UNIT-I

Metal casting Processes

Casting:-

* Casting is a manufacturing processes by which a liquid material is poured into a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as casting.

Sand casting:-

* Sand casting is widely used for centuries because of the simplicity of the process. The sand casting process involves the following basic steps.

(i) Place a wooden or metallic pattern in sand to create a mould.

(ii) Fill in the pattern and sand in a gating system.

(iii) Remove the pattern.

(iv) Fill the mould cavity with molten metal.

(v) Allow the metal to cool

(vi) Break the sand mould & remove the casting.

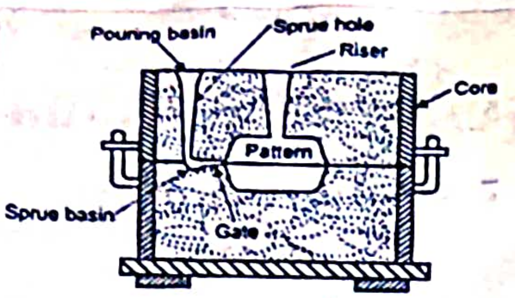


Fig.1.1 Method of sand casting

Advantages:-

* It can be employed for all types of metal.
* The tooling cost is low &
* It can be used to cast very complex shapes.

Disadvantages:-

* Rough surface
* Poor dimensional accuracy
* Higher maching tolerances.
* Coarse Grain structure.
* Limited wall thickness.

Pattan:-

* The pattan is the primary tool during the casting process.

* It is the replica of the object to be made by the casting process.

Functions of the pattan:-

(i) A pattan prepares a mold cavity for the purpose of making a casting.

(ii) A pattan may contain projections known as the core prints if the casting requires a core and need to be made follow.

(iii) Runner, gates, & risers used for feeding molten metal in the mold cavity may form a part of the pattan.

Types of pattan:-

(i) Single piece pattan (or) Solid pattan
(ii) Split pattan (or) cope & drag
(iii) Match plate pattan.
(iv) Loose piece pattan.
(v) Gated pattan.

(vi) Sweep pattern
(vii) Skeleton pattern
(viii) Segmental pattern.
(ix) Shell pattern.

Pattern material:-

* Wood → common material for the preparation for pattern
* Metal → A metal pattern can be either
* Gypsum → cast from wooden pattern
* Plastic → also cast from wooden pattern
* Wax → generally used in investment casting.

Wood:
(ex: white pine, Mahogany, Maple, Birch, Cherry)

Metal:-
(ex: cast iron, brass, aluminium, white metal)

Plastic:
(epoxy, phenol formaldehyde, & polyester resin)

Wax:
(Paraffin wax, Shellac wax, microcrystalline wax)

Pattan Allowances:-

* Pattan allowance is a vital feature as it affects the dimensional characteristics of the casting.

(1) Shrinkage (or) contraction allowance
(2) Draft (or) taper allowance.
(3) Maching (or) finish allowance
(4) Distortion (or) cambea allowance
(5) Rapping allowance.

(1) Shrinkage (or) contraction:-

* Liquid shrinkage:- → it refeas to the reduction in volume when the metal changes from liquid state to solid state at the solidus tempeatuae.

* Solid shrinkage:→ it refeas to the reduction in volume caused when metal loses temperatuae in solid state.

C.I mattable iron	= 10mm/m
Brass, Cu, Al	= 15mm/m
Steel	= 20mm/m
Zinc, Lead	= 25mm/m.

Machining Allowance:-

* In case the casting designed to be machined, they are over-sized in those dimensions shown in the finished working drawings.

* M/c allowance is given due to following reasons:

(i) casting get oxizied inside mould & heat treatment.

(ii) For removing surface roughness, slag, dirt, & other imperfections from the casting.

(iii) For obtaining exact dimensions on the casting.

(iv) To achieve desire surface finish on the casting.

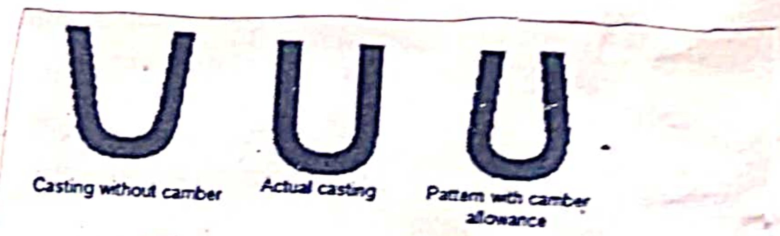
Material cast	overall length of external surface, mm			
	0-30	30-60	60-105	105-150
Al alloys	1.6	3.2	3.0	4.8
Brass, Bronze	1.6	3.2	3.0	4.8
Cast Iron	2.4	3.2	4.8	6.4
C.S	3.2	4.8	6.0	9.6

Distortion (or) Camber allowance:-

* Sometimes castings, because of their size, shape and type of metal, tend to warp (or) distort during the cooling period depending on the cooling speed.

* This is due to the uneven shrinkage of different parts of the casting.

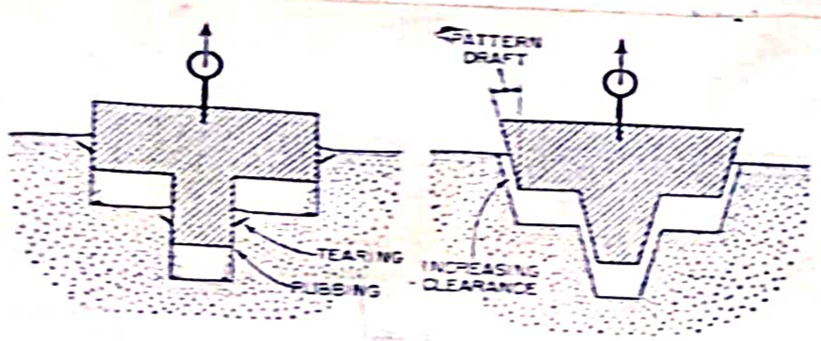
Typical Distortion Allowance.							
Length in MM		3000			6000		
Wall thickness in MM		12	25	50	12	25	50
Distortion allowance for depth	450	12	8	3	27	20	50
	600	7.5	5	2	18	12.5	5



Draft Allowance (or) Taper allowance:-

* When a pattern is drawn from a mould, there is always a possibility of damaging the edges of the mould.

* The amount of draft needed depends upon (1) the shape of casting (2) depth of casting (3) moulding method; (4) moulding material



Rapping (or) shaking Allowance:-

* When the pattern is shaken for easy withdrawal, the mould cavity, hence the casting is slightly increased to size.

* In order to compensate for this increase, the pattern should be initially made slightly smaller.

Moulding Sand:-

There are various types of moulding sand:-

(1) Green sand :→ It is composed of a mixture of silica sand (68-86%) clay (16-30%) & water (5-8%). The word 'green' is associated with the conditions of wetness (or) freshness.

(2) Dry sand :- → It is basically green sand. But mixed with 1 to 2% of cereals and 1 to 2% of peat are added additives with the green sand & also dried at 110 to 260°c.

(3) Facing sand :- → This sand is directly cover the surface of the pattern & provides a smoother casting surface & should be of fine texture.

(4) Backing sand :→ This is sand which is used to back up the facing sand and to fill the whole volume of the flask.

(5) System sand :→ M/c moulding is employed, the sand is used to fill the whole flask. Because of this, the system sand must have higher strength

Moulding Sand propaties:-

It must have the following requirements.

(1) It should be able to retain & reproduce the details as imparted by the pattern

(2) It should be able to retain the bulk structure.

(3) It should not be too much sticky either to the pattern (or) to the casting.

(4) It should prevent reaction with the liquid metal.

To achieve the above requirement, the moulding sand must have the following propaties.

* Permeability
* Plasticity
* Adhesiveness
* Cohesiveness
* Refractoriness
* Collapsibility

Permeability → During pouring & subsequent solidification of a casting, a large amount of gases & steam is generated. These gases are those that have been absorbed by the metal during melting, air absorbed from the atmosphere and the steam generated by the molding the core sand.

Flowability:-

It is the measure of the moulding sand to flow around & over a pattern during ramming and to uniform fill the flask.

Adhesiveness:-

This is the property of the sand mixture to adhere to another body.

Cohesiveness:-

* Green strength
* Dry strength
* Hot strength
* Refractoriness
* Collapsibility

Sand testing:-

* Molding sand & core sand depend upon shape, size composition & distribution of sand grains, amount of clay.

* The increase in demand for good surface finish and higher accuracy in castings necessitates certainty in the quality of mold & core sands.

* Sand casting often allows the use of the less expensive local sands. It also ensures reliable sand mixing & enables a utilization of the inherent properties of molding sand.

The following tests are performed to judge the molding & casting characteristics of foundary sands.

1. Moisture content test
2. Clay content test
3. Fineness test
4. Refractoriness of Sand
5. Strength test
6. Permeability test
7. Flowability test
8. Mould hardness test.

Moisture content test :-

* Measurement by evaporation method
* Measurement by moisture tellor method
* Measurement by moisture teller chemical reaction method.

* Measurement by evaporation method:-

(i) Sample of moulding sand weighing about 20 to 50 grams are allowed to heat at a constant temperature upto 100°c in an oven for about one hour.

(ii) It is then cooled to a room temperature and then reweighing the molding sand.

(iii) Moisture content in moulding sand is thus evaporated.

(iv) The loss in weight of molding sand due to loss of moisture, gives the amount of moisture which can be expressed as a percentage of the original sand sample.

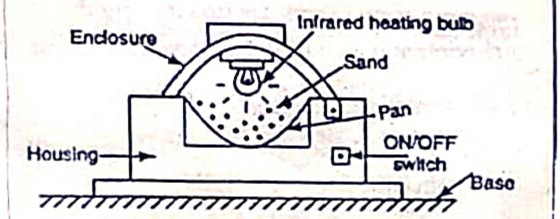


Fig.1.11 Evaporation method

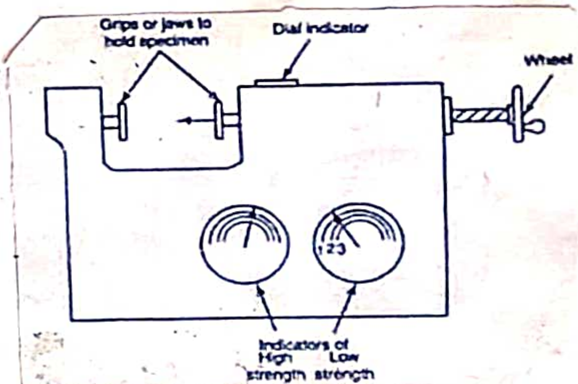


Fig.1.14 Strength Tester

Clay content test:

* The sample of molding sand weighing about 50 grams is mixed with water & 1% NaOH & allows stirring for 4-7 minute, & then waiting for 10-15 minutes for sedimentation. Now the sand was settling down. The dirty water is present at the top portion of the pan.

* The above process is repeated until to achieve clean water at the top portion of the pan. The water is drained off.

Refractoriness test:-

* It is judged by heating the A.F.S standard sand specimen to very high temp. ranges depending upon the type of sand.

* The heated sand test pieces are cooled to room temp & examined under a microscope for surface characteristics (or) by sintering has not yet set in.

* If the silica sand grains remain sharply defined and easily give way to the needle.

* At each temp level, it is kept for at least 3 minutes & then taken out from the oven for examination under a microscope for evaluating surface characteristics.

Core:-

* A core is a body made of refractory material, which is used for making cavity or a hole in casting. Its shape is similiar to the required cavity in the casting.

* Core print is a projection provided on the casting product.

Requirements of core:-

* Green strength: In the green condition there must be adequate strength for handling.

* Permeability must be very high to allow for the escape for gases.

* Good refractoriness is required as the core is usually surrounded by hot metal during casting (or) molding.

* A smooth surface finish.

* Minimum generation of gases during metal pouring.

Purpose of cores:-

* It may form a part of green sand mould.

* Cores may be employed to improve the mould surface.

Types of cores:-

(a) Acc. to the shape & position of the core:-

* Horizontal core
* Vertical core
* Hanging (or) cover core
* Balanced core
* Drop core (or) stop off core
* Ram up core
* Kiss core.

(b) Acc. to the state (or) condition of core:-

* Green sand core
* Dry sand core
* Sodium silicate core.

(c) Acc. to the type of core-hardening process employed:-

* CO_2 process
* The hot box process
* The cold set process
* Castable sand process
* Oil-No-Bake process.

Moulding machine:-

Moulding processes may be classified as hand moulding (or) machine moulding acc. to whether the mould is prepared by hand tools or with the aid of some moulding m/c. It carry out the following operations:

* Ramming the moulding sand
* Rapping the pattern for easy removal.
* Removing the pattern from the sand.

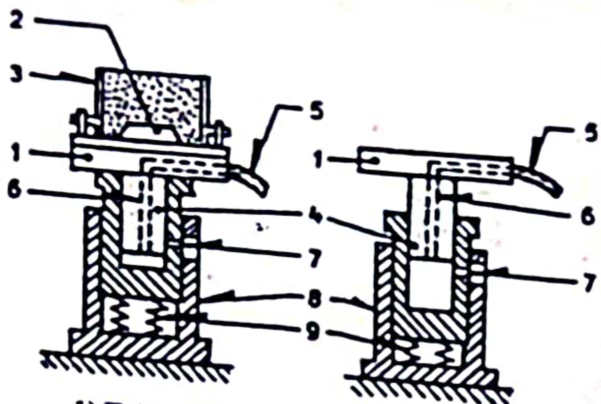
There are three types of moulding m/cs are there.

1. Jolting machine
2. Sequeezing machine
3. Sand slinger.

Jolting machine:-

* In Jolting m/c, the pattern is placed in the flask/moulding box on the table. The flask is filled up with moulding sand.
* The table with moulding box is raised to 80 mm & suddenly dropped. The table will be operated pneumatically (or) hydraulically.

* The sudden daopping of table from a height makes the sand pack evenly around the pattan.



1) Table 2) Pattern 3) Moulding box
4) Plunger 5) Pipe 6) Channel
7) Through hole 8) Cylinder 9) Spring

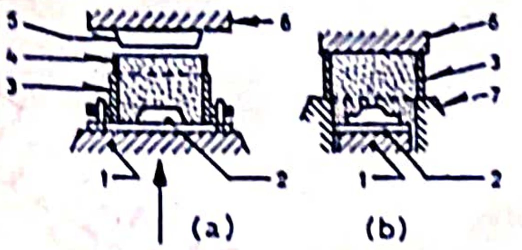
Fig. 1.34 Jolt Moulding Machine

Sequeezing machine:-

* The moulding sand in the flask is sequeezed b/w the machine table & a squeezer head.

* The mould board is clamped on the table. The flask is placed on the mould board. The pattan is placed inside the flask. The sand is filled up & leveled. The table is raised by the table lift mechanism against the squeezer head.

* The main limitation of this m/c is that the sand is rammed more densely on the top of the mould.



1) Table 2) Pattern 3) Flask 4) Sand Frame
5) Platen 6) Squeezer head 7) Frame

(a) Top Squeezer Machine (b) Bottom Squeezer machine

Fig.1.33 Squeeze moulding machine

Sand slinger:-

* In this process, the pattern is placed on a board. The flask is place over it. Now, the slinger is operated.

* The slinger has an impeller which can be rotated with different speeds. When the impeller rotates, it throws a stream of sand at greater velocity in the flask. Hence, the sand is packed in the flask.

* It is used for large & medium size moulds.

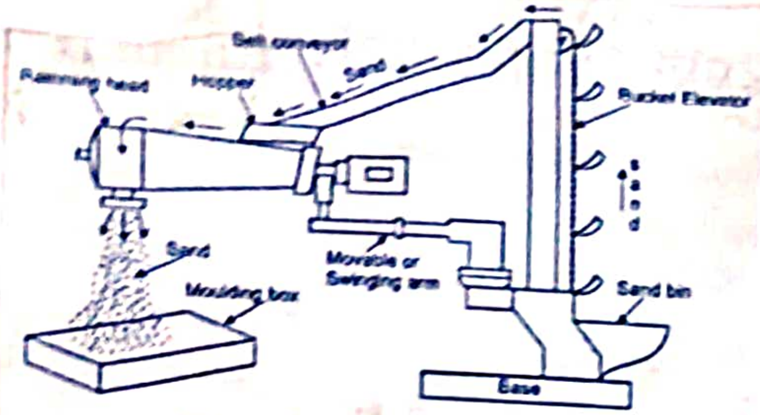


Fig. 1.35 Sand Slinger Machine

Blast furnace:-

* It is a type of furnace used for smelting metal ore, usually iron ore. The Combustion material & ore are supplied from the top while air flow is supplied from the bottom of the chamber so that the chemical reaction takes place not only at the surface throughout the ore.

* This type of furnace is typically used for smelting iron to produce pig iron which is the raw material for wrought & cast iron.

