KSU CET

S1 & S2 Notes

2019 Scheme

Manifest the leadership in you

20/8/2019

Basics Of Mechanical Engineering

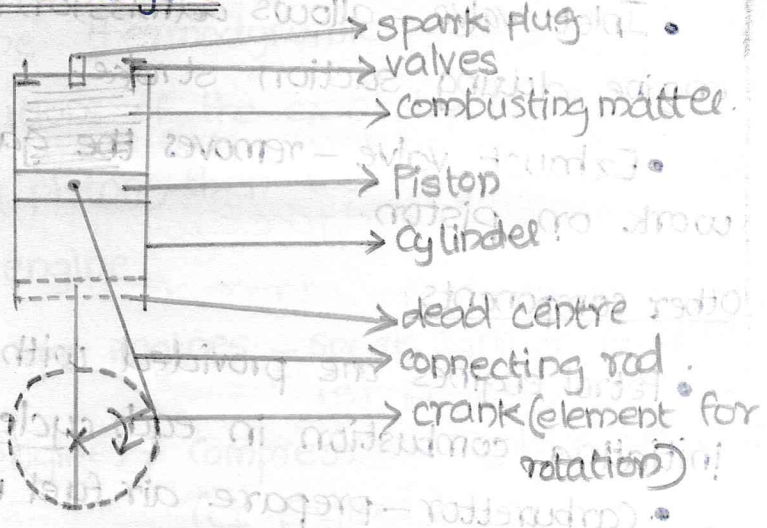
Module - IV

INTERNAL COMBUSTION ENGINES

(IC Engines)

An engine is a device which transforms the chemical energy of a fuel into thermal energy.

Components Of IC Engine



1. Cylinder : It is a container fitted with piston, where the fuel is burnt and power is produced.
2. Cylinder head / cylinder cover: One end of the cylinder is closed by means of cylinder head. This consists of inlet valve and outlet valve.
3. Piston : Piston is used to reciprocate inside the cylinder. It transmits the energy to crankshaft through connecting rod.
4. Connecting rod : It transmits the reciprocatory motion

of piston to rotary crank.

5. Crank: It is a lever between connecting rod and crank shaft.

6. Crank Shaft: It transform reciprocating motion in to a rotary motion.

7. Inlet and Exhaust Valves

- Inlet valve – allows admission of air into the engine during suction stroke.
- Exhaust valve – removes the gases after doing work on piston.

8. Other components:

- Petrol engines are provided with spark plug for initiating combustion in each cycle.
- Carburettor – prepare air fuel mixture
- Diesel engines are provided with fuel injectors for injecting fuel oil into the cylinder and fuel pump for increasing the pressure of oil before injection.

According to the number of piston strokes per cycle, IC Engines are classified as follows:

1. Four stroke engine
2. Two stroke engine

FOUR STROKE CYCLE ENGINE

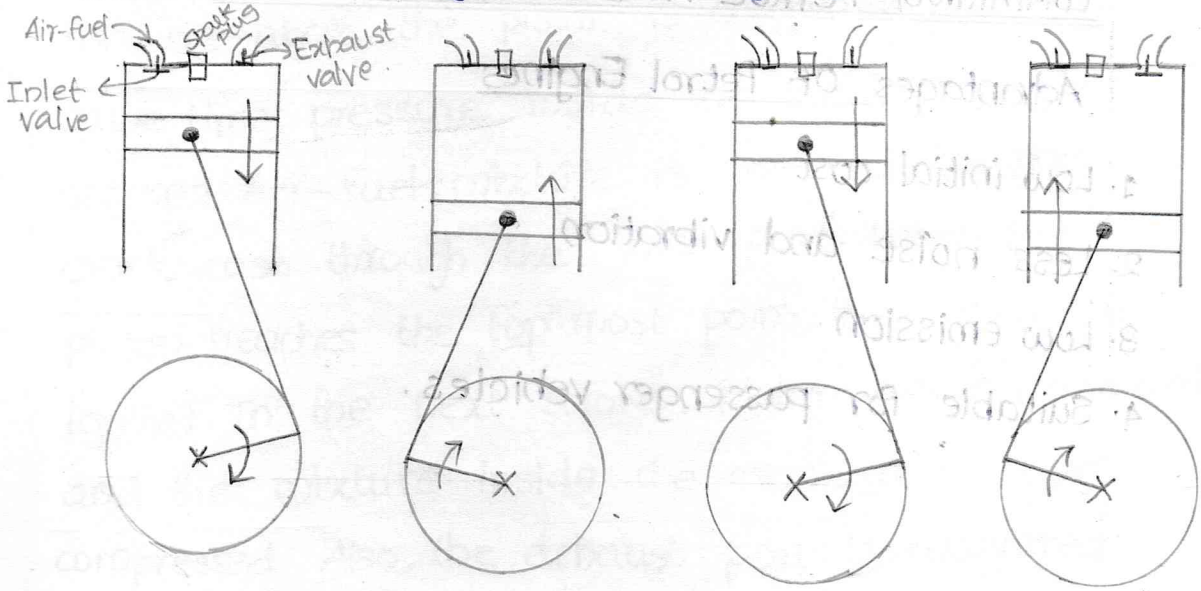
The travel of the piston from one dead centre to another is called stroke of the piston. When the piston executes two strokes, one forward (TDC to BDC) and one backward (BDC to TDC), the crankshaft completes one revolution.

When all the operations that are required to complete one thermodynamic cycle is carried out in two revolutions of the crankshaft, i.e., four strokes of the piston, then the engine is called a four stroke engine.

Note: • Petrol or gas engines – Spark Ignition Engines (SI Engines)

• Diesel engines – Compression Ignition Engines (CI Engines).

Four Stroke SI Engine (Petrol Engine)



In petrol engines, the fuel is mixed well with air before admission to the cylinder. The air fuel mixture (called charge) is prepared in a component called carburettor. From the carburetter, the charge enters the cylinder through the inlet manifold and inlet valve.

1. Suction stroke – suction valve opens and exhaust valve remains closed.

2. Compression stroke – both valves remains closed

3. Expansion stroke – both the valves closed during the start of the stroke. At the end of the stroke, the exhaust valve opens.

4. Exhaust stroke – inlet valve is closed and exhaust valve is opened.

COMPARING PETROL AND DIESEL ENGINES

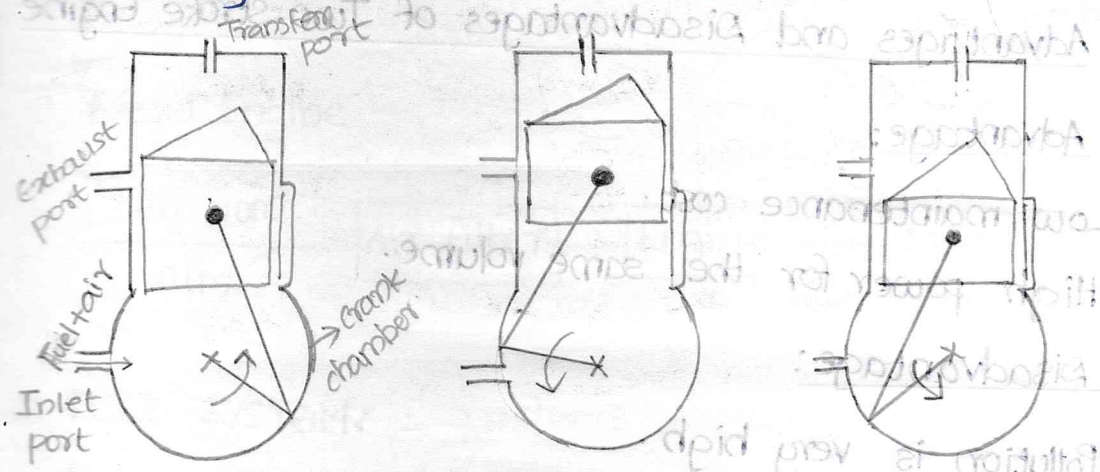
Advantages Of Petrol Engines

1. Low initial cost.
2. Less noise and vibration
3. Low emission.
4. Suitable for passenger vehicles.

Advantages of Diesel Engines

1. Low running cost.
2. Suitable for commercial vehicles.

Working of Two Stroke - Engine (Petrol)



One cycle is completed in two strokes. In two stroke engine, valves are replaced by ports. The cylinder is connect to a closed crank chamber. During the upward motion of the piston, the mixture above the piston is compressed. At the same time, pressure inside the crank case is reduced. Air-Fuel mixture is injected to the crank case through the inlet port. When the piston reaches the top most point, the mixture is ignited. In the next stroke, piston moves downward and the mixture inside the crank case is compressed. Also, the exhaust port is uncovered

and then the transfer port also uncovered. The product of compression is removed by the freshly admitted air-fuel mixture. This process is called scavenging.

