Lecture Note

on

Production Technology

Semester: 3rd Semester
Branch: Mechanical Engineering

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CHAPTER-1 METAL FORMING PROCESSES

Manufacturing → The process of converting raw materials into a finished product by means of various process.

\# Types of manufacturing → (i) Forming (hammering)
(ii) Casting
(iii) Joining or fabrication process. (welding)
(iv) metal removal or metal cutting (lathe, shaper).

Metal forming →

Metal forming → Large set of manufacturing processes in which the material is deformed plastically to take the shape of the die geometry. The tools used for such deformation are called die, punch etc depending on the type of process.

Plastic deformation →
The permanent change of in shape of a metal object as a result of applied or internal force. It is the deformation beyond elastic limits. This feature permits metal to be formed into pipe, wire, sheet etc with an optimal combination of strength, ductility and toughness

Die →
A die is a specialized tool used in manufacturing industries to cut or shape material mostly using a press

Types of forming process →

(i) Cold working (Working temp. < Recrystallization temp)
(ii) Hot working (Working temp > Recrystallization temp)

Recrystallization temperature ⇒

Recrystallization temperature is a minimum temperature, in which grain size and grain orientation will change, due to recrystallization material strength will increases

Recrystallization temp. $(\frac{1}{3}$ to $\frac{1}{2})$ of melting point

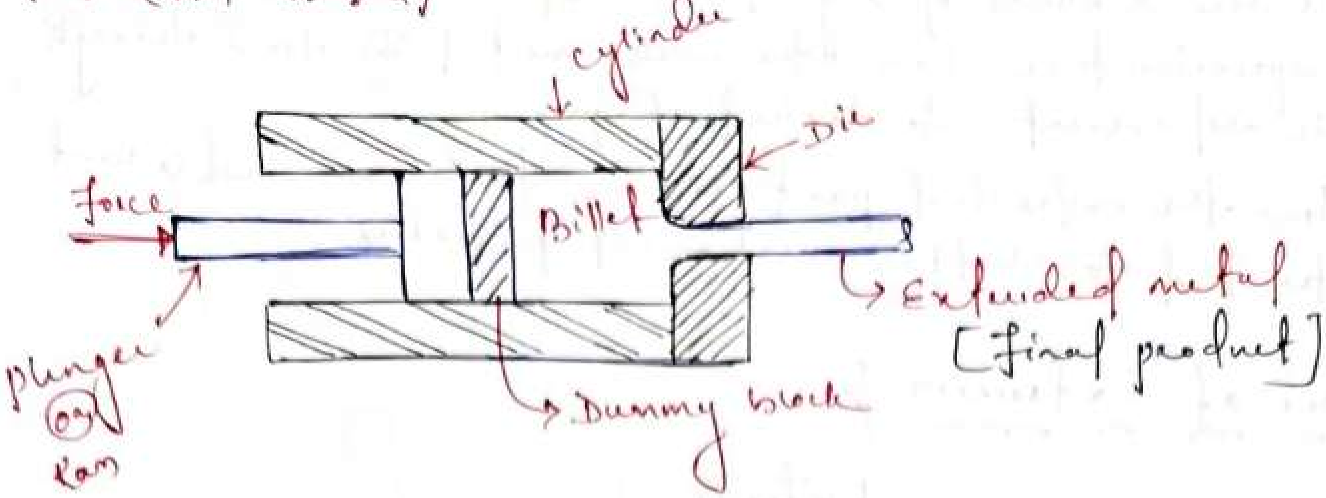
Advantages of metal forming ⇒

(i) Material removal is minimum.
(ii) Good surface finish
(iii) Sometimes strength and hardness may increase

Disadvantages of metal forming ⇒

(i) High amount of force / energy is required.
(ii) Except metal forging, all metal forming process can only produce uniform cross-sectional area product

Extrusion Process →



Extrusion is a metal forming process in which metal (or) workpiece is forced to flow through a die to reduce its cross-section (or) convert it into a desired shape.

This process is extensively used in pipe and steel rod manufacturing

The compressive force allows large deformation comparing to drawing in single pass. The most common material extruded are plastic and Aluminium.

Working Principle →

Extrusion is a simple compressive metal forming process in this process piston (or) plunger is used to apply compressive force at work piece.

(i) First billet (or) ingot (metal work piece of standard size) is produced.

(ii) This billet is heated into extrusion (or) remains at room temperature and placed into a extrusion press.

(iii) Now compressive force is applied to this part by a plunger fitted into the press which pushes the billet towards die

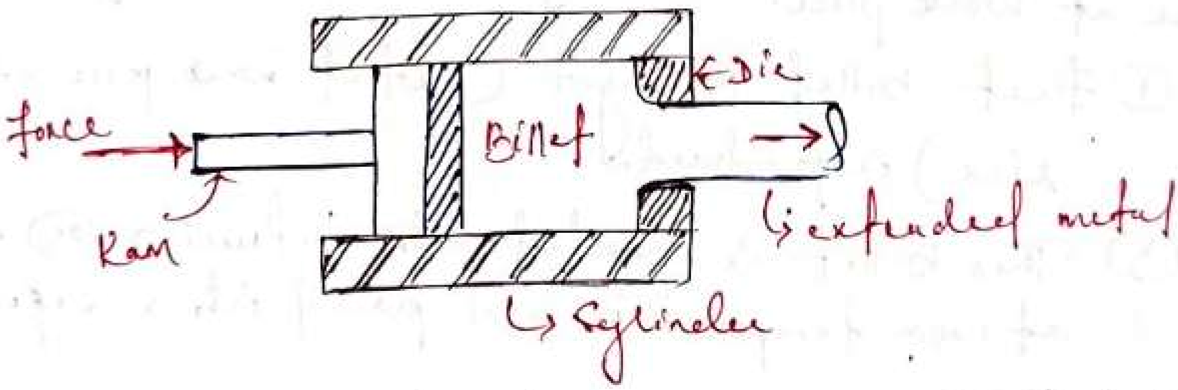
(iv) The die is small opening of required cross section. This high compressive force allow the work metal to flow through die and convert into desired shape.

(v) Now the extruded part remove from press and is heat treated for better mechanical properties.