Working:-

* The nature of reaction takes place inside the furnace is given by,

$$Fe_2O_3 + 3CO \Rightarrow 2Fe + 3CO_2$$

The compressed air blown into the furnace reacts with the carbon in the fuel to produce carbon monoxide which the mixes with iron oxide, reacting chemically to produce iron & CO_2 which leaks out of the furnace at the top.

* The temp. in the furnace is typically about 1500°C which is also enough to decompose limestone into calcium oxide & CO_2

$$CaCO_3 \Rightarrow CaO + CO_2.$$

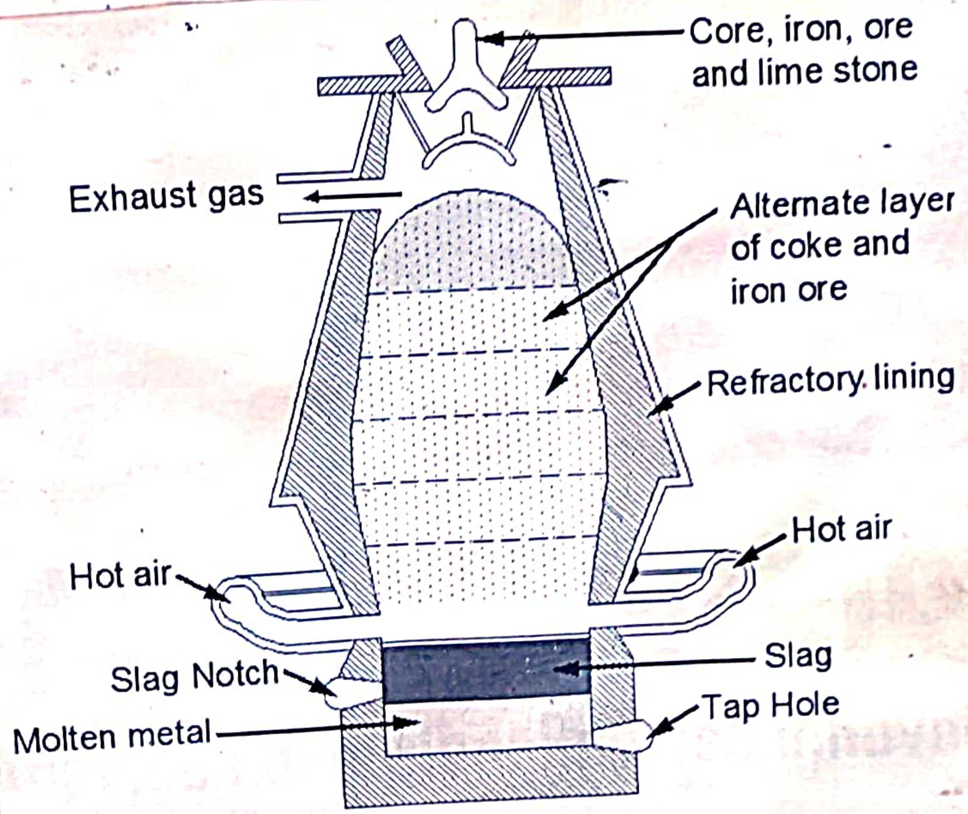


Fig. 1.37 : Blast Furnace

Cupola furnace:

Constauction:-

* It is a vatical & cylindaical shell made of 10mm thick steel plate. It is lined with refractory bricks inside.

* Two bottom doors close the bottom of the cupola. A sand bed is laid over the bottom doors sloping towords the tap hole.

* The legs are set at the bottom of the furnace using a concrete. The slag hole is provided in the shell above the tap hole.

* The slag floating over the molten metal is removed through this slag hole. The opening, called turyeas, are provided one meter above the bottom.

Preparation:-

* The slag & waste from previous melting are cleaned. Broken bricks are repaired (or) replaced if necessary.

* The tap hole is formed & lined with clay. Then a slag hole is prepared. Finally the cupola is dried thoroughly.

Firing:-

* Oil waste & wooden pieces are placed at the bottom & fire is started. Now the sufficient amount of air is supplied when the wood starts burning.

* The coke is charged at several positions. Now the coke burns.

Charging & Melting:-

* Pig iron & iron scrap are charged into the furnace through the charging door. Then the coke is charged alternatively.

* The ratio of pig iron to limestone & pig iron to coke are 25:1 & 10:1 respectively. The cupola is fully charged. Then the iron is soaked for one hour.

* Then the molten metal can directly be poured into moulds. The floating slag on the top layer of the molten metal is tapped out through the slag hole.

Application:-

* Cupola is used to melt cast iron.

Advantages:-

* Initial cost is comparatively less than other type of furnaces.
* It is simple in design
* It requires less floor area.
* Operation & maintenance are simple.

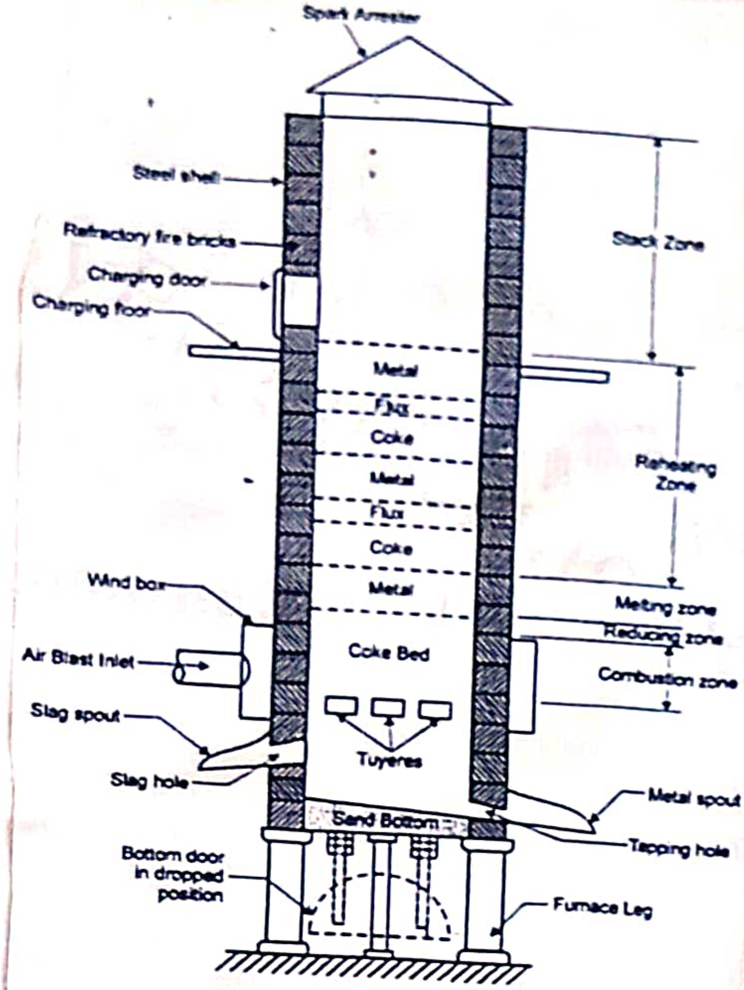


Fig.1.36 Cupola Furnace

Shell moulding processes:-

* The shell moulding casting is a semi-precise method for producing small castings in large numbers.

* The mould material contains 5 to 10% of phenolic resin mixed with fine dry silica. These are mixed with either dry oil (or) alchohol.

* The pattern is heated to 230-600°c. Then the sand-resin mixture is either dumped (or) blown over its surface. A releasing agent silicone is sprayed over the hot pattern. It results in bonding the sand grains closely together and forms a shell around the pattern.

* After a specified time of 20-30 sec, the patterns & sand are inverted. The thickness of the shell can be accurately controlled by the time of contact of the mixture with heated pattern.

* The thickness of the shell is depending on the required strength & rigidity to hold the weight of liquid metal to be poured into the mould.

* Then the mould is heated in an oven at 300°c for 15-60 sec. This curing makes the shell rigid when it can be stripped off by means of ejector pins. mounted on the pattern.

Applications:-

* It is used for making brake drums & bushings.
* Cams, cam shaft, piston & piston rings can be made.
* It is used for making small pulleys,

Advantages:-

* A high accuracy castings.
* Good surface finish
* Complex parts can be made.

Limitations:-

* Only small size of castings can be made.
* The cost is more.

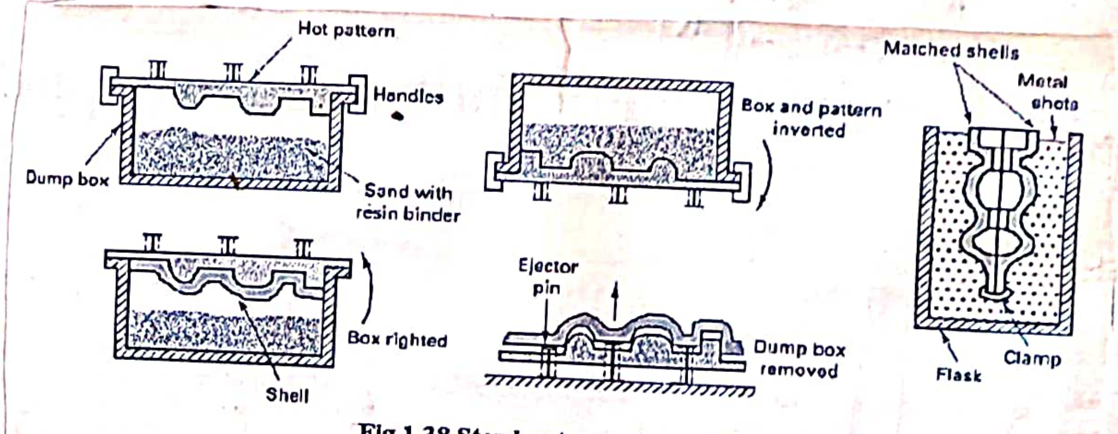


Fig.1.38 Step by step of shell moulding process

Investment casting (or) Lost wax process:-

* The castings obtained by this method they have very smooth surfaces & possesses high dimensional accuracy.

* Investment means the layer of refractory material with which the pattern is covered to make the mould.

Steps involved in lost wax process:-

(i) The master pattern is prepared by casting process. It may be made of brass, aluminium alloy (or) steel.

(ii) A composite die is used for making the master pattern.

(iii) First, halves of die cavities are clamped together. Molten wax is injected under the pressure of about 4 bar to the die cavity. If it is a plastic material such as polystyrene, polythene, the injection pressure is in the order of 35 bar with high temp.

(iv) If the size of the wax pattern is large, the several small wax patterns are first prepared and assembled together with a gating system along with central sprue.

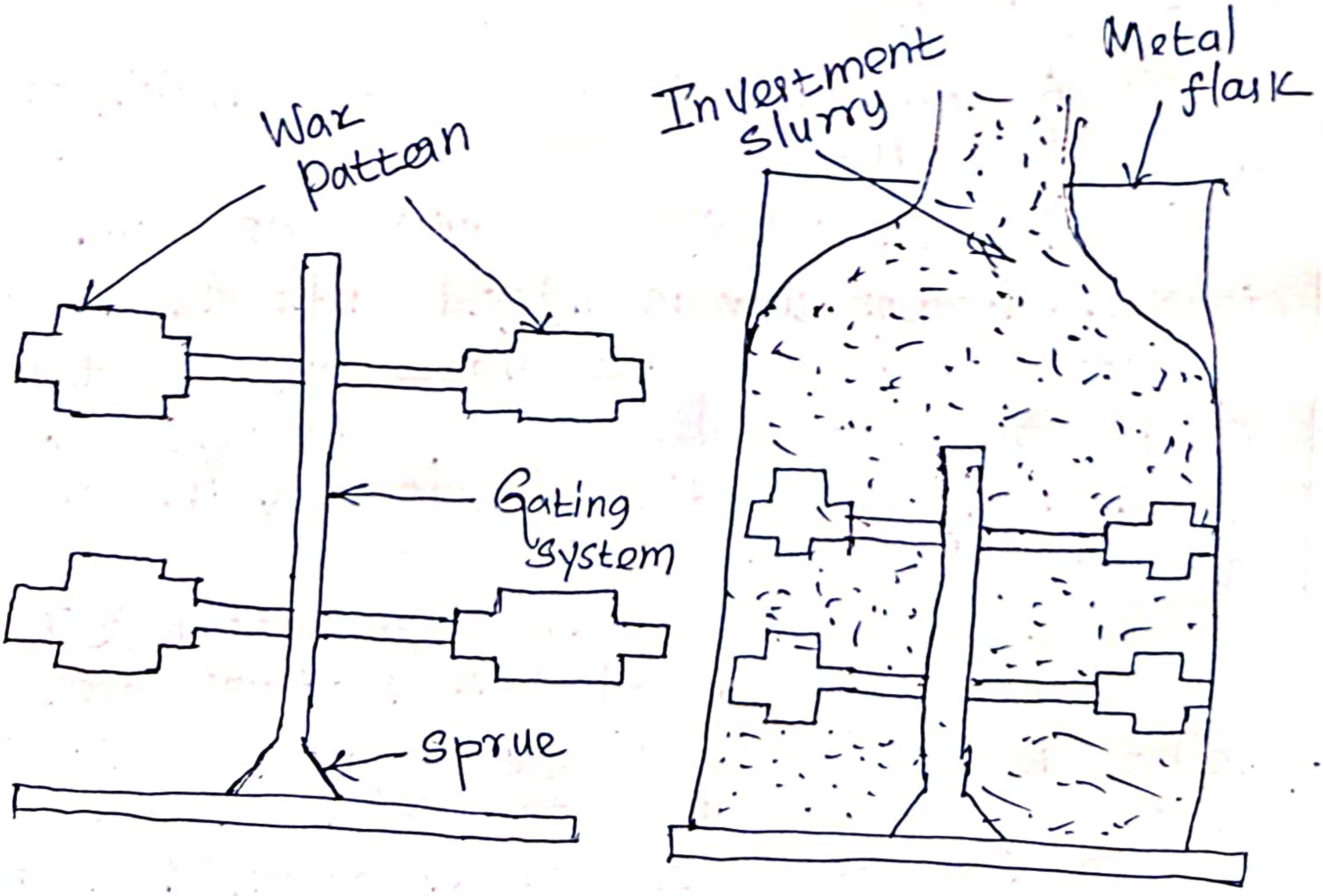
(v) The assembled wax patterns have to be smoothened/super finished before putting into operation.

Applications:-

* Production of nozzles, buckets, vanes & blades for Gas turbine
* Making parts for aerospace industry.
* This process is applied in costume jewellery.

Advantages:-

* Complex shape can be cast accurately
* Surface finish is very Good
* High accuracy can be maintained.



Pressure Die casting:-

* In the die casting process, the mould called a die, is used for making a casting which is permanent. In this process, the molten metal is forced into the mould cavity under high pressure.

* There are two types of die casting processes. They are,

1. Hot chamber die casting
2. Cold chamber die casting

Hot chamber die casting:-

* In hot chamber die casting, the melting furnace is an integral part of the mould. There is a gooseneck vessel which is submerged in molten metal.

* There is a plunger at the top of the gooseneck vessel. as shown in fig. when the plunger is in the upward position, the molten metal will flow into the vessel through a port provided on the sidewall.

* When the plunger comes down, the molten metal is forced into the dies. since, the die is immediately cooled by water & sufficient cooling is provided for solidification.

Cold chamber die-casting:-

* In cold chamber die casting, the metal melting unit is not an integral part of the m/c. The metal is melted in a separate furnace & brought to the machine for pouring.

* Cold chamber die casting is more suitable for metals with high melting points & corrosive properties.

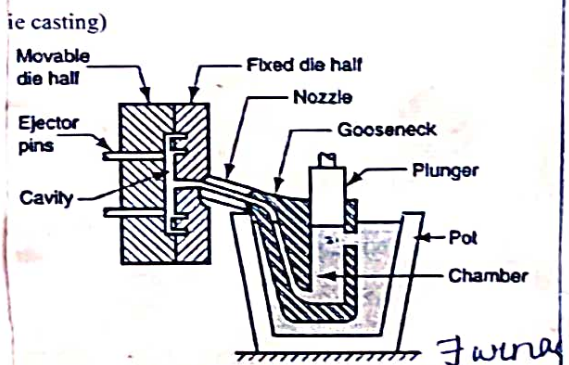


Fig. 1.44 : Hot chamber die casting

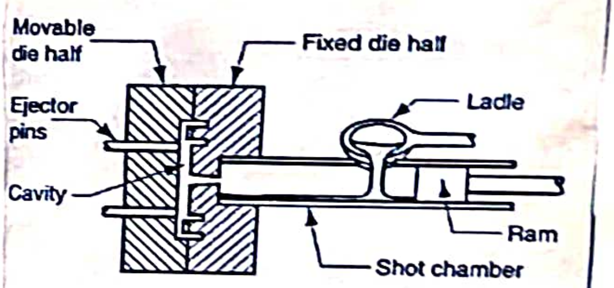


Fig. 1.45 : Cold chamber die casting

Applications:-

* House hold equipment such as washing m/c parts, Vaccum cleaner body.
* Automobile parts such as fuel pump, horn, wiper & crank case.

