

ELECTRICAL APPLIANCES (UNIT-III)

Unit-III: Principles of working, parts and servicing of Electric fan, Electric Iron box, Water heater; Induction heater, Microwave oven; Refrigerator, Concept of illumination, Electric bulbs, CFL, LED lights, Energy efficiency in electrical appliances, IS codes & IE codes.

Electric Fan:

- ✓ Electric fans, which everyone of us has seen at homes when the atmospheric temperature goes above the comfort level of human body.
- ✓ Electric fan when rotates, blows away air around it towards the corners of room and thus speeds up the evaporation process resulting in the cooling of human body and room.

Parts of Electric Fan:

1. **Capacitor:** Start capacitor is used in electric fans, capacitor stores energy and this stored energy is used to rotate the fan from rest state. This capacitor increases electric fan motor torque and allows motor to rotate rapidly.

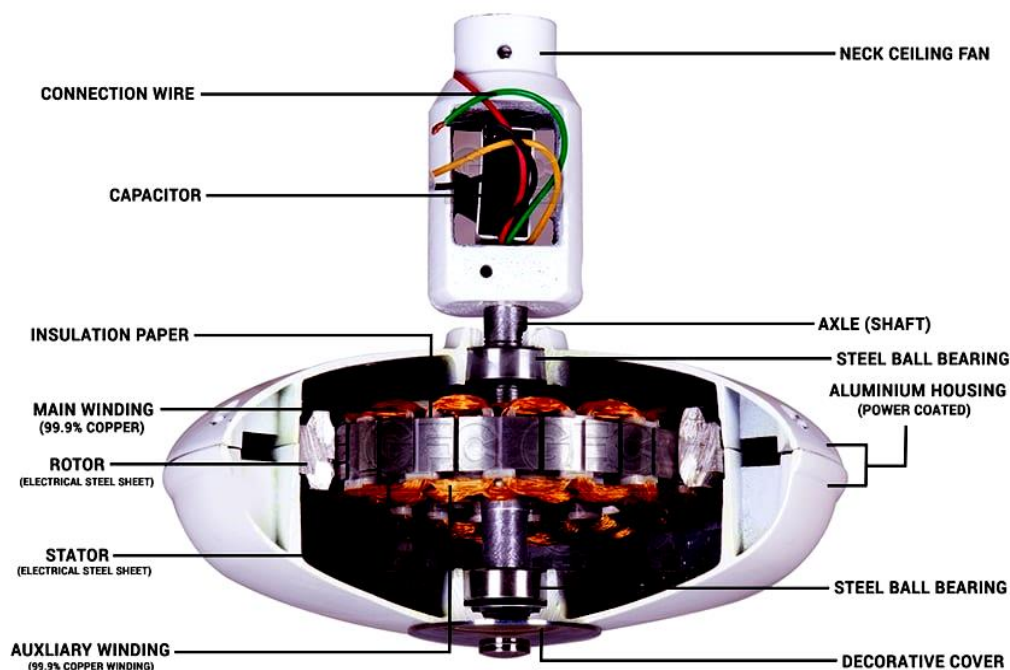


Fig (1) Parts of Electric Fan

2. **Axle:** Axle or Shaft is the metallic rod mostly made up of mild steel. Axle is connected from ceiling to fan housing. It stays at rest motion while bearings supporting the housing over it rotates.
3. **Bearings:** Ball bearings are used in the electric fan. As shown Fig (1) 2 bearings which are link between housing and axle gives the rotary motion to the housing.
4. **Stator:** Stator winding is simply the stationary winding in the electric fan motor winding. This winding has very low resistance. Main purpose of stator winding is to convert electric current into magnetic field.
5. **Rotor:** Rotor in the electric motor is the permanent magnetic in the shape of half circles. Usually 2 Pieces of Magnets are used in Electric fan but this can change to 3 Pieces or to single pc depending upon size and capacity of electric fan.
6. **Housing:** Housing is the outer part of the electric fan which carries stator, rotor and drive shaft bearing assembly on inside and blades on outer sides.

7. **Blades:** Blades or wings are the hanging part bolted on the outer area of housing. Three blades are mostly used and their length and the angle of air throw depends upon the size and capacity of electric motor.