Types of Extrusion →

- Extrusion
  - Hot working process
    - forward extrusion
    - backward extrusion
  - Cold working process
    - forward extrusion (Hydraulic extrusion)
    - backward extrusion (Impact extrusion & Cold extrusion forging)

Forward Extrusion →

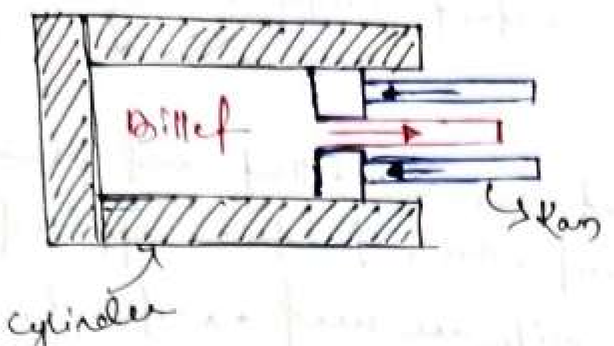


In direct or forward extrusion the work billet is contained in a chamber

The ram exerted force on one side of the work piece while the forming die through which the material is located on the opposite side of the chamber

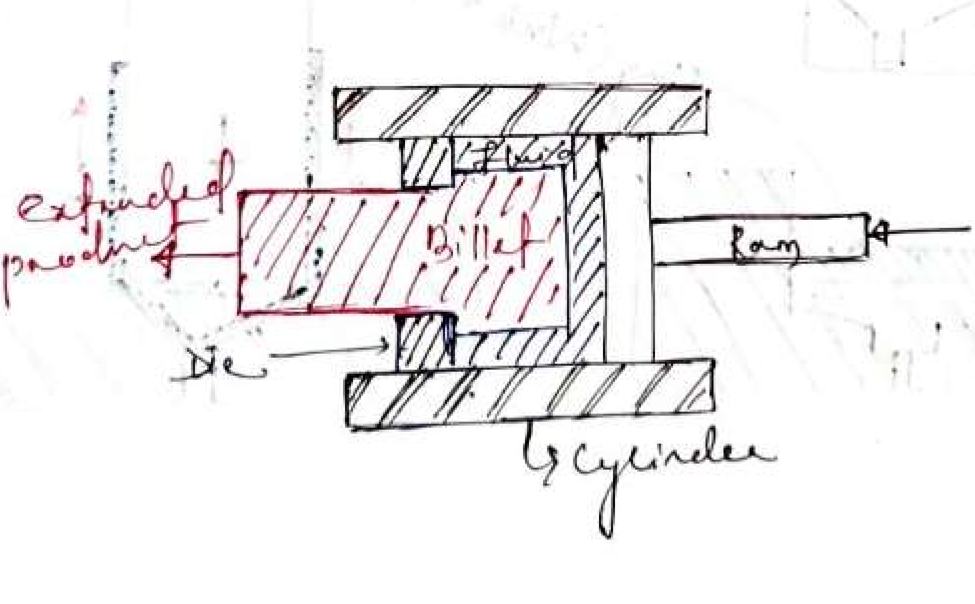
The length of extruded metal product flows in the same direction that the force is applied.
material handeling is easy.
This process is also called as direct extrusion.

Backward Extrusion :-



Indirect extrusion is a particular type of metal extrusion process in which the work piece is located in a chamber that is completely closed off at one side.
The metal extrusion die are located on the ram which exerted force on the open end of the chamber.
As the manufacturing process proceeds the extruded product flow in the opposite direction that the ram is moving.
Material handeling is tough.

Hydrostatic Extrusion :-



It is a cold extrusion process.

Friction is less.

This process is suitable for brittle (or) semi brittle material.

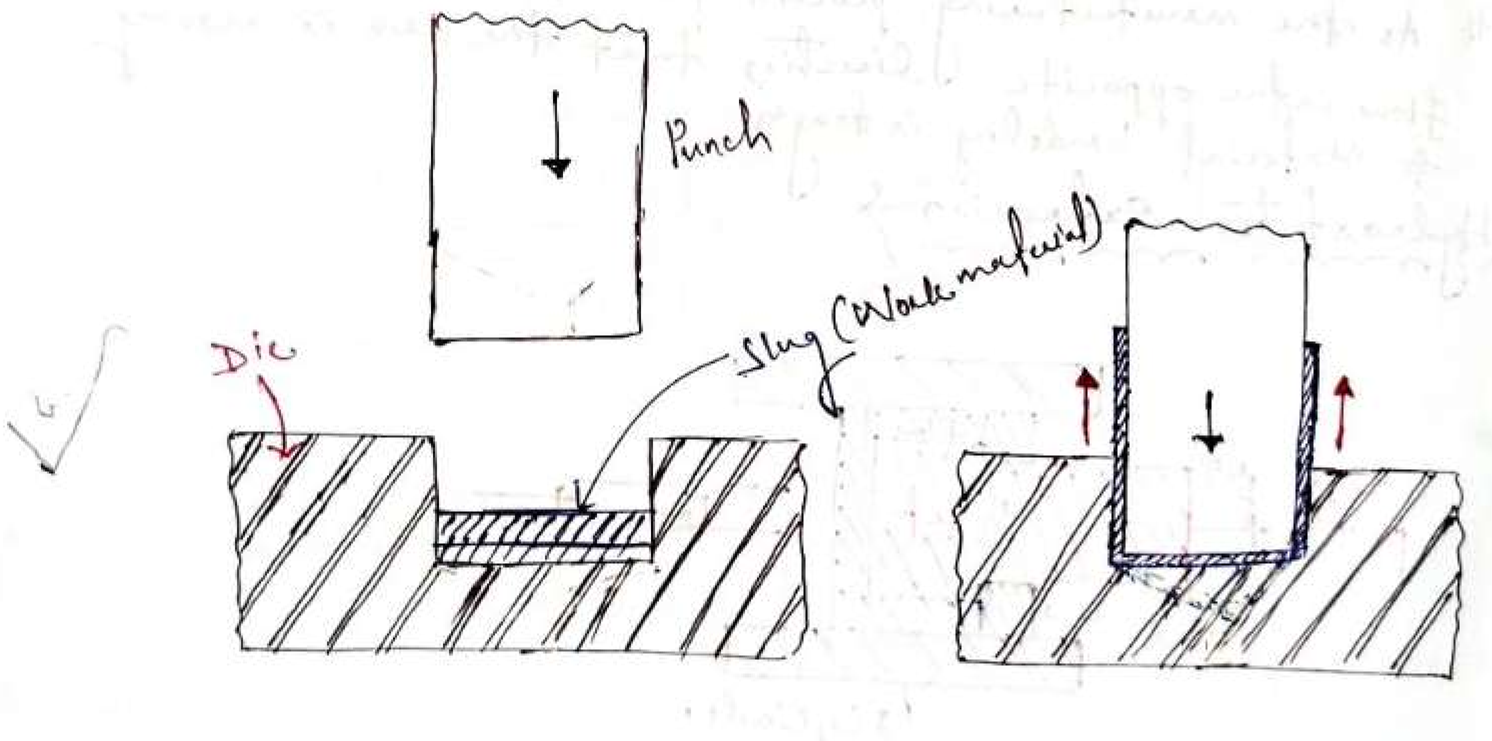
This process uses fluid to apply pressure on billet.

In this process the friction is eliminated because the billet is not in contact with the cylinder wall (or) plunger

There is a fluid between the billet and plunger. The plunger applied force on fluid which further applied on billet. Normally vegetable oils are used as fluid.

This process accomplished by leakage problem and uncontrolled speed of extrusion.