Advantages:-

* Very accurate castings of can be produced
* Castings with very good surface finish can be made.
* Rate of production is high.

Limitations:-

* Only small part can be made.
* Equipment cost is high
* It is more suitable for mass production only.

Gravity die casting:-

* It is also called permanent mould casting. The mould is generally made of two halves. They are hinged at one end. There is a provision for clamping them together at other end.
* A permanent mould is necessary for producing large number of casting of similar shape.
* Pouring cup, sprue, gates & risers are made in this mould itself. First, the mould is preheated. Then refractory material is done by spraying (or) brushing.

* The molton metal is fed into the mould with the help of gravitional force. Hence, this process is called gravity-die-casting.

* Almost all metals can be cast in this mould.

App/n:-

Used for carburetor bodies, oil pump bodies, pistons, connecting rods, etc.

Advantages:-

* Accurate casting can be made
* Good surface finish to castings
* Less floor space is enough.
* Production rate is high.

Limitations:-

* Only small castings can be made
* Suitable for mass production.
* Initial cost is high.

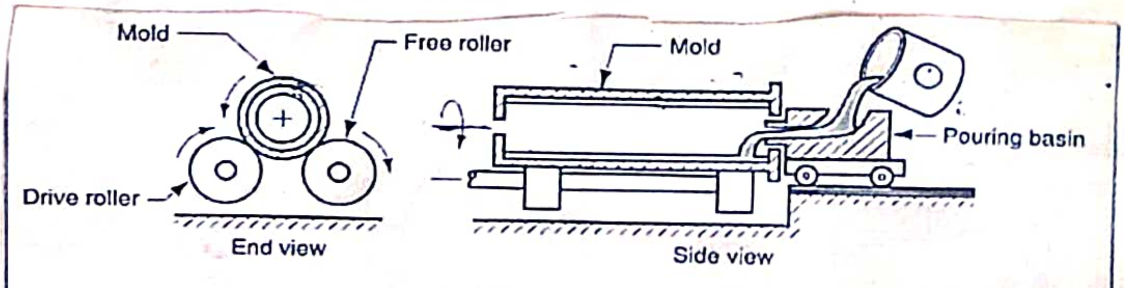


Fig. 1.40 Centrifugal casting

CO_2 process:-

* CO_2 moulding is a sand casting process that employs a moulding mixture of sand and liquid silicate binder such as sodium silicate (Na_2SiO_3). The moulding mixture is then hardened by blowing CO_2 gas through it. For this reason, the process is commonly known as CO_2 process.

Steps involved in CO_2 Process:-

* Suitable proportions of silica sand & sodium silicate binder are mixed together to prepare sand mixture.
* Additives such as Al_2O_3, molasses are added to impart the favorable properties and improve the collapsibility of the sand.
* The pattern is placed on a flat surface with the drag box enclosing it.
* The drag box is filled with the sand mixture & rammed manually till its top surface.
* At this stage, the CO_2 Gas is passed through the vent holes as shown in figure.
* Sodium silicate reacts with CO_2 gas to form silica gel that binds the sand particles together.

Centrifugal casting:-

* It is primarly used for making hollow castings such as pipe without using core. The rotating mould is mounted on a trolley as shown in fig.

* The metal is poured into the mould through a long spout. The mould is rotated by an electric motor or mechanical means as well as it moves axially on the rails.

* Due to centrifugal force, the molten metal is thrown to the walls of the mould. The outside of the mould is water-cooled so the molten metal immediately solidifies.

Applications:-

Water pipes, gears, bush bearings, fly wheels, piston rings, brake drum ect.

Advantages:-

* Cost is not required
* rate of production is high
* Pattern, runner, riser are not required
* Thin castings can be made.

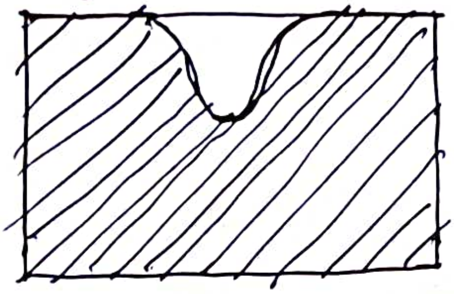
Limitations:-

* Only for cylindrical & symmetrical shape castings
* The cost of equipment is high.

Defects in sand castings:-

1. Shrinkage:-

* It is a depression on the casting surface.



Causes:-

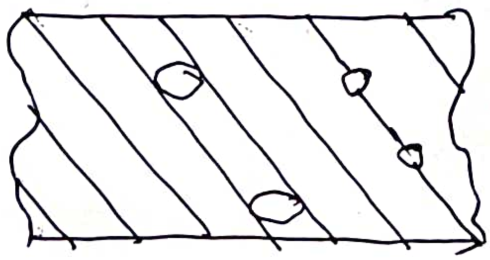
* Improper solidification
* Incorrect pouring temp
* Faulty Gating, runner.

2. Blow holes:-

* When the molten metal is poured, gases & steam are formed.

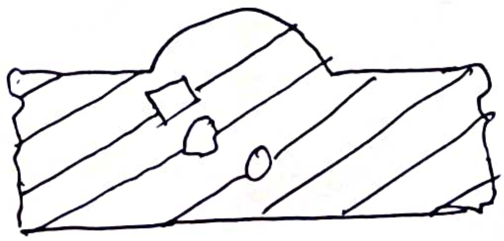
Causes:

* Excess moisture in sand
* Hard ramming
* Improper venting
* Excess binder.



3. Scab:-

* It is the erosion or breaking down a portion of the mould and the recess filled with metal.



Causes:-

* Uneven ramming
* High velocity of pouring.

The chemical reaction is given by,

$$Na_2SiO_3 + CO_2 \Rightarrow Na_2CO_3 + SiO_2$$

Application:-

* It is ideally used for casting applications where the speed & flexibility are paramount.

Advantages:-

* Good dimensional accuracy.
* Excellent surface finish
* High-production runs.

Limitations:-

* Poor collapsibility
* Significant loss in the strength & hardness of moulds.

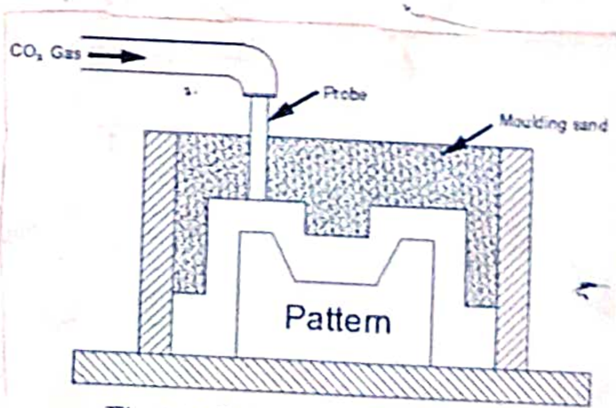
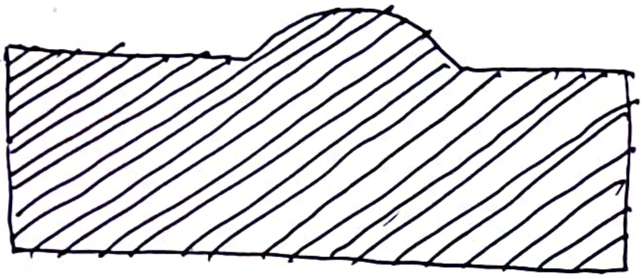


Fig. 1.47 Carbon - di - Oxide Processess

④ Swell:-

* It is the deformation of vertical mould surface.

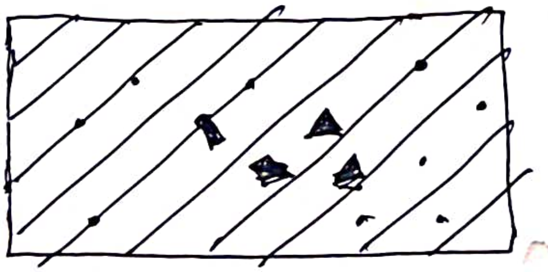


Causes:-

* Soft ramming
* Quick pouring
* Mould is not properly supported.

⑤ Hard Spots:-

* These are generally developed on iron castings rich in silicon content due to local chilling of those spots by moulding sand.

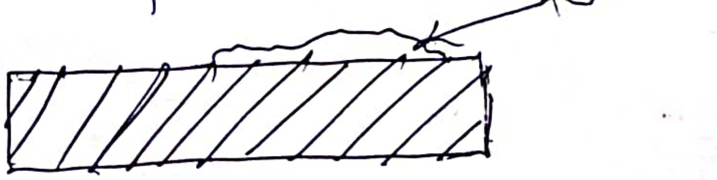


Causes:

* Rapid cooling
* Pouring at low temperature.

⑥ Runout:

It is the leakage of metal out of the mould while pouring.



UNIT-II

METAL JOINING PROCESSES

Welding:-

The process of joining similiar metals by the application of heat is called welding.

Classification:-

I. Gas welding:-

(a) Air-acetylene welding
(b) oxy-acetylene welding
(c) Oxy-hydrogen welding.

II. Arc Welding:-

(a) Carbon arc welding
(b) Plasma arc welding
(c) Shield metal arc welding
(d) TIG Welding
(e) MIG welding
(f) Submerged arc welding
(g) Electro-slag welding.

III. Resistance Welding:-

(a) Spot welding
(b) Seam welding
(c) Projection welding
(d) Resistance butt welding
(e) Flash butt welding.

④ Soild state welding:-

(a) Cold welding
(b) Diffusion welding
(c) Forge welding
(d) Explosive welding
(e) Friction Welding
(f) Ultrasonic Welding
(g) Hot pressure welding
(h) Roll welding.

Fusion Welding:- (non-pressure)

In fusion welding, the metal at the joint is heated to a molten state & then it is allowed to solidify. When the heat is alone is used during welding, the process is called fusion welding process. (non-pressure)

ex:-

Gas welding, arc welding.

Plastic Welding:- (Pressure)

In pressure (or) plastic welding, the metal parts are heated to a plastic state & they are pressed together to make the joint.

ex:-

Resistance welding, pressure welding.

Gas Welding:-

* It is one type of welding processes in which the edges of the metals to be welded are melted by using a gas flame.
* No pressure is applied during welding except pressure gas welding.

Based on the type & combination of gases used for producing flame.

(a) Oxy-acetylene welding
(b) Air-acetylene welding
(c) Oxy-hydrogen welding.

Oxy-Acetylene welding:-

* The combination of O_2 & C_2H_2 produces a flame temp about 3200°c, making it ideal for welding and cutting.
* Oxy-acetylene flame can also be used for brazing, bronze welding, forging/shaping metal and cutting.

Air-acetylene welding:-

* This process is similiar to oxy-acetylene welding process. Here air is used instead of O_2.
* It is successfully used in lead welding and many low melting temperature metals & alloys.

Gas welding equipment:-

* Gas cylinders
* Pressure regulators
* Pressure gauges.
* Hoses
* Welding torch
* Check valves (or) control valves
* Goggles
* Welding gloves

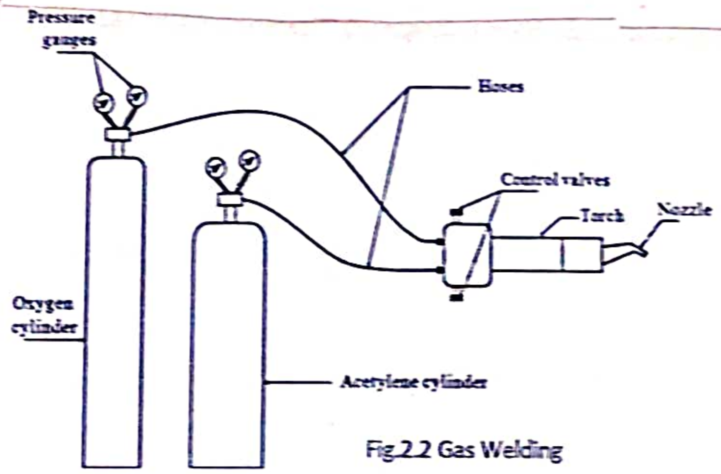


Fig.2.2 Gas Welding

Types of flames:-

* By varying the ratio of O_2 & C_2H_2, the following three types of flames can be obtained.

(i) Neutral flame
(ii) Carburising flame
(iii) Oxidising flame.

Netural flame:-

* It is obtained by supplying equal quantity of O_2 & C_2H_2. It has two zones i.e) one sharp bright inner cone & one bluish outer cone. The reaction of inner cone is given by,

$$C_2H_2 + O_2 \Rightarrow 2CO + H_2$$

* The reactions of the outer cone is given by,

$$2CO + O_2 \Rightarrow 2CO_2$$

$$H_2 + \frac{1}{2}O_2 \Rightarrow H_2O$$

The above reaction, O_2 is supplied from surrounding air. The outer cone protects the molten metal from oxidation.

ii) Carburising flame:-

* It is also known as reducing flame. which is obtained by supplying more C_2H_2 than O_2. This flame has three zones,

(1) Sharp inner cone

(2) White intermediate cone

(3) Bluish outer cone.

The mixture of carburising flame is given by,

$$O_2 : C_2H_2 = 0.85 \text{ to } 0.95$$

(iii) Oxidising flame:-

* It is obtained by supplying more O_2 than C_2H_2. It is similiar to netural flame

* The ration of the mixture of oxidizing flame is given by,

$$O_2 : C_2H_2 = 1.15 \text{ to } 1.5$$

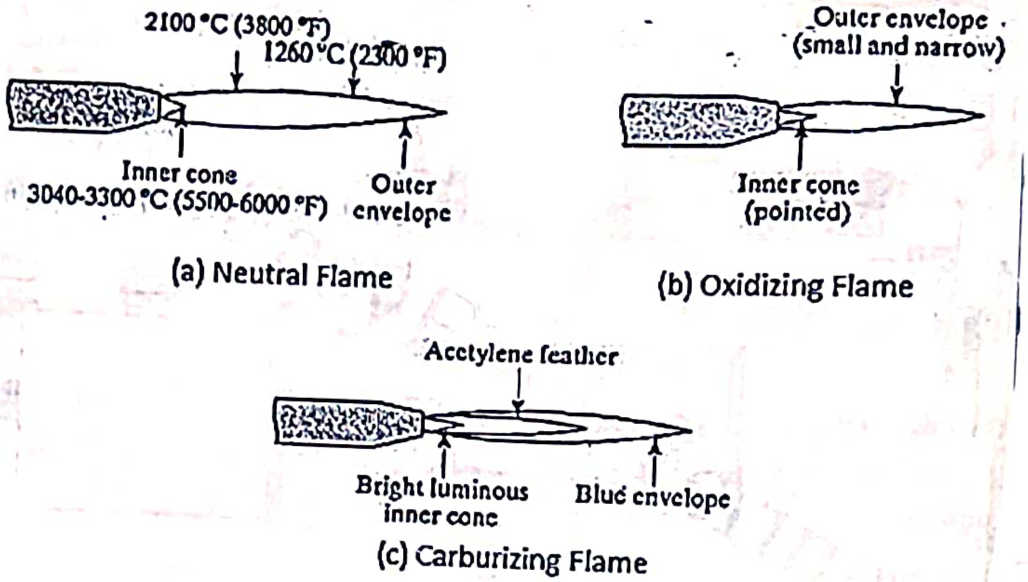


Fig.2.5 Various flame formation in Gas welding

Advantages:-

1. Temperature of flame can be easily controlled
2. The amount of filler metal deposits can be controlled.
3. The flame can be used for welding & cutting

Limitations:-

1. It is not suitable for joint thick plates
2. It is a slow process.
3. Strength of the weld is not as good as arc welding.

Applications:-

1. Oxy-acetelyne welding is extensively used.
2. It is also used for welding of dissimilar metals.

Arc Welding:-

* In this process, metals are melted & joined by heating them with an arc b/w a consumable coated metal electrodes & the workpiece.

* The flux assists in creating & stabilizing the arc and it provides the sheilding gas which prevents the reaction of the molten metal with atmospheric air.

Arc welding equipment:-

The following are the most commonly used equipment for arc welding.

1. Welding power source
2. Electrode
3. Electrode holder
4. Gloves
5. Protective shield
6. Apron
7. Wire brush
8. Chipping hammer.
9. Safety goggles.

Electrode:-

The electrode rod is made of a material (ie) compatible with the base material being welded & it is covered with a flux which protects the weld area from oxidation and contamination.

Types:-

There are two types of electrodes.

1. Consumable electrode
2. non-consumable electrode.

1. Consumable electrode:-

* The consumable electrode is not only used to produce arc b/w work & electrode but it also provides filler material during welding.
* They may be classified into following types:
  - (i) Bare electrodes
  - (ii) Lightly coated electrodes
  - (iii) Heavily coated electrodes.

