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 SCAN ME



Systems In Mechanical Engineering

UNIT-VI

Engineering Mechanisms & Their Application in Domestic Appliances

Mr. Girish G Khope

Syllabus

- **Introduction to Basic mechanisms and equipment:** Pumps, blowers, compressors, springs, gears, Belt-Pulley, Chain-Sprocket, valves, levers, etc.
 - **Introduction to terms:** Specifications, Input, output, efficiency, etc.
 - **Applications of:**
 - **Compressors** - Refrigerator, Water cooler, Split AC unit;
 - **Pumps** - Water pump for overhead tanks, Water filter/Purifier units;
 - **Blower** - Vacuum cleaner, Kitchen Chimney;
 - **Motor** - Fans, Exhaust fans, Washing machines;
 - **Springs** - Door closure, door locks, etc.;
 - **Gears** - Wall clocks, watches, Printers, etc.;
 - **Belt-Pulley/Chain-Sprocket** - Photocopier, bicycle, etc.;
 - **Valves** - Water tap, etc.;
 - **Levers** - Door latch, Brake pedals, etc.;
 - **Electric/Solar energy** - Geyser, Water heater, Electric iron, etc.
- (simple numerical on efficiency calculation)

Specifications :

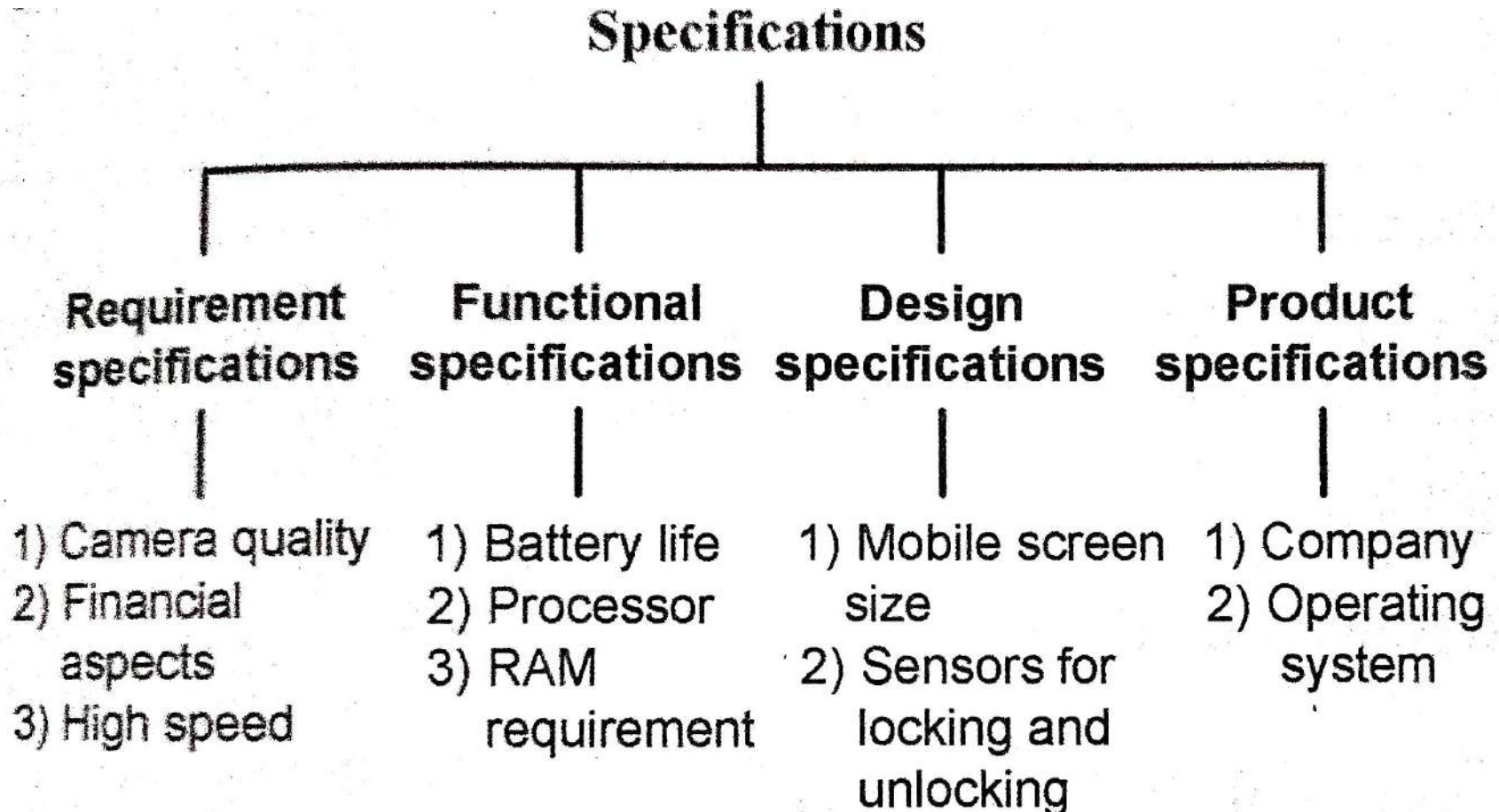
- Specifications always refers to a set of requirements to be satisfied by a product on a machine.
- Sometimes specifications often refers to a technical standard.
- There are different types of technical or engineering specifications. Specs often refers to specified documents or information within them.

Specifications are broadly classified as :

1. Requirement specifications
2. Functional specifications
3. Design specifications
4. Product specifications

Specifications :

Mobile Specification:



Specifications :

Let us consider example of pump and understood different terms associated with it and other Specifications-

1. Number of stages - single stage.
2. Type of cooling - air cooled
3. Head - 10 m
4. Inlet and outlet - diameter 1"
5. Pump speed
6. Motor horse power - 1 HP
7. Noise level - 59 dB (A)
8. Total weight - 12 KG
9. 9 Cost of the pump

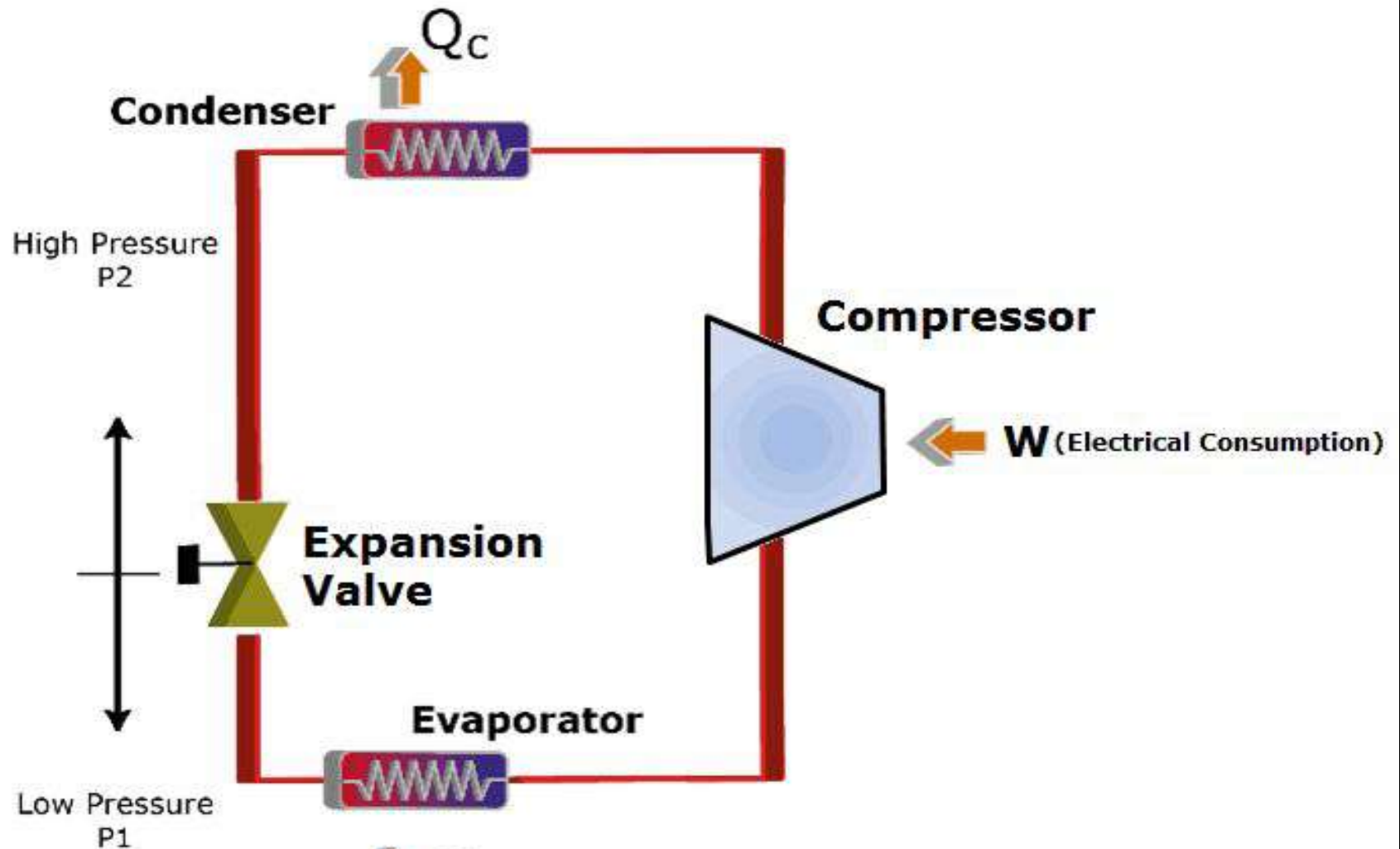
Applications of Compressors:

1. HOUSEHOLD REFRIGERATOR

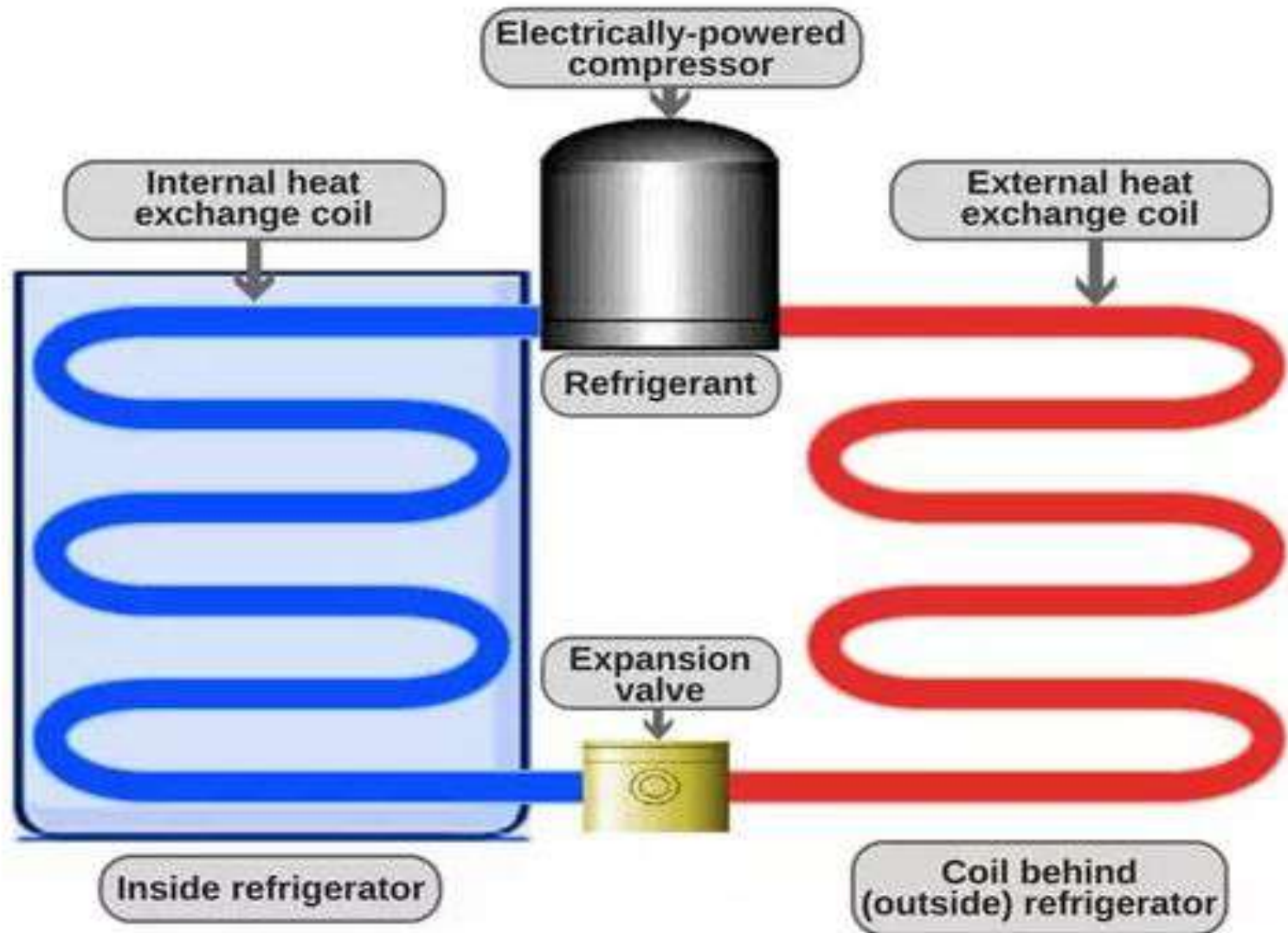
To put it simply there are 3 steps by which a refrigerator or a fridge works:

- Cool refrigerant is passed around food items kept inside the fridge.
- Refrigerant absorbs heat from the food items.
- Refrigerant transfers the absorbed heat to the relatively warmer surroundings outside.

WORKING OF REFRIGERATOR



WORKING OF REFRIGERATOR



WORKING OF REFRIGERATOR

1. *Expansion valve*

- Also referred to as the flow control device, an expansion valve controls the flow of the liquid refrigerant (also known as 'coolant') into the evaporator.
- It's actually a very small device that is sensitive to temperature changes of the refrigerant.

2. *Compressor*

- The compressor consists of a motor that 'sucks in' the refrigerant from the evaporator and compresses it in a cylinder to make a hot, high-pressure gas.

WORKING OF REFRIGERATOR

3. *Evaporator*

- This is the part that actually cools the stuff kept inside a refrigerator.
- It consists of finned tubes (made of metals with high thermal conductivity to maximize heat transfer) that absorb heat blown through a coil by a fan.
- The evaporator absorbs heat from the stuff kept inside, and as a result of this heat, the liquid refrigerant turns into vapor.

4. *Condenser*

- The condenser consists of a coiled set of tubes with external fins and is located at the rear of the refrigerator.
- It helps in the liquefaction of the gaseous refrigerant by absorbing its heat and subsequently expelling it to the surroundings.
- As the heat of the refrigerant is removed, its temperature drops to condensation temperature, and it changes its state from vapor to liquid.