Advantages and Disadvantages of Two stroke Engine

Advantage:

1. Low maintenance cost.
2. High power for the same volume.

Disadvantage:

1. Pollution is very high.
2. More noise and vibration.

16/9/2019

Efficiencies of IC Engines

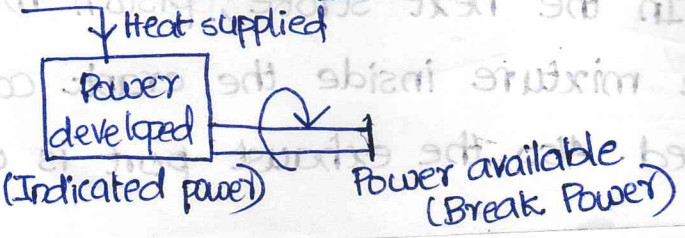
1. Thermal efficiency - ITE and BTE

$$\text{ITE (Indicated Thermal Efficiency)} = \frac{\text{Indicated Power (IP)}}{\text{Heat efficiency (I/P)}}$$

(20-30%)

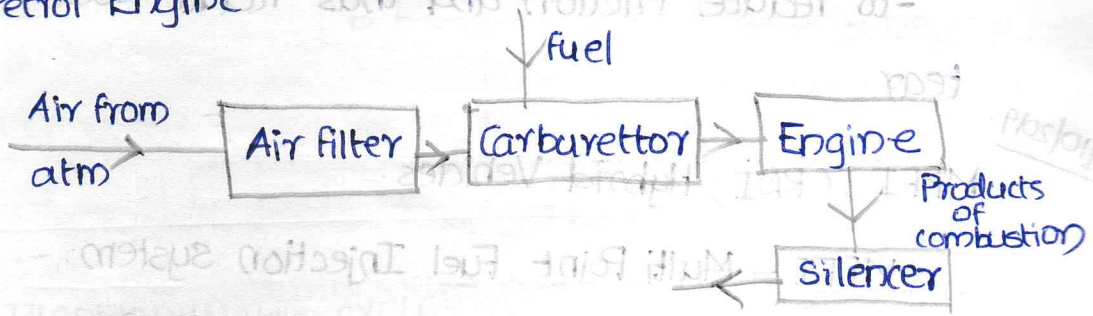
$$\text{BTE (Break Thermal Efficiency)} = \frac{\text{Break Power (BP)}}{\text{Heat efficiency (I/P)}}$$

2. Mechanical Efficiency $= \frac{BP}{IP}$

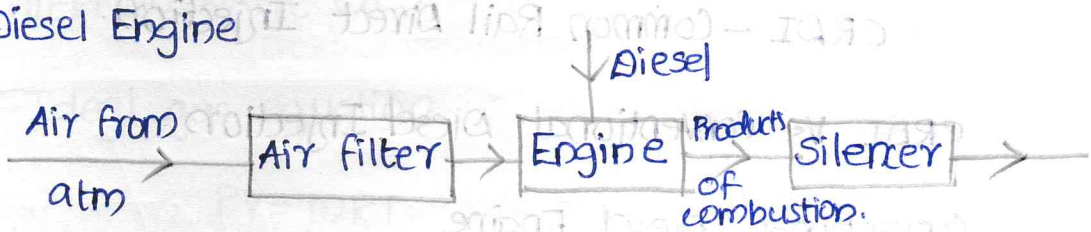


1. AIR SYSTEM

Petrol Engine

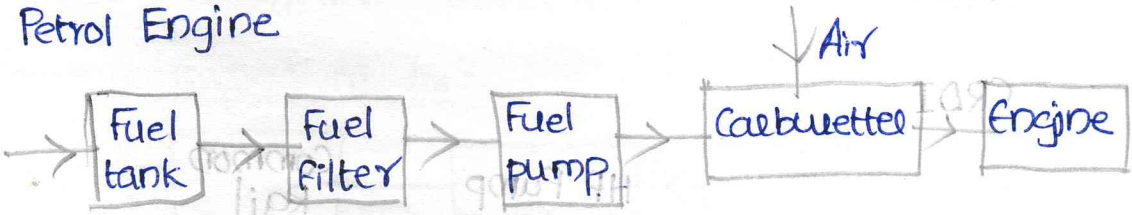


Diesel Engine

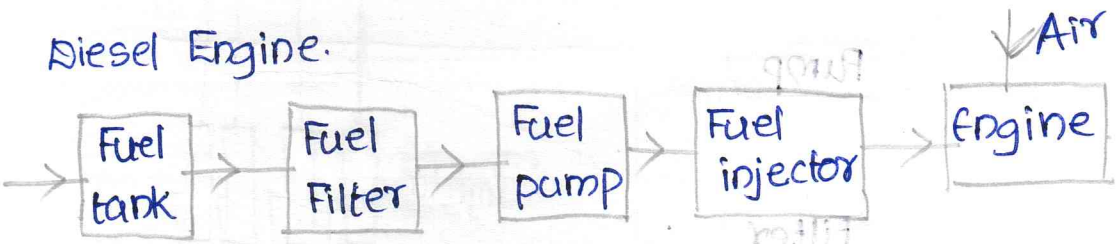


2. FUEL SYSTEM:

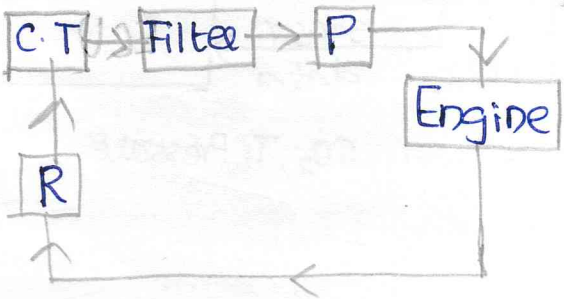
Petrol Engine



Diesel Engine.



3. COOLING SYSTEM:



C.T - Coolant tank
P - Pump
R - Radiator.

4. LUBRICATION SYSTEM

-to reduce friction and thus reduce wear and tear.

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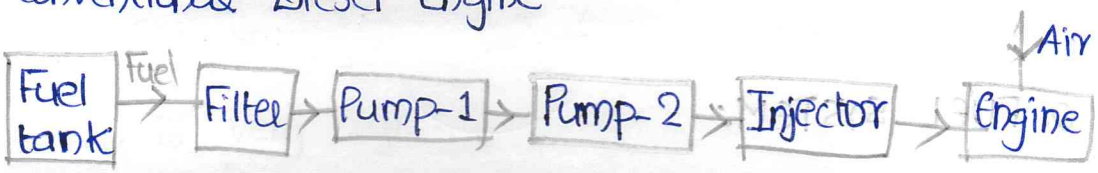
MPFI, CRDI, Hybrid Vehicles.

MPFI – Multi Point Fuel Injection system.

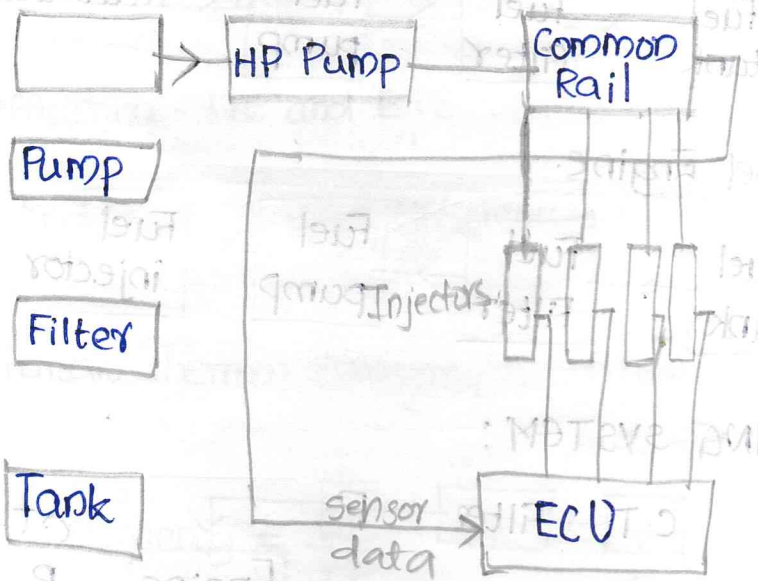
CRDI – Common Rail Direct Injection.

CRDI Vs Conventional Diesel Injection

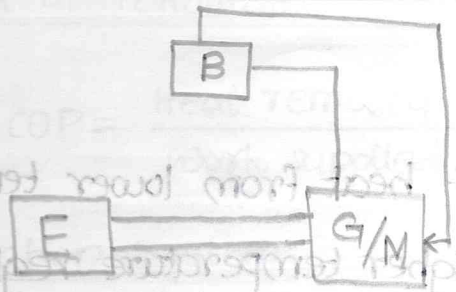
Conventional Diesel Engine



CRDI



Hybrid Vehicle.



G/M → Generator motor
E – Engine
B – Battery

THERMODYNAMIC CYCLES

Ideal gas equation

$$PV = mRT$$

R – characteristic gas coefficient.

REFRIGERATION

Refrigeration

Transfer of heat from lower temperature region to a higher temperature region to maintain a space at a temperature lower than the surrounding atmospheric temperature.

Applications:

1. Long preservation of food items without spoiling.
2. Preserved transportation of food products.
3. Preserving life saving drugs, vaccines, etc.
4. Medical and surgical aid in operation theatres, intensive care units, etc.
5. Making ice, dry ice, cryogenic fluids etc.
6. Providing comfort air conditioning
7. Working environment for efficient operation of computers, precision machineries, etc.

Unit of Refrigeration

- Unit – tonne
- 1 tonne = amount of R.E produced by melting 1 tonne of ice at 0°C → water at 0°C in 24 hrs.

Coefficient Of Performance (COP)

$$COP = \frac{\text{Heat removed in kJ/s}}{\text{Work supplied in kW}}$$

Refrigeration System:

System used for accomplishing the process of refrigeration.

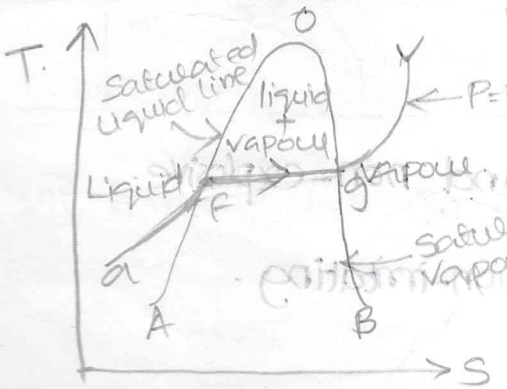
Refrigerated Space:

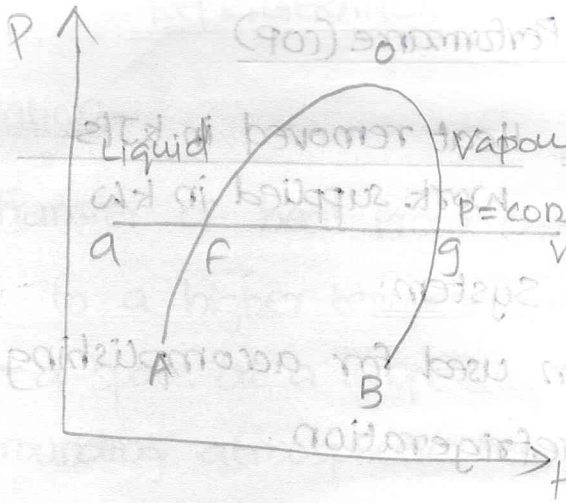
Region that is maintained at a temperature lower than its surroundings.