2. Non-consumable electrode:-

* They are made of carbon, Graphite, tungsten which do not consume during welding. Non consumables electrodes are used in atomic hydrogen welding & TIG welding.
* Here the arc length remains constant and hence, it is stable.

Advantages:-

* Equipment is self contained
* Electrode provide its own flux

Limitations:-

* It is not recommeded for welding metal less than 1.5mm thick.
* Slag cleanup is required
* Welds are subjected to prorosity.

Gas Tungsten Arc Welding:- (GTAW) (or) TIG Welding

* In TIG welding, the electric arc is produced b/w a non-consumable tungsten electrode and the workpiece.
* There is electrode holder in which the non-consumable tungsten electrode is fixed to produce the arc.
* While supplying the electric power b/w electrode & w/p, the inert gas from the cylinder is passed through the nozzle of the welding head around the electrode.
* The inert gas is surrounded the arc & it protects the weld from atmospheric effects & hence, defect free joints are made.
* Filler metal may (or) may not be used. When a filler metal is used, it is fed manually into the weld pool.

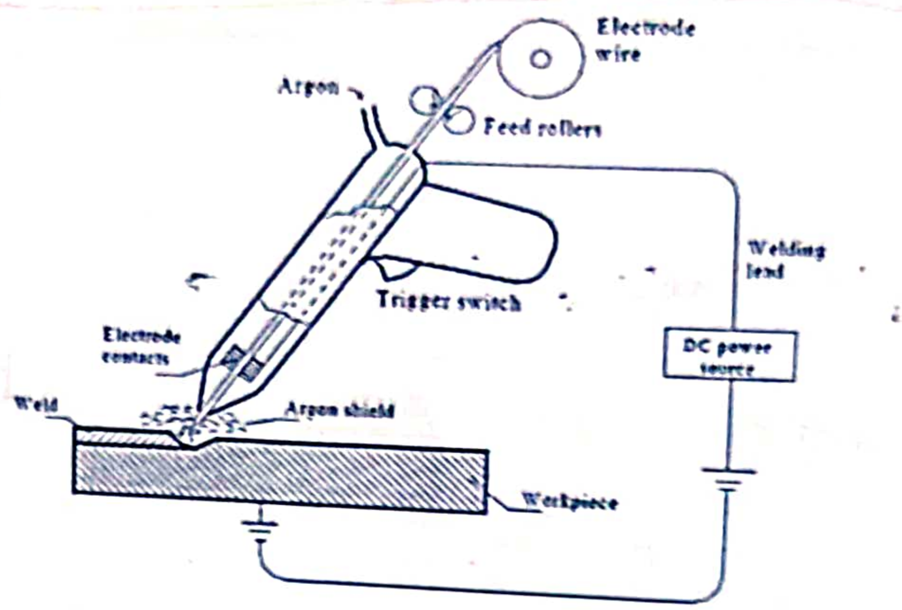


Fig.2.7 Metal Inert Gas (MIG) Welding

Advantages:-

* More suitable for thin sections.
* It does not create as much spatter and spark.
* No flux is required.

Disadvantages:-

* Restricted for flat & horizontal welding.
* It is slow in operation.
* equipment is more sophisticated.

Applications:

* AL, Mg, Cu alloys can be welded easily
* Thin parts & sheet metals can be welded easily.

Gas Metal arc Welding:- (MIG welding)

* In this arc welding, the electric arc is produced b/w a consumable metal wire electrode & the w/p.

* During welding, the arc & welding zone are surrounded by an inert gas. as shown in fig. Ar, He, CO_2, Ar–O_2 or other gas mixture are used as the inert gas. The surrounded inert gas protects the weld from atmosphere.

* A consumable electrode wire having chemical composition similiar to the parent material. The arc heats & melts both workpiece edges & electrode wire. The fused electrode material is supplied to the surfaces of the workpieces.

* Due to automatic feeding of the electrode the process is referred as a semi-automatic. The operator controls only the torch positioning and speed.

* A constant voltage DC power source is most commonly used with GMAW. The currents ranges from 100A to 400A depending upon the dia of the wire.

Advantages:-

(i) It is suitable for welding a variety of ferrous & non-ferrous metals.

(ii) No flux is required & hence there is no slag to remove.

Limitations:-

(i) It cannot be used in the vertical or overhead welding positions. due to the high heat input.

(ii) The process is more expensive

(iii) It needs more maintenance.

Applications:-

(i) Manufacture of tanks, pressure vessels & pipes.

(ii) It is used for welding Al, Stainless steel, nickel & Mg without weld defects.

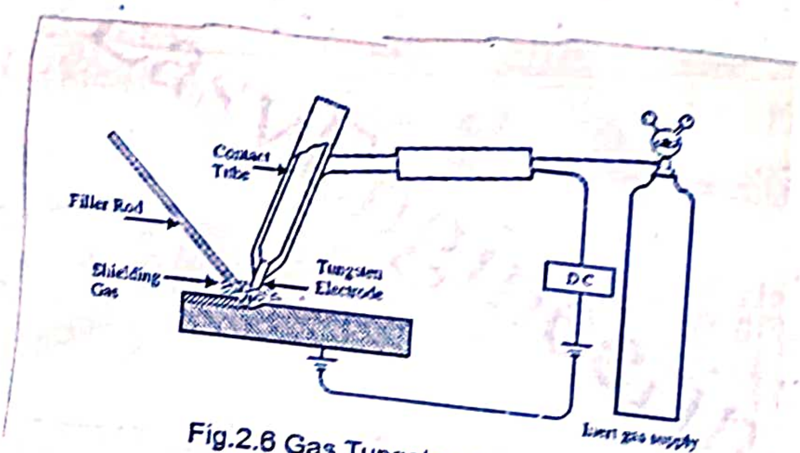


Fig.2.6 Gas Tungsten Arc Welding

	MIG welding	TIG welding
1.	It uses consumable electrode	It uses non-consumable electrode.
2.	It is used for thicker material	It is used for thinner material.
3.	Feeding of electrode is continuous	Feeding of electrode is discontinuous.

4. The process is easier	It is a difficult
5. It produces low quality weld.	It produces high quality weld.

Submerged Arc Welding:- (SAW)

* In this welding, the complete welding setup is dipped in the flux powder & it is named as submerged arc welding.

* The electric arc is produced b/w consumable bare electrode & w/p. But the arc is completely submerged ie) hidden under the flux powder. The arc is not visible outside.

* The flux powder is fed in front of the moving head. It is supplied from a hopper. The flux powder is made up of silica, metal oxides, & other components fused together & it is crushed to the proper size.

* Voltage used is 25V to 40V. Current used in SAW welding depends on the w/p thickness since the flux must cover the joint to be welded.

* Submerged arc welding is specially used for welding carbon steels & alloy steels. It can be used to weld chromium steels & chromium-nickel steels.

Advantages :-

1. Very high quailty welds are produced
2. It is a very fast method.
3. Deep penetration can be obtained.

Limations :-

1. It is not suitable for welding works which is inclined & vertical.
2. The welding zone is not seen.
3. Operation is limited.

Applications :-

1. It is used in pressure vessels, boilers, tanks, nuclear reactors, chemical vessels.
2. Fabrication of trusses & beams.
3. All types of heavy industry & manufacture of vessels and tanks for pressure & storage use.

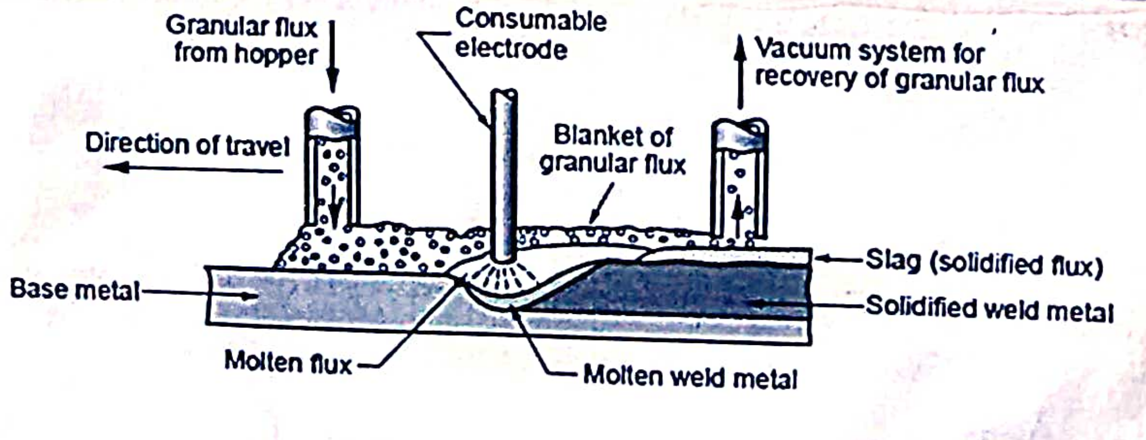


Fig.2.8 Submerged Arc Welding

Electroslag Welding:- (ESW)

* It is a highly productive & single pass welding process for thick materials in a vertical (or) close to vertical position.

Principle:-

The heat is generated by an electric current passing b/w consumable electrode and workpiece through slag.

Working:-

* ESW is similiar to electro gas welding, but the main difference is the arc starts in a different location. An electric arc is initially struck by wire that is fed into the desired weld location & then flux is added.

* The wire is then continually fed through a consumable guide tube into the surface of the metal work pieces & the filler metal are then melted using the electrical resistance of the molten slag to cause coalescence.

* The wire & tube then move up along the w/p while a copper retaining shoe that was put into place before starting.

* Keep the weld b/w the plates that are being welded as shown in fig.

Advantages:

* Heavy thickness metals can be welded
* low stress formation
* Preparation of joints is easy.
* High deposition during the weld.
* Low distortion.

Disadvantages:-

* Difficult to weld cylindrical objects.
* Hot cracking may occur.
* High cost.

Applications:-

* It is used for welding carbon steels, alloy steels, & nickel alloys.
* Forgings & castings can be welded.
* Heavy plates can be welded.

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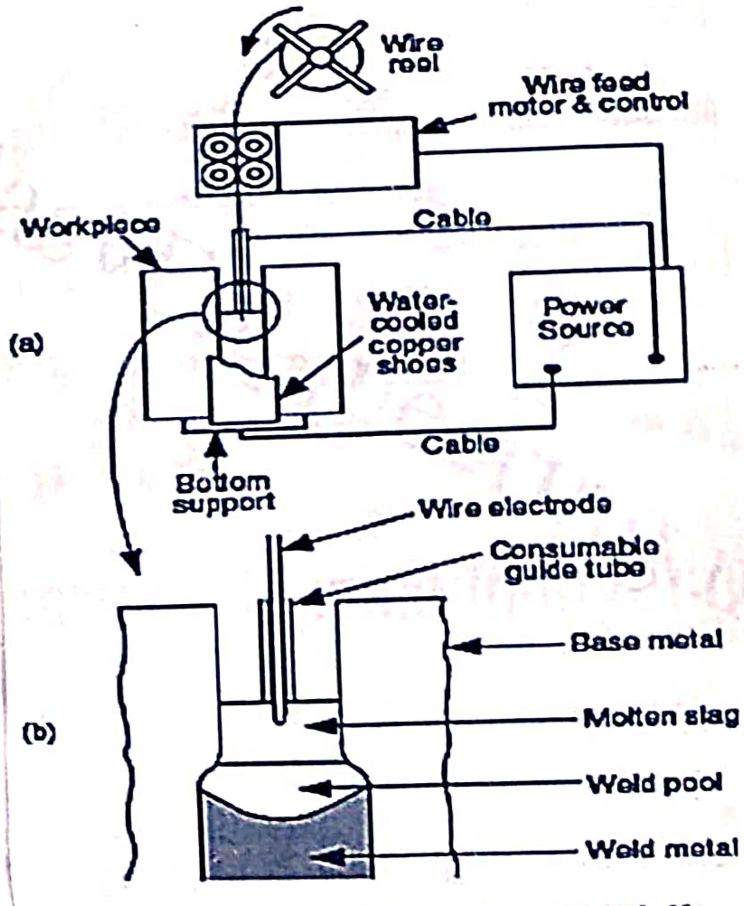


Fig.2.9 Electroslag welding

Resistance welding:-

* It is a thermo-electric process in which heat is generated at the interface of the parts to be joined by passing an electrical current through the parts for a precisely controlled time and under a controlled pressure.

* The name "resistance" welding derives from the fact that the resistance of the work pieces and electrodes are used in combination or contrast to generate the heat at their interface.

* The current is generated by a transformer as shown in fig. & is fired through electrodes which hold the metal pieces in place. These electrodes also apply force to the metal pieces, usually before, during & after the firing of the electric current. This method is called resistance welding because it is the resistance b/w the contact surfaces of the metals being welded that generates the heat to fuse them together.

* Depending upon the joint to be make resistance welding can be divided into different categories:

(a) Spot welding (b) Seam welding

(c) Projection welding (d) Percursion welding

Advantages:-

* Very short process time
* No consumables, such as brazing materials.
* Because of low voltage
* clean & environmentally friendly.
* A reliable electro-mechanical joint is formed.

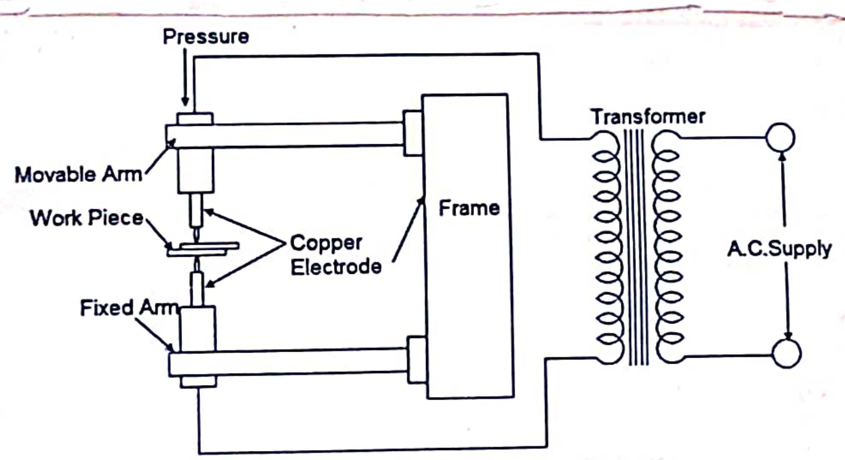


Fig. 2.10 : Resistance welding

Resistance Spot Welding:-

* It is widely used in mass production of automobiles, appliances, metal furniture.
* The joint made so is not air tight or water proof.
* Two opposing solid cylindrical electrodes are pressed against the lap joint & two metallic sheets to be weld.

* In this process, water cooled copper electrodes are used to clamp the sheets to be welded into place. The force is applied to the electrodes ensures intimate contact b/w all the parts in the weld configuration.

* The contact resistance b/w the two pieces of sheet metal to be jointed is much higher than the bulk resistance of the copper electrodes.

* The highest resistive heating occurs b/w the two pieces of sheet metal. As current continues to flow, melting occurs & a weld nugget is formed b/w the two sheets.

* On termination of the welding current, the weld cools rapidly under the influence of the chilled electrodes.

* This causes the nugget to solidify, joining the two sheets of metal.

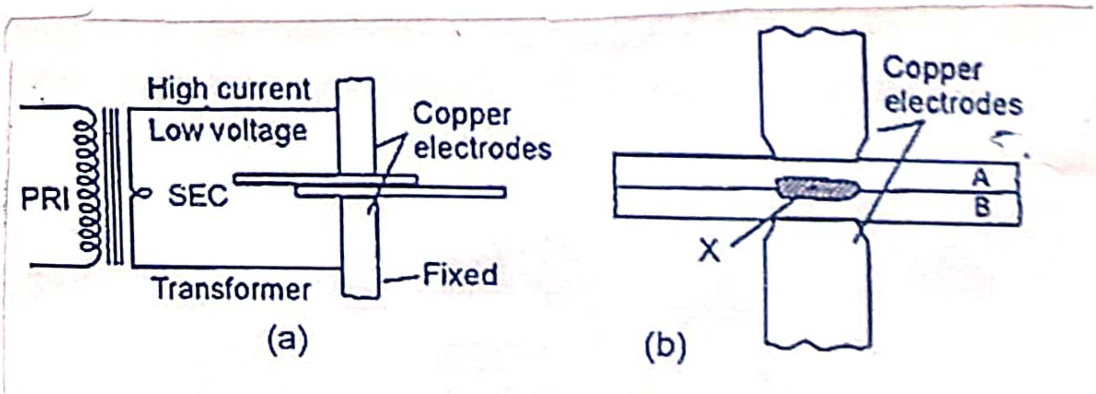


Fig. 2.12 : Spot Welding

Plasma Arc Welding Processes:-(PAW)

* It is an arc welding process where in coalescence is produced by the heat obtained from a constricted arc setup b/w a tungsten electrode and the water-cooled.