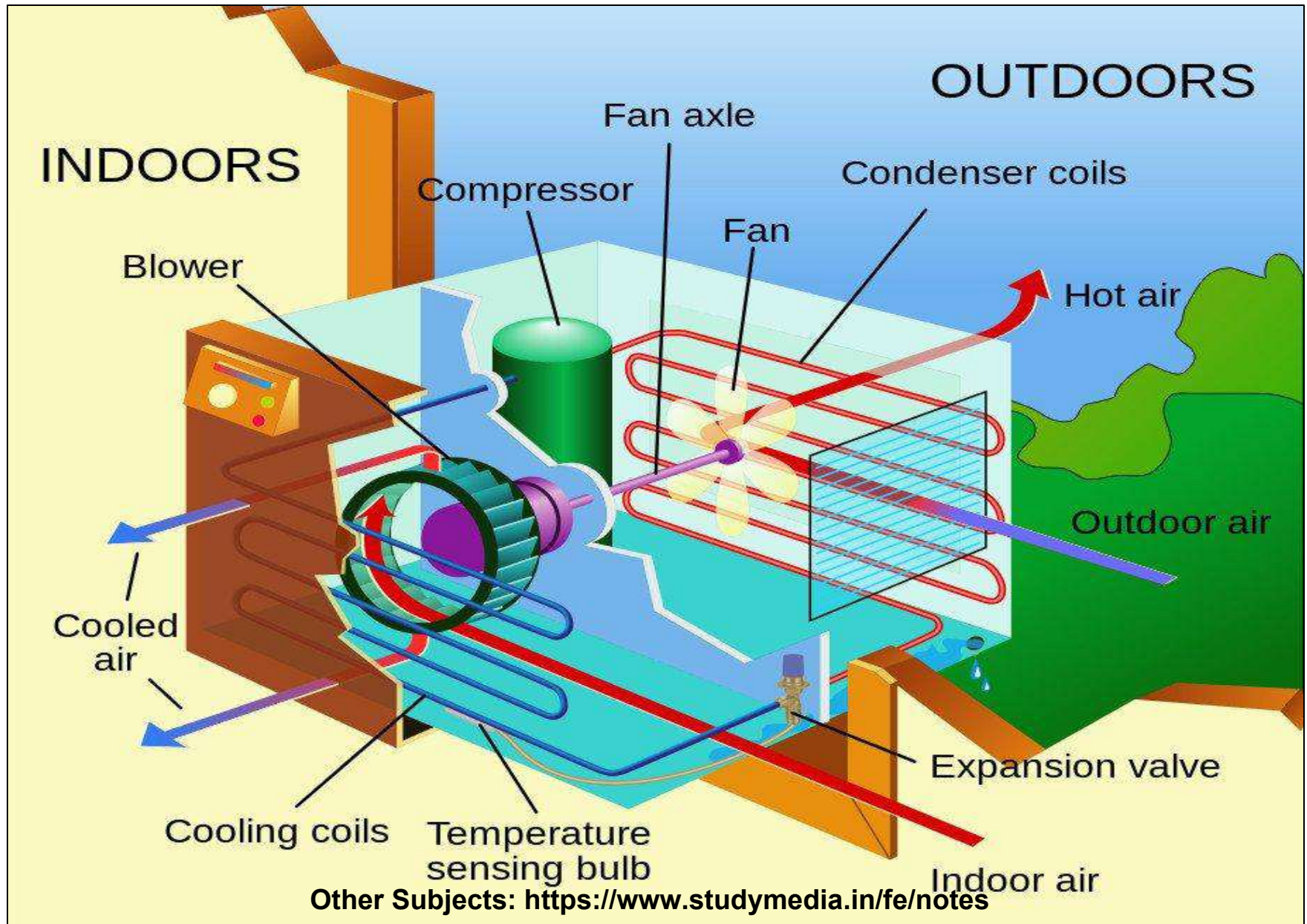
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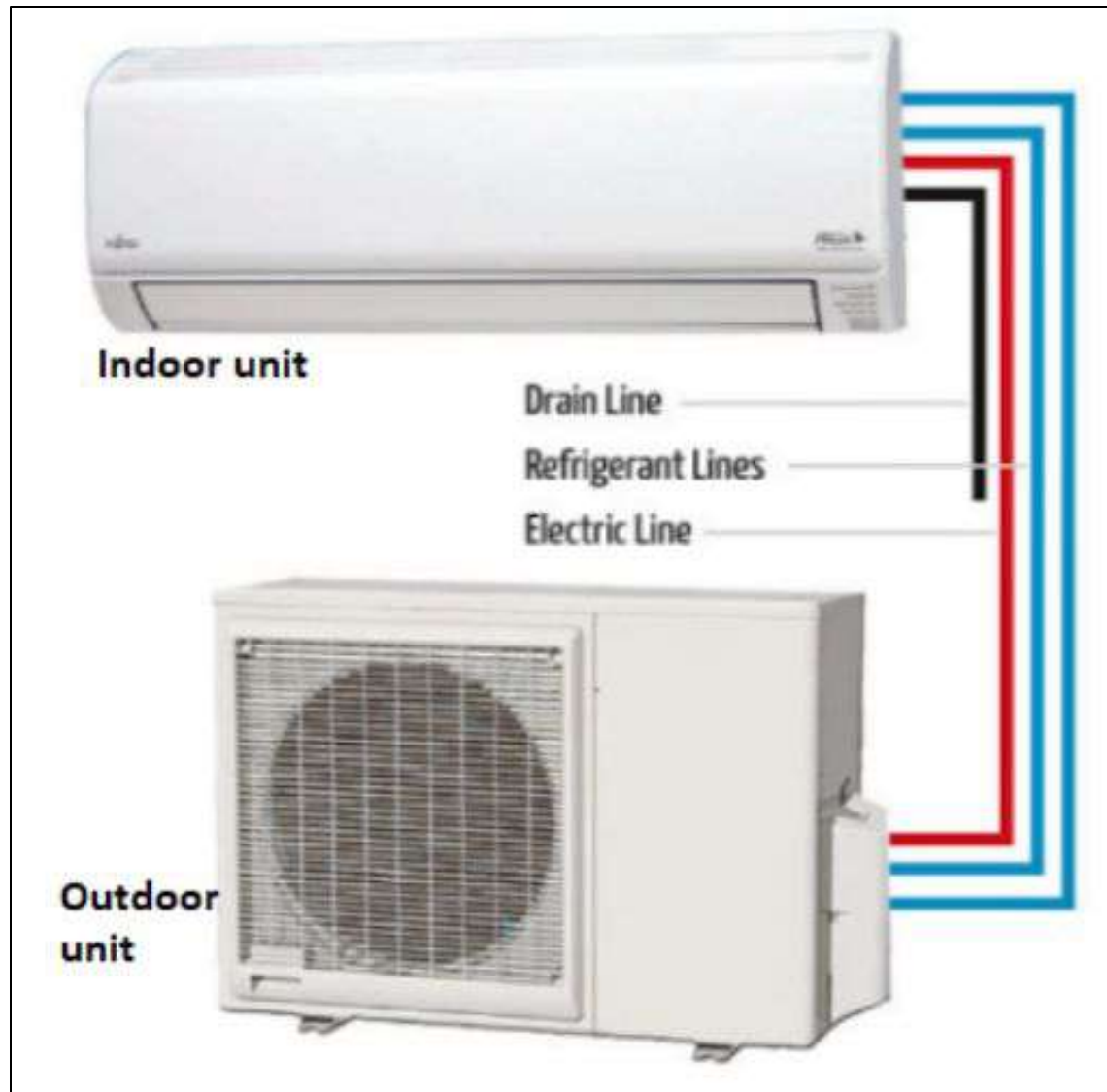
APPLICATION OF COMPRESSORS

2. AIR CONDITIONER

- An air conditioner (AC) in a room or a car works by collecting hot air from a given space, processing it to release cool air into the same space where the hot air had originally been collected.
- This processing is primarily done using four components:
 - Evaporator
 - Compressor
 - Condenser
 - Expansion valve

AIR CONDITIONER





Split AC Unit

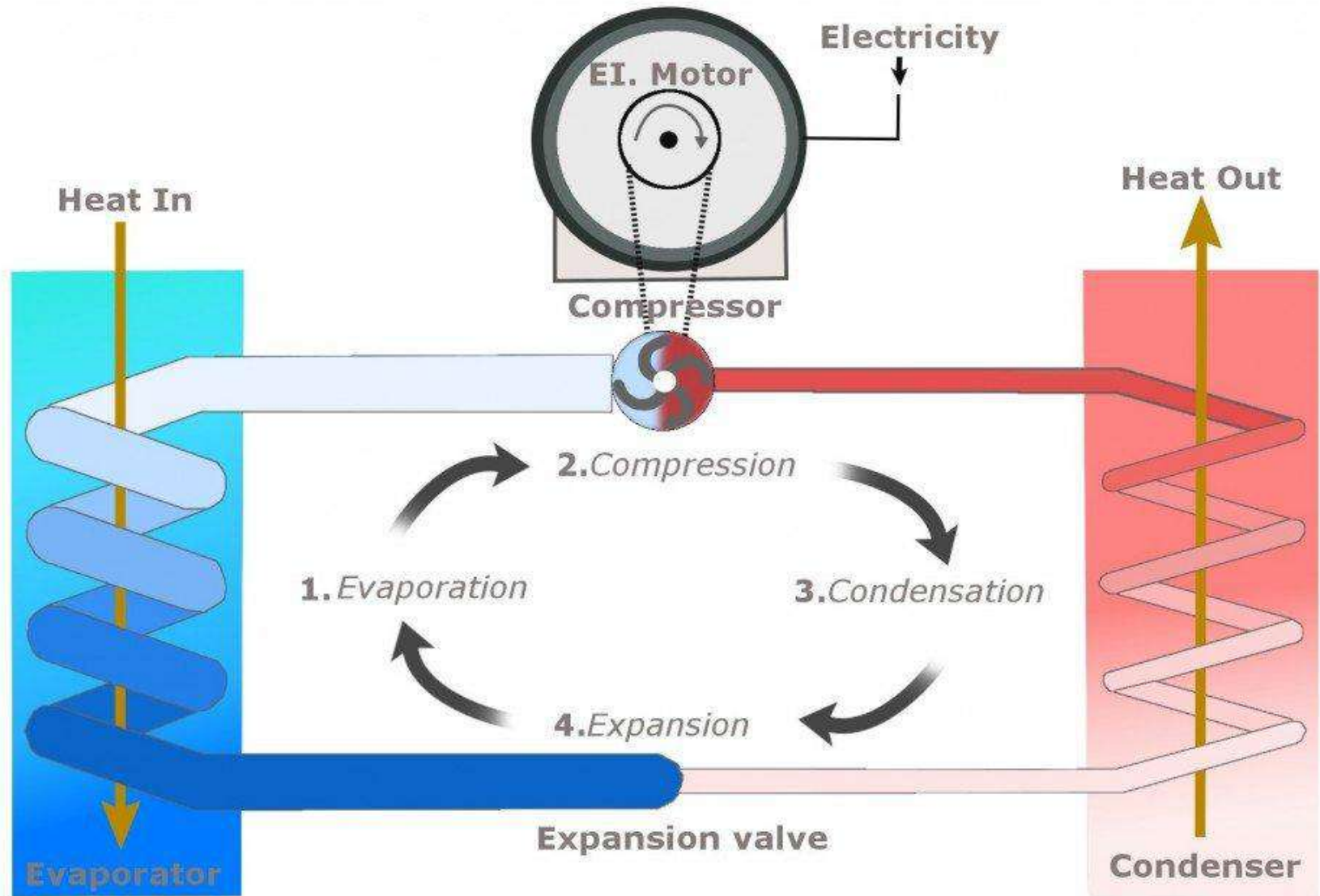
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APPLICATION OF COMPRESSORS

3. WATER COOLER

- The water is introduced to the cooler by filling a container called the cooler reservoir.
- The reservoir is surrounded by evaporator coils in which the refrigerant flows.
- **The cooler has four major components: the compressor, the condenser, the expansion valve and the evaporator.**

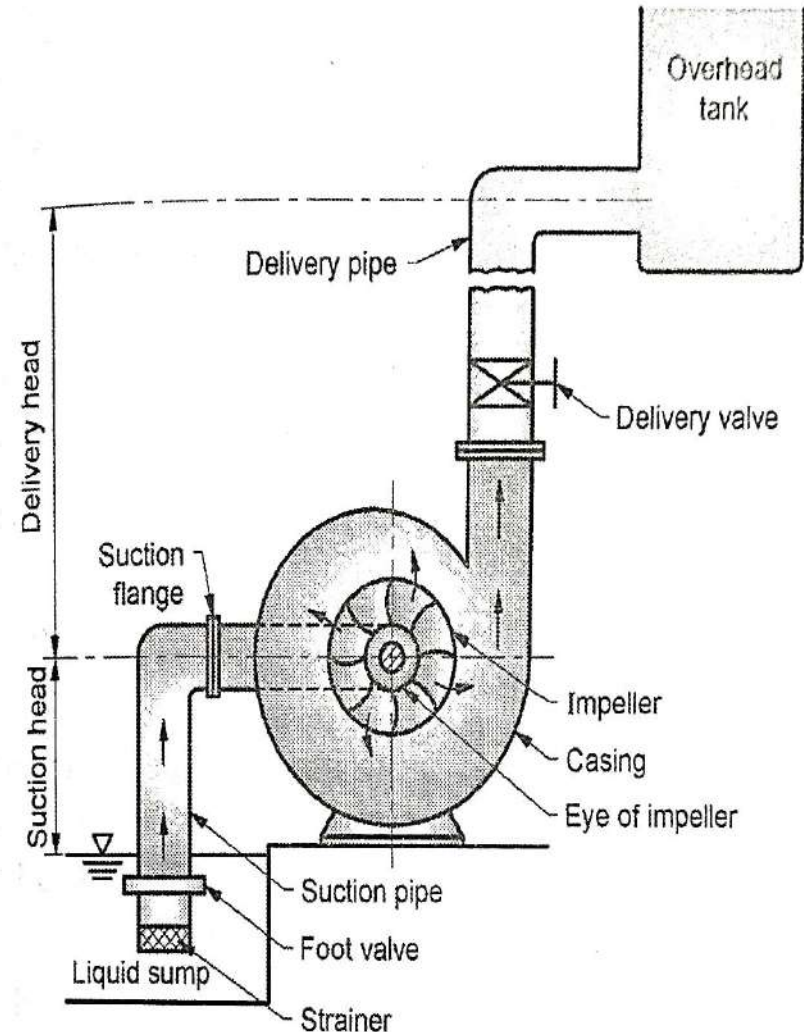
WATER COOLER



Applications of Pumps:

1. WATER PUMP FOR OVERHEAD TANK

Centrifugal pump is used to lift the water from the water sump to the overhead tank. Once the pump is switched on, it starts pumping the water. The ON and OFF of the pump can be done with an automated sensor system.



Applications of Pumps:

2. WATER FILTER

- There are different types of water filtration processes such as **Reverse Osmosis Water Filtration (RO)**, Ultra Filtration (UF) and Ultra Violet disinfection (UV).

Reverse Osmosis system

- It involves a simple water filtration mechanism. The filtration system includes passage of water or other solvents through a semi-permeable membrane.
- The membrane blocks the dissolved solutes that contaminate water.
- The process filters out all sorts of contaminants such as ions, pesticides, micro-organisms and other chemicals from water.

Reverse Osmosis System (RO)

The functions of the components that play an integral part in the RO system are as follows:

1. Pre-filters

- Water flowing through cold line valve passes through the Reverse Osmosis Pre-Filters.
- Some of the commonly used pre-filters are sediment and carbon filters.
- These filters remove dirt, chlorine content and other sediments present in water to protect the membranes from damage.

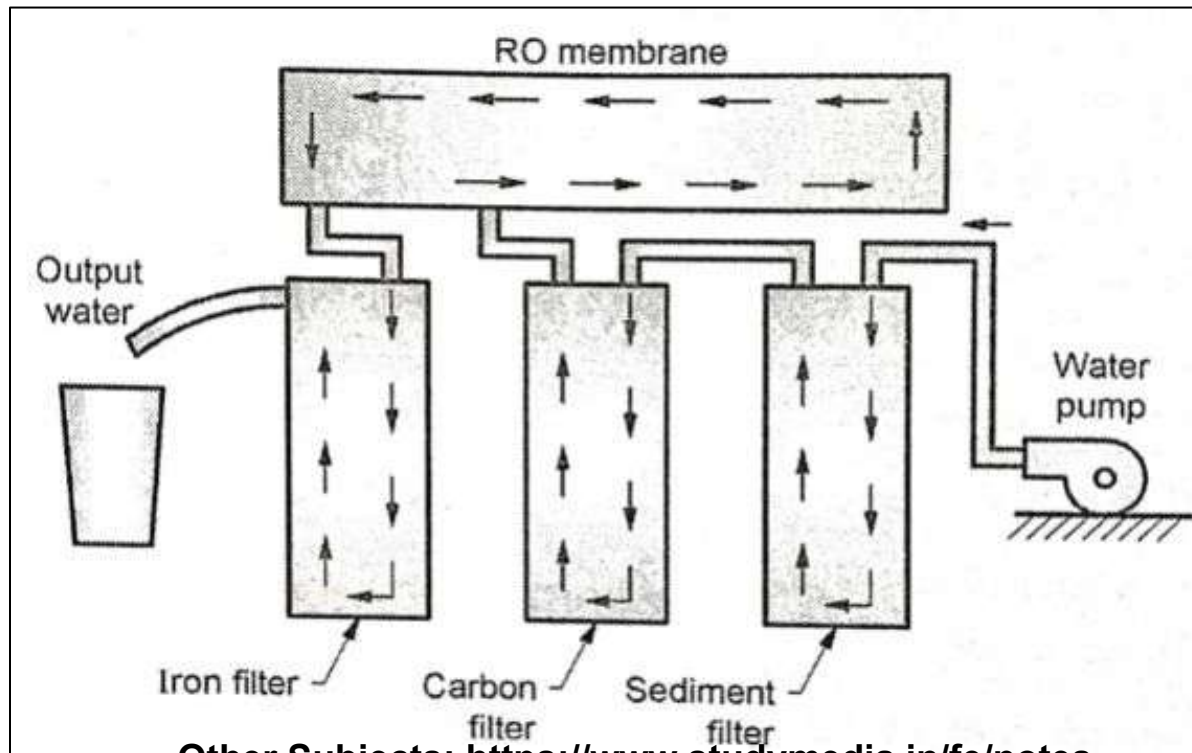
2. Reverse Osmosis Membrane

- RO Membrane is an important component of the system.
- The membrane serves the purpose of removing all sorts of contaminants in water.
- Water enters into the storage tank after this purification stage.