Impact Extrusion :-



Backward cold extrusion is called impact extrusion. The set up consist of die and punch. The slug (workpiece) for making the component is kept on the die and punch strike the slug against the die. The metal is then extruded through the gap between the punch and die opposite to the punch movement. Because of the impact force the side wall go straight along the punch. The height of the side wall is controlled by the amount of metal in the slug. It is used with softer materials such as aluminium and its alloys.

Application of Extrusion :-

Extrusion is widely used in product of tubes and hollow pipes.

(ii) Extrusion is widely used to produce plastic object

Rolling :-

... extruded th

Applications of Extrusion ⇒

(iii) Aluminium extrusion is used in structure work in many industries.

Advantages of Extrusion ⇒

(i) It can easily create complex cross-sections

(ii) This working can be done with both brittle and ductile material.

(iii) High mechanical properties can be achieved by cold extrusion.

Disadvantages of Extrusion ⇒

(i) High compressive force is required

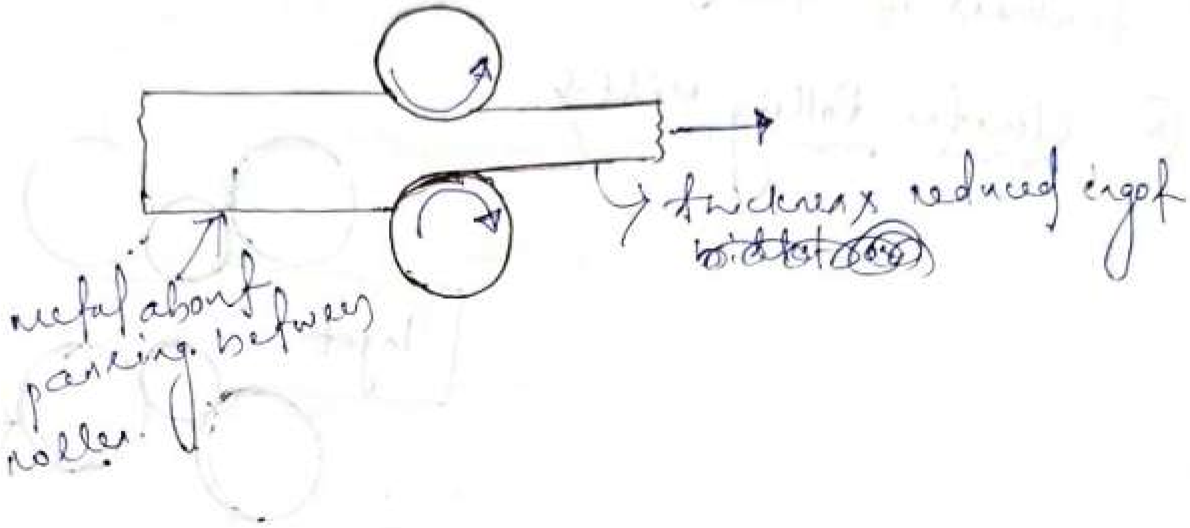
(ii) High initial (or) setup cost.

Rolling

Rolling →

Rolling is a metal forming process in which the cross-sectional area is reduce by passing the workpiece through a pair of rolls.

In rolling process thickness of the ingot reduces and length of the ingot increases by compressive force applied by rolls.



Classification of Rolling ⇒

Rolling –
- → Hot Rolling → [Temp. of the metal ingot is above the recrystalisation temp. of metal]
- → Cold Rolling [Temp. of the metal is below the recrystalisation temp. of metal]

Difference between Hot rolling and Cold rolling :-

Hot rolling	Cold rolling
# Hot rolling is conducted above recrystallization temp. of metal i.e 0.3 to 0.5 of melting point of metal.	# Cold rolling is conducted below recrystallisation temp. of metal.
# No strain hardening occurs. Large reduction of cross-sectional area can be obtained.	# Strain hardening occurs strength increases but ductility decreases.
# Yield strength reduces and ductility increases for which plastic deformation occurs by applying less amount of power.	# Strain hardening and high yield strength limited deformation in one pass.
# Coarse structure of cast ingot is converted into a fine grained structure. Fine grained structure improves physical properties.	# No scale formation on oxidation of metal surface occurs. Results good surface finish. Grain become large and distorted.
# Poor control over dimension due to thermal expansion	# No thermal expansion

Limitations :-

Hot rolling	Cold rolling
# Oxidation, scale formation on surface reduces surface finish	# No working of low ductility metal.
# Handling is tough	

Types of Rolling mills →

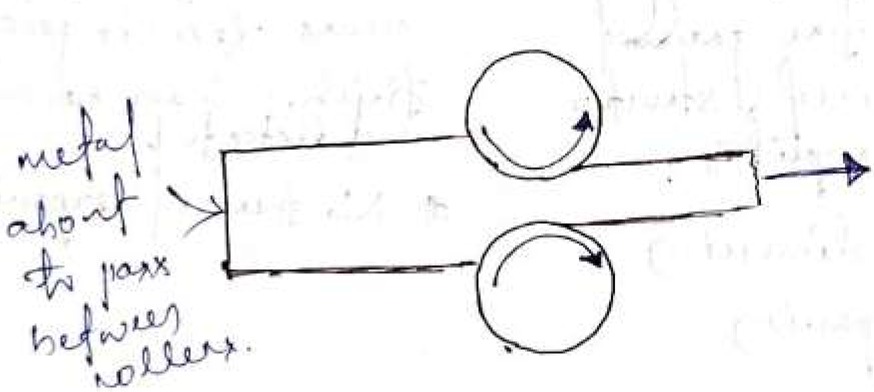
Rolling mills may be classified according to the number and the arrangement of the rolls.

(I) Two high rolling mills.

(a) Non reversing
(b) Reversing.

(II) Three high rolling mills.
(III) Four high rolling mills.
(IV) Tandem rolling mills.
(V) Cluster rolling mills.
(VI) Planetary

I) Two high rolling mills →



Two high non reversing rolling mill →

(1) Both the rolls rotates in opposite directions to one another as shown in the figure. The direction of rotation is fixed, cannot be reversible thus the work can be rolled by feed from one direction.