* The process employs two inert gases, one forms the arc plasma & the second shields the arc plasma.

* It is to increase the energy level of the arc plasma in a controlled manner. such that greater thickness can be welded with the minimum spread of the welding arc.

* The arc is constricted with the help of a water-cooled small diameter nozzle which squeezes the arc, increases its pressure, temperature and heat intensity & thus improves arc stability, arc shape, & heat transfer characteristics.

Equipment:-

(a) Power supply
(b) High frequency generator
(c) Plasma torch
(d) Shielding gases
(e) Voltage control
(f) Current & gas decay control.

Advantages:-

* Poneration is uniform
* Arc stability is good
* Fully penerated key holes &
* High accuracy weld can be produced.
* High speed weld can be obtained.

Disadvantages:-

* Huge noise occurs during welding
* chances of electric hazards
* It is limited to high thickness

Applications:-

* Used in aerospace applications
* Used in welding nickel alloys
* Used for melting metals.
* Used for tube mill applications.

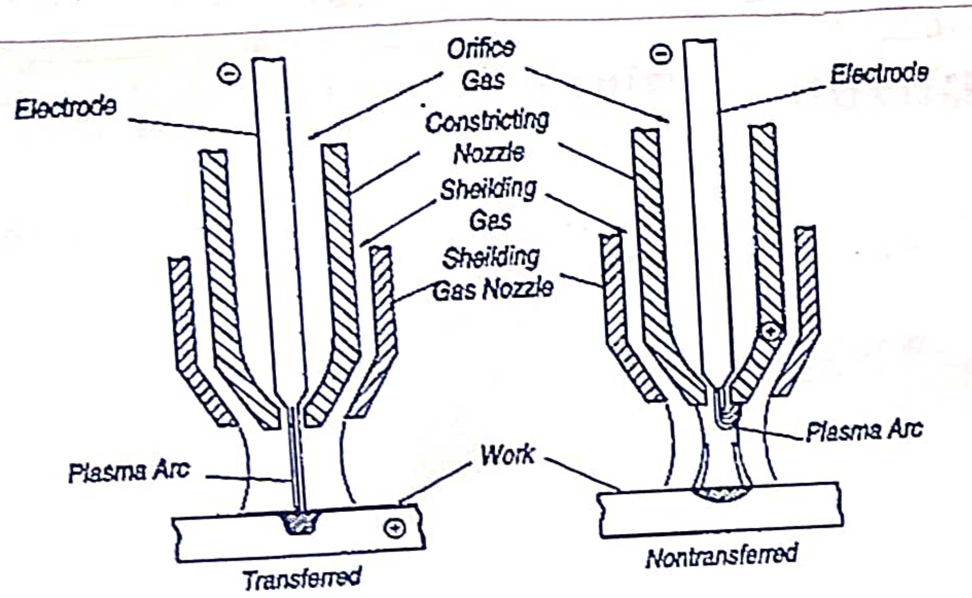


Fig. 2.17 : Plasma Arc welding

Thermit welding:-

*Welding the parts by using liquid thermit steel around the portions to be welded is called thermit welding.

*In this process neither arc is produced to heat parts nor flames are used. For getting the high temperature, the exothermic reaction is used.

*It is depending on the chemical reaction b/w iron oxide & aluminium. The reaction in thermit welding is,

$$8Al + 3Fe_3O_4 = 4Al_2O_3 + 9Fe$$

Working principle:-

Thermit is mixture of aluminium & iron oxide in the ratio of 1:3. This is placed in a furnace & it is ignited.

It is classified into two types:

(i) Pressure welding process

(ii) Non-pressure welding process.

*During pressure welding process, the part to be welded are butted & enclosed in a mould. The mould can be easily removed after the welding of metals.

* In non-pressure welding process, the part to be welded, & lined up in parallel & a groove is taken in the parts.

Applications:-

* It is used in steel rolling mills.
* It is used to weld non-ferrous metals
* Automobile parts are welded

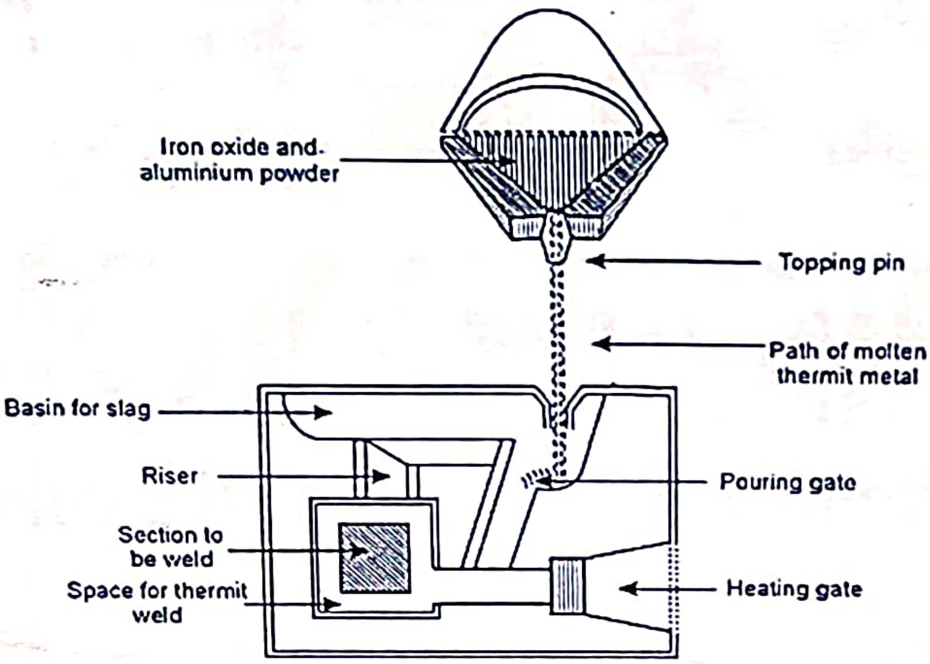


Fig.2.19 : Thermit welding process

Electron Beam Welding:- (EBW)

* EBW is a welding process utilizing a heat generated by a beam of high energy electrons. The electrons strike the w/p & their kinetic energy converts into thermal energy heating the metal. So that edges of w/p are fused & joined together forming a weld.

* This process is carried out in a vaccum chamber as shown in fig. [illegible] at a pressure of about $2*10^{-7}$ to $2*10^{-6}$.

* Such high vaccum is required in order to prevent loss of electrons energy in collisions with air molecules.

* Due to high voltage applied b/w the cathode and the anode the electrons are accelerated upto 30% - 60% of the speed of light.

* Electrons accelerated by electric field are then focused into a thin beam in the focusing coil. Deflection coil moves the electron beam along the weld.

EBW machine consists of the following,

* Electron beam gun
* Power supply & control
* Gun & work motion equipment
* Welding chamber with vacum pumps
* Alignment & viewing system.

Applications:-

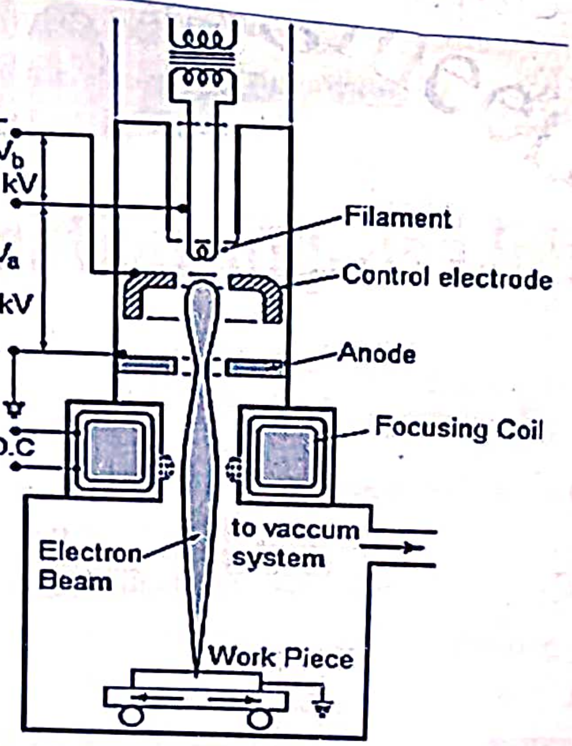
* Almost all metals can be welded with the electron beam welding process.
* It produces high integrity joints
* The cooling rate is much higher.

Advantages:-

* Tight continuous weld
* Low distortion
* Narrow weld & narrow heat affected zone.
* Filler metal is not required.

Disadvantages:-

* Expensive equipment
* High production expenses
* X-ray radiation.



~~Friction~~

Fig. 2.18 : Electron Beam welding

Friction Welding:-(FRW)

* In this process the two surfaces to be welded are rotated relative to each other under light normal pressure. When the interface temp. reaches due to frictional rubbing & when it reaches the required welding temperature.
* Friction welding is a solid state welding process which produces coalescence of materials by the heat obtained from mechanically-induced sliding motion b/w rubbing surfaces.

* The work parts are held together under pressure.

* This process usually involves the rotating of one part against another to generate frictional heat at the junction.

* In the origional process one part is held stationary & other part is rotated by a motor which maintains an essentially constant rotational speed.

* A flywheels is revolved by a motor until a present speed is reached. It rotates one of the pieces to be weld. Rotating power is disengaged from the rotating piece & the pressure is increased.

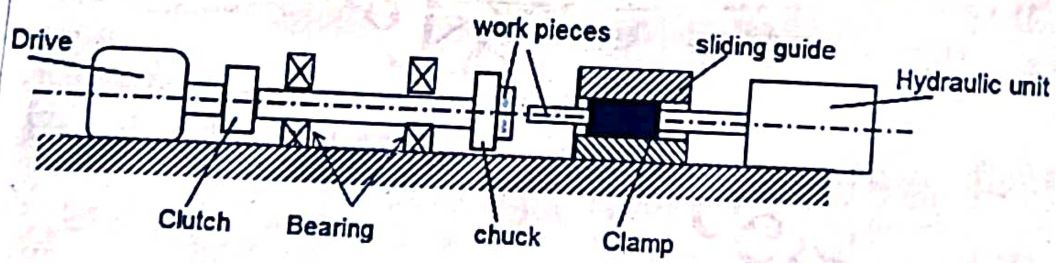


Fig.2.20 : Friction Welding

Advantages:-

* Good mechanical properties in the as-welded condition.
* Can operate in all positions.
* Low environmental impact.

Friction - Stir - Welding :- (FSW)

* FSW is a solid-state joining process that uses a third body tool to join two facing surfaces. Heat is generated b/w the tool & material which leads to a very soft region near the FSW tool.

* It then mechanically intermixes the two pieces of metal at the place of the joint, then the softend metal can be joined using mechanical pressure.

* It is primarily used on aluminium, and most often on extruded aluminium & on structures which need superior weld strength without a post weld heat treatment.

* A constantly rotated non-consumable cylindrical shouldered tool with a profiled probe is transversely fed at a constant rate into a butt joint b/w two clamped pieces (or) butted material as shown in fig.

* Frictional heat is generated b/w the wear-resistant welding components & the work pieces.

Applications:-

* ship building
* Aerospace industries
* Automotive industries
* Railways
* Fabrication industries.

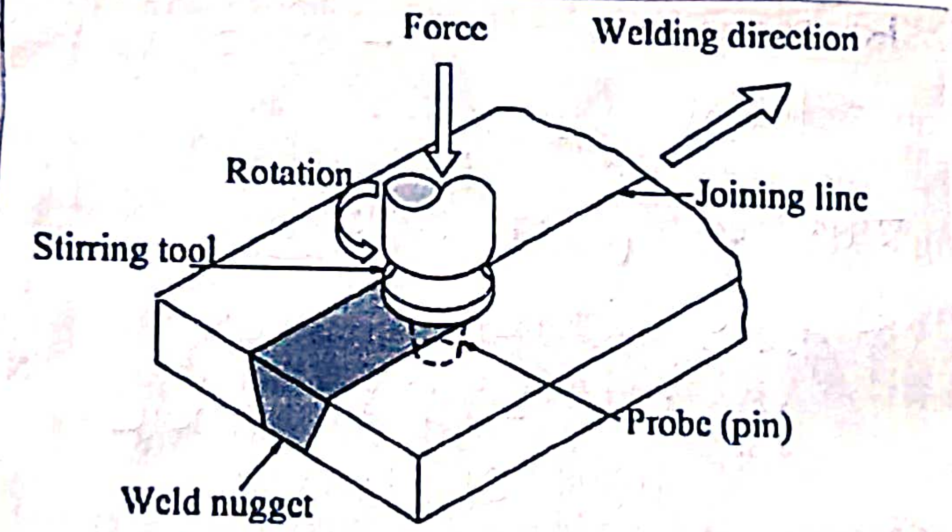


Fig. 2.21 Friction stir welding

Brazing:-

* It is the process of uniting two or more metals of similiar (or) dissimiliar type with the help of an alloy in the form of spelter & flux, like borax, ash etc.

* Brazing is a joining process, which produces coalescence of materials by heating to a suitable temperature & by using a filler metal having a liquidus temp above 450°c.

* To achieve a perfect joint, the filler & parent materials should be metallurgically compatible & the design of the joint should incorporate a minimum gap into which the braze filler metal will be drawn.

Methods of brazing:-

* The metal parts which are to be brazed must be thoroughly cleaned.
* The flux must be applied to the surface
* The parts are to be clamped in the required position.
* The flux has to be applied on the surfaces
* The job has to be heated using the blow torch or the furnace
* The molten spelter has to be allowed to flow by capillary action
* The Job has to be allowed to cool slowly.

Types of Brazing:-

* Torch brazing
* Furnace brazing
* Induction brazing
* Dip brazing
* Resistance brazing
* Infra-red brazing

Advantages:-

* Temperature involved in this process is low
* Dismantling of joints is possible
* This process is quick & clean.

Disadvantages:-

* cost is high
* Skilled labours are required
* It is not suitable for mass production

Applications:-

* Used in pipe fittings
* Used in heat exchanger parts fabrication
* Pressure vessel manufacturing
* Jewellery applications

Soldering:-

* It is a joining process, which produce coalescence of material by heating them to the Soldering temperature & by using a filler metal having liquidus temperature not exceeding 450°c & below the solidus temperature of the base metals.

Two types of Solder are there.

(1) Soft Solder

(2) Hard solder.

Methods of Soldering:-

* the metal parts which are to be Soldered must be thoroughly cleaned.

* The type of job whether light or heavy has to be decided

* A good soldering iron has to be Slecleted.

* In light jobs, the tip of the heating head of the Soldering iron has to be heated Sufficiently.

* It has to be then cleaned, dipped in flux & rubbed on the Solder to tin the tip.

Types of Soldering:-

(1) Torch soldering
(2) Dip soldering
(3) Wave & cascade soldering
(4) Induction soldering
(5) Resistance soldering.