Reverse Osmosis System (RO)

3. Storage tank

- As the name suggests, this tank stores purified treated water.
- The storage capacity of the purifiers differs, which is the reason why you need to check the usage before making the final decision.



Reverse Osmosis System (RO)

4. Post-filters

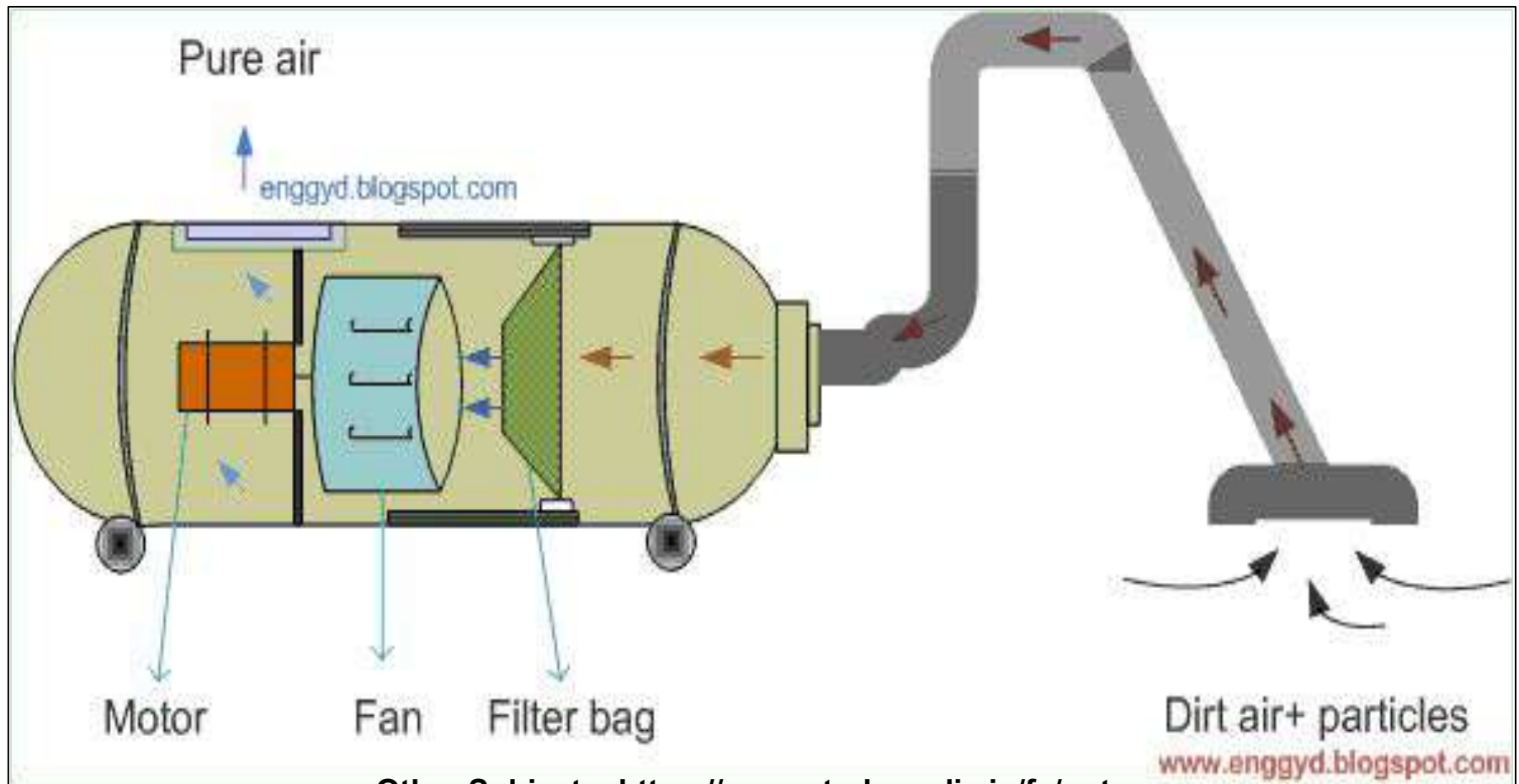
- Before water stored in the storage tank runs out of the Reverse Osmosis faucet, it enters through the final post-filters.
- It is actually a Iron filter. Iron filters remove bad odors from the water that you drink and also improves the taste of water.

5. Drain line

- The drain line is used to drain out the waste water which consists of dirt and other contaminants.

Applications of Blowers:

1. VACUUM CLEANER

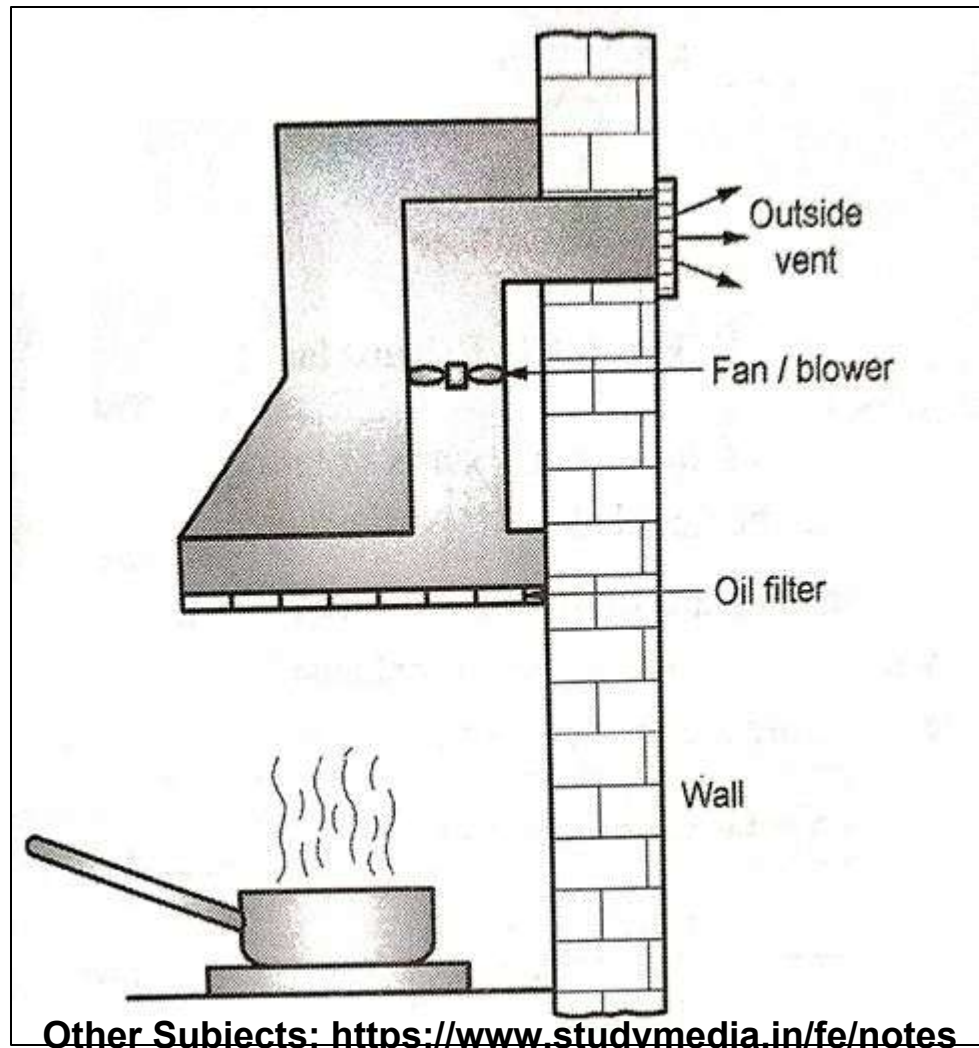


Vacuum cleaner

- The working of vacuum cleaner too simple. It works on the principle of suction process. It is exactly same as we create suction force to take a sip of juice from a straw.
- Vacuum cleaner has a motor inside it so that it can create the vacuum with the help of fan.
- The rotating fan which is connected to the motor is responsible to create the vacuum.
- As soon as the motor is switched on it begins to suck the air/dust/other particles in. If any dust particle comes within the range of the suction pipe, it gets pulled into the pipe and it is then collected in a bag.

Applications of Blowers:

2. KITCHEN CHIMNEY



Kitchen Chimney

- It mainly consists of a fan or blower which is fitted just before the vent open to the atmosphere.
- It has one oil filter which is made up of aluminium grease filters. It absorbs or collects the oil from the smoke which is going out of the kitchen through chimney.
- Once the motor is switched on the fan or blower starts and it forces the air trapped inside the pipe.
- As soon as this air is thrown away into the atmosphere vacuum is created inside the pipe which causes the smoke to get accumulated inside the pipe.
- Again this smoke is exhausted with the help of fan or blower.

Applications of Motor:

1. MOTOR FANS

1-Phase Capacitor start induction Motor.

- Ceiling fan is a Single phase Induction motor. Generally we use a capacitor start & run AC Motor for ceiling Fans.
- **Working principle:** whenever current carrying conductor is placed in a magnetic field-it experiences force. AC motor needs a rotating magnetic field in order to turn the rotor shaft. In a single phase system capacitor is used to provide a phase shift in the windings of the motor.

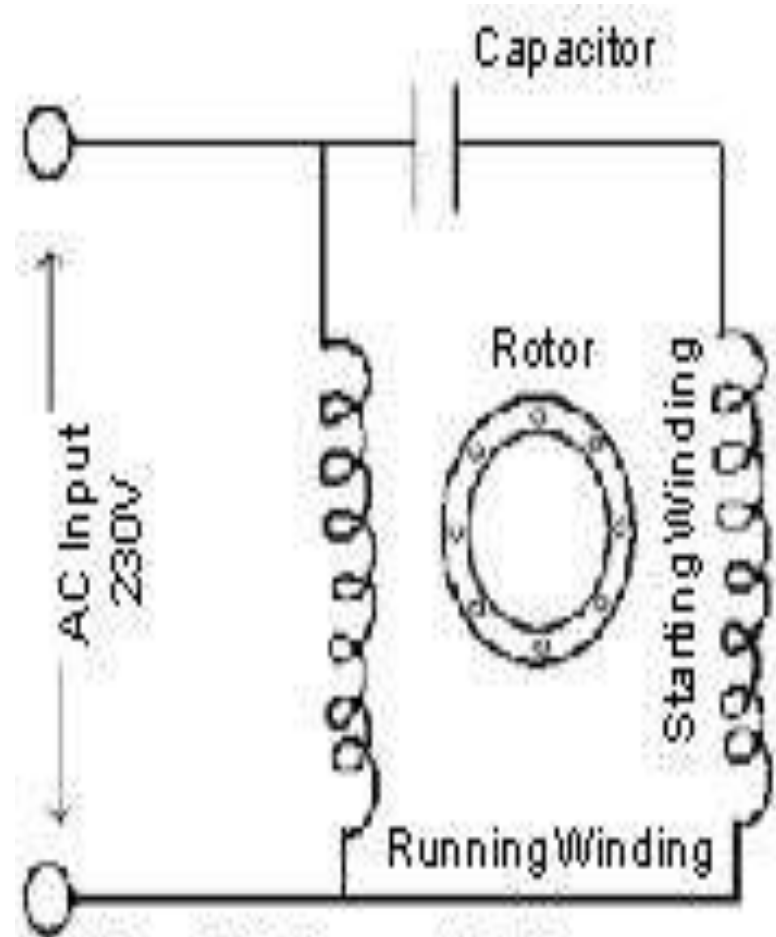


Fig. 4.2 Schematic diagram of Split Phase Motor

Application of Motors

2. EXHAUST FANS

- An exhaust fan is a ventilation device. It draws out polluted air from a room and replaces it with fresh air. Air is considered polluted when it contains high amounts of moisture, carbon dioxide, vaporized chemicals, dust, fungal spores and unpleasant odors.
- An exhaust fan has a rotating arrangement of angular blades driven by a motor.
- These blades slice through the stationary air, collecting chunks of it and pushing them out of the room. Consequently, fresh air from elsewhere is able to enter the room and occupy the space left behind by the outgoing air.
- A ventilation fan may be powered by an electric motor, internal combustion engine, hydraulic motor, or solar power.
- It may be fitted with a sensor to kick start it into motion every time steam collects in the room.
- The number of blades of the fan may vary from 3 to 5.
- Some exhaust fans are equipped with capacitors. Capacitors are electrical gadgets that regulate the flow of electric energy. In exhaust fans, they control the amount of electricity flowing into the fan's motor.

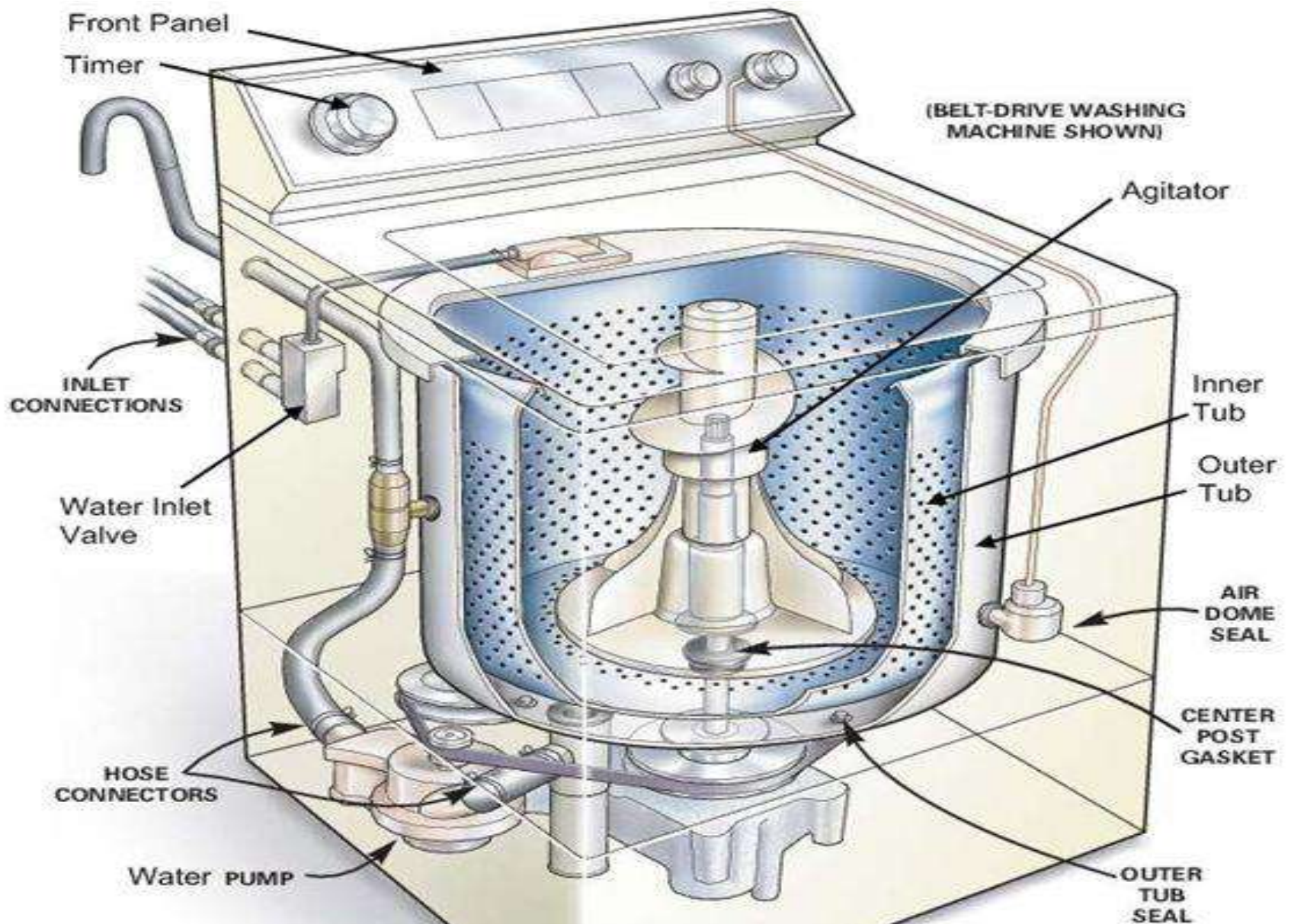


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Application of Motors

3. WASHING MACHINE

- 1) **Water inlet control valve:** Near the water inlet point of the washing machine there is water inlet control valve. When you load the clothes in washing machine, this valve gets opened automatically and it closes automatically depending on the total quantity of the water required.
- 2) **Water pump:** The water pump circulates water through the washing machine. It works in two directions, re-circulating the water during wash cycle and draining the water during the spin cycle.
- 3) **Tub:** There are two types of tubs in the washing machine: inner and outer. The clothes are loaded in the inner tub, where the clothes are washed, rinsed and dried. The inner tub has small holes for draining the water. The external tub covers the inner tub and supports it during various cycles of clothes washing.
- 4) **Agitator or rotating disc:** The agitator is located inside the tub of the washing machine. It is the important part of the washing machine that actually performs the cleaning operation of the clothes.
 - During the wash cycle the agitator rotates continuously and produces strong rotating currents within the water due to which the clothes also rotate inside the tub.
 - The rotation of the clothes within water containing the detergent enables the removal of the dirt particles from the fabric of the clothes. Thus the agitator produces most important function of rubbing the clothes with each other as well as with water.