Working of Electric Fan:

- ✓ Electric fan works on the principle of conversion of electric energy into mechanical energy and in this case mechanical energy is consumed as rotary motion of fan blades.
- ✓ When AC is supplied to electric fan it first reaches the capacitor and Capacitor delivers high energy to the stator windings.
- ✓ When stator winding energizes, it develops the rotating magnetic field and which forces the rotor to rotate in the direction of rotating magnetic field.
- ✓ In this way electrical energy is converted into mechanical energy which causes the rotor and housing to spin and the blades attached to the housing throws away the air nearby it while creating cooling effect.

Servicing of Electric Fan:

1. Disassembling the Fan:

- ✓ Turn your fan on to make sure that the motor works.
- ✓ Unplug the fan and either unhook the blade guard or unscrew the pin.
- ✓ Turn the blades or washer in the center of the fan counterclockwise to remove them.
- ✓ Slide the back half of the blade guard off of the pin in the center.
- ✓ Flip your fan around and find the screws in the back.

2. Lubricating the Bearings:

- ✓ Turn the pin on the front of the fan with your hand to see if it rotates.
- ✓ Unscrew any washers or bolts blocking the base of the pin.
- ✓ Apply lubricating oil to the front and back of the pin.
- ✓ Spin the bolts around a lubricated section of the pin while spinning it.

3. Cleaning the Motor and vent

- ✓ Inspect the back of your motor case for dust or grime and wipe it off.
- ✓ Spray the plastic vent on the back with compressed air.
- ✓ Plug your fan in and turn it on to see if the pin spins.
- ✓ Reassemble your fan by putting the blades, bolts, and case back together.

Electric Iron Box:

- ✓ An Electric Iron Box is a general household appliance used to press the wrinkles out of the clothes. This works on the basis that the combination of heat and pressure removes wrinkles.
- ✓ The principle of the electric iron is that when current is passed through a coil, the coil gets red hot and transfers the heat to the base plate of the electric iron through conduction.
- ✓ There are basically two types of electric irons
 1. Automatic
 2. Non-Automatic
- ✓ There is not much difference between the two types. The former has one regulator to control the temperature of the element and in-turn the temperature of the iron.

Parts of Electric Iron Box:

1. **Sole Plate:** The sole plate is the thick, triangular-shaped slab of iron that forms the base over which the electric iron is built up. The bottom surface and edges are heavily chromium plated, to prevent it from rusting.

2. Pressure Plate: This plate is generally called the top plate as it follows the shape of sole plate. The pressure plate has some holes through which the studs from the base plate pass through.

3. Heating Element: The heating element is present between the sole plate and pressure plate. It is pressed hard between the two plates. The heating element consists of nichrome wire wound around a sheet of mica.

4. Cover Plate: The cover plate is made of thin sheet of iron. It is placed on top of the base plate and it covers all the internal parts of the iron.

5. Handle: The handle can be made either with wood or with plastic. The handle is attached to the cover plate with the aid of screws. Studs can also be used for this purpose.

6. Pilot Lamp: The pilot lamp is housed in the cover plate of the electric iron. One end of the pilot lamp is connected to supply, while the other end is connected to the heating element. A shunt resistance is provided across the pilot lamp which assists in providing a voltage drop of 2-5 volts.

7. Thermostat:

- ✓ When it comes to an automatic electric iron, the thermostat is the most important item. It uses a bimetallic strip to operate the switch which is connected in series with the resistance (or) heating element.
- ✓ The bimetallic strip is a simple element which converts a temperature change into mechanical displacement. Thus using bimetallic strip the temperature is kept constant within certain limits.

8. Capacitor: The thermostat helps in maintaining the temperature within limits. But frequent making and breaking of circuit damages the contact points and it may also result in interference with radio reception. To avoid this, a capacitor of certain range is connected across the two contact points.

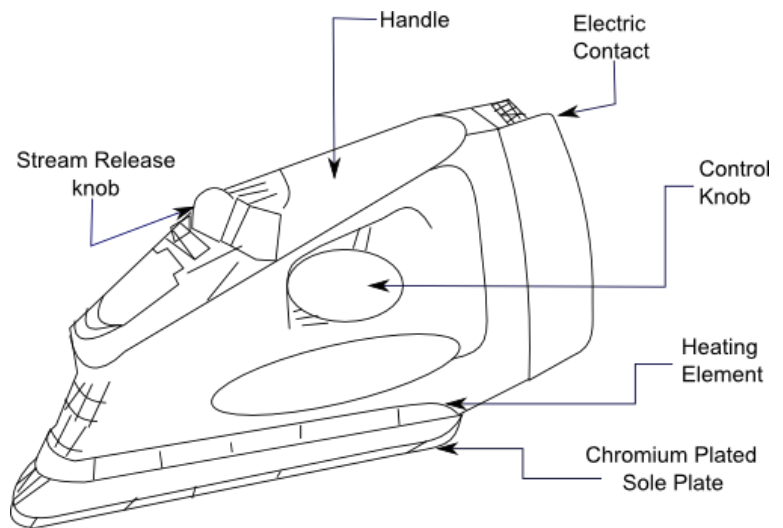


Fig (1) Parts of Electric Iron Box

Working of an Electric Iron Box:

- ✓ An electric iron relies on a basic combination of heat and pressure to remove wrinkles from clothing.
- ✓ If an electric current is passed through a coil or other heating element present in the iron, it becomes very hot. This heat is then transferred to the base plate (the smooth, flat surface that you place against clothes while ironing) through conduction, which elegantly irons your clothes.
- ✓ However, if the iron continuously draws electricity from the power supply, the heating element gets hotter and hotter. This causes a lot of energy waste, as an iron consumes a lot of electricity in just a few minutes, ruining clothes and, in the worst-case scenario, causing serious and potentially dangerous accidents.
- ✓ Therefore, it is essential that iron does not heat up to dangerous temperatures. For maintaining the optimum temperature, a thermostat is used along with pilot lamp which serves as an indicator.

Servicing of an Electric Iron Box:

1. Clean an electric iron:

- ✓ Unplug the iron and make sure it is cool before cleaning.
- ✓ Use a toothpick or pipe cleaner to remove buildup in the steam vents, making sure the debris doesn't fall into the vents.

- ✓ Use a fine sewing needle to carefully clean the spray nozzle of mineral deposits.
- ✓ To flush sediment from a steam iron, pour 1/2 cup water and 1/2 cup vinegar into the water tank. Place the iron on a rack over a broiling pan and set the iron to steam until the tank runs dry. Repeat if necessary. Or follow the instructions for using a commercial iron cleaner.

2. Service an electric iron steam and spray mechanism:

- ✓ Unplug the iron.
- ✓ Use a fine sewing needle to unclog the steam valve assembly. Also, check the valve spring and replace it if it is broken or has lost tension.
- ✓ If the spray pump is accessible, remove it and check for leaks by placing the spray tube in water and squirting the pump. Clean or replace as needed.

3. Clean an electric iron metal soleplate:

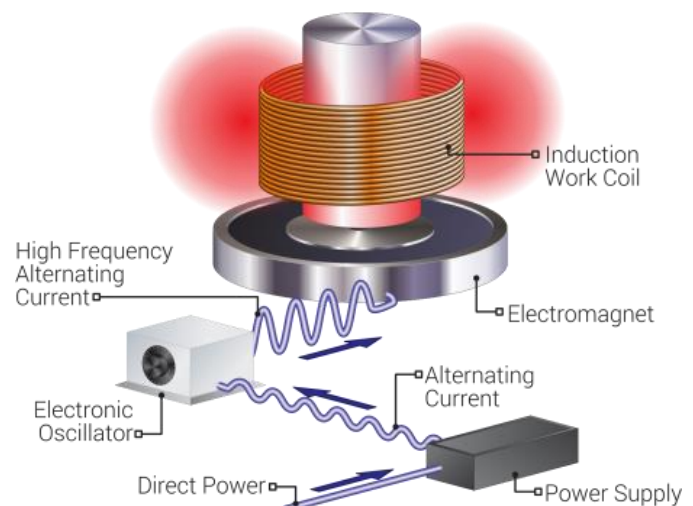
- ✓ Unplug the iron.
- ✓ Use a sponge and commercial soleplate cleaner or baking soda and water to remove dirt buildup on the soleplate. Rinse well with water and dry. Don't use harsh abrasives or immerse an electric iron in water.
- ✓ Use very fine steel wool or an emery cloth to remove scratches and burns on the soleplate, then clean the soleplate.

Induction Heater:

Induction heating is a process designed to heat an electrically conductive material such as a metal, to change its physical properties without the material coming into contact with the inductor. Heat is induced to the conductive material with circulating electric currents, as it is placed in a magnetic field. An induction heater is used for heating.

Working of Induction Heater:

- ✓ The material to be heated is positioned inside the coil. The Induction work coil is water cooled and does not touch the heated material. The power supply is used to convert direct power to alternating current.
- ✓ An electronic oscillator sends a high frequency alternating current to the electromagnet. The coil receives an alternating magnetic field. This magnetic field transfers into the material, or conductor set up for heating. An electric current, also known as an eddy current, is produced in the conductor. The conductor is then heated by the flow and circulation of eddy currents through the material resistance. This is also known as Joule heating. Ferromagnetic metals like iron can also heat up by magnetic hysteresis losses.