Refrigerant:

- Working fluid
- Heat carrying medium which absorbs heat from the low temperature region and discards it to the high temperature region.
  - e.g., Ammonia, Freon, etc.,

T-S and P-H Diagrams of Refrigerants.





OA - Saturated liquid line

OB - Saturated vapour line

afgv - constant pressure heat absorption process.

Left of AO - Liquid

Right of OB - Vapour

Between region - liquid + vapour.

Desirable Properties Of a Refrigerant.

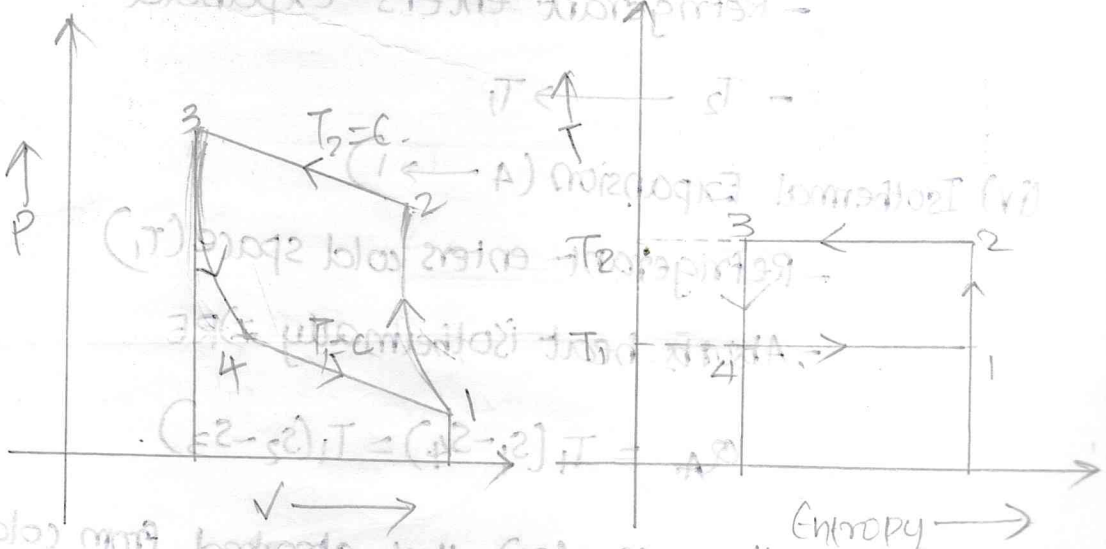
1. Saturation Pressure - slightly above / equal to atm. pressure
2. Latent heat - high
3. Specific vol. - low
4. Chemically stable.
5. Non-flammable and non-explosive.
6. Non-toxic and non-irritating.

7. Critical temperature - high (compared to condensing temp.)
8. Specific heat - low
9. Leakage detection easy
10. Cost - low and easy availability.
11. Non corrosive.

Reversed Carnot Cycle.

The Reversed Carnot Cycle operating between two temperatures can give maximum COP for any mechanical refrigeration system. Hence, it is chosen as the criterion to find the perfection of practical refrigeration system.

p-V and T-s Diagram.



If the direction of Carnot heat engine cycle is ~~ver~~ reversed, then the cycle becomes reverted carnot refrigeration cycle. It consists of four reversible processes:

(i) Isentropic compression (1 → 2)

- Refrigent enters compressor
- Low Temp. (T_1) —compressed external work→ High Temp. (T_2)

(ii) Isothermal compression (2 → 3)

Heat rejected, $Q_R = T_2(S_2 - S_3)$

(iii) Isentropic Expansion (3 → 4)

- Refrigerant enters expander
- $T_2 \longrightarrow T_1$

(iv) Isothermal Expansion (4 → 1)

- Refrigerant enters cold space (T_1)
- Absorbs heat isothermally ⇒ RE

$$Q_A = T_1(S_1 - S_4) = T_1(S_2 - S_3).$$

- Refrigerating effect (RE) = Heat absorbed from cold space.

$$RE = Q_A = T_1 (S_2 - S_3)$$

$$Q_R = T_2 (S_2 - S_3)$$

$$COP = \frac{RE}{W} = \frac{Q_A}{Q_R - Q_A} = \frac{T_1}{T_2 - T_1}$$

Limitations:

- Isothermal heat absorption and rejection - practically not possible unless the process is very very simple.
- Isentropic compression and expansion - practically not possible due to the irreversibilities.

Vapour Compression Refrigeration.

(From text)

AIR CONDITIONING

Air conditioning is the process of controlling and maintaining the internal atmosphere in a confined space. It involves the simultaneous control of temperature, humidity, motion and purity of atmosphere in the space of interest.

Classification:

(i) Based on the major function of the air conditioning system:

- Comfort air conditioning
- Industrial air conditioning

(ii) Based on arrangement of equipments in the air conditioning system:

- Central system
- Unitary system
- Combined system

PSYCHOMETRIC PROPERTIES

Properties that define the characteristics of moist air are known as psychometric properties.

1. Specific humidity: (ω)

(Absolute humidity / Humidity Ratio)

Ratio of mass of water vapour to the mass of dry air present in a given volume of atmospheric ~~air~~ air

2. Relative Humidity (ϕ)

$$\phi = \frac{\text{Actual mass of water vapour}}{\text{mass of water vapour contained in saturated air of same vol.}}$$

$\phi = 1$ (saturated air)

$\phi < 1$ (unsaturated air)

$\phi = 0$ (dry air)

3. Dry Bulb Temperature(T):

Temperature of atm. air measured by an ordinary thermometer.

4. Wet Bulb Temperature (T_w):

Temperature of atm. air measured by a thermometer whose bulb is covered by a wetted cotton wick.

5. Dew Point Temperature(T_{dp}):

Temperature of atm. air at which the water vapour present in the air starts condensing.

Condensation occurs when air is cooled at constant pressure to a temperature below the dew point temperature.

HUMIDIFICATION AND DEHUMIDIFICATION

- ↑sing humidity of air - humidification
- ↓sing humidity of air - dehumidification.

(i) Cooling and humidification:

Achieved by either spraying water into air or by forcing the air to pass through a pad soaked with water. When the air pass over the pad, a part of water evaporates and mixes with air, thus humidifying it. Heat required for evaporation is absorbed from the air, thus cooling the air.

(ii) Dehumidification with cooling

Air is passed over a cooling coil whose temperature is much below the dew point temperature of air. When air pass over the coil, the temperature of air reduces and becomes less than dew point temperature. Since temperature of air is lower than its dew point temperature, some of the water vapour in the air condenses and drips down in

a collecting tank below it. Thus the temperature and humidity of air reduces.

AIR CONDITIONING SYSTEMS

1. Central Air Conditioning System

Components are all grouped together in one central mechanical room. Extensive duct work is used to supply conditioned air to all spaces to be airconditioned. Used when the total cooling capacity required is more than 20 tonnes. Widely used in theatres, departmental stores, restaurants, and other public buildings.

Components:

(i) Compressor

(ii) condenser with cooling tower.

(iii) cooling coil (evaporator) or heating coil (steam)

(iv) A blower with motor

(v) Sprays for cooling, heating, humidifying or dehumidifying.

(vi) Filters and odour removing equipment.

(vii) Control devices.

Methods Used:

(i) All air system:

- Part of air after cooling the room is returned to the air handling unit along with some fresh air, for the next cycle.
- cooling provided by conditioned air supplied by central air handling unit.

(ii) All water system

Chilled water from the central unit is conveyed to the room using insulated plumbing lines and is circulated through heat exchangers for cooling the room space. After cooling, water is then recirculated by bringing it back to the central unit.

(iii) Air water system:

- combination of air and water distribution system
- Major load - by water coils.
- Air distribution - take care of humidity control and ventilation.

Advantages:

1. Low initial cost
2. Space of equipment - not critical.

(3) Low running cost.

(4) No problem of noise in the room

Disadvantages:

(1) Requires large ducts occupying large space.

(2) Individual room control cannot be easily achieved.

2. Unitary Air Conditioning System.

- Make use of factory assembled air conditioning unit.
- All components are assembled together as a single unit.

Advantages:

(a) Ease of selection

(b) Easy repairing

(c) Easy installation and removal.

(d) Failure in any system affect only one room.

(e) Individual room temperature control can be achieved.

HYDRAULIC PUMP

A hydraulic pump is a machine which increases the energy of a liquid utilising the mechanical energy supplied to it.

1. Centrifugal Pump

- Has high output and high efficiency.
- Simple design, hence used in almost all fields.

(Principle:

When the impeller of a pump is made to rotate by external means, the liquid mass entrapped by the impeller is thrown away from the centre of rotation, by which K.E is imparted to the liquid. The K.E is then converted to pressure head due to the shape of the casing of the pump and the liquid gets lifted up. Since the liquid is lifted by centrifugal action, the pump is called centrifugal pump.)

Main Parts:

* Impeller:- Rotating solid disc with curved blades.
  - Mounted on a shaft which is connected to an electric motor.
  - central portion known as eye of impeller.

