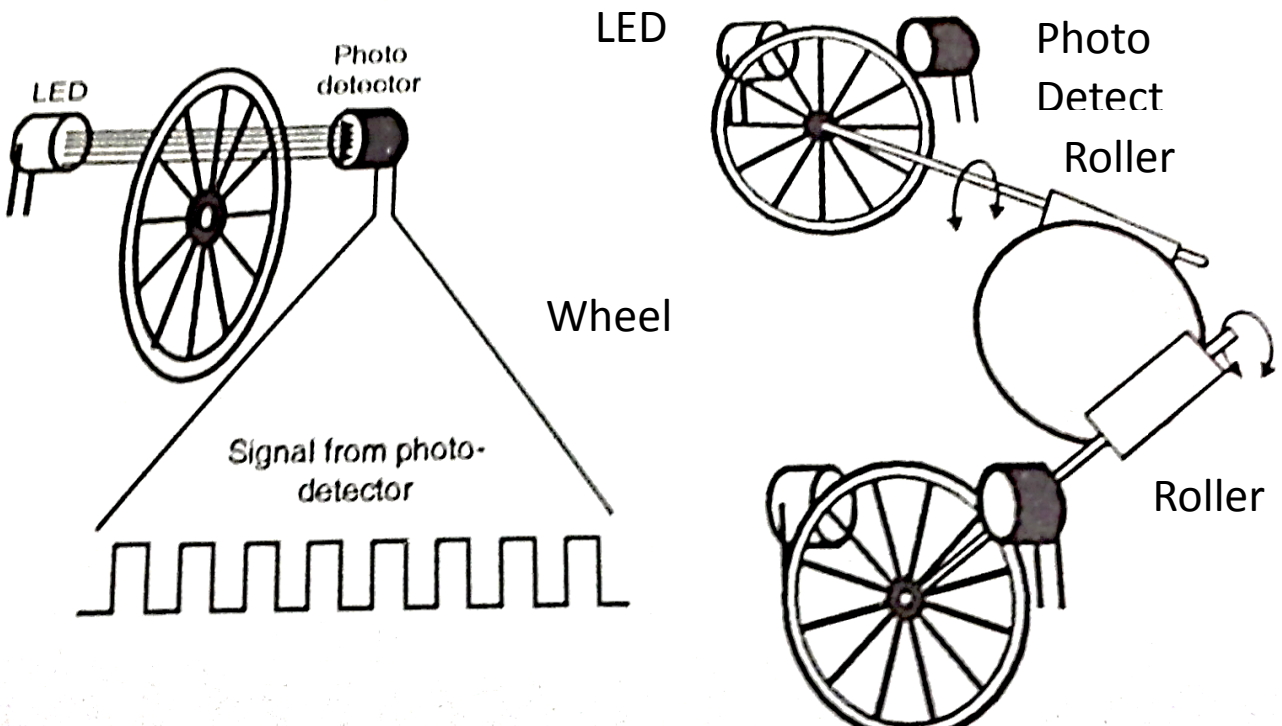
- This type of switches have LED which generates light when electric power is applied.
- Opposite to LED, a photo-transistor is used.
- The property of photo-transistor is that it allows the current flow in the circuit, as long as light is applied to it, when the light falling to the photo-transistor is removed, it will no longer allow the current to pass through it.
- In this type of switch when the key is not pressed, the light from LED falls onto the photo-transistor. This makes the current flow through the photo-transistor and the produces very low output voltage(V_{out})
- When the key is depressed, the light emitted from the LED is blocked this will stop the current flow through the photo-transistor and forces the photo-transistor to a cut-off condition.
- In this condition the current cannot flow through the photo-transistor and a different value will be produced as output voltage (V_{out})

Mouse





i) Opto-Mechanical Mouse



Opto-Mechanical Mouse:

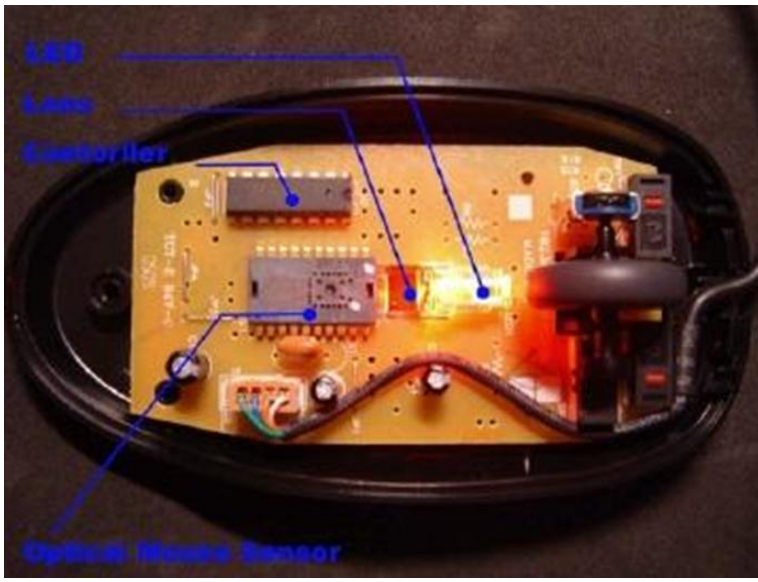
Constructional parts:

1) Small Rubber Ball that rotates as the mouse is moved around the mouse pad.
2) Two small rollers- Track Movements on the x-axis and y-axis
3) Small Wheels with holes in it- Attached to each roller.
4) LED and Photosensor attached on either side of wheels.

Working of Opto-Mechanical Mouse:

1) When the mouse is moved, the ball of the mouse moves and it turns two separate rollers fixed at 90^{o} to each other. One roller is used for vertical movement and another is used for horizontal movement of a cursor on a screen.
2) Each Roller connected with a wheel. These wheels are rotated by the corresponding movement of the rollers.
3) There are small opening on the rim of each wheel. As the wheel rotates a pair of LED and Photo-detector detects the number of openings passed between them. Each opening on the wheel allows the light from the LED to fall on the photo-detector and generate an electric signal.
4) These signals are passed to the PC through the wire connecting the mouse to the main system. The PC passes them to mouse and speed required for the movement of the screen cursor.
5) Pressing any mouse button also produces a signal. Depending upon the button being pressed, the number of times button being pressed and present location of the cursor on the screen, the driver software accomplishes the task desired by the user.

ii) Optical Mouse (New Design)



Construction:

1) LED to illuminate the surface on which the mouse is used.
2) A sensor made of Photo Detector Array basically a small video camera to detect the pattern on the surface.
3) Digital Signal Processor (DSP) for pattern Recognition purpose.

Working

1) The LED produces red light i.e. emitted onto s surface.
2) The light is reflected off the surface back to the sensor (camera)
3) The sensor sends each image that is reflected back to a Digital Signal Processor for analysis.

4) Using the thousand of images that the sensor (Camera) is sent to the DSP for analysis, the DSP is able to detect both the patterns and images and can determine Information Technology the mouse has moved at what distance it has moved and at what speed. It is able to determine coordinates which are the sent to the computer to which mouse is connected.
5) At this point, the coordinates have been received by the computer and will show the movement of the mouse, usually by its cursor on the computer screen.
6) Computer is updated with mouse coordinates more than 100 times/sec because the movement is so fast, the appearance of the mouse cursor on screen is very smooth.