Fig(1) Working of Induction Heater

Electric Water Heater:

The Electric heater used to heat up water is called Electric Water Heater.

Parts of Electric Water Heater:

1. Tank: The tank itself has a couple different layers that all serve different purposes. The inner shell is a heavy metal tank that has a protective glass liner that holds about 40-60 gallons of hot water. The exterior of the tank is covered in an insulating material.

2. Gas Valve Or Burner Assembly (Heating): Gas water heaters use a flame underneath the tank to heat the water, while electric water heaters use a heating element.

3. Thermostat: This serves as the temperature control device to determine how hot the water will get. You should be able to adjust the thermostat to meet your needs.

4. Dip Tube: This is the tube where water enters into the tank to replenish the hot water being used. It's located at the top of the tank and goes down to the bottom where the water is then heated.

5. Shut-Off Valve: This valve will stop water from flowing into the water heater. It's actually a separate component from the water heater and is located outside and above the unit.

6. Hot Supply: This is located inside the tank at the top; this port allows the hot water to exit the tank and flow through your home's pipes to whatever appliance you want hot water from.

7. Drain Valve: This valve is not a part of your water heater's daily use, but was created to easily empty the tank to replace the elements and remove sediment or to move the tank to a new location. This is located near the bottom of the tank on the outside.

8. Pressure Relief Valve: This is a safety device that keeps the water pressure inside the tank within safe limits.

9. Sacrificial Anode Rod: This rod is suspended in the water tank to help keep your tank from corroding. This acts similar to a magnet by attracting corrosive minerals in the water to the rod instead of eroding the tank.

Working of Electric Water Heater:

- ✓ A typical water heater will use a storage tank and will use electricity to heat a certain amount of water at a time.
- ✓ There's also a thermostat to monitor the temperature and a pressure relief valve to help ensure the heating process doesn't produce unsafe levels of water pressure.
- ✓ Water enters the tank from the main water supply.
- ✓ The heating burner/element at the bottom of the tank starts to heat the water. As the water heats, it will rise to the top of the tank.
- ✓ When you need hot water, it's taken from the top of the tank where the hottest water is.
- ✓ For tank less water heater, the process is slightly different. Because there is no storage tank, there is a heating exchanger that is used to heat the water

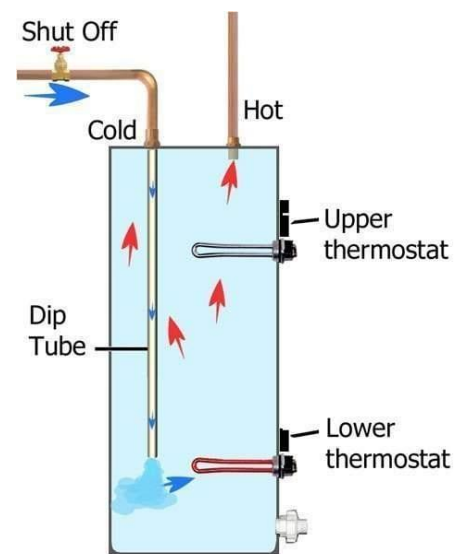


Fig (1) Working of Electric Water Heater

Microwave Oven:

Microwave ovens are one of a few electric methods of cooking. The microwave oven evolved from research on Doppler radar technology by accident when a researcher (Percy Spencer at Raytheon) found a chocolate bar in his pocket had melted when he was exposed to microwave radiation.

Parts of Microwave Oven:

1. Magnetron Assembly: This is the component that generates the microwave energy which is in turn used to heat the food. The magnetron generates these waves using very high voltages.

2. Waveguide: It is a hollow metallic tube that helps to along a certain path by making use of successive reflections within the surface of its inner walls. A microwave oven would typically use this to transmit the waves produced by the magnetron to the internal cavity where the food is placed.

3. Transformer: Microwave ovens are high power devices. They need high voltages to work sufficiently. A step-up transformer is used to transform this relatively low voltage to a high enough value for use within a microwave oven. The device needs about 4000 volts or more to generate the microwaves.

4. Cooling Fan: As heating occurs in the microwave Oven, it is necessary to have a system in place that ensures the components do not overheat. For that reason, some microwave ovens come with a cooling fan. This is used to dissipate the heat generated by the microwave's components as do most electronics do.