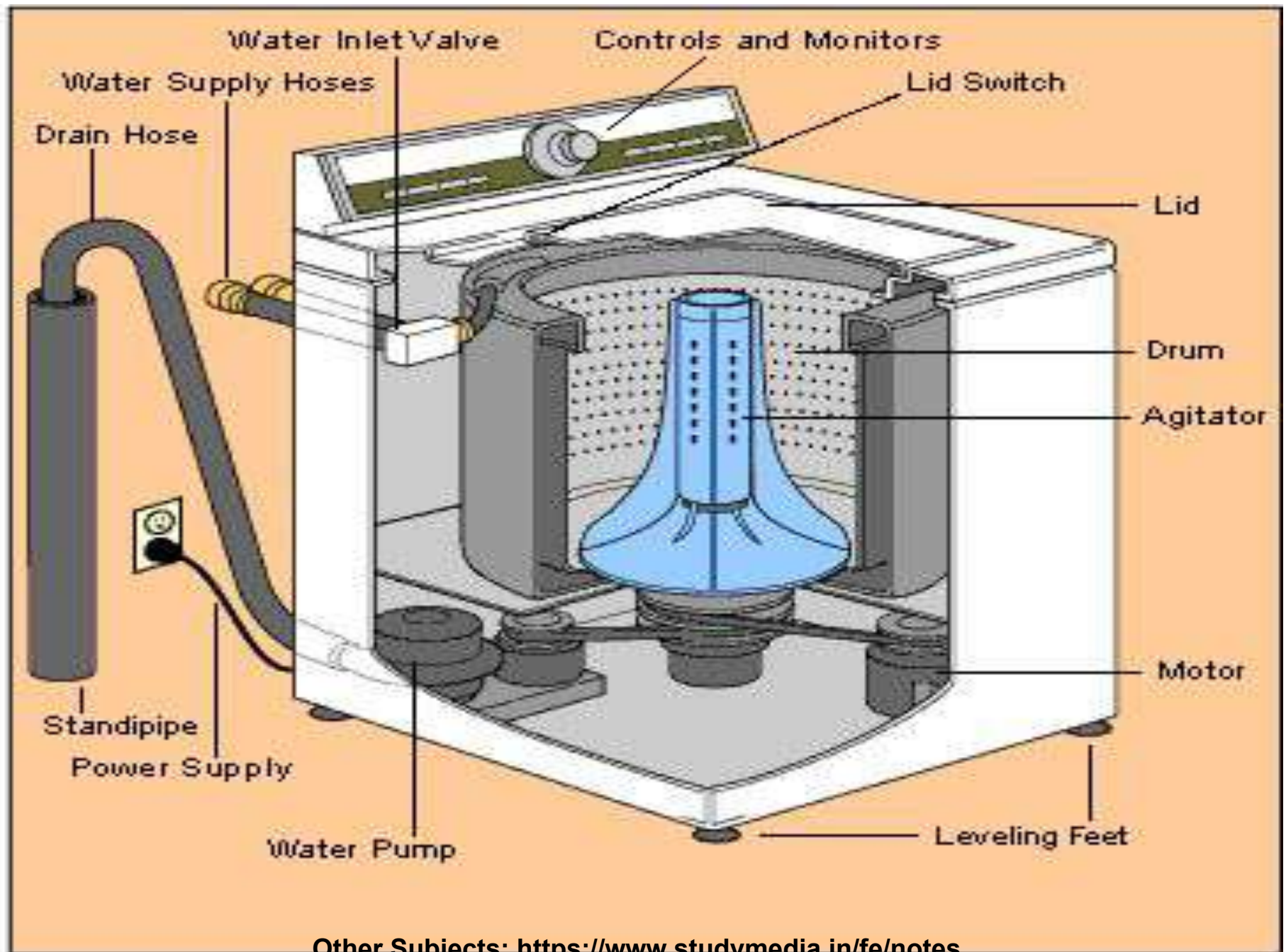


Parts of the Washing

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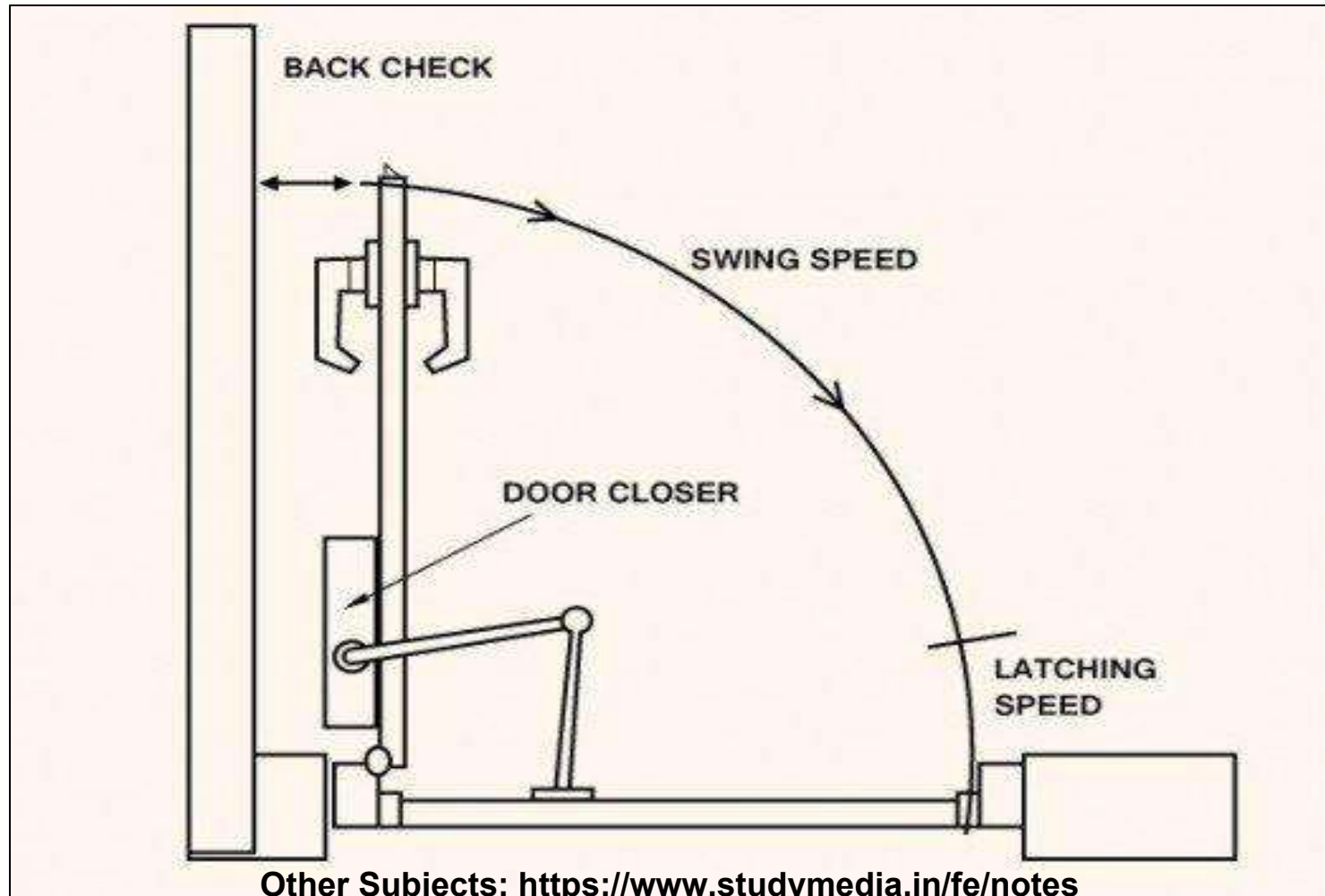
Washing Machine

- 5) **Motor of the washing machine:** The motor is coupled to the agitator or the disc and produces rotation. These are multispeed motors, whose speed can be changed as per the requirement. In the fully automatic washing machine the speed of the motor i.e. the agitator changes automatically as per the load on the washing machine.
- 6) **Timer:** The timer helps setting the wash time for the clothes manually. In the automatic mode the time is set automatically depending upon the number of clothes inside the washing machine and the type of wash cycle being performed.
- 7) **Printed Circuit Board (PCB):** The PCB comprises the various electronic components and circuits which are programmed to perform in unique ways depending on the load conditions. They are sort of artificial intelligence devices that sense the various external conditions and make the decisions accordingly. These are also called [fuzzy logic systems](#). Thus the PCB will calculate the total weight of the clothes, and find out the quantity of water and detergent required, and the total time required for washing the clothes. Then they will decide the time required for washing and rinsing.
- 8) **Drain pipe:** The drain pipe enables removing the dirty water from the washing that has been used for the washing purpose.

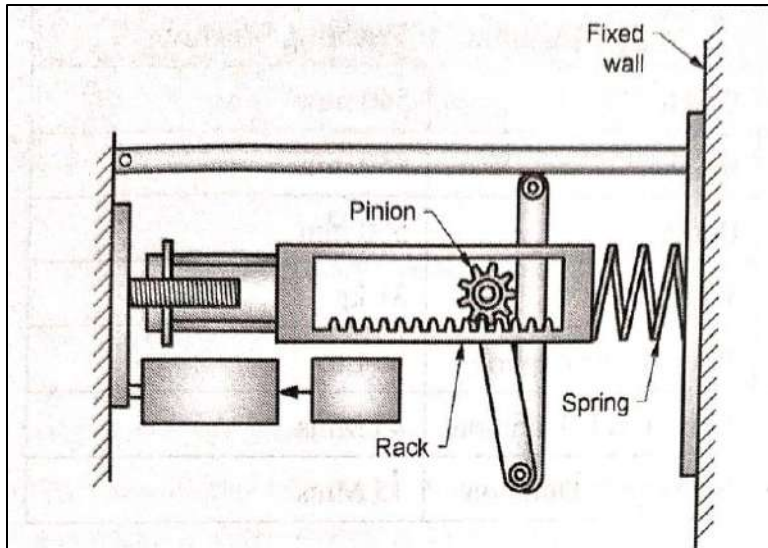


Applications of Springs:

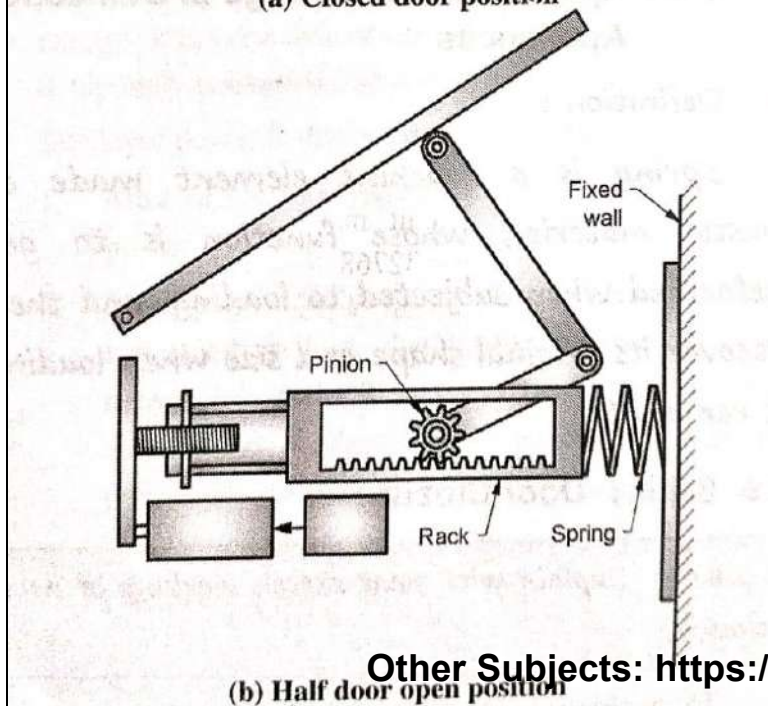
1. DOOR CLOSURE



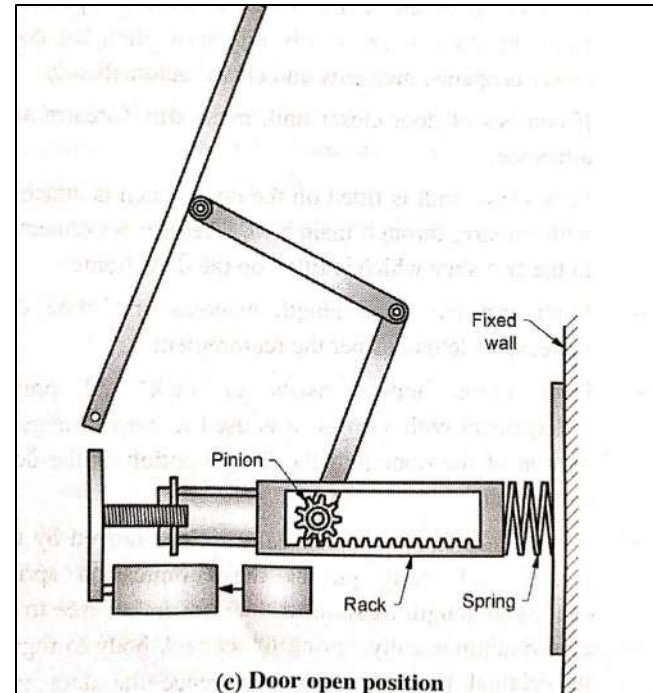
Door Closure



(a) Closed door position



(b) Half door open position



(c) Door open position

Door Closure

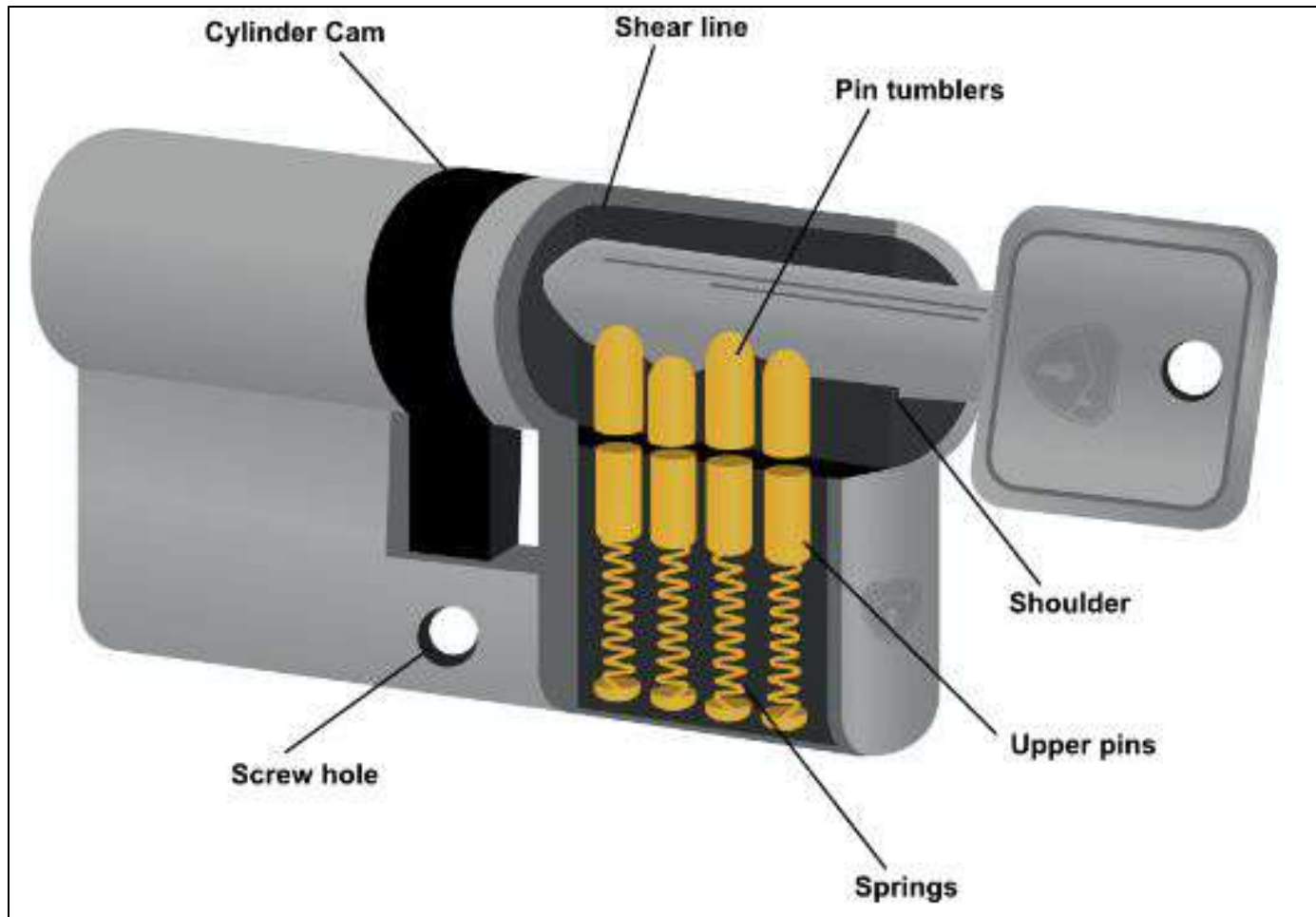
- A door closer is a mechanical device designed to close a door slowly but firmly enough to latch. It accomplishes this by using spring tension modulated by hydraulic fluid.
- One end of hydraulic arm is attached to door & other end is attached to door frame.
- When the door is opened, the door closure pulls the door & closes it because of spring which is there in sealed tube.
- It includes a fluid filled chamber which releases the pressure to close the door in a slow manner rather than banging it.