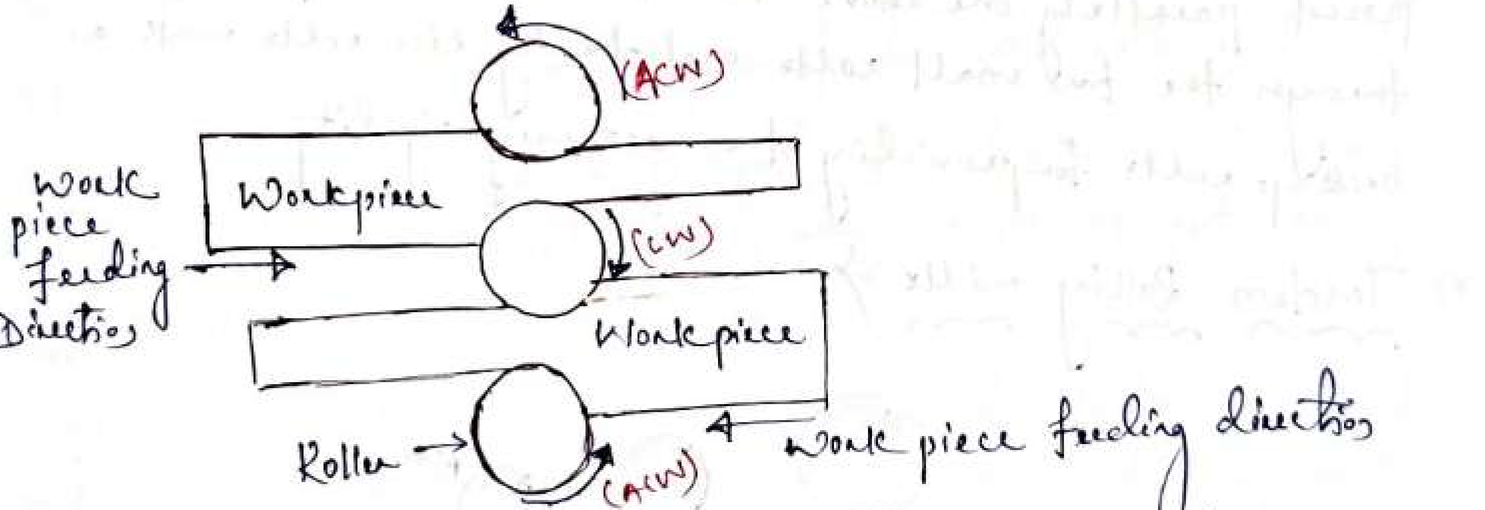
(iii) The space between the roll can be adjusted by raising or lowering the upper roll. The position of lower roll is fixed.
(iv) This mill is used where the bar has to pass once and in open train mill.

Two high reversing rolling mill →

(i) In this type of rolling mill there is a drive mechanism which can reverse the direction of rotation of the roll.
(ii) Because of this drive mechanism the metal may pass back and forth through the rolls several times.
(iii) This type of mill is used in blooming and slabing mills and for roughing work in plate, rail structure and other mills.

(ii) Three high rolling mills →

It consists of a roll stand with three parallel rolls one above the other adjacent rolls rotate in opposite direction.

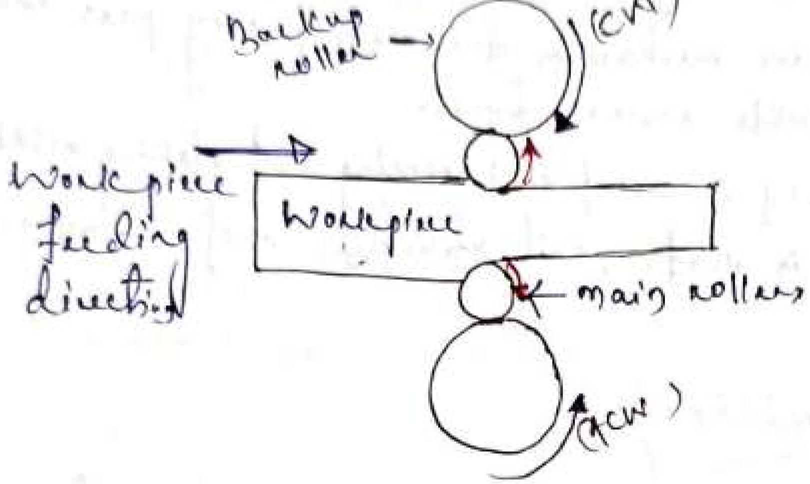


This arrangement is used for rolling of two continuous passes in a rolling sequence without reversing the drive

First of all the metal has passed through the bottom and the middle roll in one direction, the end of the metal is entered into the other set of the rolls for the next pass

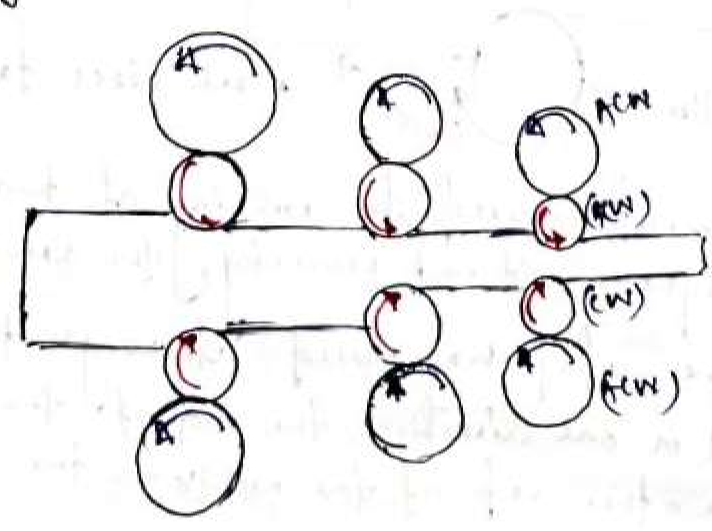
(III) For this purpose a mechanically operated lifted table are used to bring the metal to the level of the rolls. Since the rolls run in one direction only much less powerful motor and transmission system is required.

(III) Four high rolling mills ->



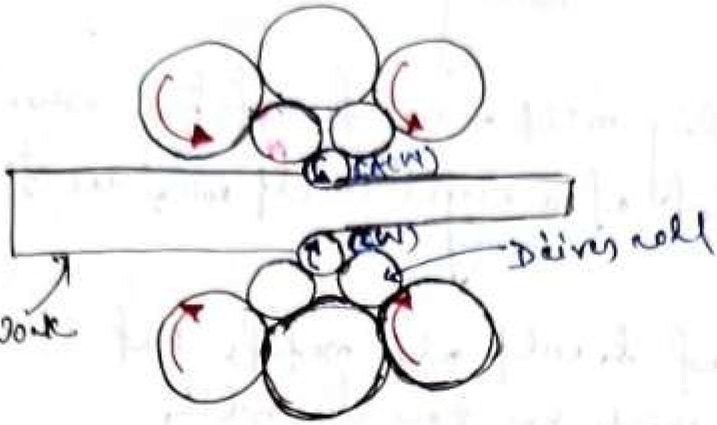
The four high rolling mills has a rolling stand with two small size rolls and two big size rolls. These four rolls placed parallely one above the other. The work piece passes through the two small rolls and the big size rolls work as backup rolls for providing the necessary rigidity.

(IV) Tandem Rolling mills ->



The tandem mill consist of 3 to 6 mills stands arranged in series to progressively reduced the thickness of the strip in a single pass. The advantages of the Tandem rolling process include cost reduction.