5. The Control Panel: This is the main component that users interact with. From here, we can set the duration, the level of intensity with which you want to cook the food, and even the operation you want to do, whether it is grilling, defrosting or microwaving a meal.

6. The Door: Most microwaves will have a glass door that lets you see the food inside. This lets you monitor your food allowing you to choose to interrupt any process if need be. Another function of the door is to keep the microwaves inside the cavity of the device where the food is.

7. Case: This makes up the body of the device. The case's purpose is to protect the microwave's components from damage and the elements like dust and excessive moisture.

Working of Microwave Oven:

- ✓ When we initiate a task to microwave Oven current enters the magnetron assembly and heats a filament inside it. This acts as a cathode and once heated, it releases electrons.
- ✓ These are accumulated and used to generate the microwaves which are then guided to the cavity where the food is placed.
- ✓ The waves themselves do not carry thermal energy. Unlike in non-microwave ovens where a heating element is used, microwave ovens cook food by generating the heat from within the food itself. This happens due to vibrations.
- ✓ The waves are absorbed by certain molecules within the food which in turn causes them to vibrate. This vibration produces kinetic energy which is then converted to heat energy and the food gets heated or cooked.

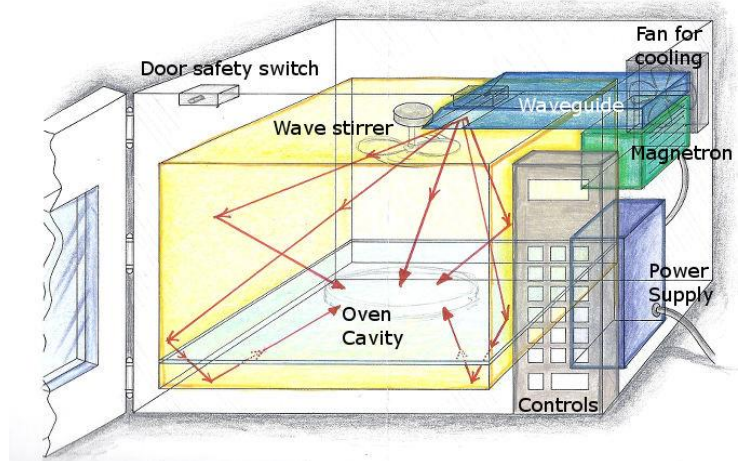


Fig (1) Structure of Microwave Oven

Refrigerator:

A Refrigerator (Colloquially Fridge) is a home appliance consisting of a thermally insulated compartment and a heat pump (mechanical, electronic or chemical) that transfers heat from its inside to its external environment so that its inside is cooled to a temperature below the room temperature.

Parts of Refrigerator:

A refrigerator consists of several key components that play a crucial role in the cooling process:

1.Expansion Valve: It is the flow control device. It controls the flow of refrigerant into the evaporator coil.

2. Compressor: It is the heart of the refrigerator. Piston fitted inside compress the air in the cylinder, which then passes through the condenser coil.

3. Evaporator: It consists of a metal finned tube. The tube has made up of metal which has high thermal conductivity. Hence it allows fast transfer of heat. Main function of the evaporator is to absorb the heat from the stuff kept inside the refrigerator.

4. Condenser coil: It is fitted backside of the refrigerator. It cools down vapors coming from the compressor and vapors converts to liquid refrigerant. Condenser coil exchanges the heat with the environment.

Working of Refrigerator:

- ✓ The principle of refrigeration and cooling is very simple: it involves removing heat from one region and depositing it in another.
- ✓ The refrigerant, which is in liquid state, passes through the expansion valve and turns into a cool gas due to the sudden drop in pressure.
- ✓ As the cool refrigerant gas flows through the chiller cabinet, it absorbs the heat from the food items inside the fridge. The refrigerant, which is now a gas, flows into the compressor, which sucks it inside and compresses the molecules together to make it into a hot, high-pressure gas.