Applications of Springs:

2. DOOR LOCKS

- It consists of row pins usually five in numbers.
- Each pin has its own cylinder arrangement.
- When the lock is locked it holds two pieces of metal together with the help of spring force.
- The pins are of varying length .To open the lock we need to align all pins at equal level.
- Notches are provided on the key to push the pin upward to correct amount in there respective cylinder to separate the two blocks from one another.

Door locks

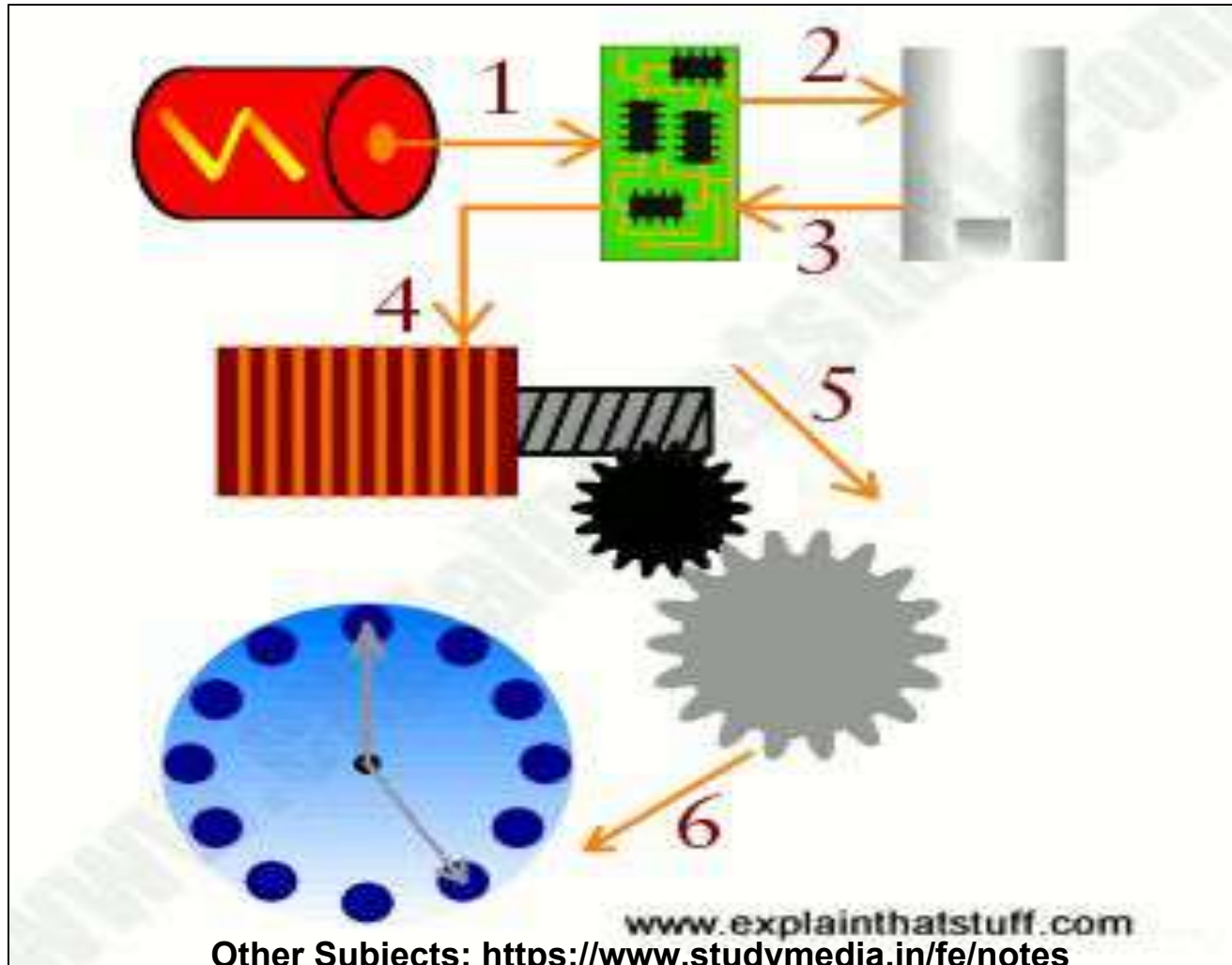


<https://www.youtube.com/watch?v=smIdInCQ-kU>

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Applications of Gears:

1. Wall clocks:

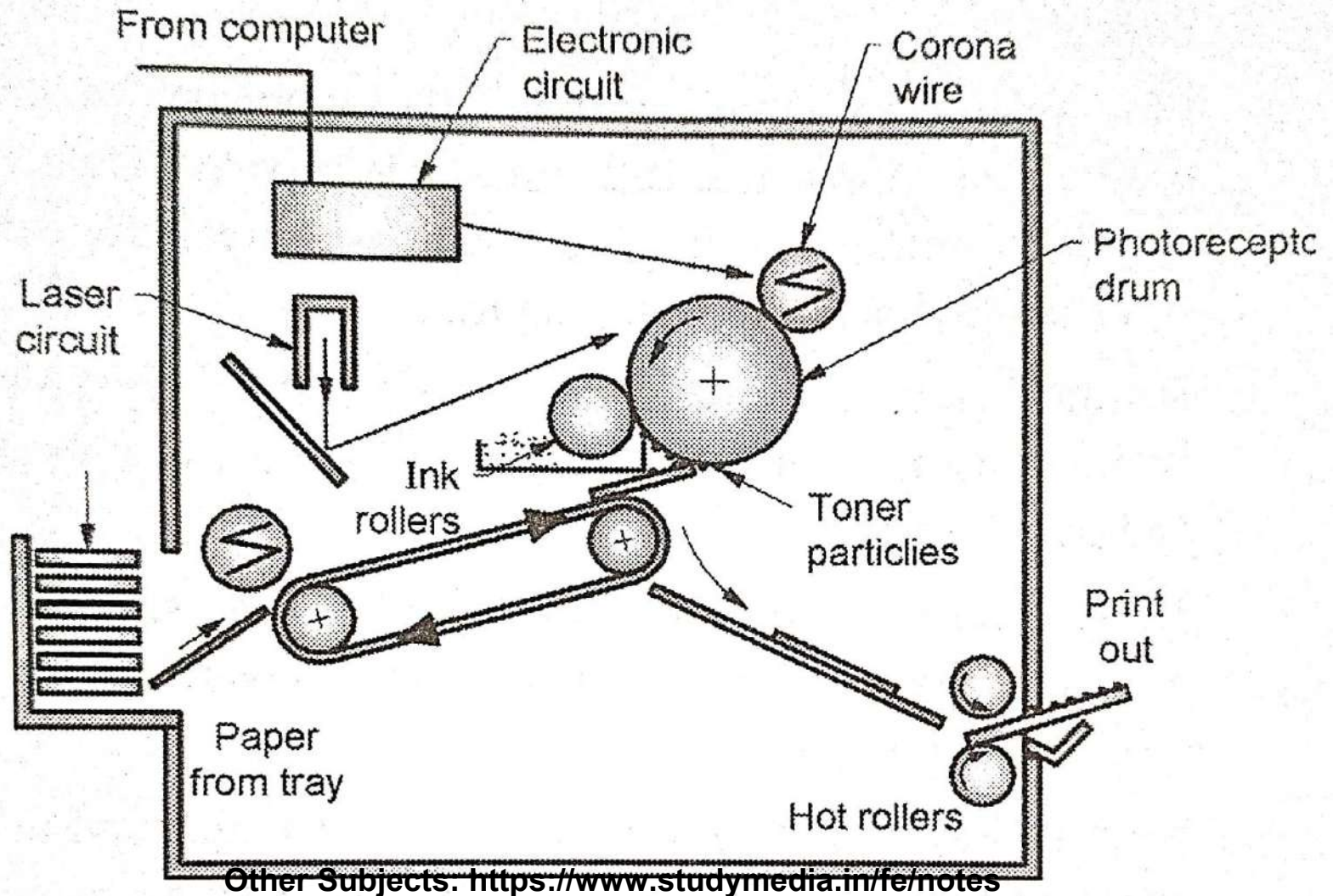


Wall clocks

1. Battery provides current to microchip circuit.
2. Microchip circuit makes quartz crystal (precisely cut and shaped like a tuning fork) oscillate (vibrate) 32768 times per second.
3. Microchip circuit detects the crystal's oscillations and turns them into regular electric pulses, one per second.
4. Electric pulses drive miniature electric stepping motor. This converts electrical energy into mechanical power.
5. Electric stepping motor turns gears.
6. Gears sweep hands around the clock face to keep time.

Applications of Gears:

2. PRINTERS



Printers

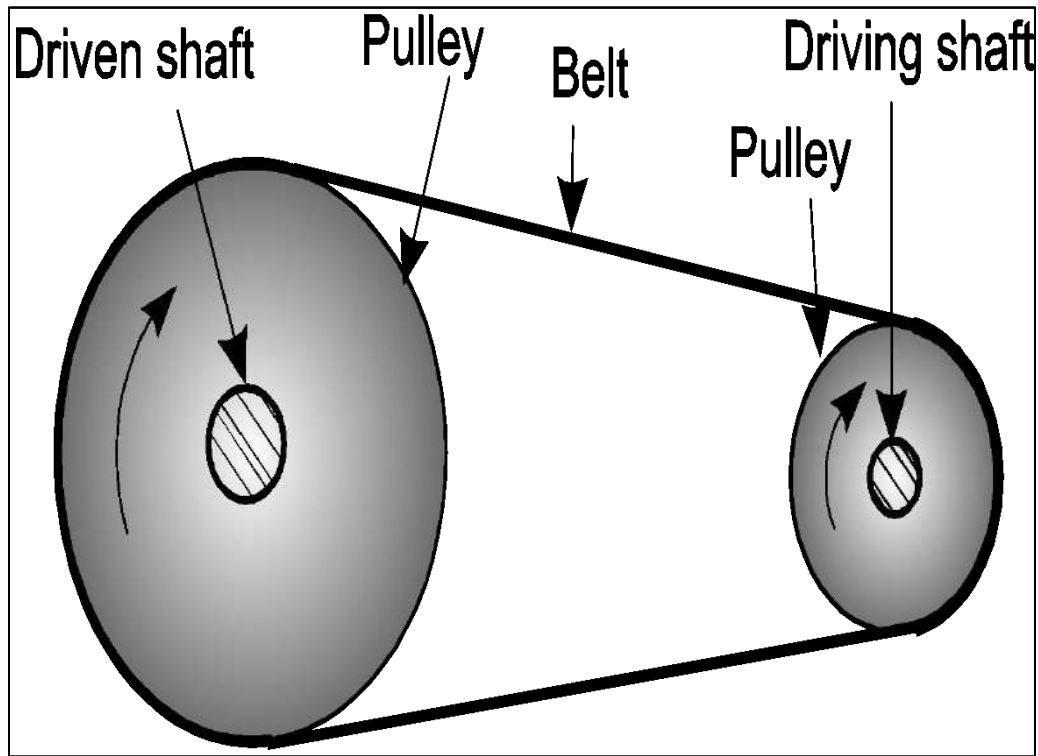
- 1 Millions of bytes (characters) of **data** stream into the printer from your computer.
- 2 An **electronic circuit** in the printer (effectively, a small computer in its own right) figures out how to print this data so it looks correct on the page.
- 3 The electronic circuit activates the **corona wire**. This is a high-voltage wire that gives a static electric charge to anything nearby.
- 4 The corona wire charges up the **photoreceptor drum** so the drum gains a positive charge spread uniformly across its surface.
- 5 At the same time, the circuit activates the **laser** to make it draw the image of the page onto the drum. The laser beam doesn't actually move: it bounces off a moving [mirror](#) that scans it over the drum.

Printers

- 6 An **ink roller** touching the photoreceptor drum coats it with tiny particles of powdered ink (toner). No ink is attracted to the parts of the drum that have a positive charge. An inked image of the page builds up on the drum.
- 7 A sheet of **paper** from a hopper on the other side of the printer feeds up toward the drum. As it moves along, the paper is given a strong positive electrical charge by another corona wire.
- 8 When the paper moves near the drum, the image is transferred from the drum onto the paper but, for the moment, the toner particles are just resting lightly on the paper's surface.
- 9 The inked paper passes through two hot rollers (the **fuser unit**). The heat and pressure from the rollers fuse the toner particles permanently into the fibers of the paper.
- 10 The **printout** emerges from the side of the copier. Thanks to the fuser unit, the paper is still warm.