Sr No	Opto-Mechanical	Optical Mouse
1	Less Maintenance	Zero Maintenance
2	Less Mechanical Parts so life of Mouse is more	No Mechanical part
3	Uses a photo-detector and LED for finding the movement of the mouse	Uses LED and sensor (camera) for finding the movement of the mouse
4	Requires less cleaning of a mouse	No required Cleaning

Scanners:

i) **Flatbed scanners:** Flatbed consists of a box with a glass top and a cover. You put your document face down on the glass.
Inside the box, a scanning element moves across the length of the page and converts it into digital information.

ii) Sheet-fed scanners

Sheet-fed scanners are similar to flatbed scanners except the document is moved and the scan head is not.
Sheet-fed scanners use rollers to pass a sheet of paper or photograph over a stationary image head.

iii) Handheld scanners

Handheld scanners use the same basic technology as a flatbed scanner, but rely on the user to move them instead of a belt.
This type of scanner typically does not provide good image quality. However, it can be useful for quickly capturing text. They are good for scanning logos or other small pieces of artwork**.**

iv) Drum scanners

Drum scanners use a technology called a photomultiplier tube (PMT). In PMT, the document to be scanned is mounted on a glass cylinder.

Block Diagram of Scanner
Anatomy of a Scanner
Parts of a typical flatbed scanner include:

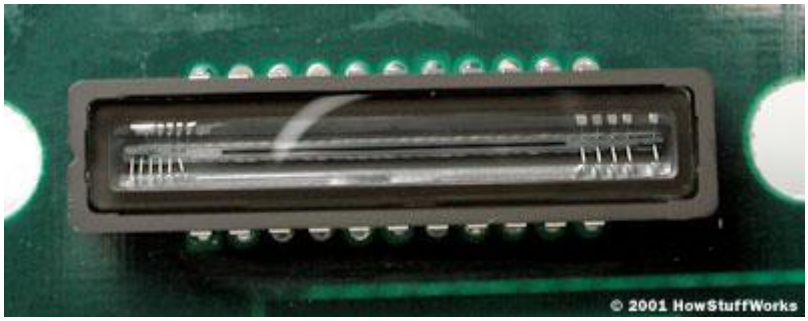
- **Charge-coupled device (CCD) array**
  The core component of the scanner is the **CCD array**. CCD is the most common technology for image capture in scanners. CCD is a collection of tiny light-sensitive diodes, which convert photons (light) into electrons (electrical charge). These diodes are called **photosites**. In a nutshell, each photosite is sensitive to light -- the brighter the light that hits a single photosite, the greater the electrical charge that will accumulate at that site.

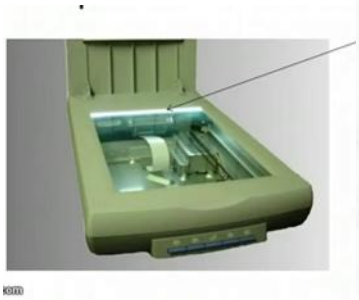
- **Mirrors**

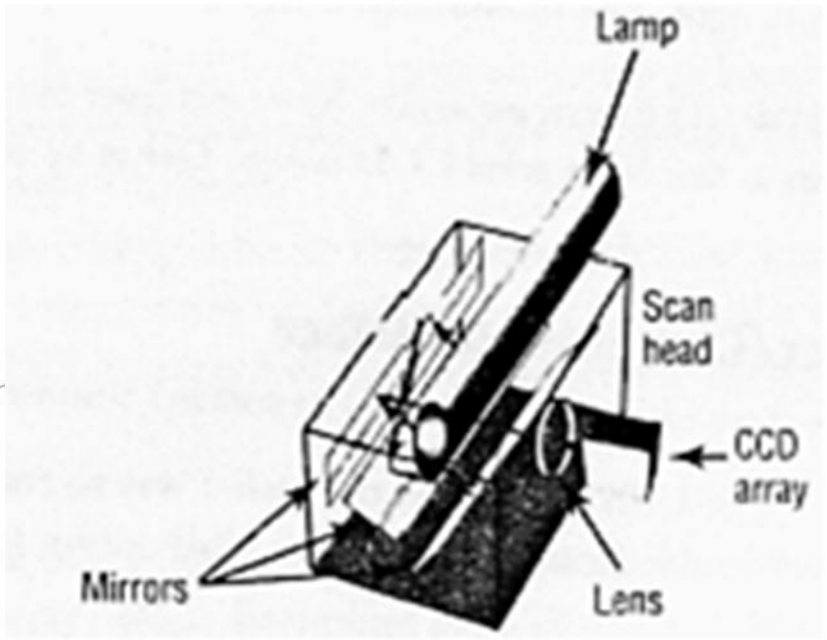
- **Scan head**

- **Glass plate**
- **Lamp**
- **Lens**
- **Cover Filters**
- **Stepper motor**
- **Stabilizer bar**
- **Belt**
- **Power supply**
- **Interface port(s)**
- **Control circuitry**

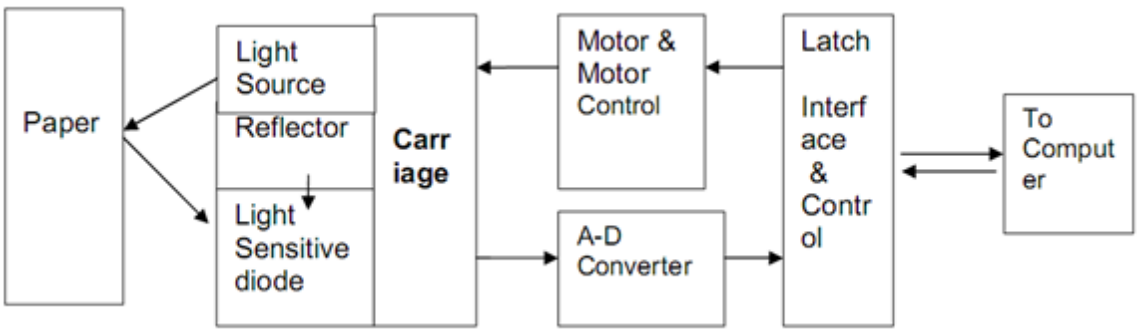
Close-up of the CCD array







Block Diagram of Flat-Bed Scanner



1. Light Source illuminates a piece of paper placed face down on the glass window above the scanning mechanism.

2. Motor moves the scan head beneath the page. As it moves the scan head captures light reflected from individual areas of the page. Reflection takes place through a system of mirrors.
3. A lens focuses the beams of light on to light sensitive diodes that translate the amount of light into electrical current.
4. The more the reflected light, the more is the voltage of the signal. White spaces reflect more light than black or colored images.
5. ADC converts each analog signal of voltage into digital pixel representing the scanned area
6. 6. For monochrome scanner 1 bit per pixel is stored either on or off representing black or white.
7. For color scanner, the scan head makes three passes under the images and the light on each pass is directed through a red, green or blue filter before it strikes the original image.
8. Signals from three passes are converted into digital information and stored to represent red, green, or blue color value of the scanned area on the page.
9. This digital information is sent to the software in the PC, where data is stored in a format on which a graphics program or OCR can work.

Terms Related to Scanner:

OCR(Optical Character Recognition)

Is the mechanical or electronic translation of images of handwritten, type written or printed text (usually captured by a scanner) into a machine-editable text.

TWAIN

TWAIN is a standard software protocol and Applications Programming Interface (API) that regulates communication between software applications and imaging devices such as scanners and Digital Cameras.