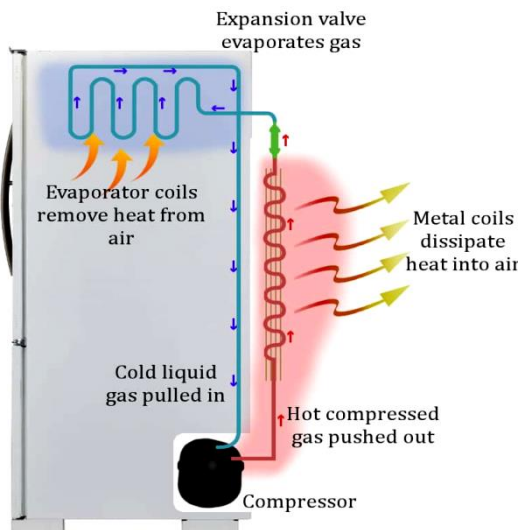


Fig (1) Working of Refrigerator

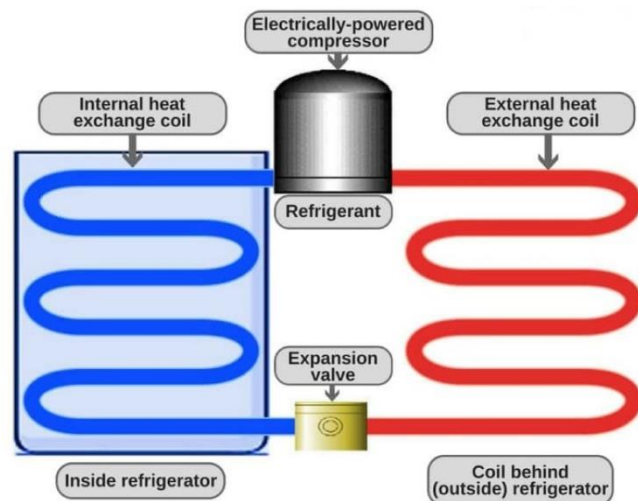


Fig (2) Refrigeration Cycle

- ✓ Now, this gas transports to the condenser coils (thin radiator pipes) located at the back of the fridge, where the coils help dissipate its heat so that it becomes cool enough to condense and convert back into its liquid phase. Because the heat collected from the food items is given off to the surroundings via the condenser, it feels hot to the touch.
- ✓ After the condenser, the liquid refrigerant travels back to the expansion valve, where it experiences a pressure drop and once again becomes a cool gas.
- ✓ It then absorbs heat from the contents of the fridge and the whole cycle repeats itself.

Concept of Illumination:

- ✓ As a body is gradually heated above room temperature, it begins to radiate energy in the surrounding medium in the form of electromagnetic waves of various wavelengths.
- ✓ The usual method of producing artificial light consists in raising a solid body or vapour to incandescence by applying heat to it.

- ✓ When a certain temperature is reached, light waves are also radiated out in addition to heat waves and the body becomes luminous.
- ✓ As the temperature is increased, the wavelength of visible radiation goes on becoming shorter. Obviously, from the point of view of light emission, heat energy represents wasted energy.
- ✓ Illumination is defined as the energy of light (ϵ) striking a surface of specific unit area per unit time. This definition is shown using the expression:

$$\epsilon = \frac{I_s \cos \alpha}{d^2}$$

where ϵ is the illumination (or light energy) in lumens (L)/mm², I_s is the source intensity in candlepower, α is the angle between the source light rays and a unit vector normal to the illuminated surface, and d is the distance (in mm) from the source to the illuminated surface.

Electric Bulb:

- ✓ The light bulb is an electric light source that's technically called a lamp. This term is, of course, also more commonly used by consumers to mean a portable type of lighting such as a table lamp or a desk lamp.
- ✓ The most common type of "lamp" or bulb is the incandescent light bulb. These types of light bulbs are the oldest and simplest form of bulb technology, dating back to Thomas Edison's experiments with filament types back in 1879.

Working of Electric Bulb

- ✓ An Electric bulb works on the principle of incandescence, a general term meaning light produced by heat. In an incandescent type of bulb, an electric current is passed through a thin metal filament, heating the filament until it glows and produces light.
- ✓ Incandescent bulbs typically use a tungsten filament because of tungsten's high melting point. A tungsten filament inside a light bulb can reach temperatures as high as 4,500 degrees Fahrenheit. A glass enclosure, the glass "bulb", prevents oxygen in the air from reaching the hot filament.
- ✓ After the electricity has made its way through the tungsten filament, it goes down another wire and out of the bulb via the metal portion at the side of the socket. It goes into the lamp or fixture and out a neutral wire.
- ✓ Electric bulb is compatible with either AC or DC current.