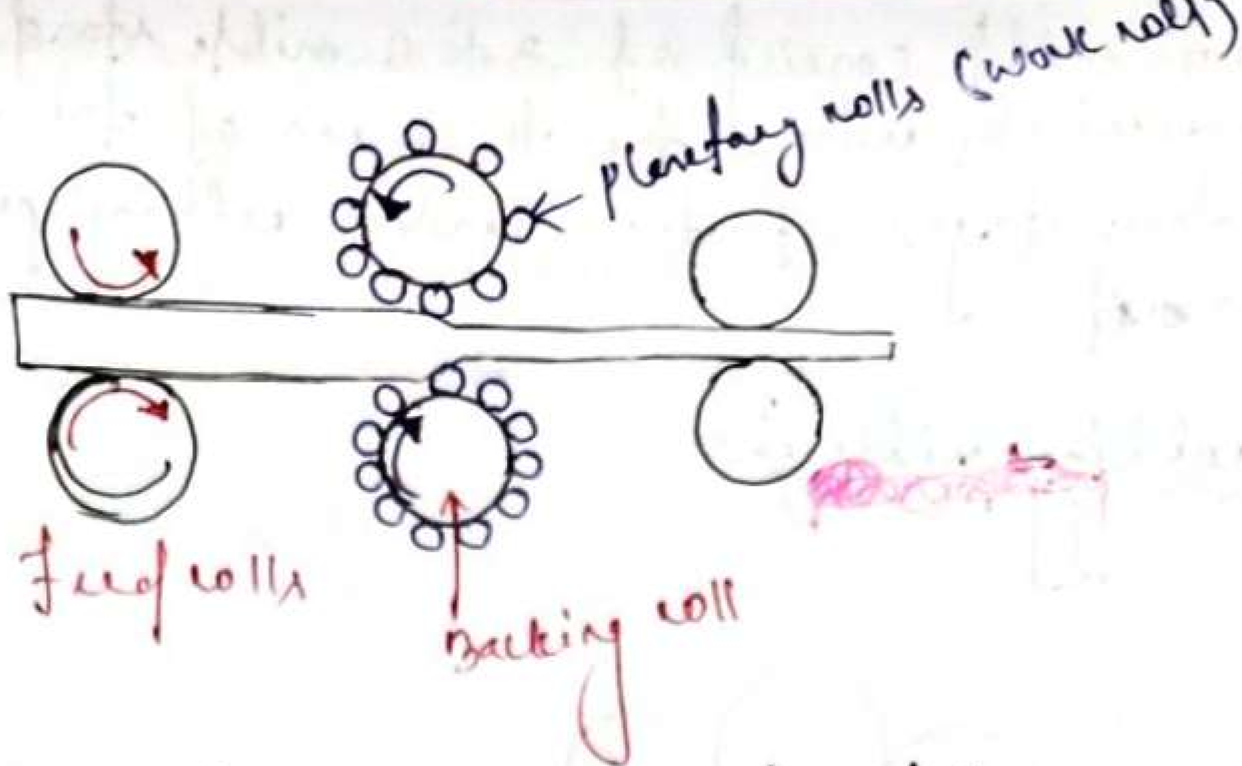
(v) Cluster rolling mills:-



It consist of two working rolls of smaller diameter and a number of backup rolls of large diameter

* The no. of backup rollers may go as high as 20 or more depending upon the amount of support needed for the working rolls during the operation.
* This type of mill is generally used for cold rolling.
* Cluster mills are used to reduced the thickness of stainless steel, high carbon steel of any other high strength alloy steel.
* The main advantages of cluster mill is the backup roll take out a large amount of heat from the working roll and work piece

(4) Planetary



In planetary rolling mill a no of rotating wheels are used as work roll instead of a single small roll are fixed to the large backup roll.

This mill can be used to roll all metals but it is especially useful for those which has low ductility.

CHAPTER-2 Welding

Welding :-

Welding is a process of joining different materials.

- Welding joins different metals/alloys with the help of a number of processes in which heat is supplied either electrically or by means of gas torch.

- In order to join two or more piece of metals together by one of the welding processes, the most essential requirement is Heat. pressure may employed but this is not in many processes essential.

Classification of Welding process :-

(1) They may be classified on the basis of

(a) Source of heat, i.e flame, arc etc

(b) Type of interaction i.e liquid / liquid (fusion welding), solid / solid (solid state welding)

(ii) In general various welding processes are classified as

(a) Gas welding –
- Air acetylene welding
- Oxyacetylene welding
- Oxyhydrogen welding
- Pressure gas welding

(b) Arc welding –
(a) TIG welding (Tungsten inert gas)
(b) MIG welding (metal inert gas)
(c) plasma arc welding
(d) Stud arc welding
(e) Carbon arc welding
(f) Shield metal arc welding

© Resistance welding → (i) Spot welding
(ii) Seam welding
(iii) Projection welding
(iv) Resistance butt welding
(v) Flash butt welding
(vi) High frequency resistance welding
(vii) Percussion welding

(d) Solid state welding → (i) Cold welding
(ii) Diffusion welding
(iii) Explosive welding
(iv) Forge welding
(v) Friction welding
(vi) Hot pressure welding
(vii) Roll welding

(e) Thermo chemical welding → Thermit welding with pressure

(f) Radiant energy welding → (i) Electron beam welding
(ii) Laser beam welding

Advantages of welding process ⇒

(i) A large number of metals/alloys both similar & dissimilar can be joined by welding
(ii) A good weld is as strong as the base metal
(iii) Generally welding equipment is not very costly
(iv) Portable welding equipments are available
(v) Welding permits considerable freedom in design

Disadvantages ->

(I) Welding gives off harmful radiation (light), fumes and spatter.

(II) Welding results in residual stresses and distortion of the work piece.

(III) A skilled welder is a must to produce good welding jobs.

Welding Fluxes ->

During welding if the metal is heated/melted in air, Oxygen from the air combines with the metal to form oxides which result in poor quality, low strength welds (or) in some cases may even make welding impossible. In order to avoid this difficulty a flux is employed during welding.

A flux material is used to prevent, dissolve (or) facilitate removal of oxides and other undesirable substances. A flux prevents the oxidation of molten metal.

Flux is fusible and non-metalic

During welding flux chemically reacts with the oxides and a slag is formed that floats to and cover the top of the molten puddle of metal and thus helps keep out atmospheric oxygen and other gases.

Fluxes are available as powders, pastes (or) liquids.

Flux may be used either by applying it directly on to the surface of the base metal to be welded (or) by dipping the heated end of the filler rod in it. The flux sticks to the filler rod end.

After welding the slag from over the welded joint can be removed by chipping, filling or grinding.
Ex→ Ammonium chloride, Zinc chloride, Borax, Hydrochloric acid.

Oxy. Acetylene Welding →

Oxy. Acetylene welding is one type of oxy-fuel welding. This welding can be used for welding almost all metals and alloys used in engineering field.

Equipment used in Oxy. Acetylene welding →

(i) Oxygen cylinder
(ii) Acetylene cylinder
(iii) Blow pipes and torches.
(iv) Pressure regulator.
(v) Safety valve

Oxygen cylinder →

In this cylinder Oxygen is filled at pressure of 125 kgs to 140 kgs per square centimeter.