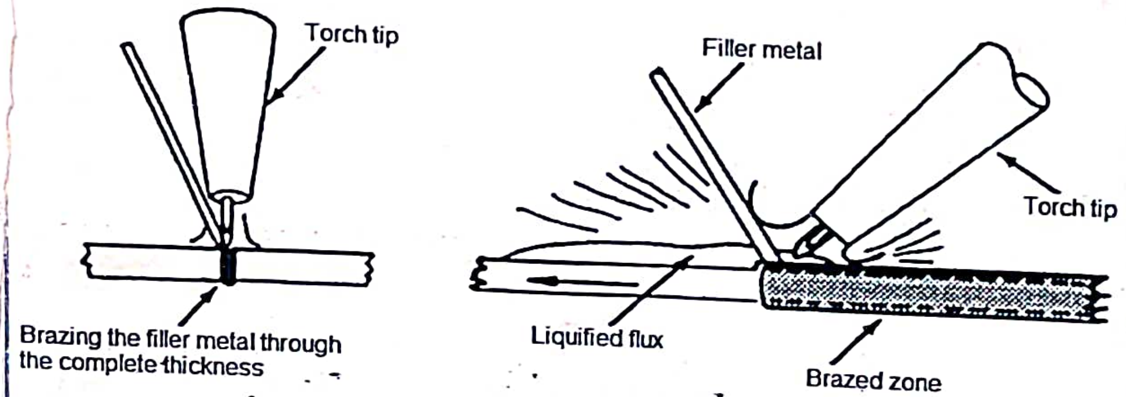


Fig.2.22 Brazing Process

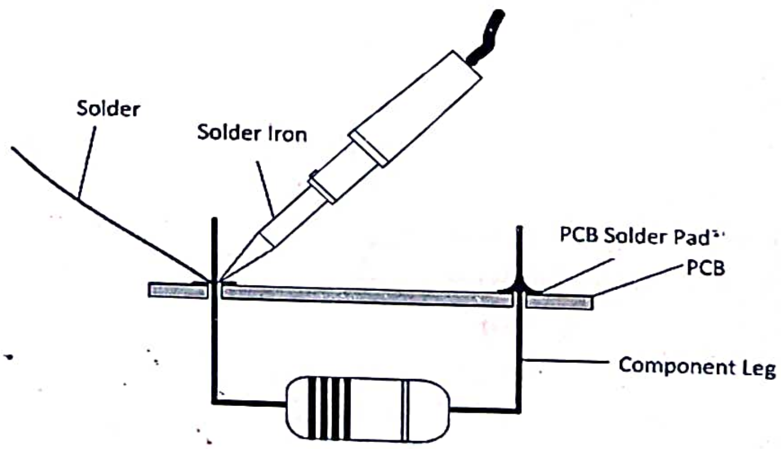


Fig. 2.24 Soldering Process

Welding defects:-

① **porosity:-**

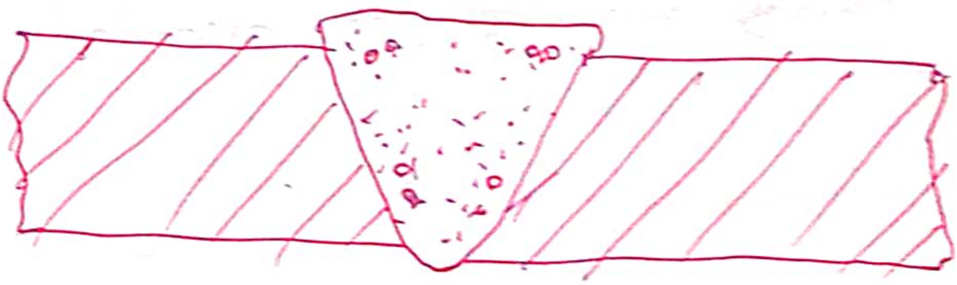
* It is a group of small holes throughout the weld metal. It is caused by trapping of gas during the welding process, due to chemicals in the metal, dampness.

Causes:-

* moisture,
* Insufficient gas shielding
* Welding onto small gaps filled with air.

Remedies:-

* Rebake (or) use fresh welding consumable
* Dry (or) clean plate edges
* Increase welding gap.



② Slag inclusion:-

* It is the entrapment of slag (or) other impurities in the weld. It is caused by the slag from previous runs not being cleared away (or) insufficient cleaning & preparation of base metal before welding commences.

Causes:-

(i) Slag runs ahead of the weld

(ii) Insufficient de-slagging b/w passes

(iii) Convex passes which produce slag pockets.

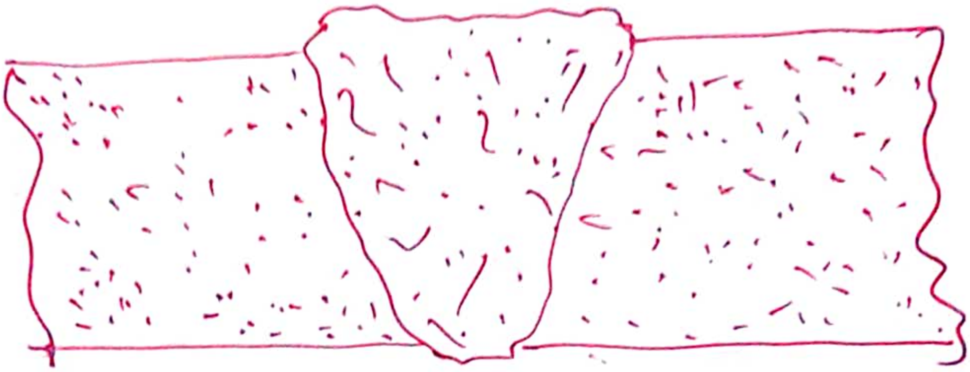
Remedies:-

(i) Increase the travel speed (or) electrode angle.

(ii) Remove slag carefully, grind if necessary.

(iii) Avoid sharp angles (or) grooves b/w beads and layers.

(iv) Plan bead sequence such that sharp corners are avoided.



③ Under cut:

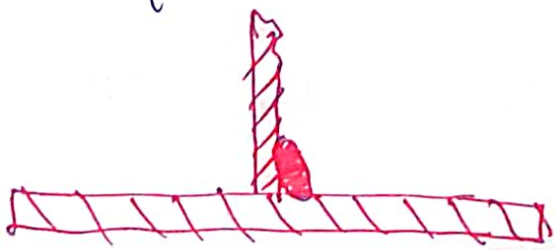
These are grooves (or) slots along the edges of the weld caused by,

* Too fast a travel
* Too great a heat build up
* Bad welding Technique.

④ Lack of Peneration:-

It is the failure of the filler metal to penetrate into the joint.

* Incorrect edge peneration
* Incorrect welding technique
* Inddequate de-slagging



UNIT-III

Metal Forming Processes

Purpose of Mechanical Working Process:-

(i) To reduce the original block or ingot to the finished dimensions of the part, thereby, reduce maching, material cost & time.

(ii) To improve mechanical properties of the materials by refinement of the grain structure, directional control of the flow lines & removal of cavities & other impurities.

Hot Working:-

It is metal forming process in which metals are given desired shape by subjecting them to forces which causes them to undergo plastic deformation above the recrystallisation temperature.

ex:

Rolling, forging, extrusion piercing

Drawing, spinning.

Advantages:-

- refinement of grain
- to eliminate porosity
- mechanical properties are improved.

Cold Working:-

- Working below recrystallization temp.
- No crystal formation.
- Good surface finish
- Internal stress formation
- Limited size.

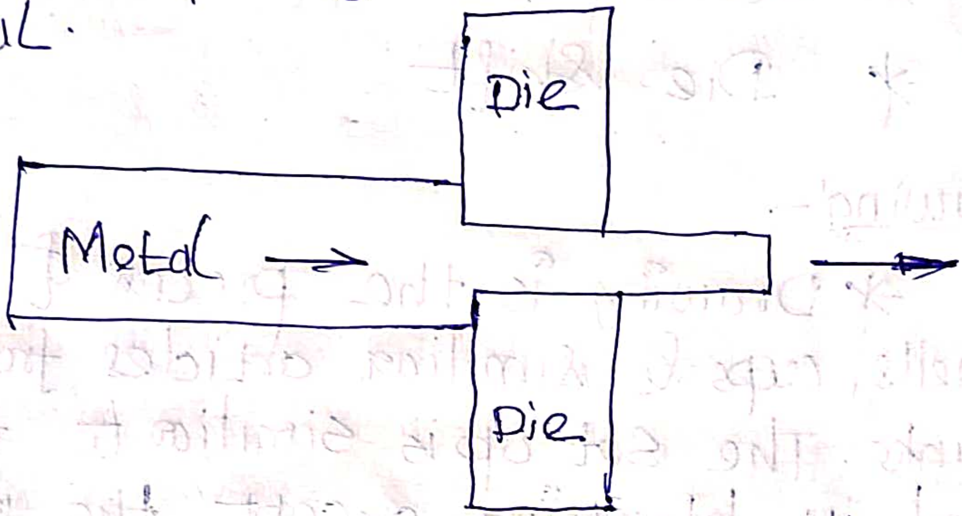
Forging:-

Forging is a mfg process involving the shaping of metal using localized compress forces.

Forging
- Open die forging
  - Hand forging
  - Power forging
- Closed die forging
  - Drop forging
  - Press forging
  - M/C forging

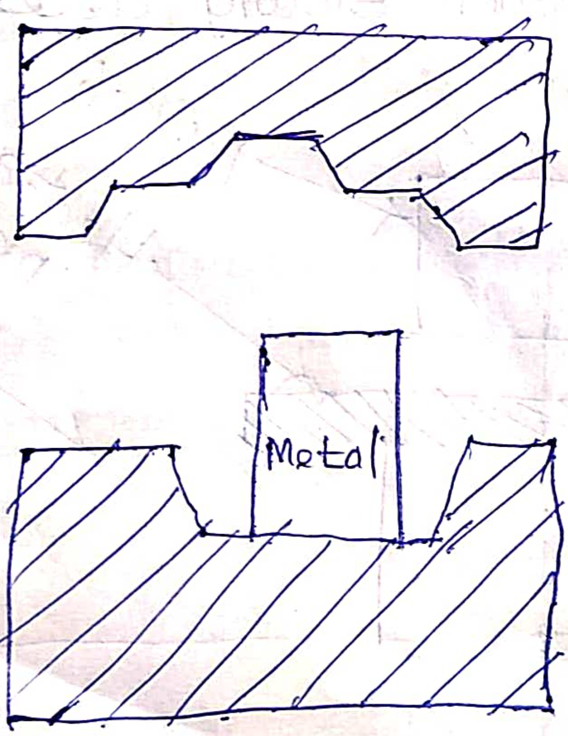
Open die forging:-

It is the process of deforming a piece of metal b/w multiple dies that do not completely enclose the material.



Closed die forging:-

It is a forging process in which dies moves towards each other & covers the w/p in whole or in part.



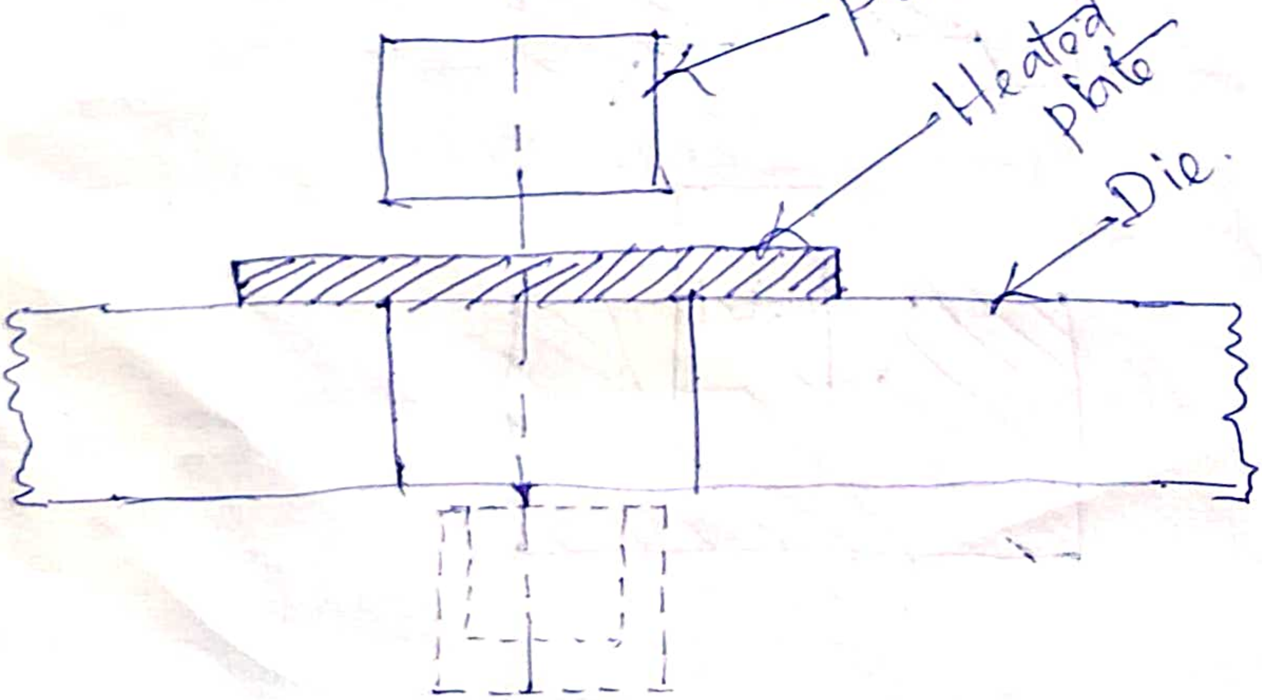
Forging defects:-

* Unfilled section
* cold shut
* Scale pits
* Die shift

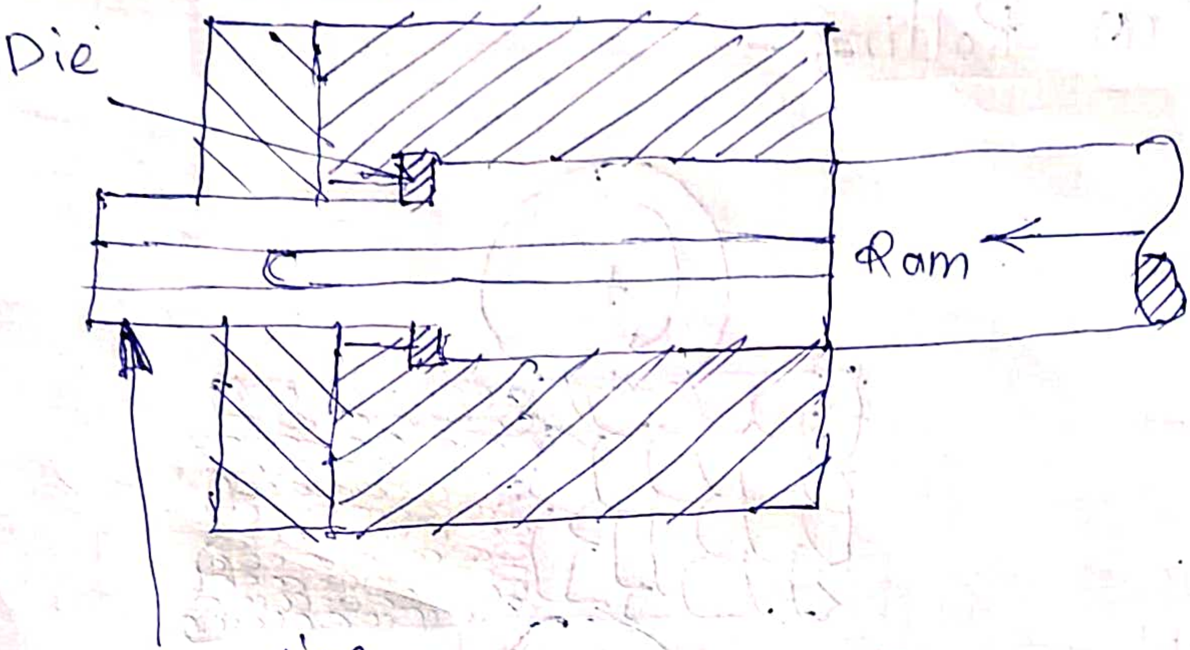
Drawing:-

* Drawing is the process of making shells, cups & similiar articles from metal blanks. The set up is similiar to them used in blanking except the punch & die are provided withe necessary rounding at the corner to allow for smooth flow of the metal during drafting.

* The blank is first kept on the die plate, the punch slowly decesed on the blank.



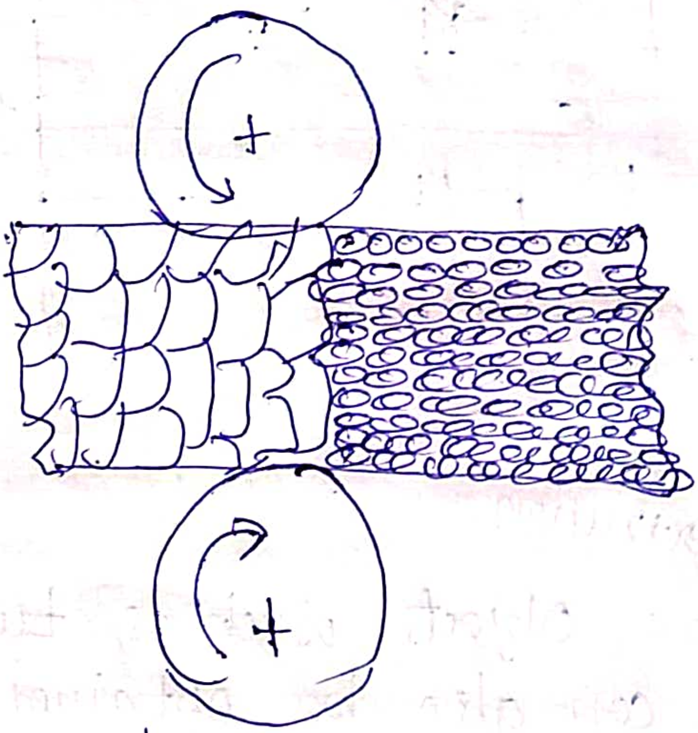
(iii) Tube Extrusion:-



* Hollow objects such as tubes & other shapes can also be obtained by forward that extrusion. One way of obtaining a tube is by means of a solid ram in a double action press as shown in fig. The solid ram moves through the heated metal billet creating a hole at the centre. Later, the hollow plunger moves the metal billet through the die. Because of the presence of the solid ram very close to the die. the necessary hole is made in the extruded metal.

Hot working:-

(i) Rolling:-



*It is a deformation process in which w/p thickness is reduced by compressive forces exterted by two opposing rolls.