Resolution:

Scanners vary in resolution and sharpness. Most flatbed scanners have a true hardware resolution of at least 300x 300 dots per inch (dpi).

The scanner’s dpi us determined by the number of sensors in a single row (x-direction sampling rate) of the CCD (Charge coupled device) or CIS (Contact image sensor) Array by the precision of the stepper motor

Interpolation:

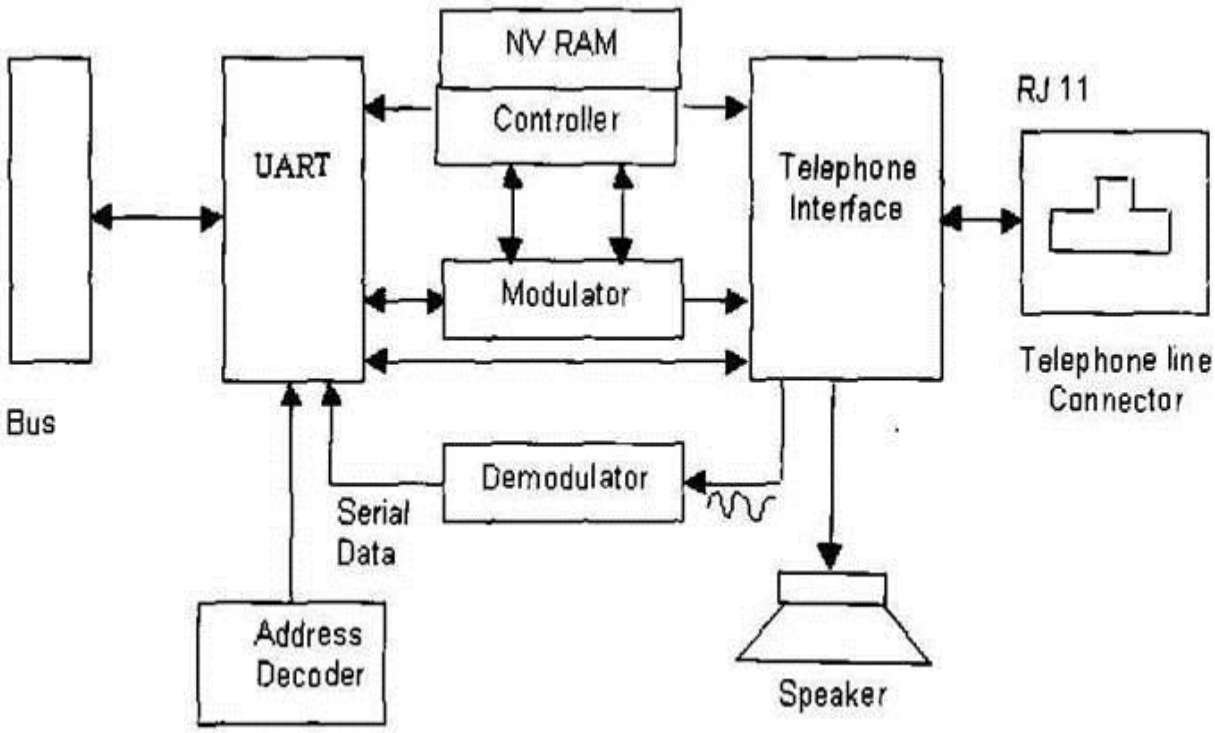
Interpolation is a process that the scanning software uses to increase the perceived resolution of an image. It does this by creating extra pixels in between the ones actually scanned by the CCD array. These extra pixels are an average of adjacent pixels.

For example if the hardware resolution is 300x300 and the interpolated resolution is 600x300 then the software is adding a pixel between every one scanned by a CCD sensor in each row.

Modem

Modem(Modulate/Demodulate) An input/output device that converts digital data from a computer to analog data fro transmissions over the telephone lines by modulating it into waves, at the other end , the modem converts the analog data back to digital form so that can be read by the computer.

Internal Modem



 The internal modem is a stand-alone board that plug directly into an ISA or PCI expansion slot

 The internal modem contains its own universal asynchronous receiver/transmitter (UART) The UART work here logically as serial port

 A modulator circuit converts the serial digital data from the computer into analog signals to be transmitted over telephone line. The analog signal is then coupled to the telephone line using a circuit very similar to that used by ordinary telephone to couple voice signals. Then this analog signal passes to the telephone line through telephone jack (RJ-11 connector socket)

 On the receiver side, serial signals received from telephone line. The telephone interface separate received signals and passes them to demodulator. The demodulator converts analog signals into digital form and send this serial data to UART. The UART convert serial bit data into parallel byte and placed on the system's data bus.

 Besides combining and separating modulated audio data, the telephone interface generates the Dual-Tone-Multi-Frequency (DTMF) dialing signals needed to reach a remote modem.

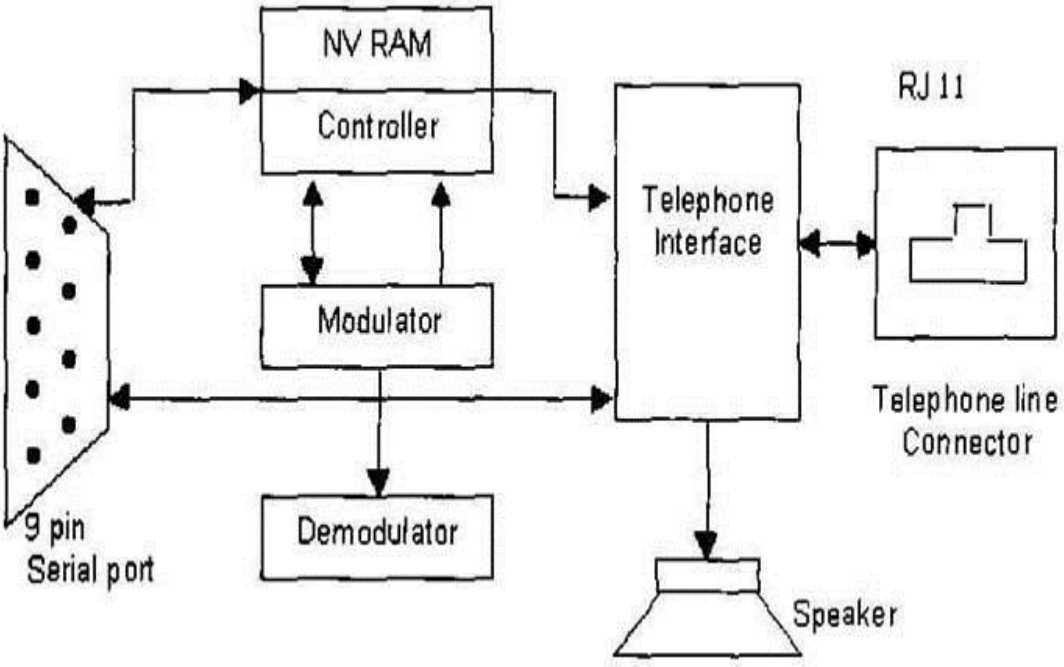
 When a remote modem dials in the telephone interface defects the incoming signals and alerts the UART to begin negotiating a connection. Finally the telephone interface drives a small speaker during find stages of modem operation.

 The speaker is used to hear a dial tone, dialing signals and audio negotiation between the two modems. Once a connection is established, the speaker is usually disabled.

 A controller circuit manages the overall operation of the modem. Generally it is used to manage modem between in control and data operating modes

 The NVRAM (Non Volatile RAM) it is used to store modem parameters.