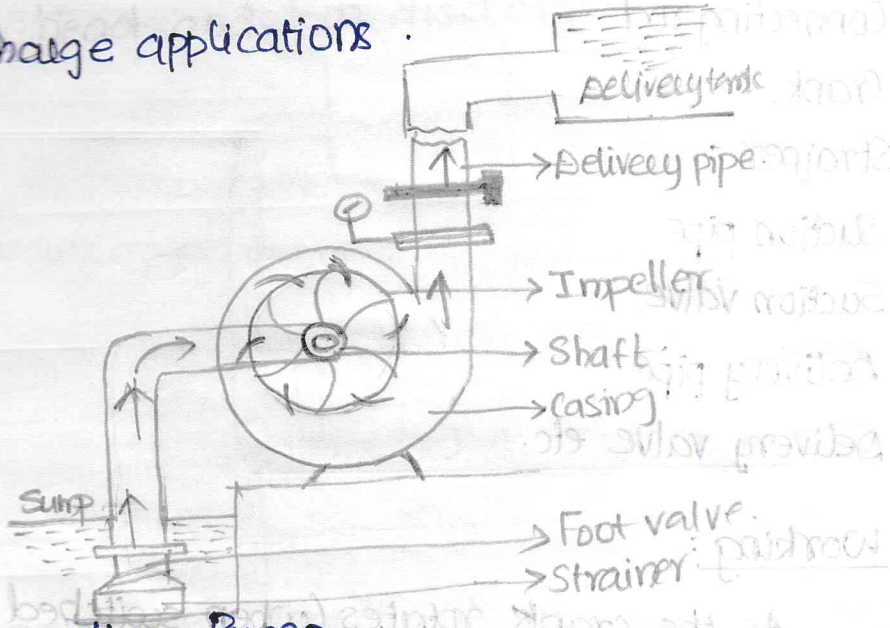
* Casing :- Air ~~tight~~ tight chamber surrounding impeller.
* Suction Pipe
* Delivery Pipe
* Foot valve :- Unidirectional valve which permit water from sump to the pump.
* Strainer : Used to protect the pump from leaves and wooden pieces.

Working :

- Priming :
  - Operation of filling the suction pipe and casing with the liquid to be pumped.
  - Used to remove air particles and help to create strong vacuum to achieve pumping action.
- After priming switch on the motor and impeller rotates. It creates vacuum at inlet hence water is reached into eye of impeller. Impeller creates impelling action. So velocity of liquid ↑ses. Now this high velocity liquid reached at the top of the casing. The construction of casing is on the basis of gradual increase of area. So velocity of liquid ↓ses and K.E is converted into pressure energy, i.e., we get high pressure

liquid at delivery pipe so we can lift the liquid to the required height (tank).

- It is commonly used for low head and high discharge applications.



2- Reciprocating Pump

- It is a +ve displacement pump and it operates on the principal of pushing of liquid by a piston (reciprocating motion) in a closed cylinder.
- Required low pressure at inlet and high pressure at outlet is obtained by reciprocating motion of piston.

Main parts:

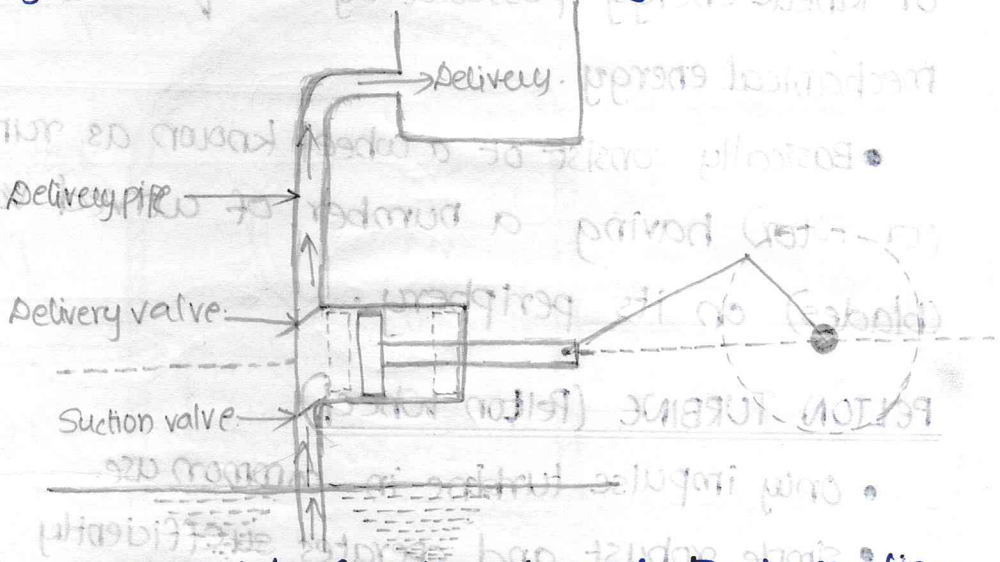
* Cylinder
* Piston
* Connecting rod
* Crank
* Strainer
* Suction pipe
* Suction valve
* Delivery pipe
* Delivery valve etc.

Working:

As the crank rotates (when switched on the motor) the piston moves out (left to right) which creates vacuum or low pressure in suction pipe. So liquid enter into cylinder through the suction valve. The delivery valve is closed in this stroke.

In return stroke the pressure developed in liquid opens the delivery valve and closes the suction valve. So liquid flows out to the tank through delivery pipe.

- Strainer is used to protect the pump from leaves and wooden pipes present in the sump.
- Reciprocating pump is generally used for high head and low discharge.



Comparison b/n Centrifugal and Reciprocating

Centrifugal Pump	Reciprocating Pump
• Low head and high discharge.	• High head and low discharge.
• Priming is required.	• No need of priming.
• Smooth flow.	• Pulsating flow.
• Compact size.	• Heavy size.
• Less initial cost	• High initial cost.
• Low maintenance cost	• High maintenance cost.
• Low wear and tear.	• High wear and tear.

HYDRAULIC TURBINES

Hydraulic turbine is a prime mover in which the shaft work is developed by converting the potential or kinetic energy possesed by a liquid into mechanical energy.

- Basically consist of a wheel known as runner (or rotor) having a number of curved vanes (blades) on its periphery.

PELTON TURBINE (Pelton wheel)

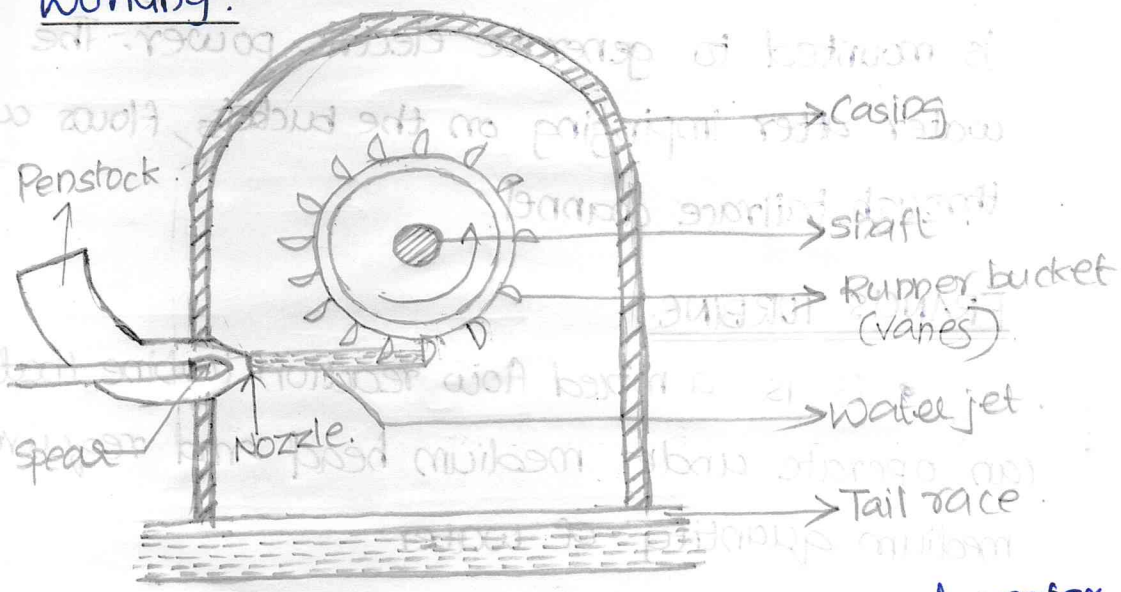
- Only impulse turbine in common use.
- simple, robust and operates efficiently
- Smooth running and good performance.

Major Components:

1. Runner :
   - Circular disc mounted on a shaft supported in bearings.
   - Cups / Buckets (curved vanes) are equidistantly mounted on circumference of circular disc.
   - made of cast iron, bronze or stainless steel.
2. Splitter
3. Penstock – for conveying water from reservoir to turbine
   – concrete or steel pipes.

4. Nozzle - increases kinetic energy of water
5. Spear - regulate water flow through turbine.
6. Casing - to prevent splashing of water to surroundings.

Working:



When inlet valve to turbine is opened, water from reservoir flows through inlet pipe (penstock) to the nozzle. In the nozzle, energy available in water is converted to kinetic energy. The jet of water leaving the nozzle impinges on the splitter of the bucket, gets divided into two and flows through both sides of the bucket and leave out through the other edge. Due to an impulsive force, bucket rotates and hence, the runner also rotates. As the runner moves, the bucket moves away and next bucket comes in position in front of the jet.

The jet now strikes on the next bucket, thus establishing a continuous rotation of the runner. When runner rotates, shaft also rotates. At the other end of the shaft, an electric generator is mounted to generate electric power. The water after impinging on the buckets, flows out through tailrace channel.

FRANCIS TURBINE

- It is a mixed flow reaction turbine that can operate under medium head and requires medium quantity of water.

Major components

1. Scroll casing (spiral casing)
2. Guide vanes (wicket gates)
3. Guide wheels
4. Runner
5. Draft tube – passage between runner and tailrace.

Working:

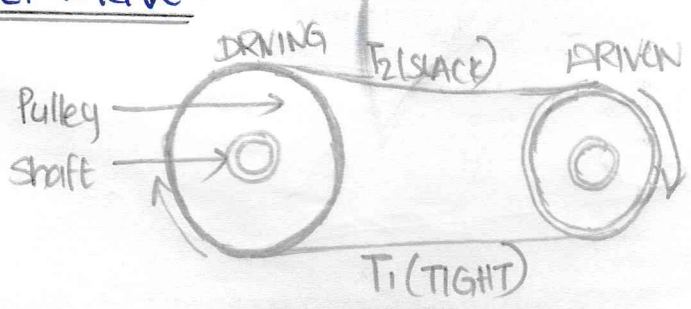
POWER TRANSMISSION DEVICES

The mechanical power can be transmitted from one shaft to another by four methods of mechanical drive. They are:

1. Gear drive: Very short distance power transmission.
2. Chain drive: Upto one metre power transmission.
3. Belt drive: Upto 15m
4. Rope drive: Upto 100 m

- The shaft from which the power is transmitted is known as driver shaft and shaft to which the power is transmitted is known as driven shaft.
- The choice of selection of power transmission devices depends on following factors:
  - Distance between the shaft
  - Amount of power to be transmitted.
  - Speed ratio
  - Accuracy

BELT DRIVE:



• Belt drive is used to transmit the power from one shaft to another at a considerable distance (upto 15m).