Types of rolling mill:-

(1) Two high mill

(2) Three high mill

(3) Four high mill

(4) cluster mill.

Flat rolling Process:-

*Metal strip enters the roll gap. The strip is reduced by the metal rolls.

* The Velocity of the strip is increased the metal strip is reduced in size.

UNIT-IV

SHEET METAL PROCESSES:

* Many of the consumer goods enjoyed today by the modern man owe their low cost to the press tools.
* But for the cheap way of making these sheet metal components, i.e) possibility cannot that not have been thought of roaming. Automobiles, types writers, Mechanical toys, etc. at such a low cost.

Stresses Induced	Operations
1. Shearing	shearing, blanking, piercing, trimming, starring, matching, nibbling.
2. Tension	stretch forming
3. Compression	corning, sizing, ironing, hobbing
4. Tension & compression	Drawing, spinning, bending, forming, embossing

Shearing action has three basic stages:

1) Plastic deformation

2) Fracture

3) Shear.

* When the metal is placed b/w the upper & lower blades of the shear & pressure is applied plastic deformation first takes place. This extends into the interior of the metal from 5 to 40% of its thickness.

* As confirmed pressure is applied to the cutting blade, the fracture (or crack) start at the cutting edge of the each blade, the point of the greater stress concentration.

* As the blade descends further, the small fracture meet & the metal is then sheared. The same shearing action takes when the punch moves in return stroke, the the cup would be stripped by this counter bored portion.

Bend allowance (B) $= \alpha (R + Kt)$

$\alpha \rightarrow$ bend angle

$R \rightarrow$ Inside radius of the bend

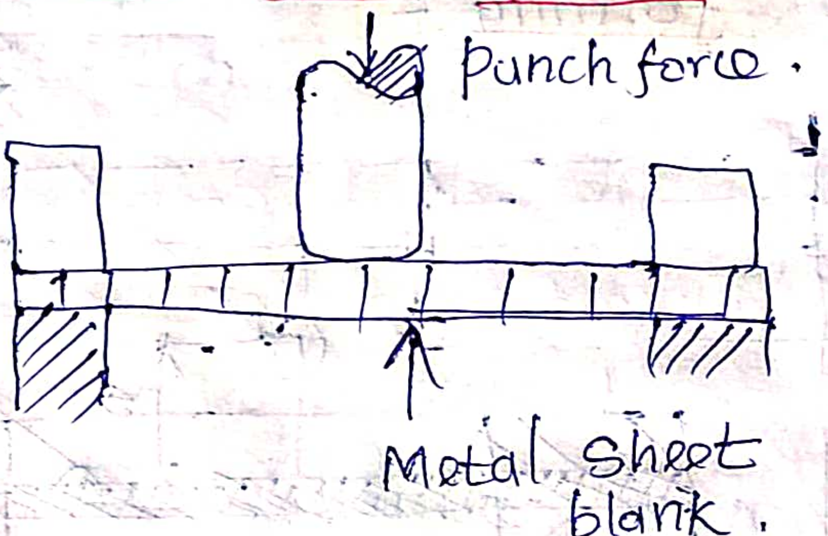
$K \rightarrow$ location of neutral axis from bottom surface

$= 0.33$ when $R < 2t$

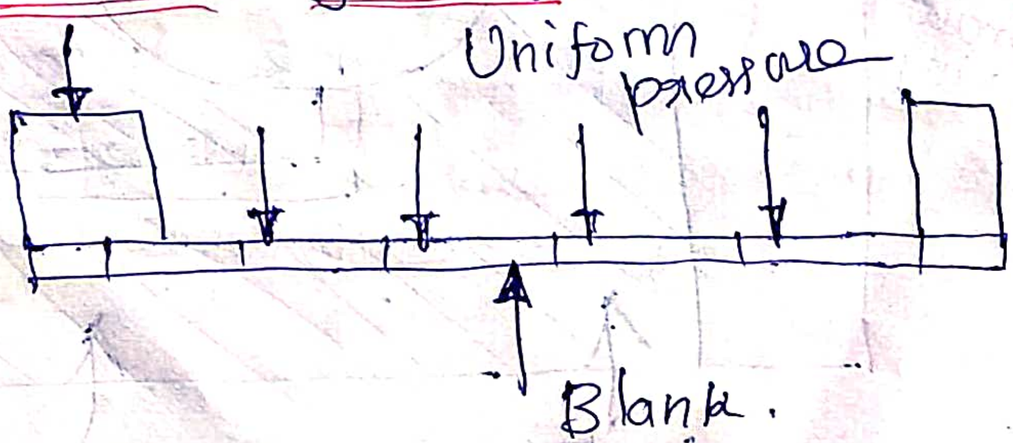
$= 0.50$ when $R > 2t$.

$t \rightarrow$ sheet thickness (mm)

(i) Hydraulic Press forming:-



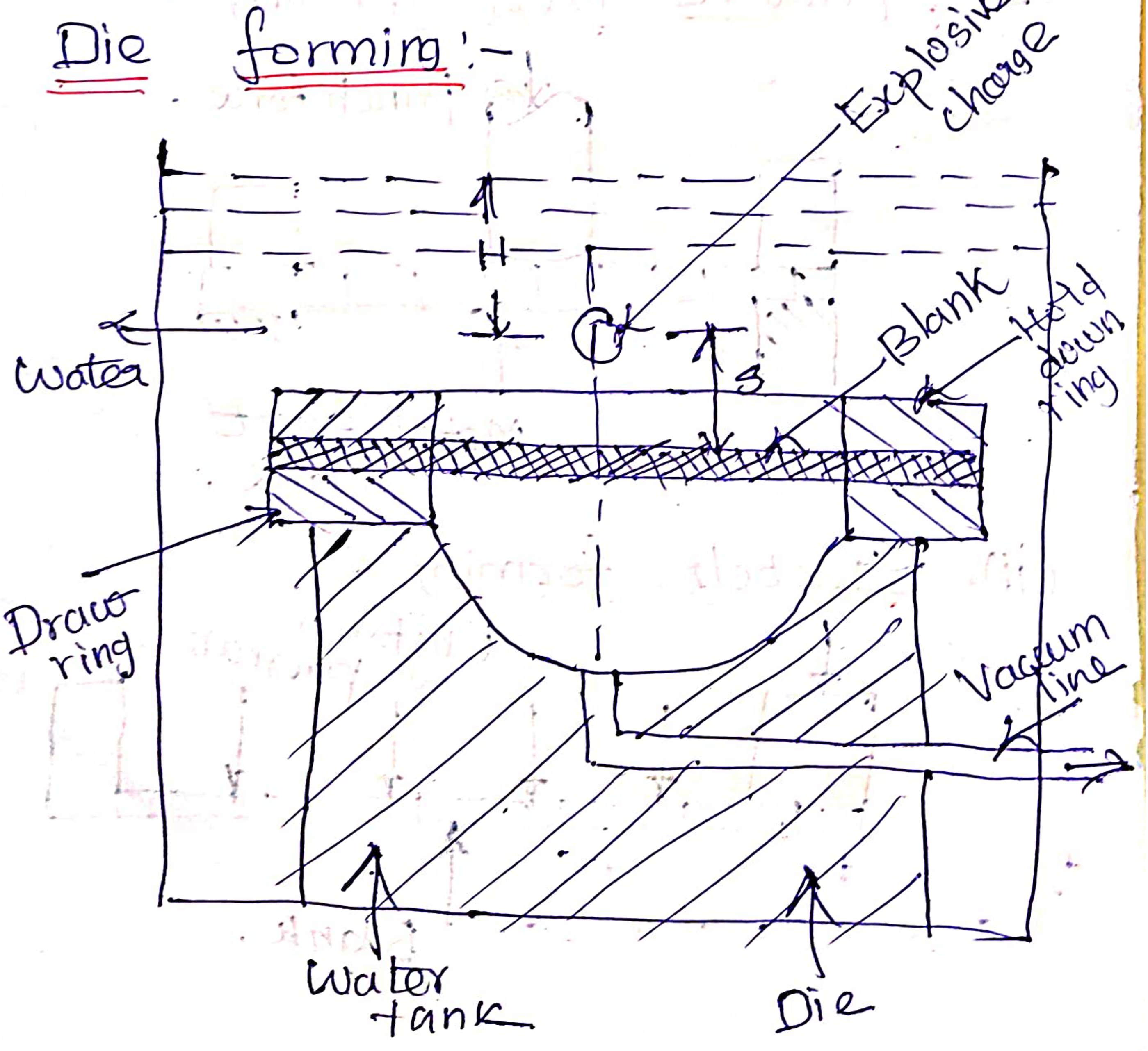
(ii) Stretch forming:-



* In the stretch forming, the complete deformation is carried out in plastic state only. The material is first brought into plastic state by stretching. In the process, the sheet is held in the joints of hydraulic cylinders. & is stretched beyond elastic limit.

* The sheet used in stretch forming should there uniform thickness, otherwise the thinner portions are likely to be over stretched.

③ Die forming :-



* The above fig. shows die forming process. The charge is placed at a some distance from the sheet metal blank & is immersed in a transmitting medium.

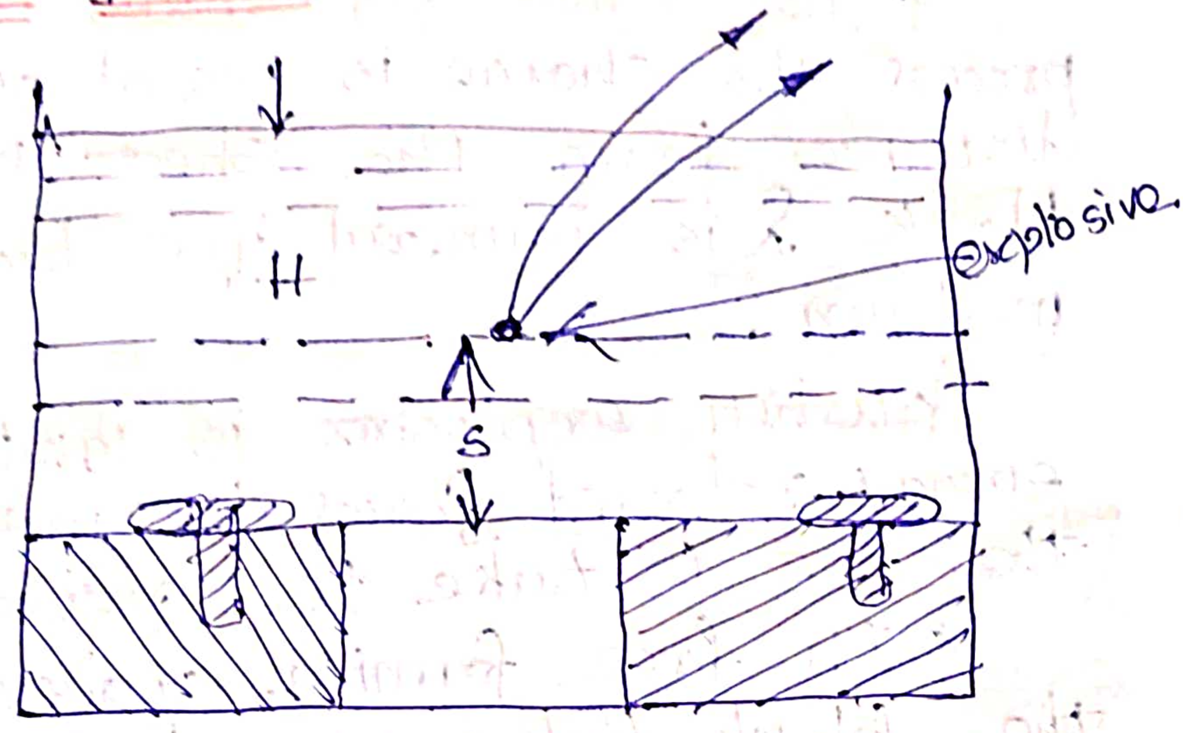
* When explosive is ignited the energy released forces the metal into the die to take the required shape.

* In free forming, stretching of the blank takes place & deformation of the w/p depends on its ability to get stretched.

* This method is generally used to produce shallow components. The free forming technique looks promising for axially symmetrical shape like domes. Its ultimate accuracy limits depends upon the reproducibility of the materials used.

* Their deformation hardening characteristics & the reproducibility of the explosive charge.

Explosive forming:-



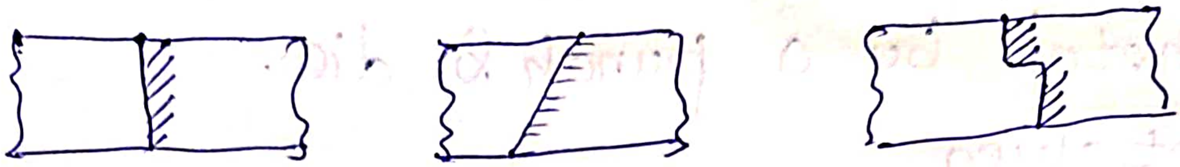
Advantages:-

1) By this process, the sheet metal is formed into shapes which cannot be produced economically.
2) Investment cost is low.
3) Components can be made to close tolerances.

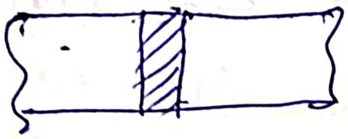
Disadvantages:

The process should be conducted at safe & remote places because a lot of sound & noise is produced.

Sheet metal operations:-



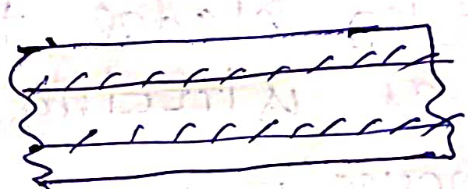
(a) shearing cut off



Parting

Blanking.

Notching



Slitting

* Shearing is a general name for most sheet metal cutting but in a specific sense designates a cut in a straight line across the strip, sheet or bar.
* Cutting off: This means severing a piece from a strip with a correct along a single line.
* Parting - It signifies that scrap is removed b/w the two pieces to part them.

Punching:

Producing circular holes on a sheet metal by a punch & die.

Notching:

Process of removing metal to the desired shape from the side (or) edge of a sheet.

slitting:

When shearing is conducted b/w rating blades, the process is refered to as slitting.

Lancing:-

This makes a cut part ring across a strip.

Nibbling:-

It is an operation of cutting among shape form shear metal without special tasks.

Trimming:-

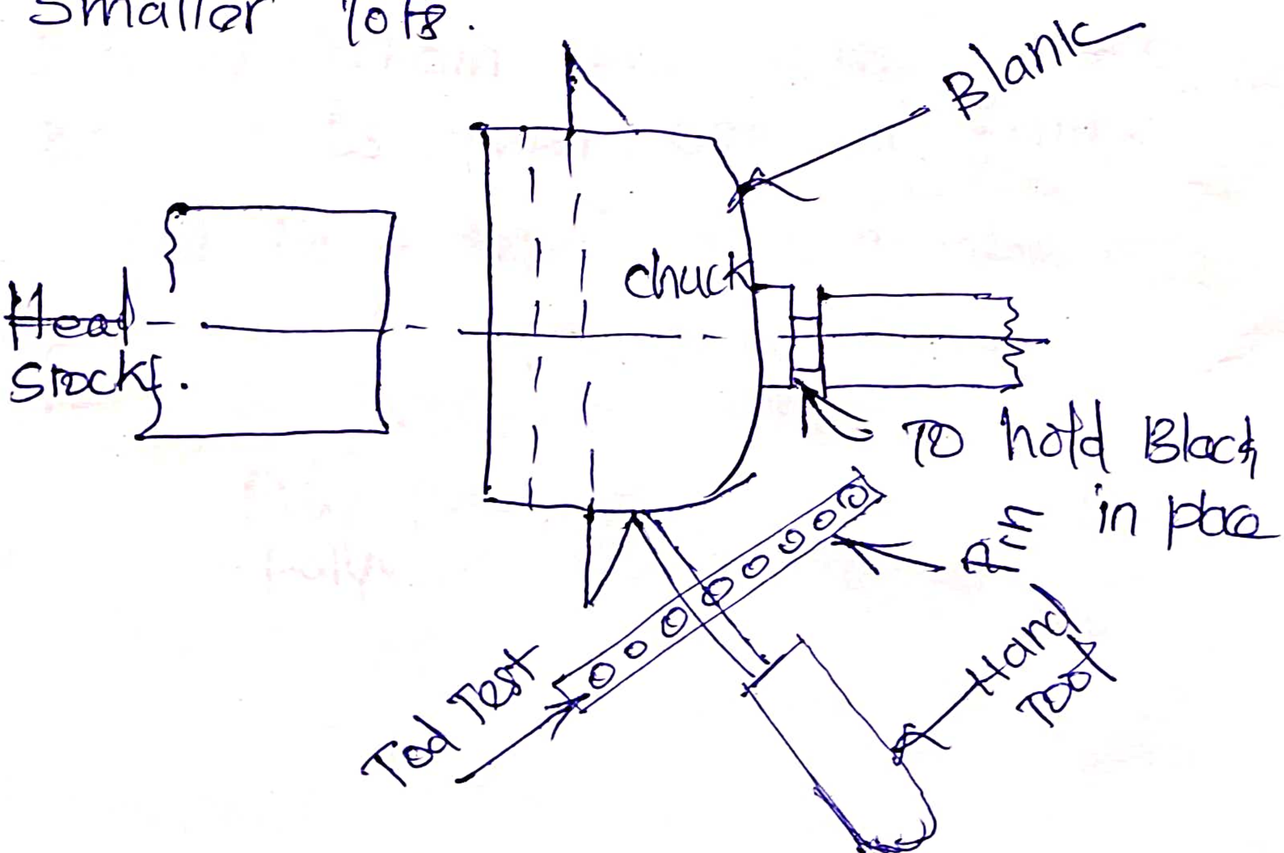
cutting action excess metal in a flange from a piece.