External Modem



External modem is a stand-alone device connected to serial port(COM1 or COM2)of system

· A 9-pin 0r 25-pin serial cable connects the PC serial port to the modem. This often makes external modem setup faster and easier than internal modems, since you need not worry about interrupt lines and I/O address settings –hardware conflicts are rare with external modems

Working of External modem is as same as internal modem. The difference is that it uses standard serial interface RS232C so that it uses motherboard UART for serial bit to parallel byte or parallel byte to serial bit conversion.

External modem must be powered by small AC adapter. External modem provides a series of signal status LEDs. The LEDs allows you to easily check the state of serial communications.

Advantages

- Installation of modem is easy
- Not required/needed to open the system
- Easy to configure
- Front panel LEDs of external modem shows status of communication

Disadvantages:

- Externally powered
- Serial interfacing cable may generate problem

Comparison between External Modem versus Internal Modem

Sr. No	**Features**	**External Modem**	**Internal Modem**
1	Built in UART	No	Yes
2	Price comparison	Higher	Lower
3	Extras to buy	RS232 modem interface cable	Nothing
4	Easy to moving to another computer	Easy	Difficult
5	Power supply	Plugs into wall	None-powered by PC
6	Reset if modem hangs	Turn modem OFF, then ON again	Restart computer
7	Interface type	RS 232 serial or USB port	PCI or ISA

Internal Modem installation steps

1. Unpack the parcel, check for any damage or breakage, read instructions
2. Switch off computer
3. Insert modem card on the PCI slot of the motherboard
4. Connect RJ45 cable to the RJ-11(phone jack) or cable jack in the connector
5. Plug telephone handset into phone connector of modem if user wants to have phone on the same line
6. Plug power cable to the jack at the modem end and power plug in wall jacket
7. Power on the PC
8. PC found new hardware and asks for driver for the modem
9. Insert driver CD in the CD-ROM drive & browse the modem driver for Windows XP
10. Run setup program which is given by modem supplier to install necessary driver files
11. Install software required for the modem from the CD

Or

After powering on the PC autorun the driver CD & Run setup program which is given by modem supplier to install necessary driver files

Or

Download the driver from internet & install the modem.

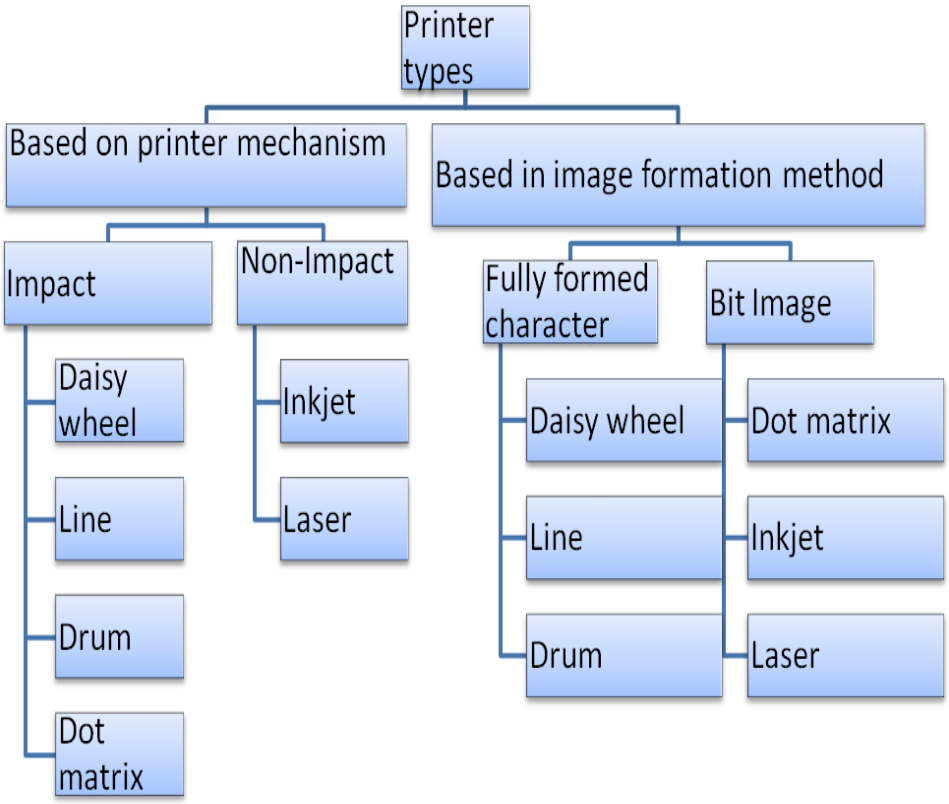
External Modem Installation steps

1. Unpack the parcel, check for any damage or breakage, read instructions
2. Switch off computer & modem
3. Plug male end of cable into female connector marked serial port on modems back panel, fix the screws. Plug other end of cable in serial port on back of computer
4. Plug telephone cable in line connector

5. Plug telephone handset into phone connector of modem if user wants to have phone on same line.
6. Plug power cable in connector at modem end and power plug in wall jacket
7. After installing turn on the computer and then modem. When modem led is on, it will report operating status of modem.
8. Follow installation steps of internal modem from step no. 8 to step no. 11

Printers

Printer Type



Characteristics

i) Speed: It is specified as character per second, Line per minute or pages per minute. It indicates how fast a printer works.

ii) Quality Resolution: It specified as DRAFT, NLQ (Near Letter Quality) or LQP(Letter Quality Printer).This implies how good the shape of the printed character is.

iii) Character Set: Indicating the total number of data characters and control characters recognized by printer

iv)Interface: It specifying whether the printer receives character from printer in parallel form or in serial form.

v) Buffer size: Indicating how many data characters can be stored in the printer buffer memory before printing

vi)Print Mechanism: It specifies as impact dot matrix, impact daisy wheel, inkjet or laser

vii) Print Size: It specifies as character size and number of character per line.

viii) Print Direction: It specifies as unidirectional, reverse, bi-directional logic seeking.

Dot Matrix Printer

These printers form characters and images by placing pattern of dots on the paper by striking inked ribbon with an number of small pins.

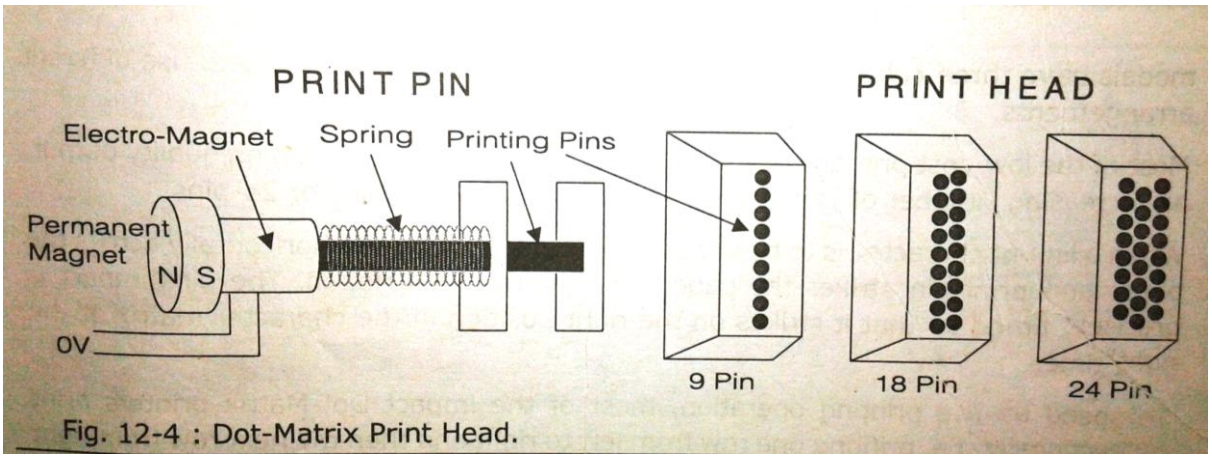


Fig. 12-4 : Dot-Matrix Print Head.