• Pulleys are mounted on driver and driven shaft. An endless belt is fitted tightly over these pulleys.

• Different types of belts used in belt drives are:

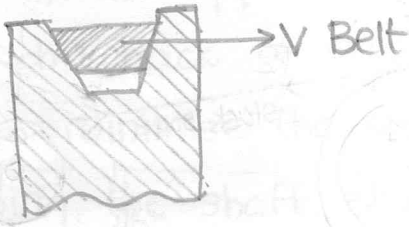
1) V-belt
2) Flat belt
3) Circular Belt

1) V-Belt

• Used for transmitting moderate power in workshop and factory when the two shaft are near to each other.

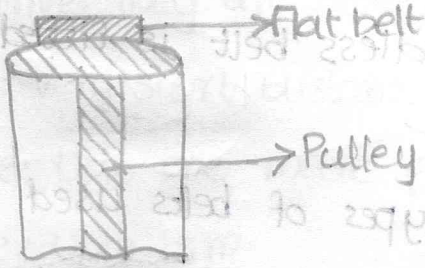
• Angle of V-belt is 30° - 40°.

• Slipping is almost negligible.



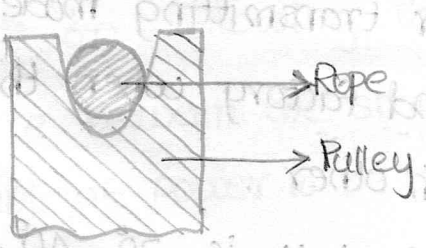
2) Flat Belt

- Used to transmit moderate power in factory and workshop when the distance b/n two shaft is upto 8m.



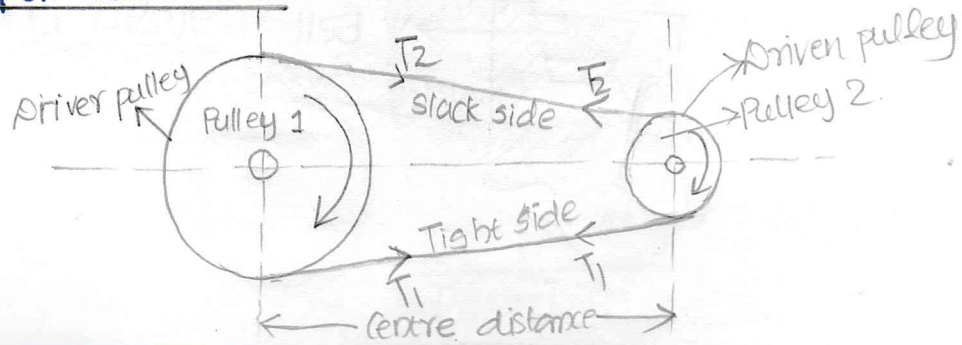
3) Circular Belt

- Used for transmitting large amount of power when the two shafts are more than 8m apart.
- Angle of circular belt is 40°-60°.



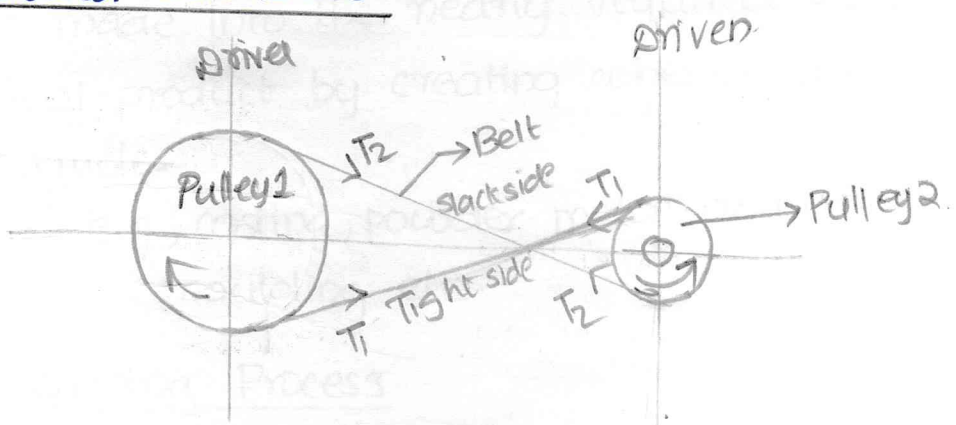
TYPES OF FLAT BELT DRIVES:

1. Open Belt Drive :



- Used to transmit power when the distance between the shaft is upto 15m.
- Shaft arranged in parallel to each other and rotating in same direction.
- Drived pulley pull the belt from one side and deliver the same to other side.
- Hence tension on the former side will be greater than later side.
- The side where tension is more is known as tight side and other side is known slack side.

2. Crossed Belt Drive:-

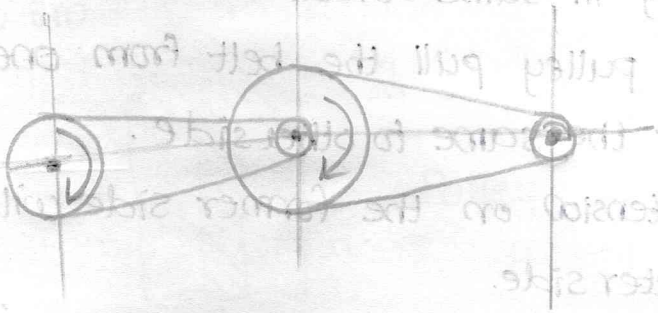


- It is used to connect shaft which are parallel and rotating in the opposite direction.
- The main drawback of crossed belt is rubbing.
- Inorder to minimise the wear and tear due to rubbing the shaft should be placed at

a minimum distance of ~~20b~~ 20b, where,

b-breadth of belt.

3. Compound Belt Drive



- It is used when

MODULE - VI

MANUFACTURING PROCESS.

Manufacturing:

Production of finished products having definite geometric shape and properties in order to satisfy the needs.

Manufacturing Process

1. Primary manufacturing process

* Metal in a molten form or solid powder is made into the nearly required shape of the final product by creating cohesion among the particles.

e.g., casting, powder metallurgy, plastic moulding etc.

2. Deforming Process

*Original shape of a solid is converted to another shape maintaining the cohesion among particles.

e.g., forging, rolling, extrusion, sheet metal working, explosive forming, swaging etc.

3. Machining Process

Shape and size of the metal is changed by removing material from the unwanted region.

e.g., turning, drilling, grinding, milling, etc.

4. Joining Process

Two or more metal parts are united together to make intermediate product or final product.

e.g., resistance webbing, pressure welding, brazing, soldering, etc.

5. Surface finishing process

Provide required cleaning, surface finish and protective coating to the final product, without changing the dimensions of the part.

e.g., buffing, honing, electroplating, etc.

6. Property Modification Process

The material property of the product is changed to achieve the desired characteristics without changing its dimensions.

e.g., heat treatment and surface treatment process like, stress releiving, annealing, tempering, etc.

CASTING

Casting is a process in which molten metal is poured into a mould or cavity and allowed to solidify.

Molten metal

* The liquid form of the metal with which the component is to be made.

* Obtained by melting the metal by heating it to very high temperature.

* Cupola, Open hearth furnace, electric furnace, --- are the furnaces commonly used for melting metal.

Mould:

A negative print of the product to be cast.

Moulding:

The process of making mould of desired shape using sand, pattern and core so that the molten metal can be poured into it to produce casting.

Pattern:

Model or replica of the component to be made by casting. Has the shape and size of the final component.

Core:

Solid mass prepared using drysand, inorder to introduce into the mould cavity, to form a hole or recess.

Gate:

Channel or passage through which the molten metal flows to the mould cavity. The gating system include:

(i) Pouring basin
(ii) Sprue
(iii) Gates
(iv) Riser

Advantages of Casting

1. Cheapest method of fabrication.
2. Large size components can be produced easily.
3. Components of complicated shape can be cast easily and in lesser time.

4. Higher strength and rigidity.
5. Overall production time of the finalised component is reduced.
6. Required dimensional accuracy can be easily achieved.
7. Almost all metals and alloys and plastics can be cast.

Steps in Casting

1. Making the pattern
2. Preparation of moulding sand and making mould and core.
3. Melting of metal and pouring into the mould.
4. Cooling and solidification
5. Removing from mould
6. carrying out fettling (removing unwanted projection)
7. Final finishing and heat treatment.

Casting Process

1. Sand casting
2. Shell mould casting
3. Permanent mould casting
4. Die casting

5. Centrifugal casting
6. Investment casting

Sand Casting:

- Most widely used casting process.
- Most sandcasting operation use silica sand (SiO) mixed with other minerals.
- Used sand can be reused.

Gating system of sand casting

Major elements of sandcasting gate system are

1. Cope and Drag
   - The moulding flask is made up of two parts of gating system.
   - The top half is known as cope and bottom half is known as drag.
2. Mould Cavity
   - The molten metal flowing into the gap present inbetween cope and drag is known as mould cavity.
3. Pattern:
   - Geometry of mould cavity is created by

use of pattern.

4. Sprue:

- It is the funnel shaped cavity to flow the molten metal.
- The top of the sprue is known as pouring cup.

5. Runner:

- The molten metal is passed from sprue to the gate through runner.

6. Gate:

- It is a region where runner joins with mould cavity.

7. Riser:

- Riser is used to findout the mould cavity is filled or not.
- It also act as vent hole to flow out the gases which is generated in solidification process.

8. Core:

- It is used to obtain a desired hole in the cavity.

Defects in Casting

Imperfections in the castings.