Acetylene cylinder →

In high pressure system, acetylene cylinder carry a porous mass inside, soaked in acetone, which has capacity to dissolve 25 times its own volume of acetylene for every atmosphere of pressure applied.

In low pressure system, acetylene is drawn from low pressure acetylene generator.

Torches ⇒

Torches may vary in design, but all are made to provide complete control of the flame.

Regulators ⇒

The flow of gas needs to be controlled. Regulators take high pressure and reduce it to a lower working pressure.

Hoses ⇒

Hoses is used to move the Oxygen and fuel gas to the torch. To prevent the wrong hose from being installed (or) set up incorrectly, the oxygen hose is usually green (or) black and fuel gas hose is usually red.

Safety valves ⇒

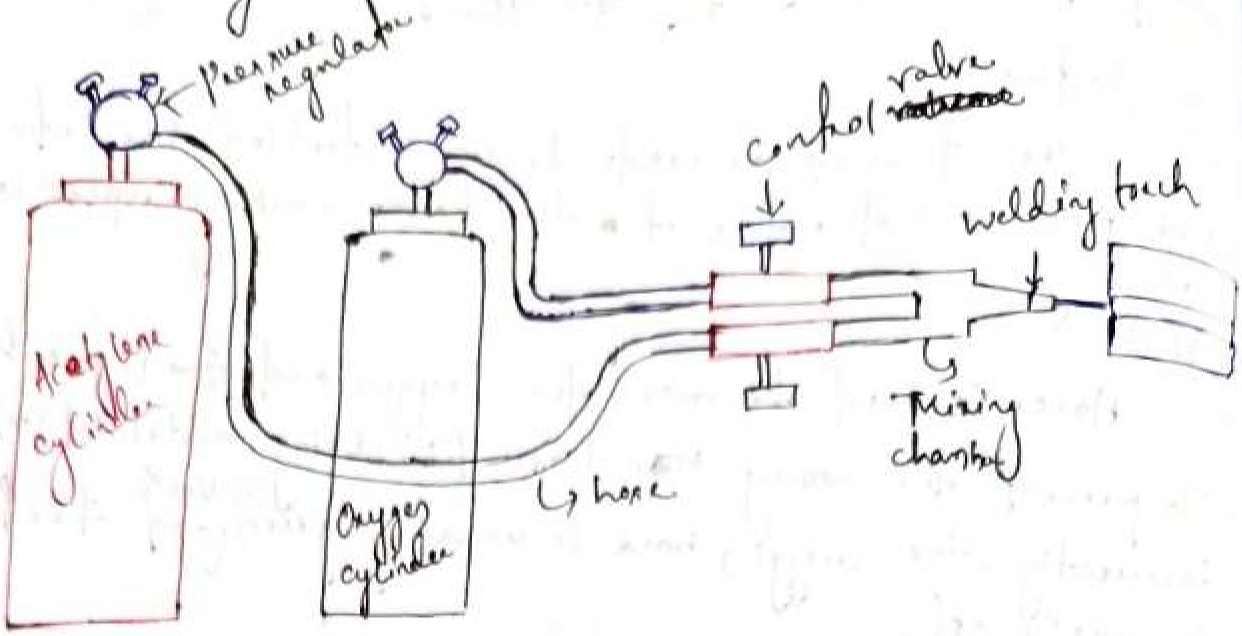
Safety valves keep the flow of gas going in one direction, preventing gas from flowing back into the wrong line (or) cylinder. They also reduce the possibility of a flashback.

Process ⇒

It is commonly referred to as gas welding, is a process which relies on combustion of oxygen and acetylene. When mixed together in correct proportions within a hand held torch (or) blowpipe, a relatively hot flame is produced with a temp. of about 3200°C. The flame resulting at the tip of the torch is sufficiently hot to melt and join the parent metal.

A filler metal rod is generally added to the molten metal pool to build up the seam slightly for greater strength.

Filler → The rod which provide additional metal in completing the welding is known as filler



Types of flame →

To Ignite a flame →

Open the acetylene control valve of the welding torch and after the system has been flushed clear of air the gas is ignited. At this stage enough of oxygen is drawn in from the atmosphere to burn acetylene partially.

The acetylene control valve is then adjusted until the flame ceases to smoke.

The oxygen control valve of the welding torch is then opened in order to adjust the proportion in which acetylene and oxygen are required to mix and burn.

This results in three distinct types of flames as discussed such as

(i) Neutral flame (Acetylene Oxygen in equal proportion)

(ii) Oxidising flame (Excess of Oxygen)

(iii) Reducing flame (Excess of acetylene)

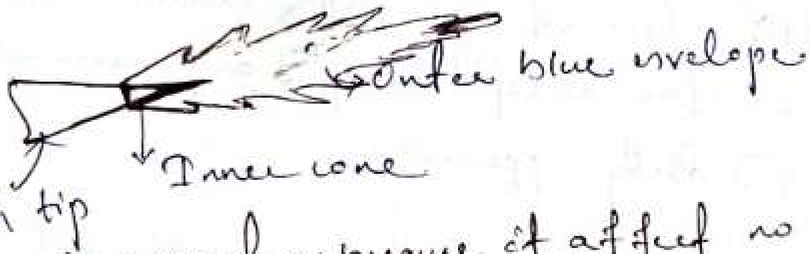
In Oxy-acetylene welding, flame is the most important tool. All the welding equipment simply serves to maintain and control the flame. The correct type of flame is essential for the production of satisfactory welds. The flame must be proper size shape and condition in order to operate with maximum efficiency

Neutral flame →

A neutral flame is produced when approximately equal volume of oxygen and acetylene are mixed in the welding torch and burnt at the torch tip. [Oxygen to acetylene ratio is 1.1 to 1]

The temperature of the neutral flame is of the order of about 5900°F (3260°C)

The flame has a nicely defined inner cone which is light blue in colour it is surrounded by an outer flame envelope, produced by the combination of Oxygen in the air and superheated carbon monoxide and hydrogen gases from inner cone. This envelope is usually a much darker blue than the inner cone



A neutral flame is named so because it affect no chemical change on molten metal and therefore it will not oxidize or carburize the metal.

Neutral flame is commonly used for the welding of

(i) mild steel (ii) Stainless steel

(iii) cast iron (iv) copper

(v) Aluminium

Oxidizing Flame :-

If after the neutral flame has been established, the supply of oxygen is further increased the result will be an oxidizing flame.

An oxidizing flame can be recognized by the small core which is shorter, much bluer in colour and more pointed than that of the neutral flame.

The outer flame envelope is much shorter and tends to fan out at the end, on the other hand the neutral and carburizing envelops tend to come to a ~~sharp~~ sharp point

An oxidizing flame burns with a decided loud roar

An oxidizing flame tends to be hotter than the neutral flame. This is because of excess oxygen and which causes the temp. to rise as high as 6300°F.