* Frictional flow
* Roll force & power requirements.

Spinning:-

* It is the process used for making sharped articles which are symmetrical. The process of spinning consists of rotating the blank, fixed against the form block & the applying a gradually moving force on the blank so that the blank take the shape of the form block.

* Spinning is comparable to drawing for making cylindrical shaped parts. Because of simple tools used in spinning. It is economical for smaller lots.



UNIT-V

Manufacture of Plastic Components

Introduction:-

* In general the term 'plastic' is applied to all materials capable of being molded or modeled. Plastics have been increasingly accepted for modern engineering appln due to the fact that plastics are attractive materials and offer advantages in weight, cost, moisture strength.

Types of plastics:-

(a) Thermoset or Thermosetting plastics:-

(i) Once cooled & hardned, these plastics retain their shapes & can't return to their orgional form.

(ii) They are hard & durable

ex:

Poly ethylene (PE)
Poly propylene
Polyvinyl chloride (PVC).

	Thermoplastics	Thermosetting Plastics.
(i)	Softened by heating	can't be Softned
(ii)	Structure is made of linear chain charac-teristics	structure is made of cross linked molecules.
(iii)	Produced by addition of polymerization process	Produced by condensation process.
(iv)	Can be produced by heating	can't be reproduced.
(v)	Softer & less strong	Harder & strong
(vi)	Scrap can be reused	scrap can't be reused.

Characteristics of Plastics:-

(1) Elongation
(2) Heat resistance
(3) High rigidity
(4) Surface hardness
(5) High viscosity
(6) Max. usage temp.

(7) Density.

(8) Ignition temp

(9) Humidity absorption

(10) Chemical resistance.

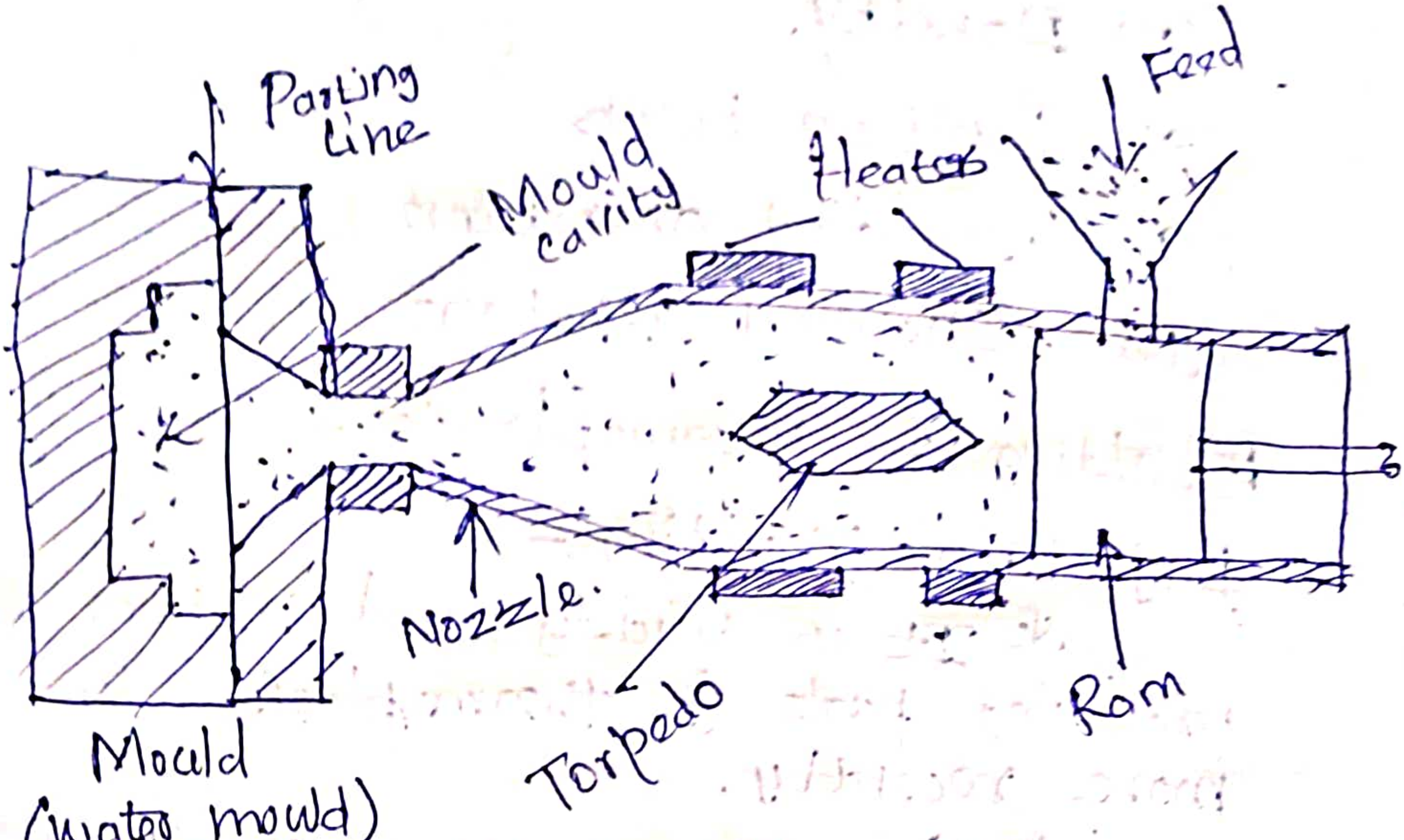
Moulding of thermoplastic:-

Injection Moulding:-

* It is widely used method of producing parts of thermoplastic & more recently.

* The process resembles the hot chamber die casting of metals. The die, split to allow removal of the solidification of product is kept shut with an appropriate press force and ejectors are provided for removing the moulded components.

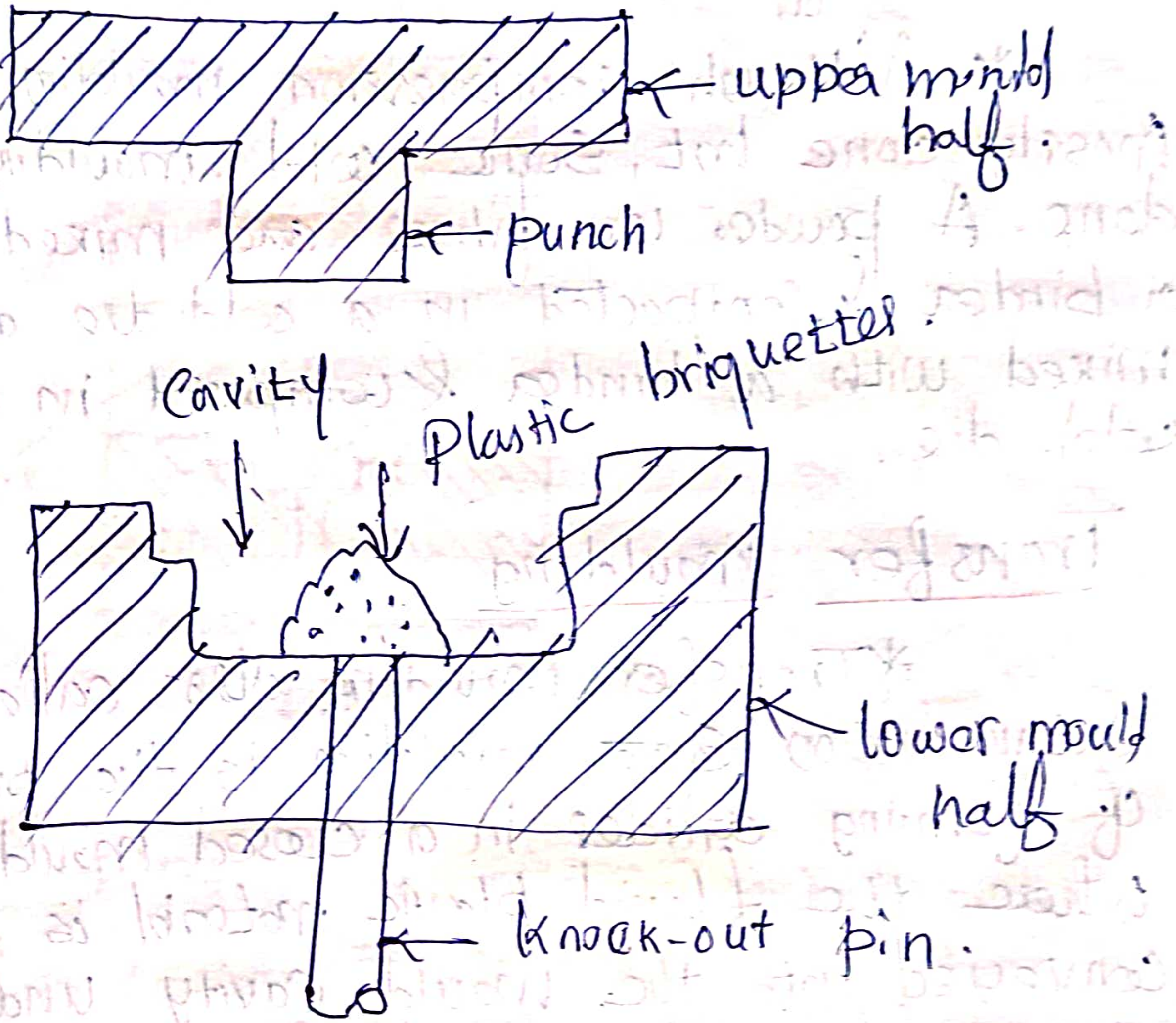
* The difference b/w metals & plastics lies in the supply of the polymer which is usually fed in solid form, pellets (or) powder through a hopper to a injector screw, the die end of which is surrounded with heaters that gradually bring the polymer to the required temperature there the material is softned.



The process state with feeding plastic pellets into the hopper above the heating cylinder of the machine. The resin falls into & is pushed along the heated tube by reciprocating screw until a sufficient volume of the melted plastic is attainble at the injection nozzle end. This may from 1sec to 5 in 6min per sheet. the entire screw is then plunged forward to force the plastic into the mould. Each shot may produce one (or several parts depending on the die used.

Compression Moulding:-

*It is essentially a forging process, performed in a heated die that forms a premeasured quality of the polymer. The process is most widely used for the forming of thermosetting plastics.



*The basic procedure for compression moulding illustrated in the fig. Consist of placing a measured amount of powder of a compressed perform, into the open mould cavity, closing the mould & then applying heat & pressure through a uncounted morning due to the material.

* compression moulding may be of the positive type, Semi positive type or the flash type. In the later, Some of the material is allowed to escape, usually along the through die perimeter. over a land (or) costing area. In the form of a thin flash (or) fin which is finally trimmed off.

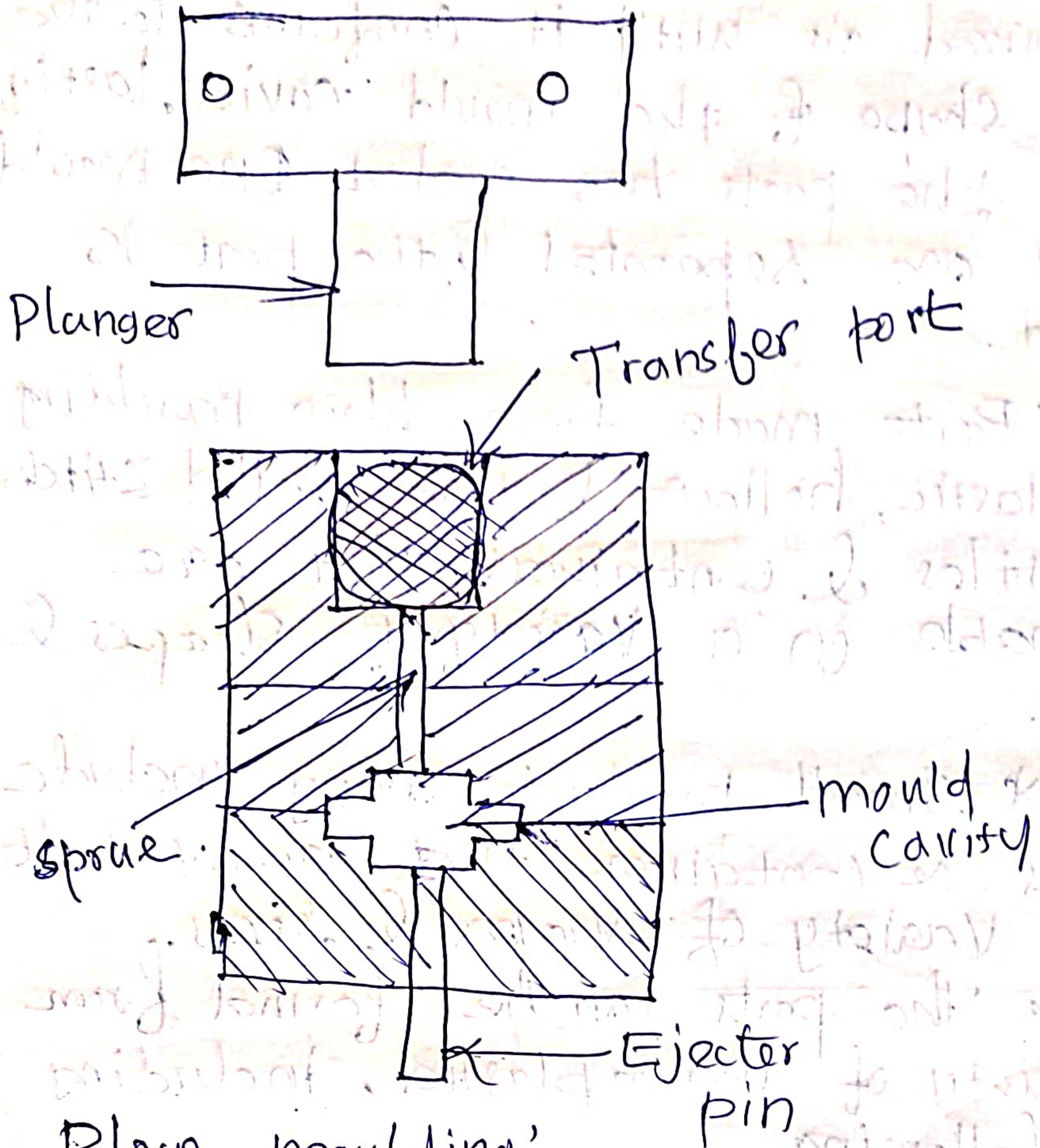
* Although compression moulding is mostly done hot, Some cold moulding is done. A powder (or) fibres are mixed with a binder & compacted in a cold die are mixed with a binder & compared in a cold die.

Transfer moulding

*Transfer moulding also called extrusion (or) Gate moulding is the process of forming articles in a closed mould. where the fluid plastic material is conveyed into the mould cavity under pressure from outside of the mould.

* The material, often a preheated prefrom, is placed in a heated transfer pot. As soon as the material is sufficient softened, the plunger forces the almost fluid plastic through the orifice (spruce) into the closed mould

where final cure takes place..



Blow moulding :-

* It is a mfg process that is used to create hollow plastic parts by inflating a heated plastic tube until it fills a mold & forms the desired shape.

* The raw material in this process is a thermoplastic in the form of small pellets or granules, which is first melted & formed into the hollow tube.

* The parison is then clamped b/w two mould halves & inflated by pressurized air until it conforms to the inner shape of the mould cavity, lastly, after the parts has cooled, the mould halves are separated & the part is ejected.

* Parts made from blow moulding are plastic, hollow & thin walled items as bottles & containers, that are attainable in a variety of shapes & sizes.

* Small products many include bottles & containers that are available in a variety of shapes & sizes.

* The parts can be formed from a variety of thermoplastics, including the following.

Low density polyethylene (LDPE)
High density polyethylene (HDPE)
Polyethylene Terephthalate (PET)
Polypropylene (PP)
Polyvinyle Chloride (PVC)