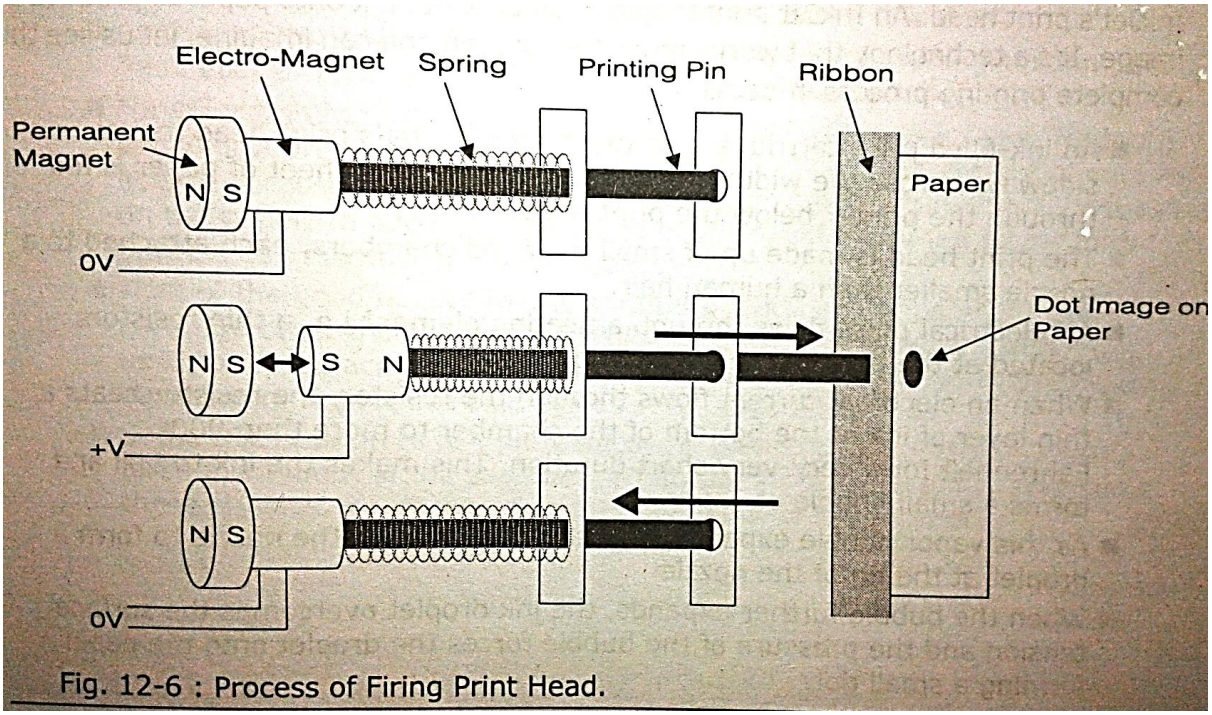


Fig. 12-6 : Process of Firing Print Head.

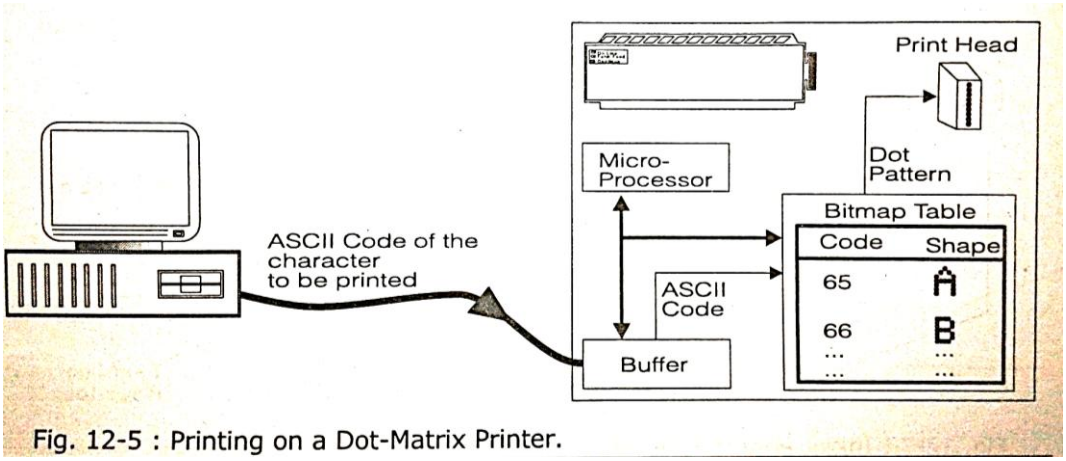
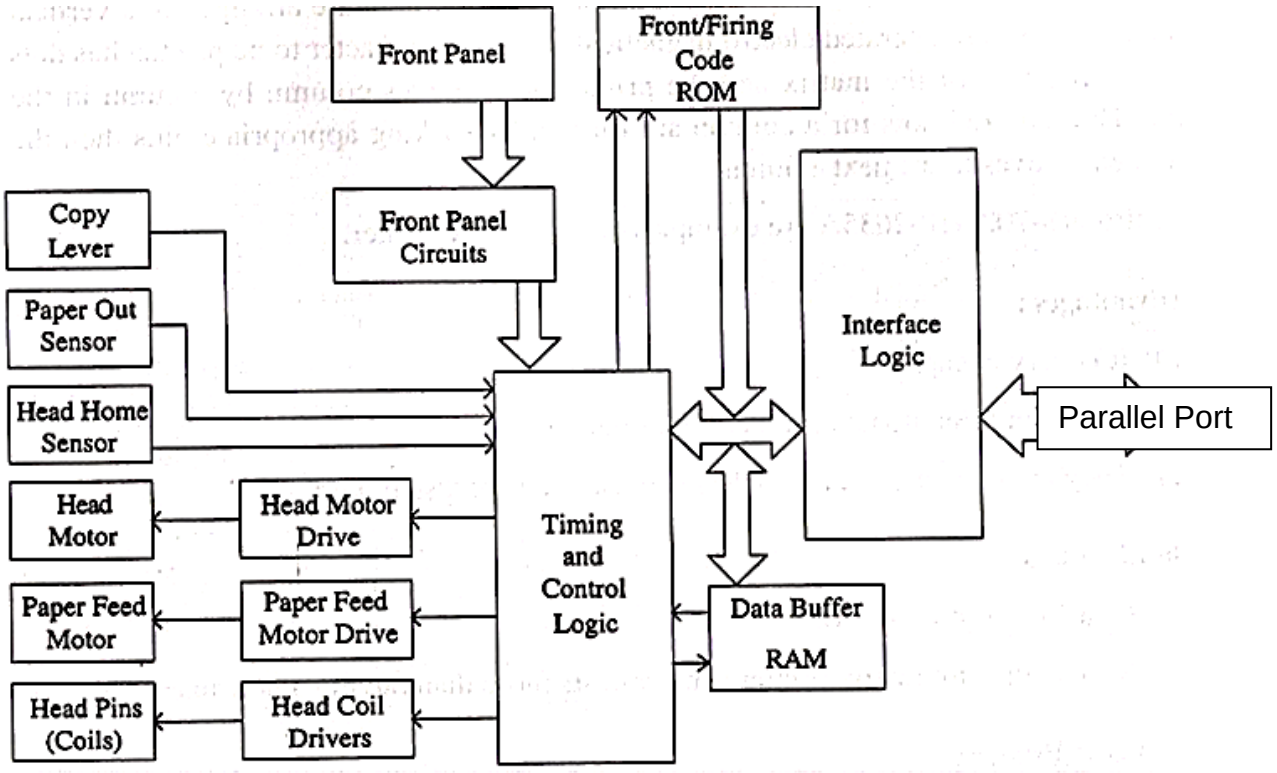


Fig. 12-5 : Printing on a Dot-Matrix Printer.