Applications of Belt-Pulley :

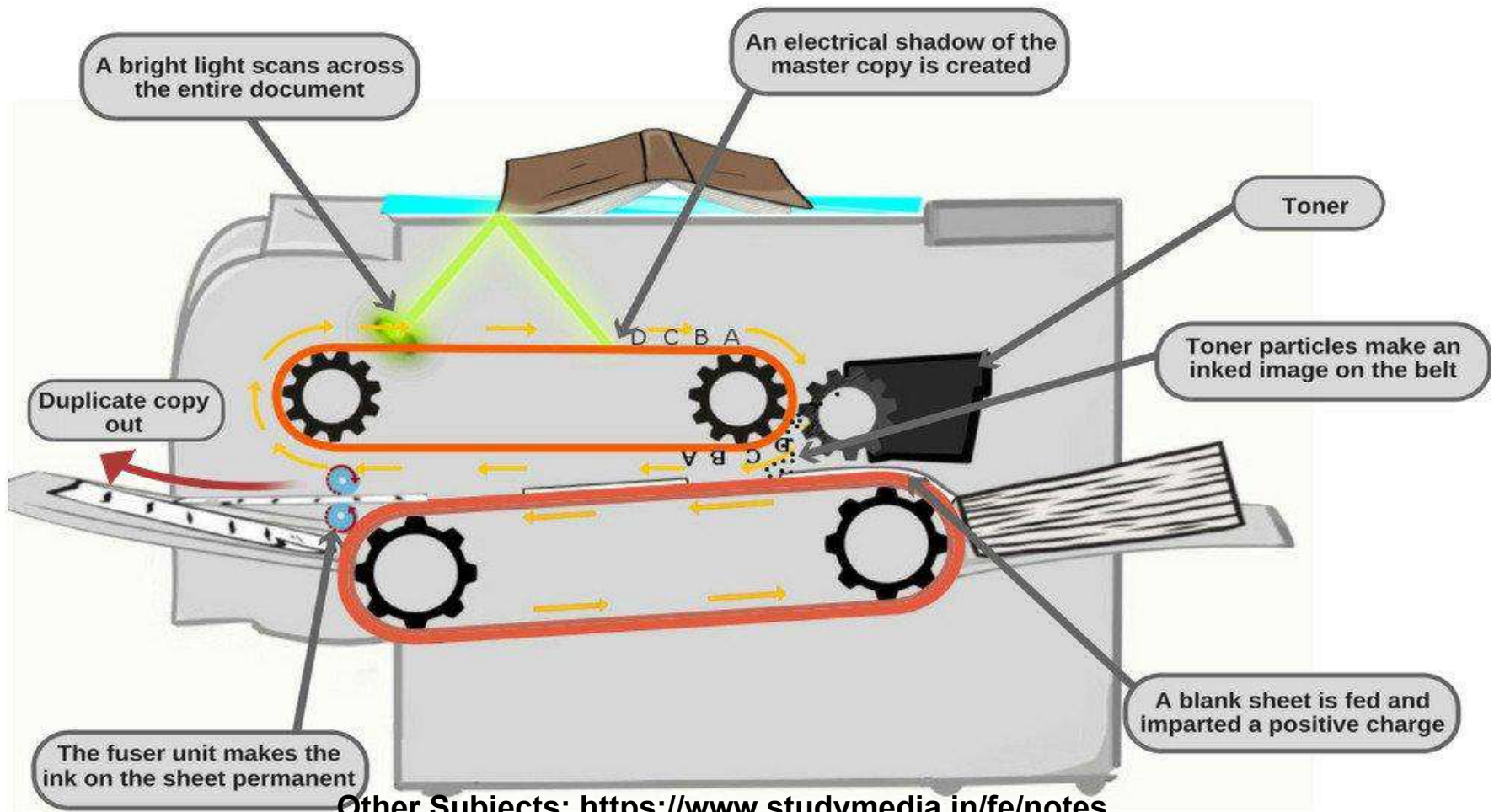
Belt - Pulley



Applications of Belt-Pulley

Photocopy:

Science ABC



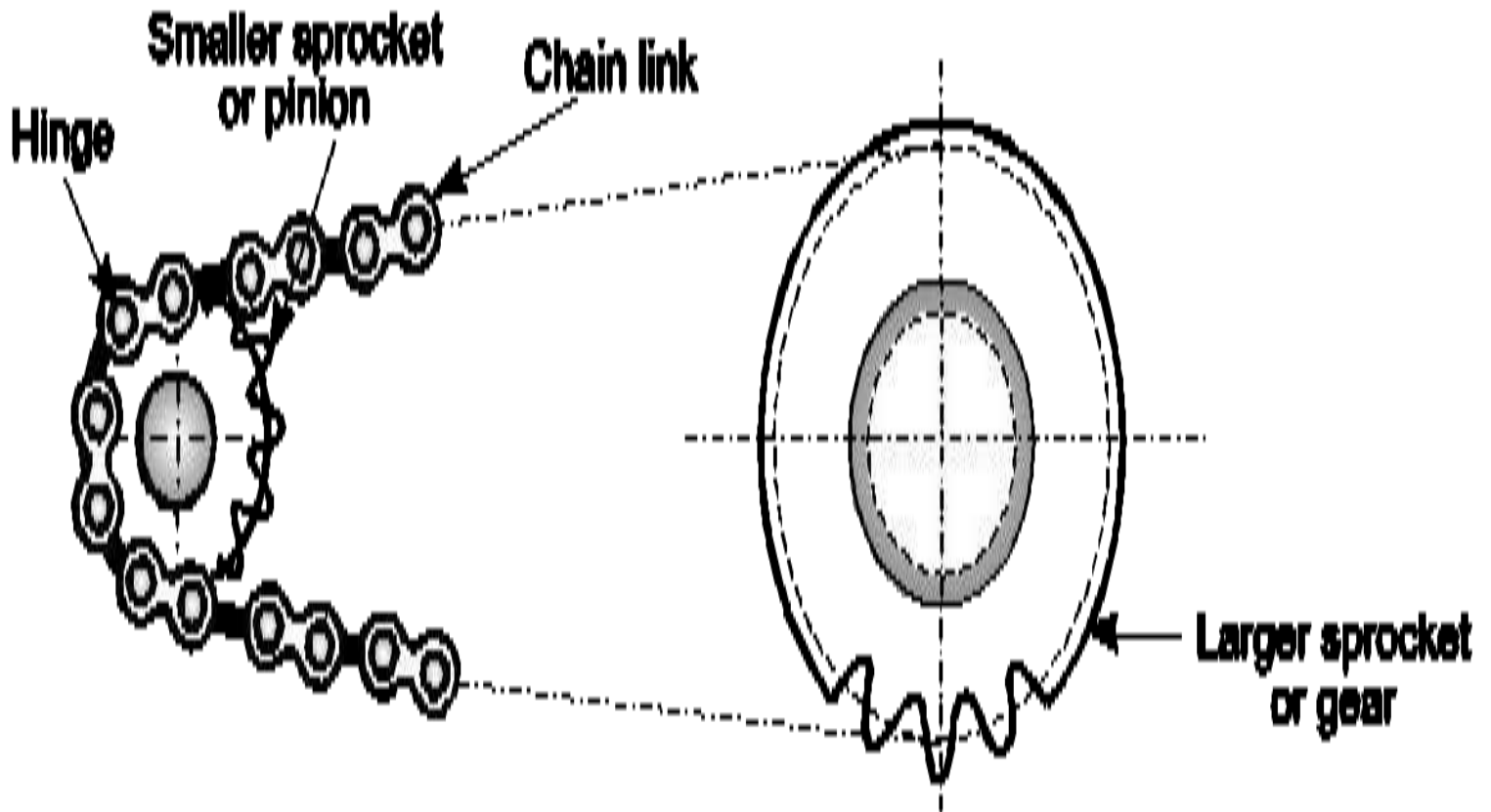
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Photocopy

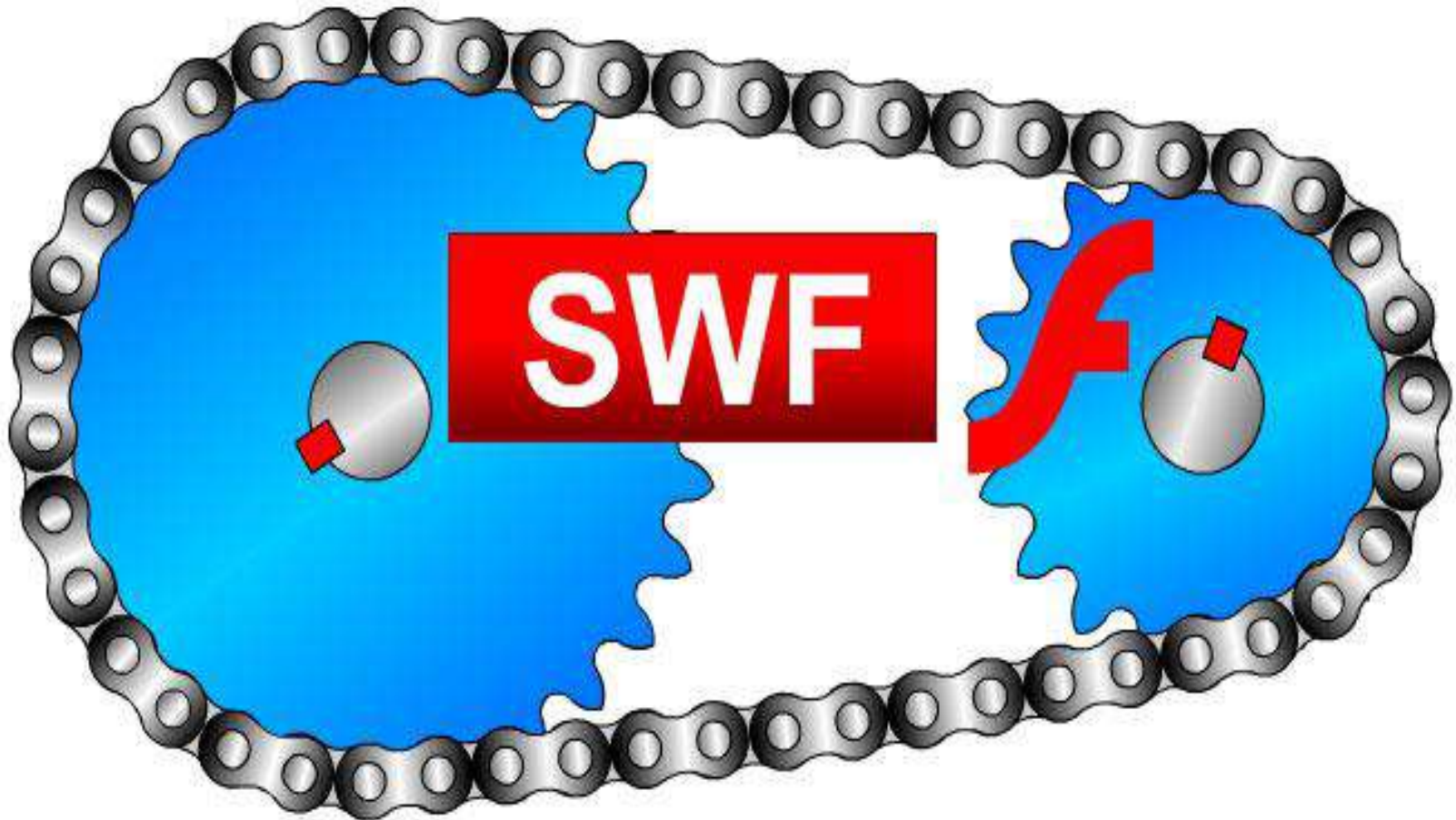
- To begin the photocopying process, the top lid of the photocopier is opened and the master copy is placed face-down on the glass surface, where a bright light beam will scan the entire document.
- White areas on the paper reflect more light, while black areas reflect little or no light.
- An electrical shadow (or image) of the master copy is formed on the photoconductor.
- As the conveyor belt (with the photoconductor coating) moves, it takes the electrical shadow along with it too.
- The negatively-charged toner particles stick to the electrical shadow and an inked impression of the master copy is made on the conveyor belt.
- A blank piece of paper is fed into the photocopier from the other side, which slowly moves towards the photoconductor belt.
- As it moves on the conveyor belt, a strong positive charge is imparted to it. The strong positive charge of the blank paper pulls the negatively-charged toner particles towards itself. Consequently, a duplicate image of the master copy is formed on the blank paper.
- Finally, just before spitting the paper out, a fuser unit (a pair of hot rollers) supply heat and pressure so the toner particles are permanently attached/fused onto the paper. This is why a freshly ejected duplicate copy is quite warm to the touch.

Applications of Chain-Sprocket :

Chain - Sprocket



Mechanisms: Chain and Sprocket



Back

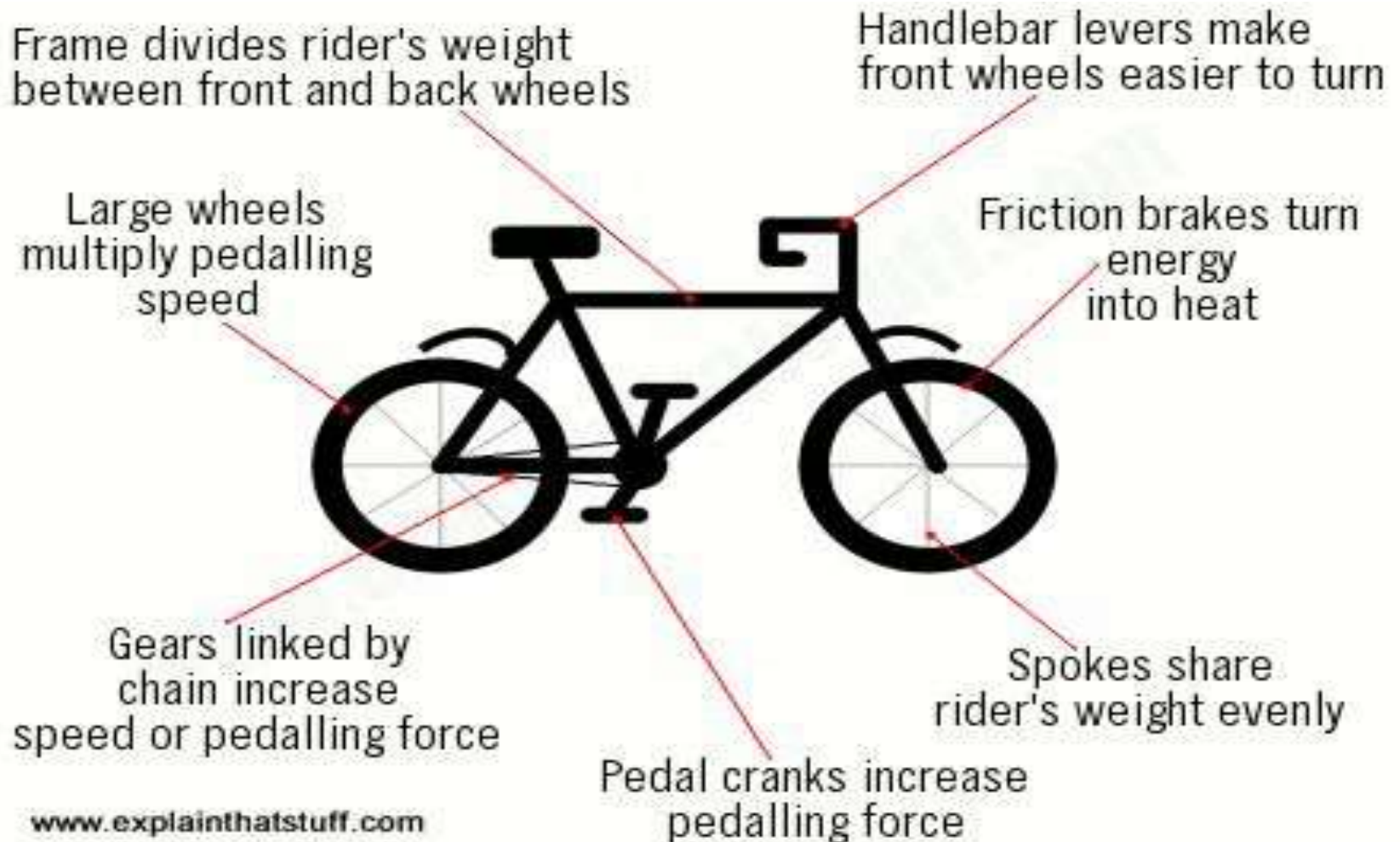
Multimedia D&T Education <http://www.notesandsketches.co.uk>

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Applications of Chain-Sprocket

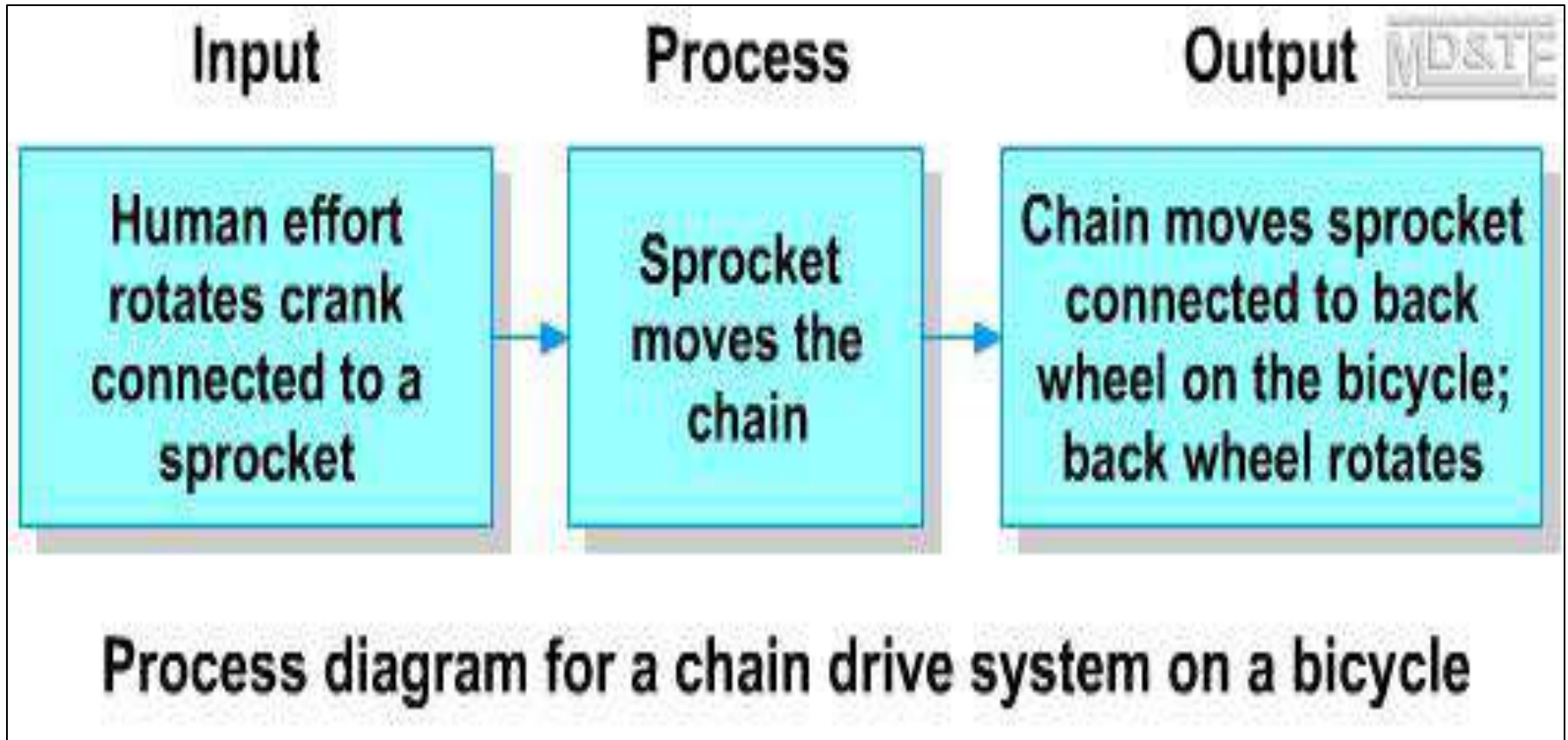
Bicycle:



Bicycle

- A **sprocket** is a toothed wheel that fits onto a shaft. It is prevented from rotating on the shaft by a key that fits into keyways in the sprocket and shaft.
- A **chain** is used to connect two sprockets. One sprocket is the driver sprocket. The other sprocket is the driven sprocket.
- Motion and force can be transmitted via the chain from one sprocket to another, therefore from one shaft to another.
- Chains that are used to transmit motion and force from one sprocket to another are called **power transmission chains**.