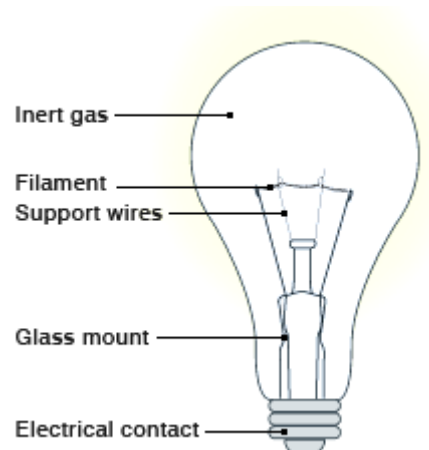


Fig (1) Structure of Electric Bulb

CFL:

- ✓ The term 'CFL' stands for Compact Fluorescent Lamp. It is also known as compact fluorescent light, energy-saving light, and compact fluorescent tube.
- ✓ The CFL was initially designed to replace the incandescent lamp in terms of its compactness as well as energy efficiency. The basic construction of a CFL consists a tube which is curved/spiraled to fit into the space of an incandescent bulb, and compact electronic ballast in the base of the lamp.

Working of CFL:

- ✓ A CFL uses vacuum pipe which is principle wise same to the strip lamps (commonly known as Tube light). Tube has two electrodes on both ends which is treated with Barium. Cathode is having a temperature of about 900° C and generates a beam of electrons which is further accelerated by potential difference between electrodes.

- ✓ These accelerated electrons strike Mercury and Argon atoms which in turn results in the arise of a low temperature plasma. This process initiates the radiation of Mercury in Ultra violet form. Tube's inside face contains 'Luminophore' whose function is to convert Ultra violet light into visible light.
- ✓ This tube is fed with AC power supply which facilitate the changing functionality of Anode and Cathode. The CFL also consists a switched mode converter. It functions on a very high frequency and acts as a replacement of ballast (choke) and starter assembly.

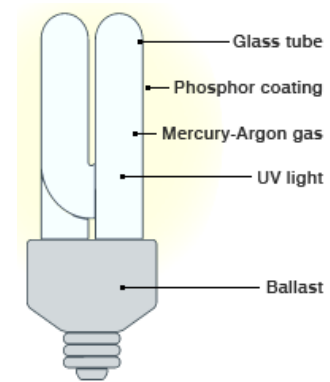


Fig (1) Structure of CFL

LED (Light Emitting Diode):

- ✓ The lighting emitting diode is a p-n junction diode. It is a specially doped diode and made up of a special type of semiconductors, which emits light when forward biased, then it is called a Light-Emitting diode.
- ✓ The emitted light may be visible or invisible. The amount of light output directly proportional to the forward current. The LED symbol is similar to a diode symbol except for two small arrows that specify the emission of light. The LED includes two terminals namely anode (+) and the cathode (-). The LED symbol is shown Fig 1(a)

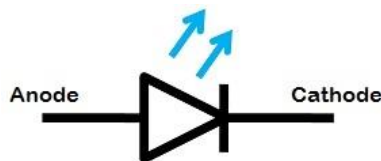


Fig 1(a) Circuit Symbol

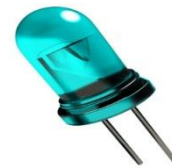


Fig 1(b) Light Emitting Diode (LED)

Working of LED:

- ✓ The light-emitting diode simply, we know as a diode. When the diode is forward biased, then the electrons & holes are moving fast across the junction and they are combined constantly, removing one another out.
- ✓ Soon after the electrons are moving from the n-type to the p-type silicon, it combines with the holes, then it disappears. Hence it makes the complete atom & more stable and it gives the little burst of energy in the form of a tiny packet or photon of light.

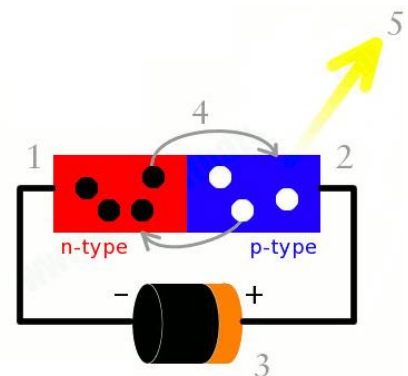


Fig (2) Working of LED

1. From the Fig (2), we can observe that the N-type silicon is in red colour including the electrons which are indicated by the black circles.
2. The P-type silicon is in the blue colour and it contains holes, they are indicated by the white circles.
3. The power supply across the p-n junction makes the diode forward biased and pushing the electrons from n-type to p-type. Pushing the holes in the opposite direction.
4. Electron and holes at the junction are combined.
5. The photons are given off as the electrons and holes are recombined.