1. Formation of blow holes.
2. Inclusion of foreign matter.
3. Incomplete cavity filling (misrun)
4. Rough surface
5. Localised enlargement.
6. Thin projections on casting
7. Small cavities formed on surface.
8. Internal air pockets are formed by rapid pouring of metal.

FORGING:

Forging is the process of changing the shape of a metal by heating it to plastic state and applying compressive force on it by sudden blows or steady pressure.

The shop in which forging is carried out is called smiths shop or smithy.

Advantages:

1. Improves structure of a metal and hence its

mechanical properties.

2. Can withstand heavy load conditions.
3. Higher reliability.
4. Metals can be easily shaped without damaging structure.
5. Renders uniform density as well as dimensions.
6. Defects like porosity gets eliminated.
7. Resistance to impact loads get increased.
8. No material wastage.
9. High rate of production.
10. Parts can be easily welded.
11. Parts can be made to close tolerance.
12. Smooth surface can be obtained.

Disadvantages:

1. High tool cost.
2. High tool maintanence cost.
3. Some metal may develop crack by forging.
4. Limitation in size and shape.
5. Temperature range for each material must be exactly maintained.

Classification Of Forging Process

Can be broadly classified as

1. Smith forging
2. Impression die forging

SMITH FORGING (OPEN-DIE FORGING)

- Process of reducing a metal billet using flat dies to obtain the required shape and size.
- Product of lesser accuracy compared to impression die forging.
- Less expensive and simple tooling.

1. Hand Forging

Smith forging done by hand hammering on heated work piece kept on an anvil is called hand forging.

2. Power Forging

In power forging, instead of hammering by hand, power hammers are employed.

The work piece is placed between the ram die and anvil die. Hammering occurs

when compressed air is admitted to the top of the piston (ram) in the ram cylinder. The hammer is pulled back by admitting air to the bottom side of piston, which rises the piston and ram die upwards.

IMPRESSION DIE FORGING

Process of reducing and shaping a metal billet using closed impression die of the required shape.

1. Drop Forging

Heated metal is placed in the cavity of the die and force is applied by impact due to hammer drop. The material shape changes gradually in each drop.

2. Press Forging

steady pressure is applied slowly over the heated metal placed in the die. A hydraulic press which exerts continuous pressure on the heated metal is employed. Due to the continuous pressure, the metal squeezes to the shape of the die.

3. Roll Forging

There are two rollers on parallel shafts. The rollers have grooves of required shape for about 50% of its roller. The heated workpiece is placed in groove and the roll is rotated to get pressed to the shape of the groove.

ROLLING

Rolling is the process of forming metal to the desired shape by passing it in between a pair of rolls.

* Hot rolling – above recrystallisation temp.
* Cold rolling – below recrystallisation temp.

When the hot metal is passed through the grooves in the rolls, the metal squeezes and its cross section reduces with increase in length.

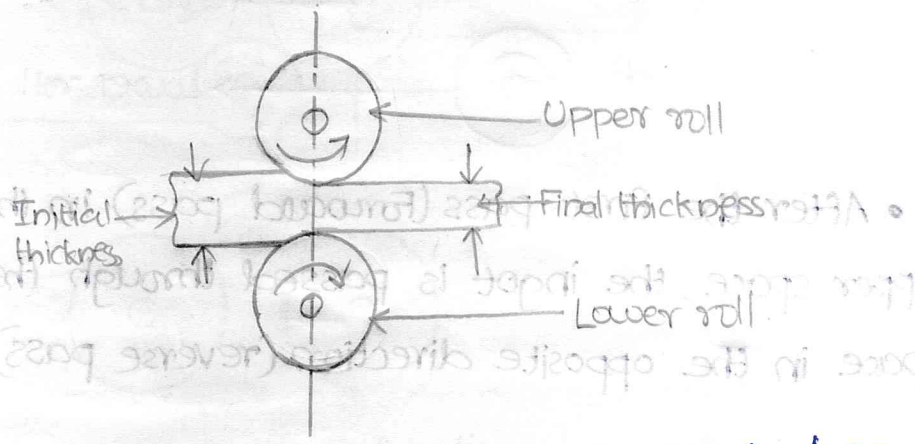
Intermediate shapes for Hot Rolling.

1. Bloom – rectangular/square piece of metal of standard sizes (150mm x 150 mm to 250 mm x 300 mm)
2. Billet – similar to bloom but smaller in cross section (50 mm x 50 mm to 150 x 150 mm).

3. Slabs – rectangular cross section with low thickness of order of 50 mm and width 350 mm to 1500 mm.

Types Of Rolling Mill

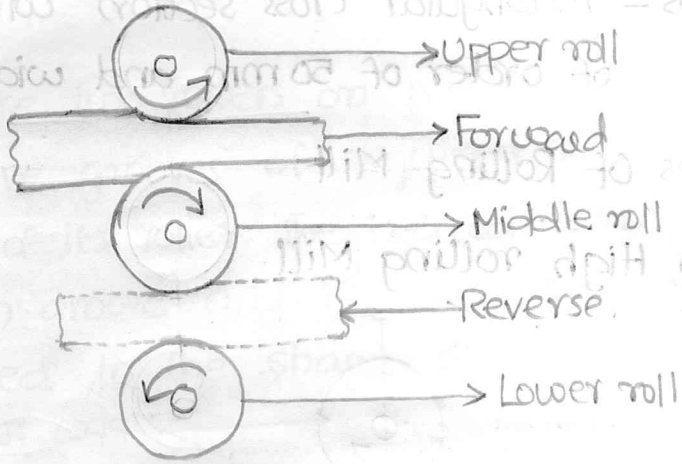
1. Two High rolling Mill.



Two rolls, in the same vertical plane, rotate in opposite direction. The ingot is passed between the roll. After first pass, the rolls are reversed in direction, so that ingot goes back to original position. Again, after adjusting space between rolls, it is further rolled. The process is repeated until the desired size is obtained.

2. Three High rolling Mill.

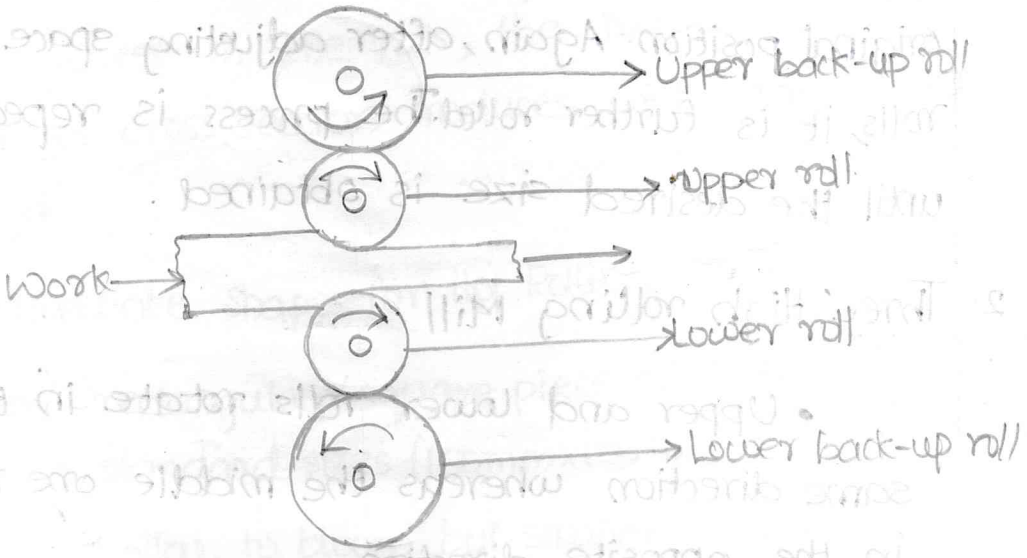
- Upper and lower rolls rotate in the same direction whereas the middle one rotate in the opposite direction.



- After the first pass (Forward pass) in the upper space, the ingot is passed through the lower space in the opposite direction (reverse pass).

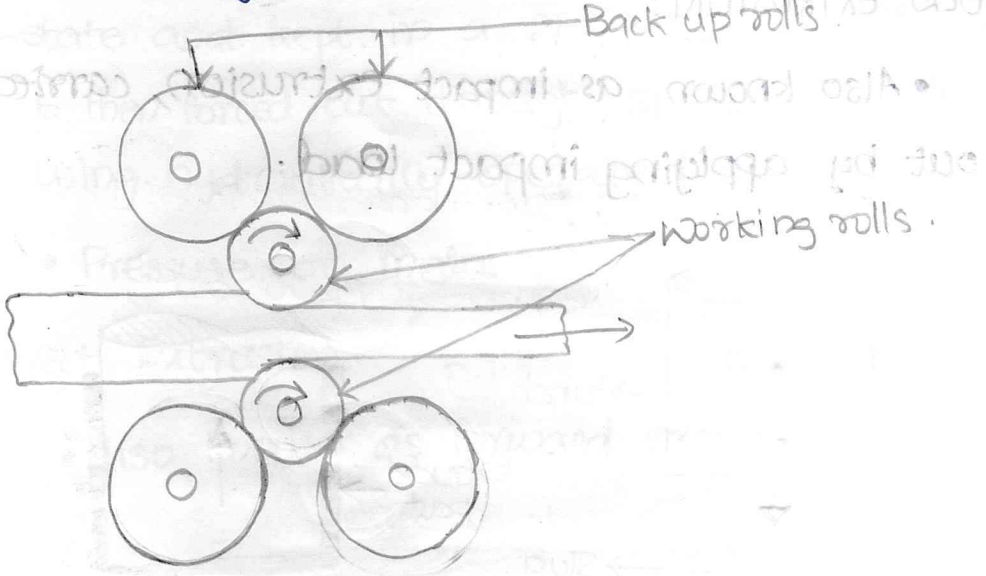
3. Four High Rolling Mill

- Two working rolls – exert pressure on the metal.
- Two backup rolls – prevent deflection of working rolls



- e.g., Slabbing mills.

4. Cluster Rolling Mill



- Consist of several rolls.
- Used as finishing mills.

5. Continuous Rolling Mills

- Number of two high rolling mills kept in series
- Metal out from first one continuously passed through next and so on.