Chain & Sprocket mechanism in Bicycle

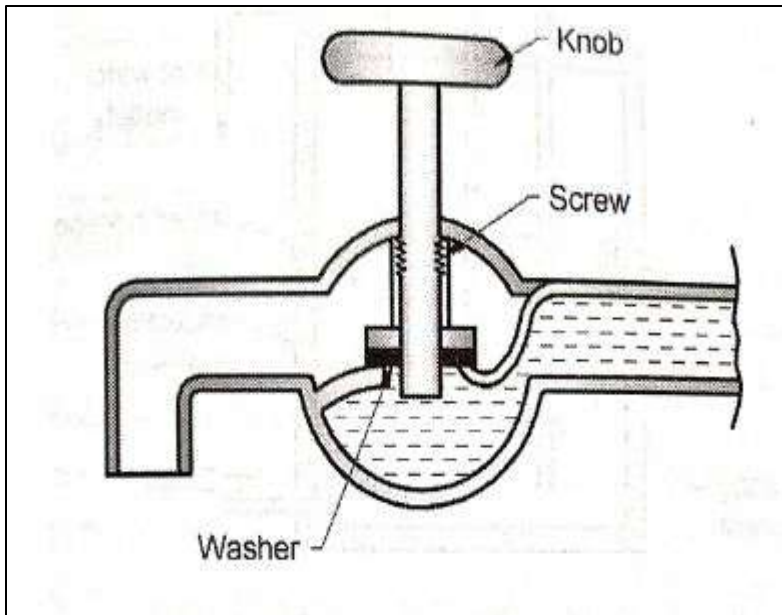


Applications of Valves :

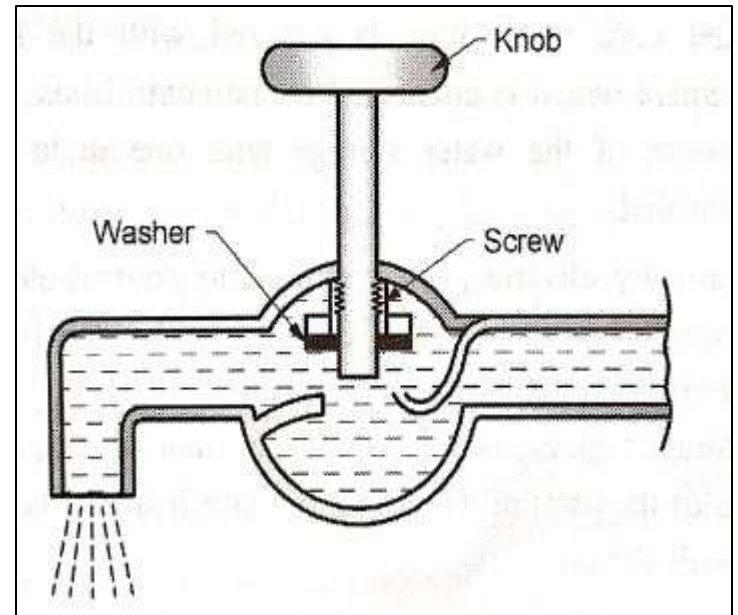
Water Taps:

- The part of the tap that you turn, is the top end of a screw which goes down into the casing of the tap.
- At the bottom end of this screw is a **rubber or leather washer** that presses down on to the end of the water pipe, preventing the water from coming any further.
- When you turn the tap on, the screw rises, lifting the washer with it and allowing the water to gush up from the pipe and run out through the spout.
- When you turn off the tap, you are screwing the washer down again on to the pipe and cutting off the flow of water.
- If there's a leak, it could be one of several problems:
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Water Taps



Water tap closed position



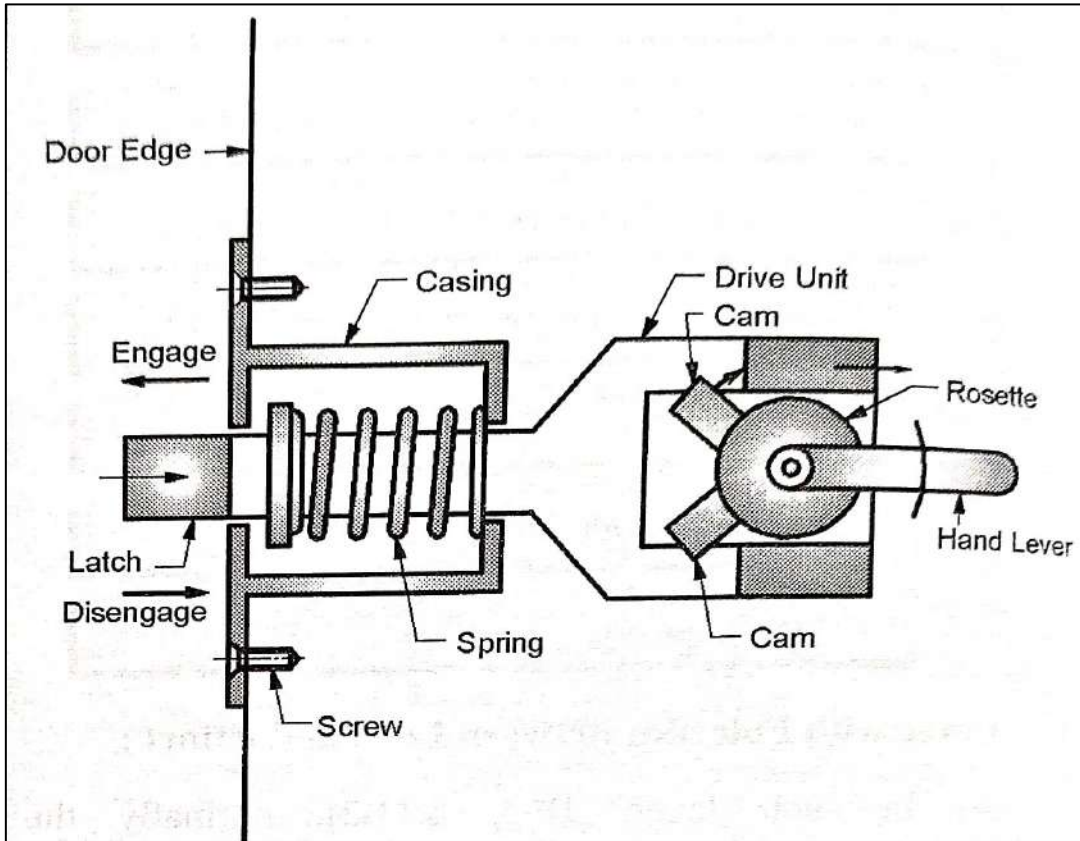
Water tap Open position

Applications of Levers :

1. Door Latch:

- The hand lever is a one arm lever and it is used to apply the torque.
- The hand lever is fitted on the rosette and cam is connected to rosette.
- As hand lever rotates the cam applies the force on drive unit and pulls drive unit toward right by overcoming the spring force.
- As the latch is connected to the drive unit, it is retracted from the strike plate and door is disengaged.
- When hand lever is releases, the restoring force of the spring forces the drive unit as well as the latch to move towards the left.

Door Latch

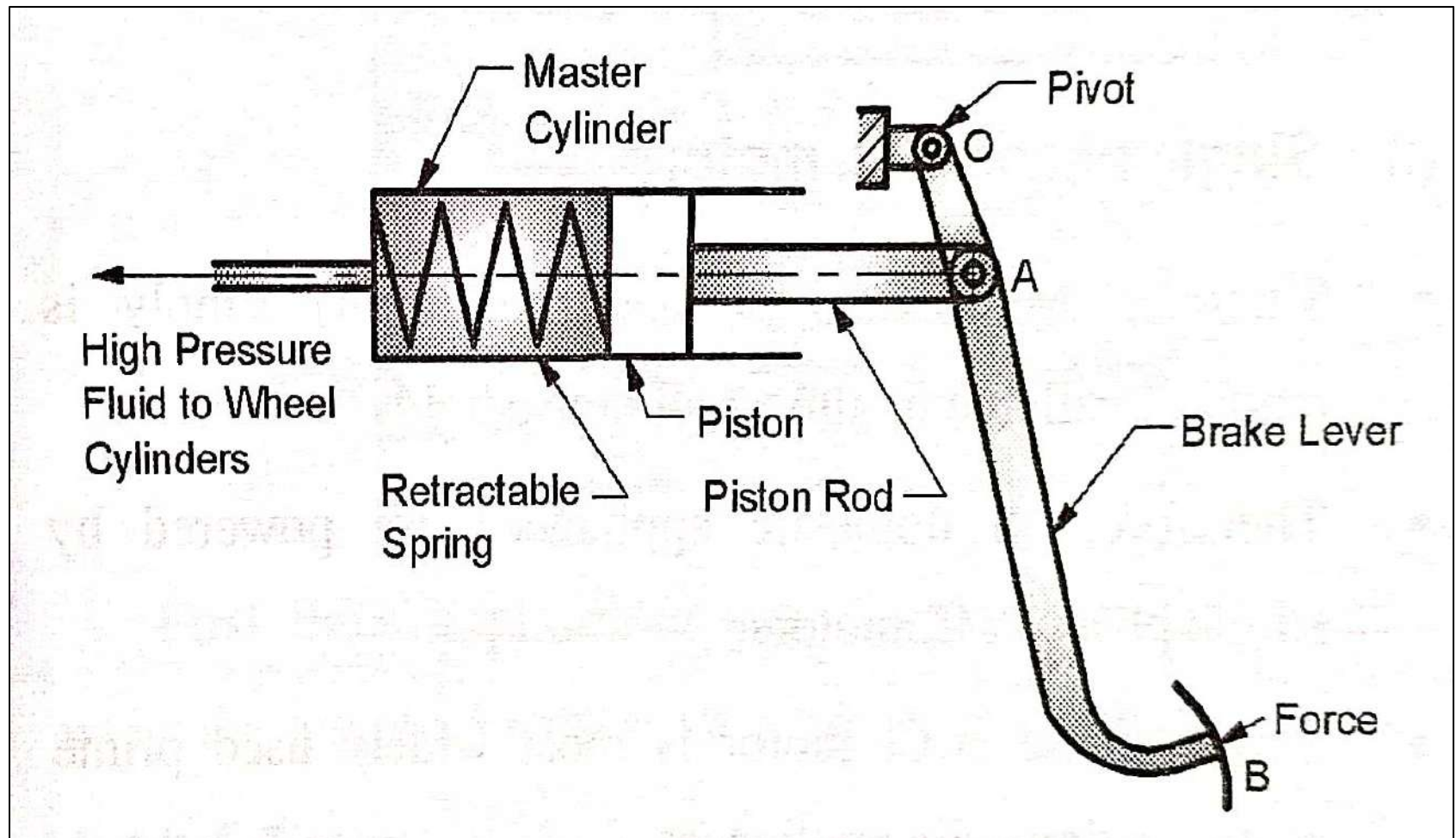


Applications of Levers

2. Brake Pedals:

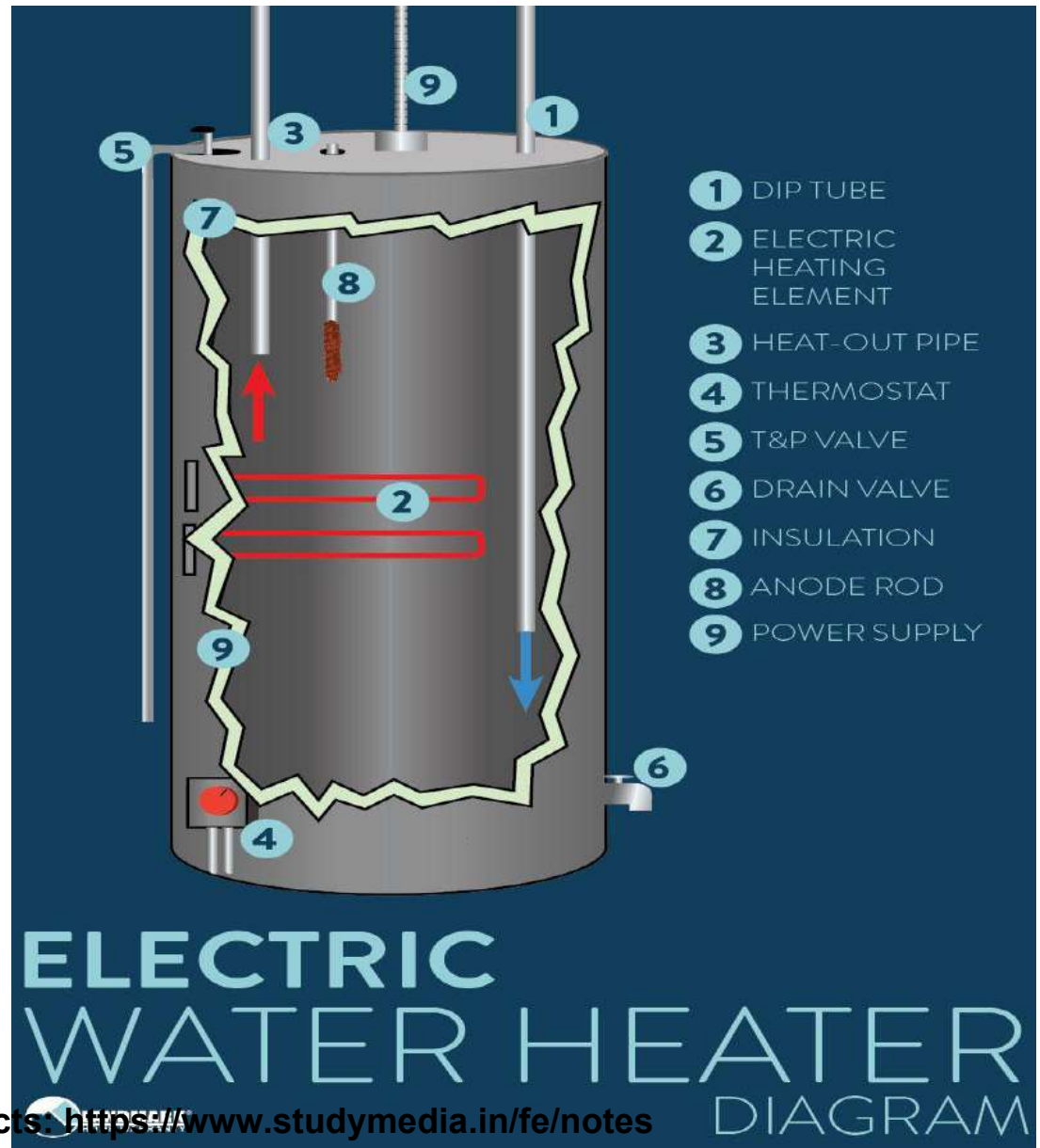
- The brake lever (pedal) is used for applying the brake in vehicles.
- The brake lever (pedal) is pivoted at point O. It is connected to piston rod at point A and braking force is applied at point B.
- When braking force is applied at point B, it pushes the piston and increases the pressure of brake fluid in master cylinder.
- The high pressure brake fluid is supplied to all wheel cylinders for braking action.
- When brake is released, the retractable spring helps to bring the piston and brake lever to original position.