BLOCK DIAGRAM OF A DOT MATRIX PRINTER



1. Front panel & Front panel Circuit: Used to select print mode & perform self test

2. Interface Logic: Takes data & Control Signal from Pc and also generates for PC

3. Data Buffer: Stores data from PC. Then sends to ORM for getting dot information of particular character and then send to print head**.**

4. Timing & Control Logic: Used to generate control signal for print mechanism and for interface logic

5. Head coil drivers & head pins: Controls the firing of different pins at appropriate times corresponding to the matrix pattern of the character to be printed.

6. Paper feed motor & paper feed motor drive: Moves the paper vertically

7. Sensors:

Different sensing circuits are available to keep the printer safe from abnormal conditions. The sensing circuits include:

Head Home sensor: It detects whether the head carriage is at the extreme left margin
Paper Empty sensor: It provides signals when there is no paper in the printer.
Pin error and overheat error: It detects the abnormal timings used to fire the pins.

Working of Dot Matrix Printer:

1) The dots are printed on the paper by striking against an inked ribbon by a series of print wires or pins aligned in a line in the printer head

2) Normally there are 9 pins and high quality printers have 24 pins.

3) The striking of print wires is also called as firing.

4) The print pins are kept away from the ribbon by springs in the holding mechanism. The rear end of the print pin has a small head which is hammered by a electromagnet during printing.

5) Print head moves horizontally across the paper and the print pin strikes the paper through an inked ribbon.
6) Pin's impact is precisely timed so that it strikes the right position in the character matrix at the right time.
7) Major factor determining printing speed is the time required between the successive strikes of each print pins. The time needed to retract and reactivate each print pin puts a physical limit on how fast the pins can be fired.
8) PC sends series of ASCII codes that represent characters, punctuation marks etc to be printed over serial or parallel cable along with some printer movement information such as tabs, carriage return etc., to control the position of print head and print carriage.
9) The ASCII codes are stored in the buffer (RAM) as the printing speed is less than the speed at which the PC sends data to the printer. When the buffer becomes full the printer informs the PC to stop sending further characters until some of the characters in the buffer are printed.
10) The controller inside the printer selects a particular dot pattern for the ASCII code received from the PC. The dot pattern is stored in the ROM.
11) The selected dot pattern is sent to the print head. Based on this information the print head fires different pins on the print head. The controller also controls the movement of print head and the paper.

INK JET Printer

It is non-impact printer but doesn't print pages at a time. It prints character by character. The characters are formed by color ink dots/drops of 20*20 matrix. The cost of an ink-jet printer is very close to a dot matrix printer and gives a better quality. It is also economical. These printers are perfect compromise of cost, speed and quality.

Principle of Operation

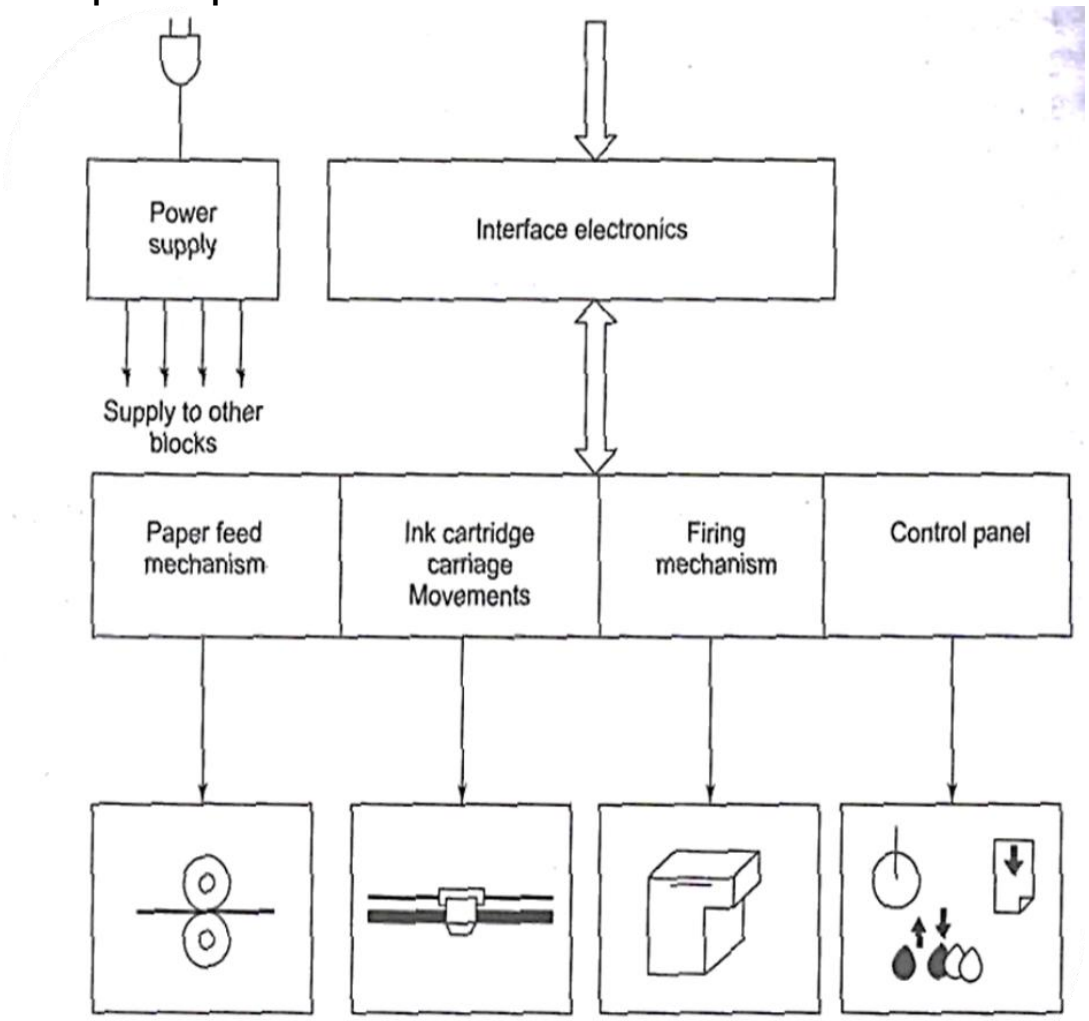
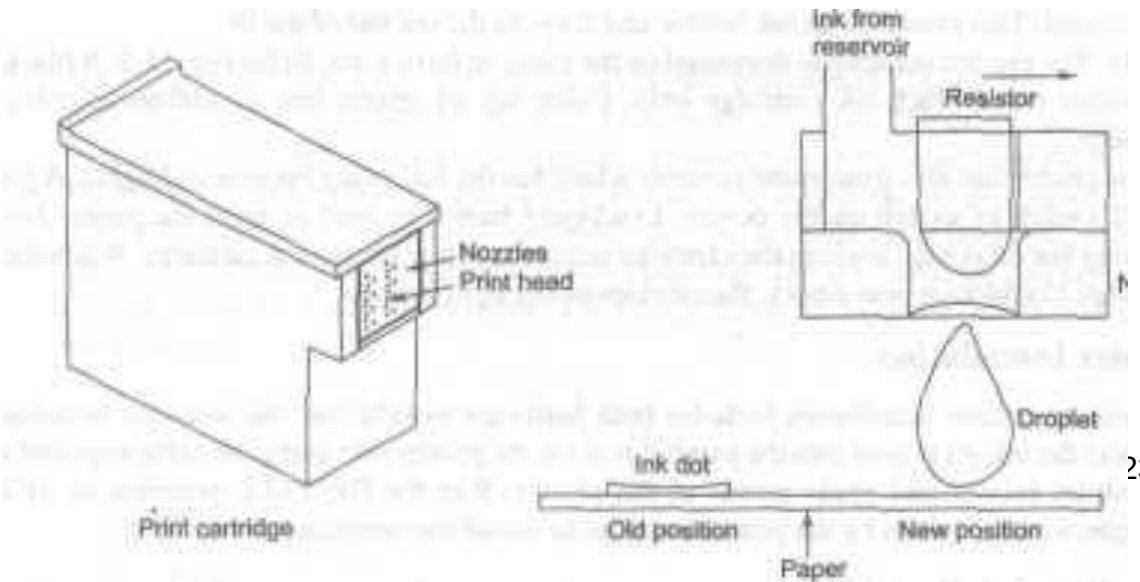