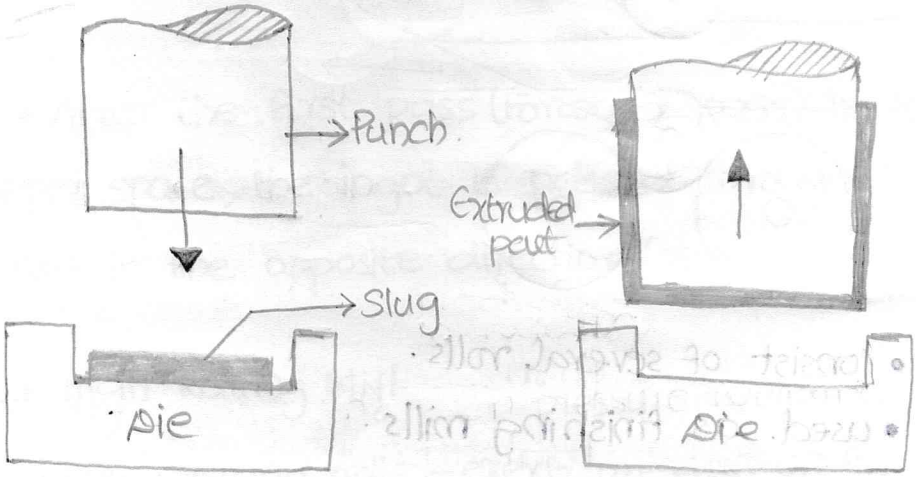
EXTRUSION

- The process of forming tubes, rods, etc., by compressing the material inside a chamber and forcing it out through a small opening of desired shape.

- Principle similar to squirting of toothpaste from its tube.

COLD EXTRUSION:

- Also known as impact extrusion, carried out by applying impact load.



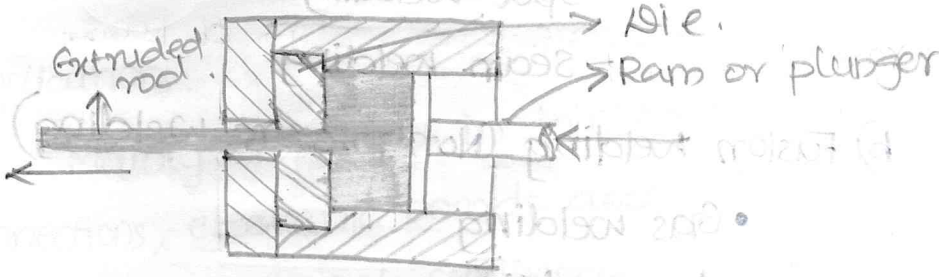
- Material in the form of slug is placed on the die and the impact load is applied by a punch.
- Material flows up along the surface of the punch forming the component of desired shape and size.
- Extruded part is removed from punch using compressed air.

HOT EXTRUSION:

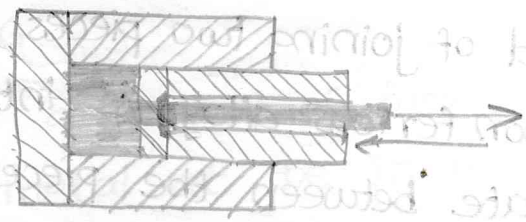
- Metal to be extruded is heated to plastic state and kept in a pressure chamber. It is then forced out through specially made dies using hydraulically operated press.
- Pressure on metal varies from 50 to 75 kPa.

1. Direct Extrusion:

- Also known as forward extrusion.



2. Indirect Extrusion



- Also known as backward extrusion.

3. Tube Extrusion.

METAL JOINING PROCESS.

Metal joining process is the technique of uniting two or more metal parts to make a subassembly or a final product.

1. Welding (joining by establishing atom to atom bond)
   a) Plastic Welding (Pressure welding)
      - Forge welding
      - Resistance welding
        - Spot welding
        - Seam welding
   b) Fusion welding (Non-pressure welding)
      - Gas welding
      - Arc welding

2. Brazing:

Method of joining two pieces of metals in which a non ferrous alloy is introduced in a liquid state between the pieces of metal being joined and allowed to solidify.

Types:
- Torch brazing
- Furnace brazing
- Resistance brazing
- Induction brazing

Applications:

For fastening pipe fittings, stove burners, carbide tip on tools, radiators, heat exchangers, etc.

3 Soldering:

Method of joining two or more metal pieces by means of a fusible alloy or metal called solder, applied in a molten state.

Types: • Soft soldering (150 to 300°C – m.p of solder)
• Hard soldering (300 to 400°C – ").

Applications:

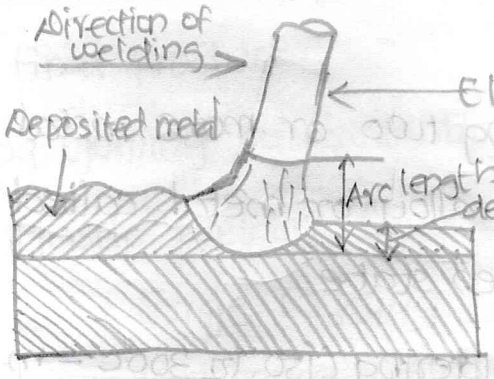
Mainly employed in joining wires in electric connections, electronic boards and similar small parts which are not subjected to load and temperature.

ARC WELDING.

* It is a method of fusion welding in which the metal at the joint is heated to molten state by an electric arc.

* When the anode, positive pole of a DC power supply (electrode) and the cathode, negative pole (metal to be joined) are brought together

and separated by a small distance (2 to 4 mm), electric arc is formed whose temp. is about 6000 to 7000°C.



* Heat of arc raises the temp. of the metal, melts at the point of arc and forms a pool of molten metal.

* Electrode is also melted and provides the joint between metals to be joined.

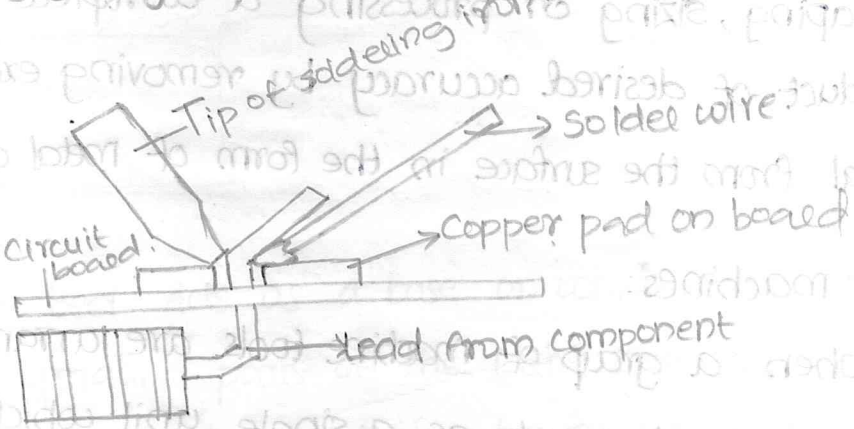
Electrodes

1. Non-consumable electrodes
   (carbon, graphite or tungsten)
2. Consumable electrodes.
   - Bare (uncoated) electrode
   - Coated electrode.

Difference b/n brazing and soldering

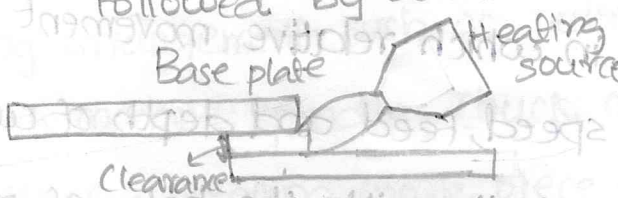
Brazing	Soldering
• Melting point of filler metal >450°C	• Melting point of filler metal <450°C
• Copper base or silver base alloy.	• Tin and lead alloy.
• High joint strength.	• Low joint strength
• Flux: Borax and mixture of borax and boric acid	• Flux: Aluminium chloride, zinc chloride, rosin with alcohol
• Cast iron and steel parts are braze welded.	• Copper alloys, nickel alloy etc, are joined by soldering.

Soldering:



Brazing:

Filling of molten metal by capillary action followed by solidification



MACHINING PROCESS

Machining:

Manufacturing process by which a work piece is given desired size, shape and surface finish by removing the excess (or undesired) material from the workpiece with the help of a properly shaped cutting tool.

Machine Tool:

A power driven cutting machine which is used for shaping, sizing or processing a workpiece to a product of desired accuracy by removing excess material from the surface in the form of metal chips.

Transfer machines:

When a group of machine tools are arranged in a sequence to work as a single unit which is automated, then they are called transfer machines.

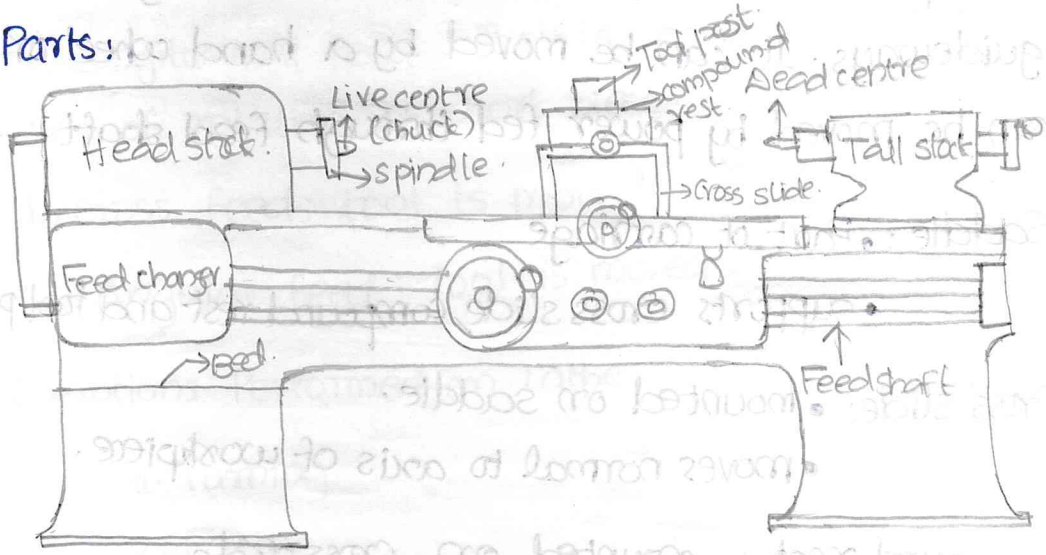
CNC Machines:

Machine tool, in which relative movement of tool and work, cutting speed, feed and depth of cut, etc are controlled automatically with the help of prearranged program fed into a computer is called CNC machine.