The high temp. of an oxidizing flame ($O_2 : C_2H_2 = 1.5 : 1$) would be an advantage if it were not for the fact that the excess Oxygen especially at high temp. tends to combine with many metals to form hard, brittle, low strength ~~oxy~~ oxides. Moreover an excess of oxygen causes the weld bead and surrounding area to have a scummy (or) dirty appearance

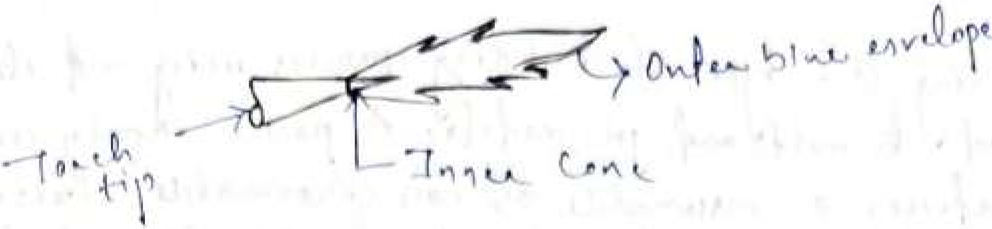
For these reasons an oxidizing flame is of limited use in welding. It is not used in the welding of steel.

A slightly oxidizing flame is helpful when welding most

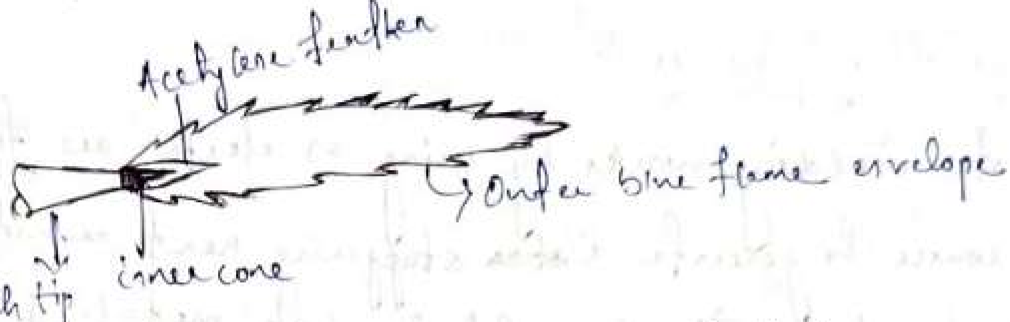
(i) Copper-base metal

(ii) Zinc-base metal &

(iii) Few types of ferrous metals such as cast iron.



Reducing flame =>



If the volume of Oxygen supplied to the neutral flame is reduced, the resulting flame will be a carburizing or reducing flame i.e rich in acetylene.

A reducing flame can be recognized by acetylene feather which exists between the inner cone and the outer envelope. The outer flame envelope is longer than that of the neutral flame and is usually much brighter in colour

A reducing flame does not completely consume the available carbon therefore its burning temp. is lower and leftover carbon is forced into molten metal. With iron and steel it produces very hard brittle substance known as iron carbide. This chemical change makes the metal unfit for many application in which the weld may need to be bent or stretched

A reducing flame has an approximate temp. of 5500°F (3038°C)

A reducing flame may be distinguished from carburizing flame by the fact that a carburizing flame contains more acetylene than a reducing flame

Arc Welding :-

Arc welding is a type of welding process using an electric arc to create heat to melt and join metals. A power supply creates an electric arc between a consumable (or) non consumable electrode and the base material using either direct (DC) (or) alternative (AC) current.

Arc welding process :-

Arc welding works by using an electric arc from an AC (or) DC power source to generate a staggering heat around 6500 degree Fahrenheit at the tip to melt the base metal & to create a pool of molten metal and join the two pieces.

The arc is formed between the workpiece and electrode, which is moved along the line of the joint either mechanically (or) manually. The electrode can either be a rod that carried the current between the tip and the work piece (or) it can be a rod (or) wire that conducts current as well as melts and supplies filler metal to the joint.

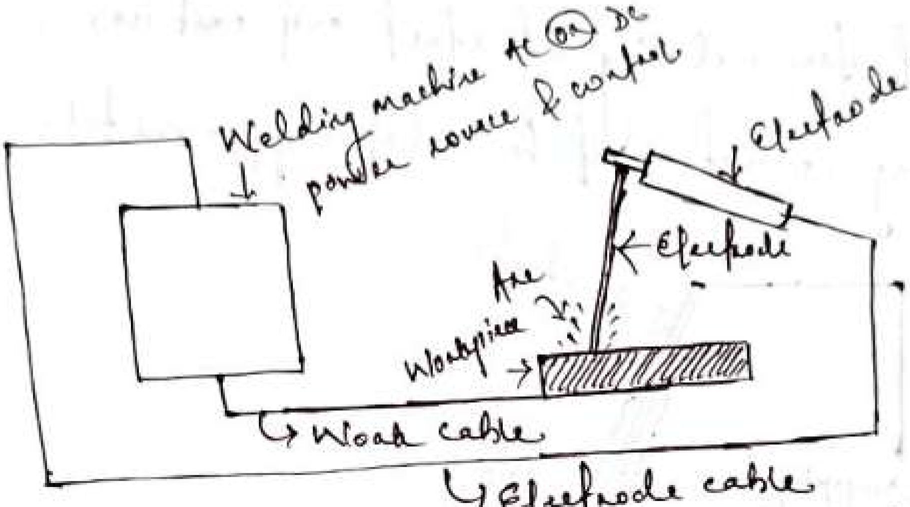
Arc Welding Electrode :-

The carbon electrode is a non-filler metal electrode used in arc welding (or) cutting. Consisting of a carbon graphite rod that may (or) may not be coated with copper (or) other coating. The tungsten electrode is defined as a non-filler metal electrode used in arc welding (or) cutting, made principally of tungsten.

Electric Arc Welding :-

In electric Arc welding the end of the metal pieces to be joined are heated locally till the melting temp. by creating an electric arc and then allowed to solidify to form the welded joint.

The arc is a flame of intense heat, generated by passing electric current through a highly resistant air gap between the electrode and the workpiece.



Different Arc welding process :-

(i) Shield metal arc welding.
(ii) carbon arc welding.
(iii) Tungsten inert gas welding.
(iv) Metal inert gas welding.

Shield metal arc welding :-

In this process a metal electrode is used and the arc is maintained between this electrode and the workpiece, which respectively from the two terminals.