Fig. 11.2 *Functional block diagram of ink-jet printer*

Paper Feed Mechanism feeds the paper. The printer accepts plain paper, envelopes, transparencies and photo paper. For each type of print medium the paper support of the printer is to be properly positioned. For quality output the proper selection of the print medium is to be selected in the printer driver setup. Once the paper feed mechanism senses and takes-in the paper it is registered at correct position.

The Ink Cartridge Carriage Mechanism is moved across the width of the paper to and fro and deposit an entire line of text or graphics for each pass.



The only difference between the ink-jet printers and dot matrix printers is the technology used to form the characters on the paper. Here we use an ink cartridge with nozzles instead of print pins. Instead of firing pins these printers eject ink drops on to the papers through nozzles to form the characters. The ink cartridge has an ink reservoir and a set of nozzles. It has also a firing chamber.
To start the ink is drawn into the firing chamber. The thin film resister at the bottom of the ink drop heats the ink upto 900 degree Fahrenheit for a millionth of a second. This produces an ink bubble and it ejects the ink out of the firing chamber through nozzle. The ejected ink drop is deposited on the paper to form a dot.
A black ink jet printer has a black ink cartridge only. Color ink-jet printer has an additional color ink cartridge.
The printer has also front panel controls which has the following buttons and lights.
1) **Power ON/OFF** Switch to switch on the paper.
2) **LOAD/EJECT** button to load or eject the paper.
Nozzle Cleaning button is used to clean the cartridge nozzle or to replace the ink cartridge. When the ink cartridge black/color runs empty, the light flashes correspond

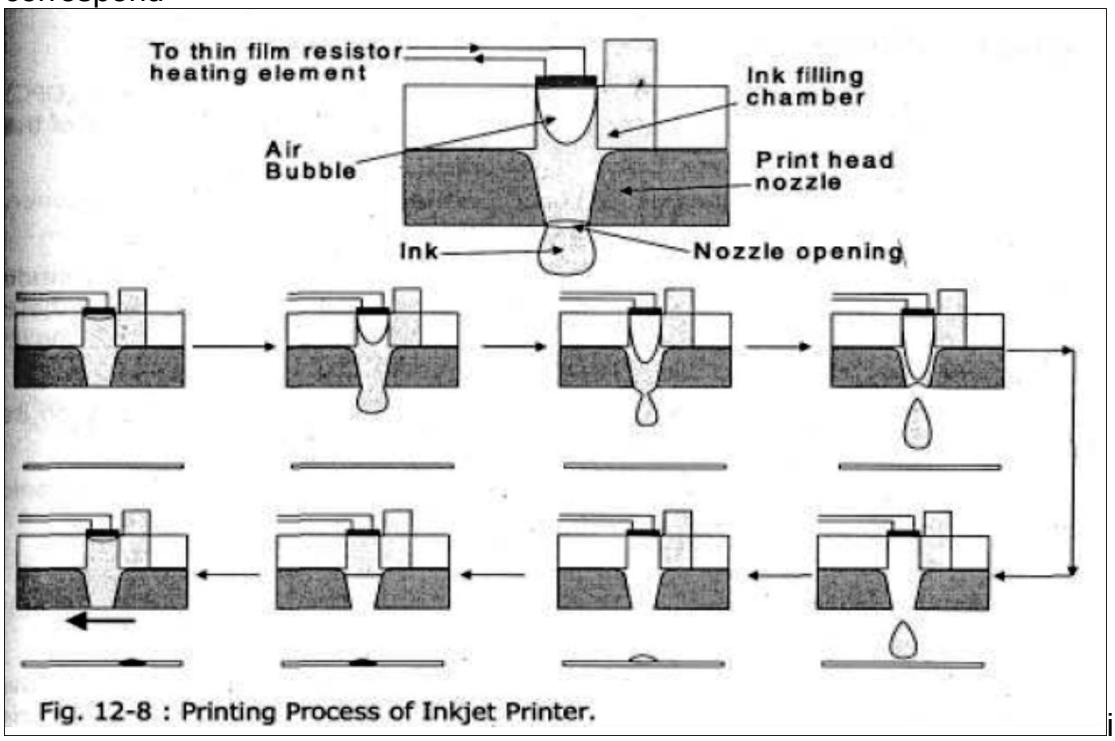


Fig. 12-8 : Printing Process of Inkjet Printer.

ing.

LASER Printer

It is used as an output device to print high quality outputs. The printer has different built-in fonts and styles of character. Normally the speed of the laser printer is in ppm(pages per minute)

Principle of Operation

Once the computer is ready to send data to the laser printer for printing the output the usual procedures of handshaking is executed. On knowing the printer is ready to receive data the system delivers the data and the printer stores them in buffer memory. With this the printing process starts.