Brake Pedals



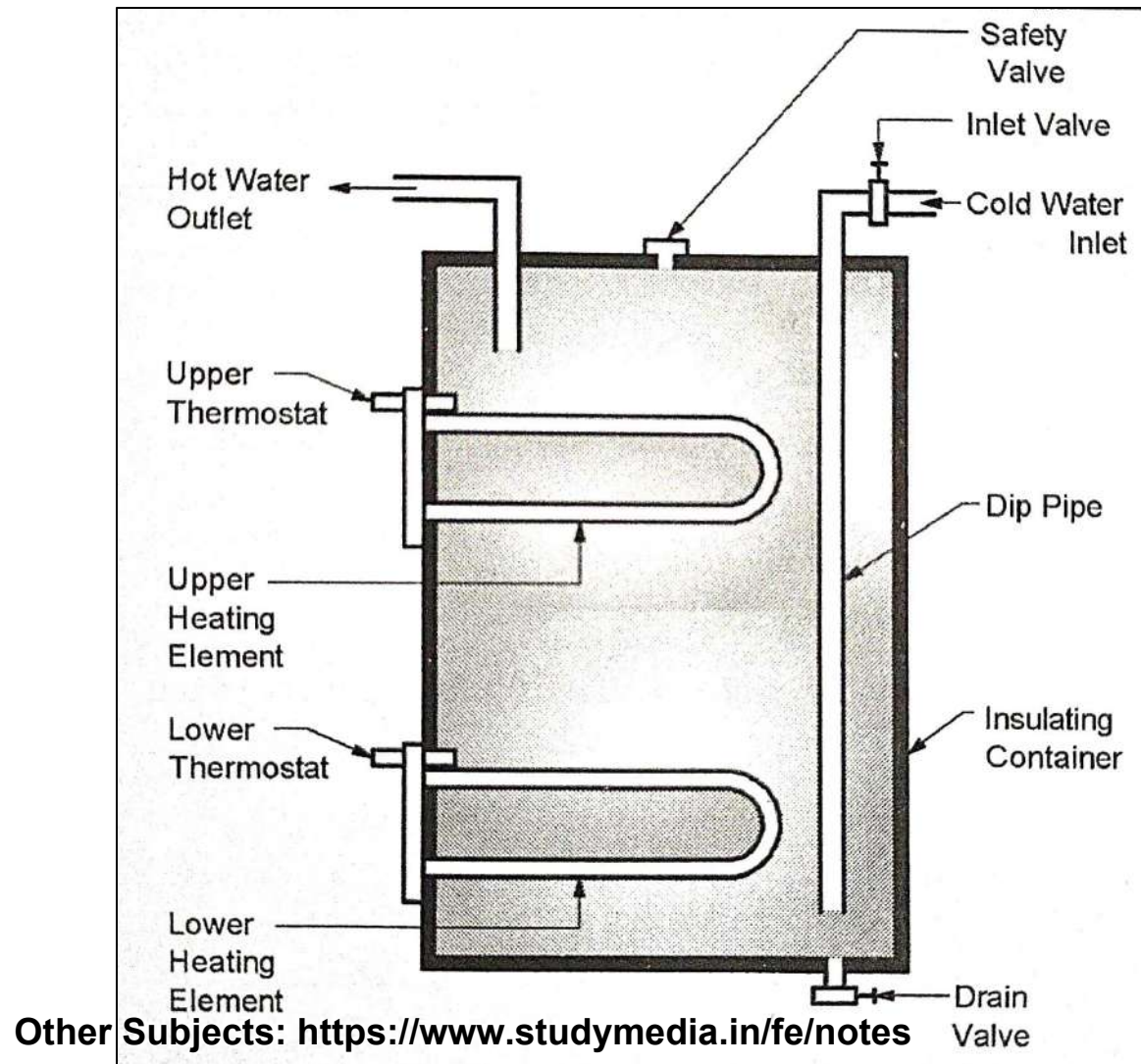
Applications of Electric/ Solar Energy

1. Electric Geyser:-



Applications of Electric/ Solar Energy

Electric Geyser:-



Applications of Electric/ Solar Energy

Electric Geyser:-

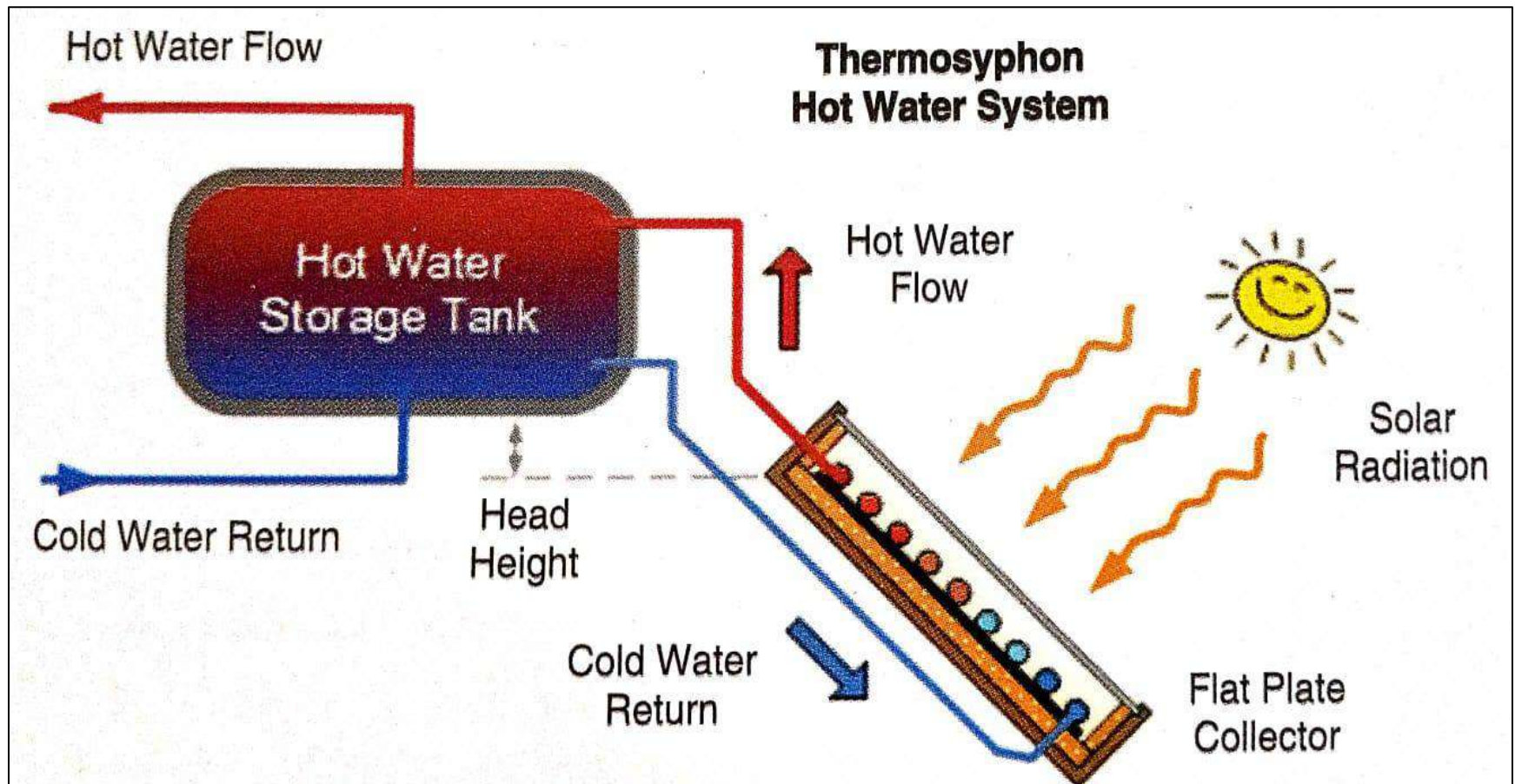
Components of Electric Geyser:

- (i) Insulating Container:
- (ii) Cold Water Inlet and Dip Pipe
- (iii) Hot water Outlet:
- (iv) Upper Heating Element and Thermostat:
- (v) Lower Heating Element and Thermostat:
- (vi) Safety Valve:

2. Solar water Heater

- A typical domestic solar water heater consists of a hot water storage tank and one or more flat plate collectors.
- The collectors are glazed on the sun facing side to allow solar radiation to come in.
- A black absorbing surface (absorber) inside the flat plate collectors absorbs solar radiation and transfers the energy to water flowing through it.
- Heated water is collected in the tank which is insulated to prevent heat loss.
- Circulation of water from the tank through the collectors and back to the tank continues automatically due to density difference between hot and cold water (thermosyphon effect).

Solar water Heater



Solar water Heater

- The working of solar water heaters is very simple to understand. The solar water heaters use two common principles for its functioning. They are:
 1. A black surface heats up when left in the sun, by absorption of solar radiation. The good absorption property of black surfaces is used to improve solar energy absorption in a solar heater
 2. The inside of car/ bus parked in sun for a long time becomes hot. This is because solar radiation can pass through the glass windows of the bus but cannot come out. It is trapped inside and thus heats up the bus. Similarly water passing through insulated pipes kept in the sun becomes hot
- These two phenomena are utilized in flat plate collectors of commonly available solar water heaters

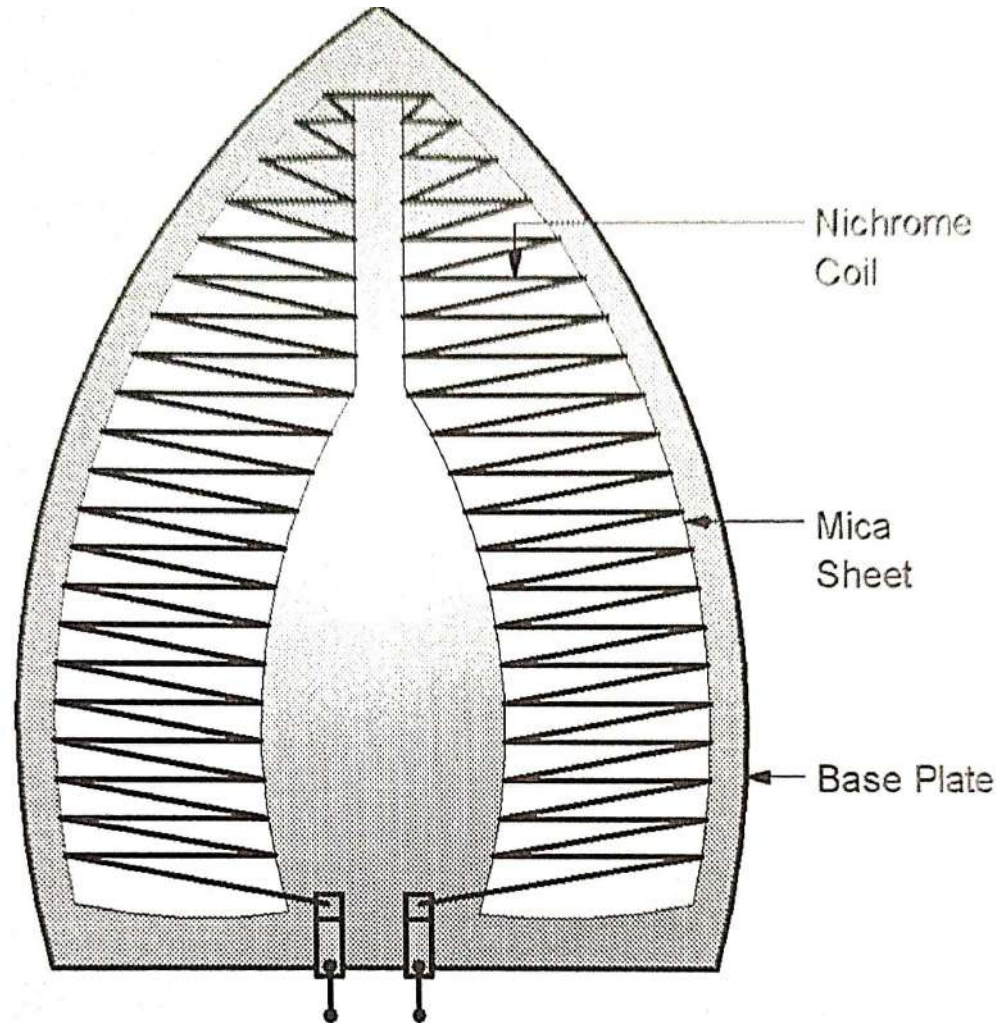
3. Electric Iron

Working of Electric Iron

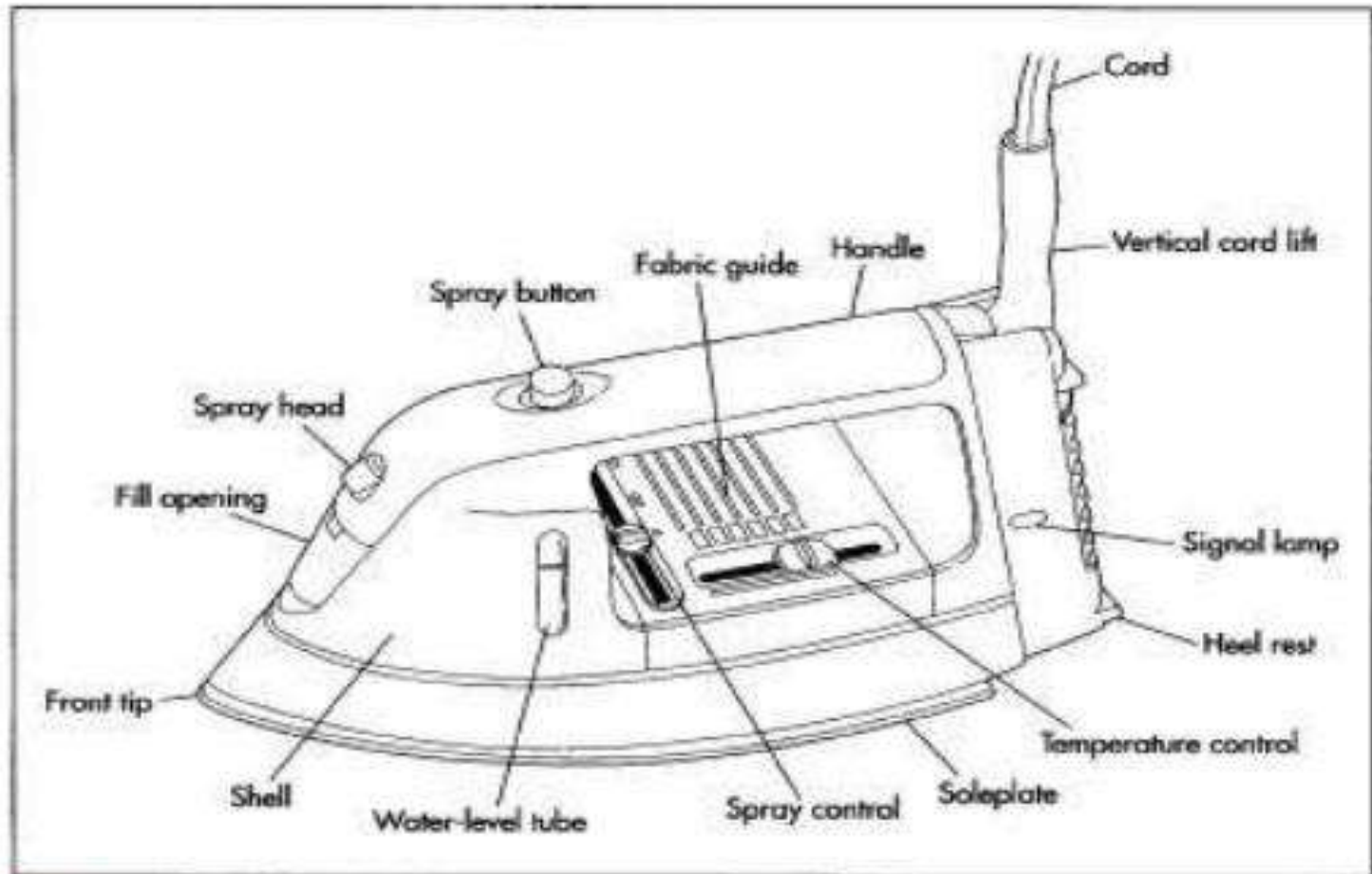
- ▶ An electric Iron is a combination of heat and pressure removes wrinkles. The principle of the electric iron is that when current is passed through a coil, the coil gets red hot and transfers the heat to the base plate of the electric iron through conduction.



Electric Iron



Schematic Diagram



THANK YOU !!!