Energy Efficiency in Electrical Appliances:

A small set of appliances such as fans, televisions, refrigerators, air-coolers, air conditioners, and water heaters contribute about of the total residential electricity consumption in India. Large scale adoption of energy efficient models of these appliances can thereby significantly reduce future electricity consumption in homes. In this topic, we look at the government's Standards and Labeling (S&L) programme and three aspects of its effectiveness in achieving efficiency in the Indian appliances market.

The S&L programme is run by the Bureau of Energy Efficiency (BEE), under the Ministry of Power. Since 2006, the programme promotes efficient appliances through informative labels and by eliminating lower efficiency models through mandatory standards. BEE gives a 5-star rating to the most efficient models and a 1-star rating to the least efficient ones based on a pre-determined schedule, communicated through a label affixed on the appliance. Eight appliance categories, including Air-Conditioners and Refrigerators are mandated to carry these labels, and no model can be sold unless it meets the 1-star rating, at minimum. The programme is voluntary for 13 appliance categories, including Ceiling Fans and Washing Machines, and manufacturers can sell these models without BEE labels and with an efficiency less than a 1-star rating.

Mandate and Tighten Standards

For any appliance, BEE starts with a voluntary S&L programme and usually makes it mandatory in two-three years. BEE's mandatory list has increased from two to eight and now covers most major appliances including, Refrigerators and Air-Conditioners.

Table 1: List of appliances on the Standards and Labeling (S&L) Programme

Mandatory Appliances	Voluntary Appliances
Frost Free Refrigerators	Induction Motors
Tubular Fluorescent Lamps	Agricultural Pump Sets
Room Air Conditioners	Ceiling Fans
Distribution Transformers	Domestic LPG stoves
Room Air Conditioners	Washing Machine
Direct Cool Refrigerators	Computer
Electric Geysers	Ballast
Colour TV	Office Equipment
	Diesel Engine Driven Moonset Pumps for Agricultural Purposes
	Solid State Inverters
	Diesel Generators
	Variable Capacity Air Conditioners
	LED lamps

IS Code:

In the field of Electrical Engineering, Engineers and other Professionals get exposed to Electricity indirectly during generation, transportation, installation and usage. Such conditions might cause hazards if accurate safety measures are not taken.

To promote the safety and the right usage of equipment, there are certain rules and regulations formulated by the Bureau of Indian Standards (BIS). BIS follows the following five principles –

- Safety.
- Ease of use and adaptability.
- Simple technology.
- Value for money products.
- Energy efficiency and environment.

BIS has published the following code of practice for public safety standards in order to promote the right to information, transparency and accountability in a proper manner to the public.

Code of Practice for Electrical Wiring Installation:

- **IS – 732** (1989)
- **Section** – Electrical Installation.
- **Application** – Design of installation, selection and erection of equipment, inspection and testing of wiring system.

Code of Practice for Earthing:

- **IS – 3043** (1987)
- **Section** – Electrical Installation.
- **Application** – Design, installation and calculation of Earthing system.

Lightning arrester for Alternating Current System:

- **IS – 3070** (1993)
- **Section** – Electro technical: Surge Arresters.
- **Application** – Identification, ratings, classification and testing procedure of Arrester.

IE Code:

The International Electrotechnical (IEC) is an international standards organization that prepares and publishes international standards for all Electrical, Electronic and related technologies – collectively known as "Electrotechnology". IEC standards cover a vast range of technologies from power generation, transmission and distribution to Home Appliances and Office Equipment, Semiconductors, Fibre Optics, Batteries, Solar Energy, Nanotechnology and Marine Energy as well as many others. The IEC also manages four global conformity assessment systems that certify whether equipment, system or components conform to its international standards.

All electrotechnologies are covered by IEC Standards, including energy production and distribution, electronics, magnetic and electromagnetics, electroacoustics, multimedia, telecommunication and medical technology, as well as associated general disciplines such as terminology and symbols, electromagnetic compatibility, measurement and performance, dependability, design and development, safety and the environment.

IEC standards have numbers in the range 60000–79999 and their titles take a form such as *IEC* 60417: Graphical symbols for use on equipment. Following the Dresden Agreement with CENELEC the numbers of older IEC standards were converted in 1997 by adding 60000, for example IEC 27 became IEC 60027. Standards of the 60000 series are also found preceded by EN to indicate that the IEC standard is also adopted by CENELEC as a European standard; for example IEC 60034 is also available as EN 60034.