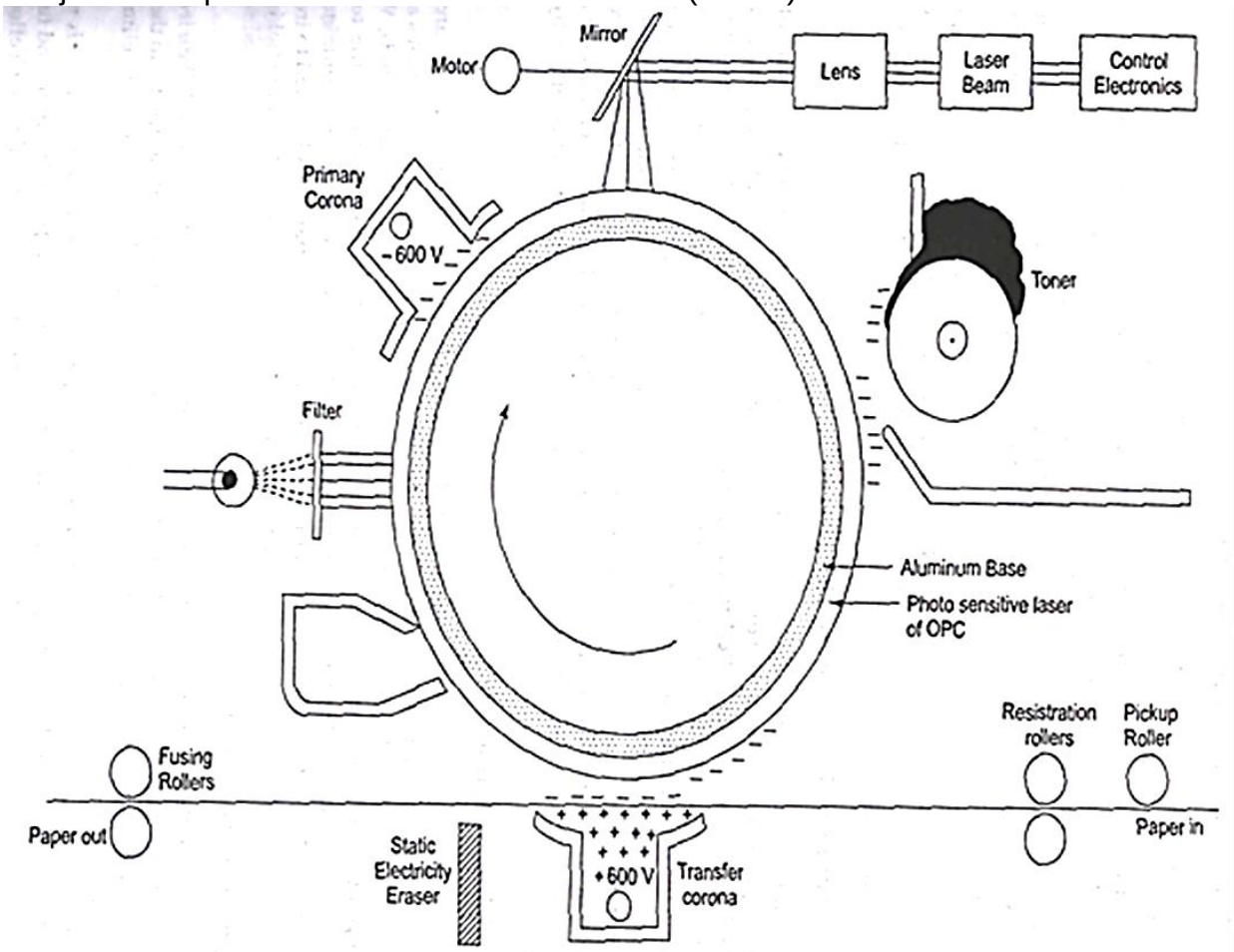
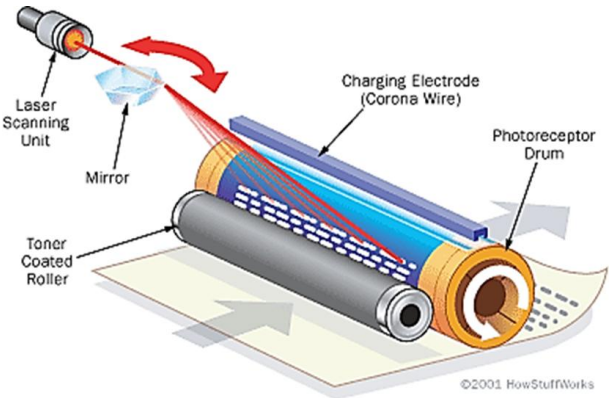


Fig. 11.1 *Functional block diagram of a laser printer*

Parts of Laser printer

1. **Organic Photoconducting Cartridge (OPC) drum- reacts to light (photosensitive)**
   - Holds a charge except where it is exposed to light
2. **Paper transport- 4 types of rollers that move paper through printer**
   - This is where most paper jams occur!
3. **Primary corona- main corona**
   - located inside toner cartridge
   - uniformly charges drum to -600V
4. **Transfer corona- transfers image from drum to paper**
   - Transfer corona charges the paper
   - The charged paper pulls toner from drum to paper
5. **Fusing roller**- permanently melts toner to page
   - This is why laser printer pages are hot
6. **Controller**- Includes printer RAM
7. **Power supply**- High-voltage AC and DC
8. **The Laser Assembly**

- The traditional laser scanning assembly includes:
  A **laser** Shines on the drum and creates an electrostatic image of what's printed. Creates areas of negative charge on the positively charged drum.



- A **movable mirror**
- Reflects the laser beam
- A **lens** Focuses the laser beam
- Multiple lenses maybe used to focus the laser beam on the various areas of the drum: the areas being closer to or farther away from the mirror and laser beam.

Before the output is actually printed to on the paper the following processes are done in sequence:

1. Cleaning the drum
2. Conditioning the drum
3. Writing (Transferring of image onto the drum)
4. Developing (Depositing toner(ink dust) onto the image)
5. Transferring the toner from the drum to paper and
6. Fusing (Fixing the toner onto paper permanently)

1. Drum Cleaning

The central part of the printing process is the drum. It is an aluminum cylinder coated with photosensitive material and could act as organic Photoconducting Cartridge(OPC). The cylinder or the drum collects the toner corresponding to the image pattern to be outputted and transfers it to the paper. Before printing any new image the drum is to be cleaned and conditioned, to avoid ghost images. Physically excess toner is constantly wiped from the drum by means of rubber cleaning blade. Then the drum is cleaned electrostatically by focusing light from eraser lamps, this removes the residual image on the drum, by neutralizing the residual charges in the drawing.

2. Drum Conditioning

A high voltage power supply provides a -600 V/dc. This high voltage is applied through thin wire called primary corona located near the drum across its surface. The corona discharge charges the drum surface a uniform negative charge of -600V.This process is called conditioning the drum

3. Writing (Transfer of Image on Drum)

- Where laser beam contacts drum, the charge is reduced to -100V from -600V
- Image of page is created on drum
- The controller loads sheet of paper to the registration roller of the paper transport system

4. Developing (Deposition of Toner)

- The toner is made of plastic resin particles bonded to iron oxide
- The particles of toner in toner cartridge are attracted to the areas of drum (-100V) exposed by laser
- Creating print image on drum

5. Transferring of Image

- Sheet of paper at registration roller is given a positive charge (+600V)
- Negatively charged toner on drum is attracted onto positively charged paper(+600V)
- Image is transferred to paper.

6. Fusing of Image

- Fusing rollers apply heat and pressure to toner
- Toner melts and permanently bonds to paper

Comparison between Dot-Matrix, InkJet and laser

Sr. No	Features	Dot matrix	InkJet	Laser
01	Print mechanism	Impact	Non-Impact	Non-Impact
02	Print Quality	Good	Better	Best
03	Cost	Low	Moderate	High
04	Noise Generated	Yes	No	No
05	Speed	Low	High	Good
06	Maintenance required	High	Low	Low from experts only
07	Support color printing	No	Yes	Yes