LATHE

Lathe is a general purpose machine tool which removes excess material from the workpiece, in the form of chips, by rotating the work piece against a single point cutting tool.

Parts:



1. Lathe Bed: Acts as a base on which different fixed and operating parts of the lathe are mounted. Guide ways are made on top for fixing and sliding tailstock and gear carriage.

2. Headstock: Located at left end of bed and houses driving arrangement such as pulleys and gears. Also supports machine spindle. Chuck can be attached to spindle for rotating work piece.

3. Tailstock: Located at right end of bed and is capable of sliding along the guideways. It houses dead centre which supports right end of workpiece.

4. Carriage: Supports, guides and feeds the tool against workpiece. It can be moved longitudinally on guideways. It can be moved by a hand wheel or can be moved by power fed through feed shaft.

5. Saddle: • Part of carriage
• supports cross slide, compound rest and tool post.

6. Cross slide: • mounted on saddle.
• moves normal to axis of workpiece.

7. Compound rest: • mounted on cross slide.
• carries a circular plate called swivel plate

8. Tool post: • Uppermost part of carriage
• holds the cutting tool and enable the cutting tool to be adjusted to the convenient working position.

Principle of working

Cutting tool is fed either parallel or perpendicular to the axis of the work piece removes material

from the rotating work to give the required size and shape.

- Tool moved parallel, gives a cylindrical surface.
- Tool moved perpendicular, gives a flat surface.

Feed Mechanism (Movement of tool relative to workpiece)

a) Longitudinal feed : Tool is moved parallel to the axis of rotation of work piece.

b) Cross feed: tool is moved $\perp^{lar}$.

c) Angular feed : tool is moved at an angle.

Operations Performed on Lathe.

1. Turning
2. Facing
3. Step, Taper turning
4. Thread cutting
5. Knurling
6. Drilling
7. Boring
8. Reaming
9. Filing
10. Grinding.

Steps:

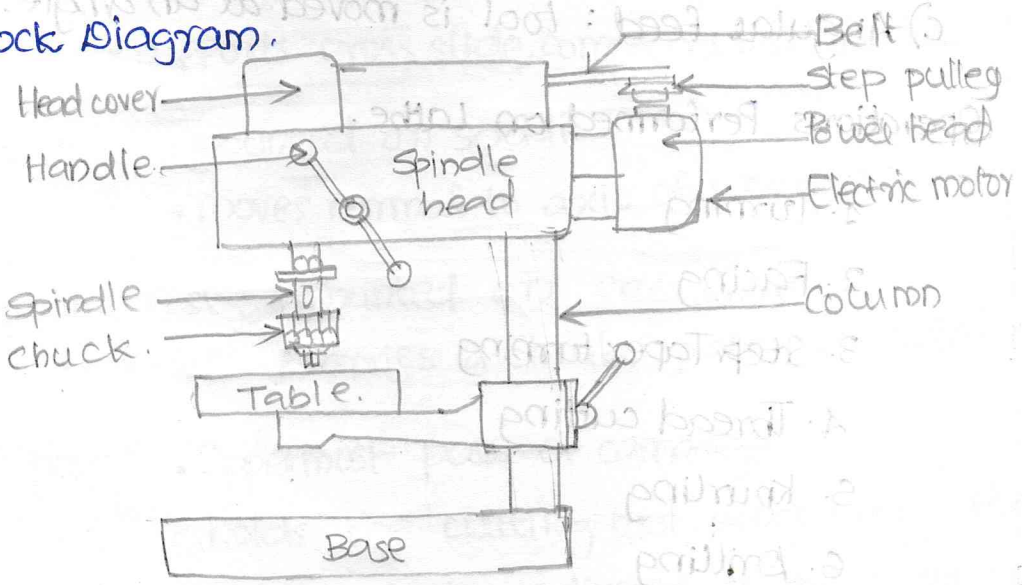
(From text).

DRILLING MACHINE

- One of the simplest machine tool used in production shops.
- It performs the operation of drilling holes on workpiece.
- Drilling operation is carried out by forcing a rotating tool called 'drill' against the work piece.

*Working Principle

* Block Diagram.



* Principle Parts:

1. Base – heavy rectangular casting which supports the entire machine.
2. Column – heavy cylindrical structure resting on base and supports spindle head, power head and table of the machine.

3. Spindle : Rotating part on to which chuck is attached. Chuck holds the drill, so that when the spindle rotates, the tool also rotates.

4. Table : Support workpiece or workpiece holding device.

5. Power head : contains electric motor, V-pulleys and V-belt which transmit rotary motion to drill spindle.

Operations Performed:

1. Drilling : Process of producing holes on workpiece by cutting and removing material from it, with the help of a twist drill.

2. Reaming : The operation of sizing and finishing the inside surface of a drilled hole.

3. Boring : Operation of enlarging a drilled hole for producing more accurate hole.

4. Counter boring : Operation of enlarging a drilled hole for a specific ~~hea~~ length.

5. Counter sinking : Operation of making a cone shaped enlargement at the beginning of a hole.

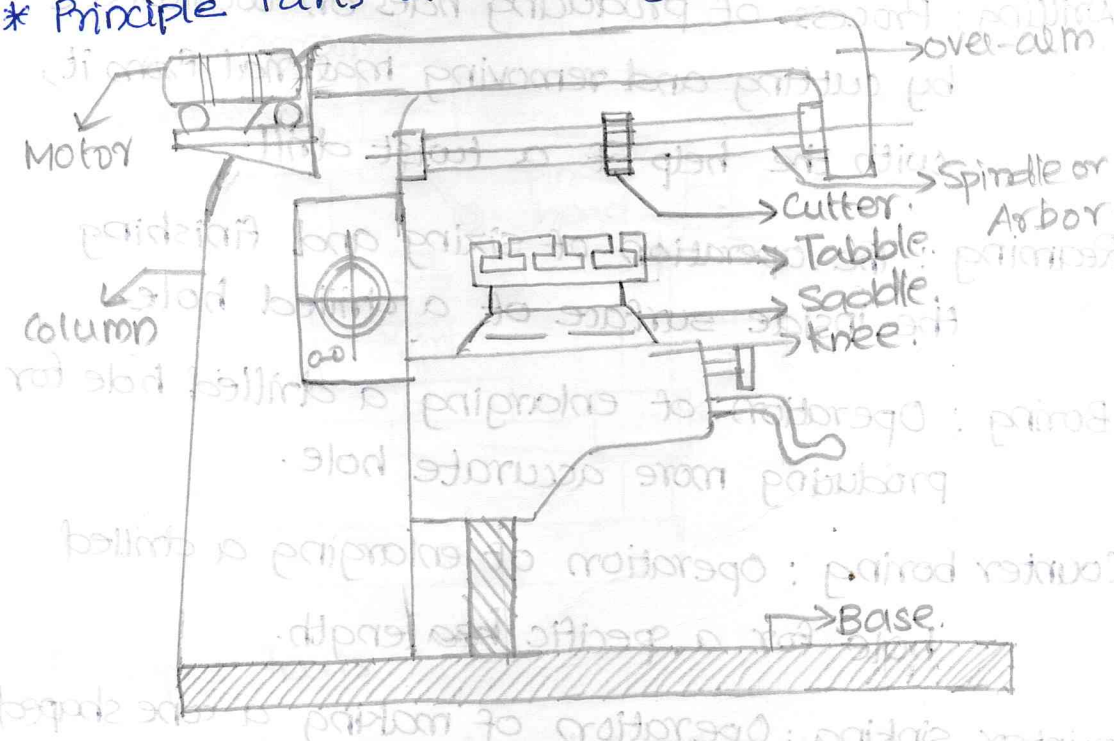
6. Tapping : Operation of cutting internal thread in a drilled hole with an externally threaded tool called tap.

~~GRINDING~~

MILLING MACHINE

- One of the commonly used machine tools which produce flat and curved surface on workpiece.
- most preferred tool due to its accuracy and high production rate.

* Principle of Milling.
* Principle Parts of a Milling Machine.



1. Base – heavy member on which all other parts rest.
2. Column – main supporting frame to which driving mechanism is fixed. Supports and guides the knee during its vertical travel.

3. Knee – structural member attached to column; can move vertically for adjusting depth of cut.

4. Saddle – supports the work table

5. Table – supports workpiece; travel longitudinally

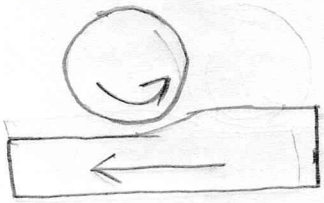
6. Overarm – mounted on top of column for supporting the spindle.

7. Spindle – mounted on upper part and receives power from motor by belt or gear.

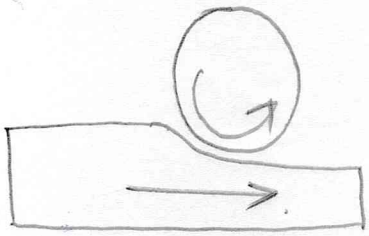
8. Arbor – Extension of spindle on to which the cutter can be mounted.

Milling Methods:

1. Up-Milling (Conventional Milling)



2. Down-Milling (Climb milling)



Milling Machine operations.

1. Plain or slab milling
2. Face milling
3. Straddle milling
4. Angular milling.

CAD/CAM.

CAD

- Computer Aided Design
- CAD may be defined as any design activity that involves effective use of computer to create and modify an engineering design.

CAM

- Computer Aided Manufacturing
- CAM may be defined as the use of computer system to plan, manage and control the operations in a manufacturing plant.