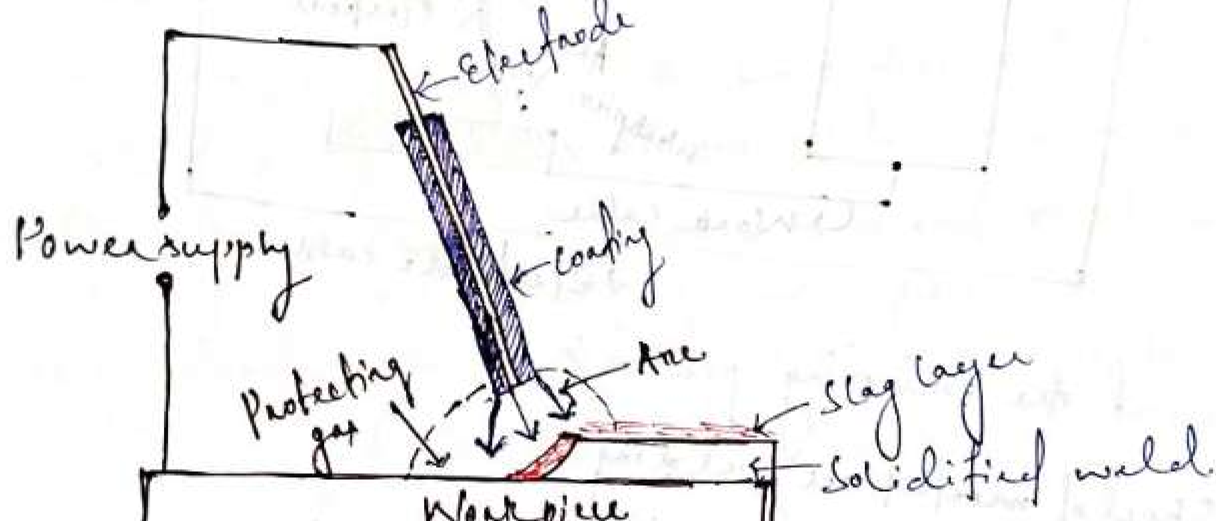
The metal electrode is coated with flux which produces a gas to shield and protect the welding area from atmospheric air. In some cases it also carries certain alloying elements which promote conduction of electric current & stabilized the arc.

Both alternating current (AC) and direct current (DC) are used for arc welding.

For AC arc welding a step down transformer is used which receives current from the supply mains at 400 400 volts and transforms it to to the required voltage for welding i.e 80-100 volt

It is used for welding of steel and cast iron

This welding is not used to weld copper metal.



[Shield Metal Arc Welding (SMAW)]

Carbon Arc Welding →

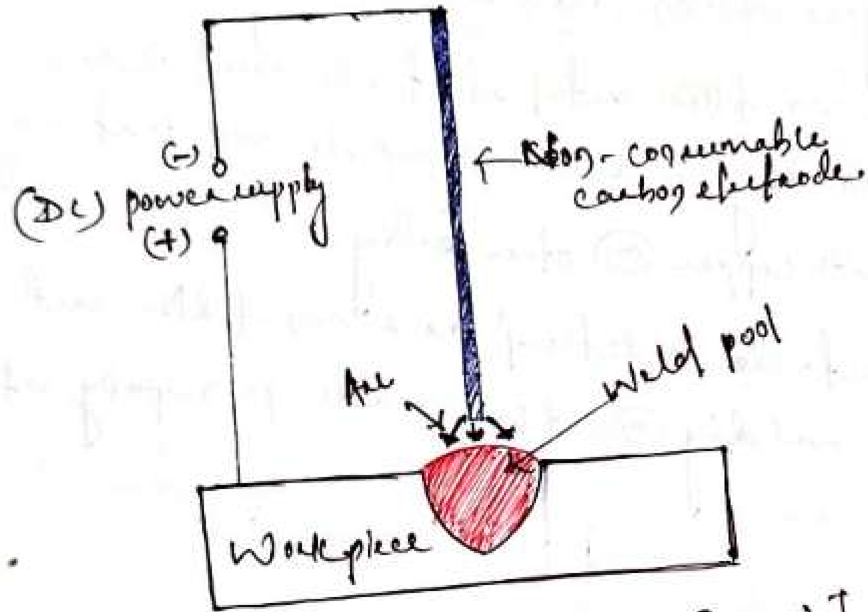
Carbon arc welding is fusion welding process where non consumable carbon electrode is used.

Only D.C is used in carbon arc welding process.

The negative terminal of the supply is connected to the carbon electrode and the positive terminal to the workpiece

A flux is used to prevent the weld metal from picking up carbon from the fused electrode.

This welding is used for joining steel sheets.



[Carbon Arc Welding (CAW)]

Arc Welding Electrode Specification →

Electrode → It is a piece of wire rod (of metal or alloy) with or without flux coated material which carries current for welding.

Welding Electrode

- Non-consumable electrode
  - Carbon (or) graphite coated
  - Tungsten
    - Pure
    - Zinc coated
- Consumable electrode
  - Bare electrode
  - Flux coated
    - Light coated
    - Heavy

Non Consumable Electrode ⇒

There are two types of non-consumable welding electrodes

The carbon electrode is a non-filler metal electrode used in arc welding (or) cutting, consisting of a carbon graphite rod that may (or) may not be coated with copper (or) other coating.

The tungsten electrode is defined as a non-filler metal electrode used in arc welding (or) cutting, made principally of tungsten.

Consumable Electrodes ⇒

Have low melting point.

When arc is generated between electrode and work piece the tip of the electrode starts melting and converted in droplets which transfers to the workpiece.

These droplets transferring to the workpiece gets deposited there and produce large heat so the thermal efficiency of consumable electrode arrangement is higher as compared to non-consumable electrode welding arrangement.

Bare Electrodes ⇒

It is made up of metals (or) alloys but without flux coating.

- It does not prevent the oxidation (or) atmospheric contamination for which the joint will be weak and low ductile so it is used for minor repairs where strength is not dominant
- It has good weld quality.
- Arc is unstable
- Improper metal transfer
- It is noise less.

Flux coated Electrode ⇒

It prevents the oxidation and the atmospheric contamination by creating a gaseous shield around the arc

- Better arc.
- Stable arc
- Better welding quality.

Light coating ⇒

These electrodes having coating parameter of 1.25.

Ex ⇒ Cytoblast.

Heavy Coating ⇒

The coating factor is between 1.6 & 2.2 for heavily coated electrode

Ex ⇒ Citofine

Resistance Welding :-

It is the joining of metals by applying pressure and passing current for a length of time through the metal area which is to be a joined. The key advantage of resistance welding is that no other materials are needed to create the bond, which makes this process extremely cost effective.

The working principle of resistance welding is the generation of heat because of electric resistance. The resistance welding such as seam, spot, projection works on the same principle. Whenever the current flows through electric resistance then heat will be generated. The same working principle can be used within the electric coil. The generated heat will depend on materials resistance, applied current, condition of a surface, applied current time period.

This heat generation takes place because of the energy converting from electric to thermal. The resistance welding formula for heat generation is

$$H = I^2RT$$

where,

H is a generated heat, and the unit of heat is a joule.

I is a electric current. & the unit of current is a ampere

R is an electric resistance, the unit of this Ohm

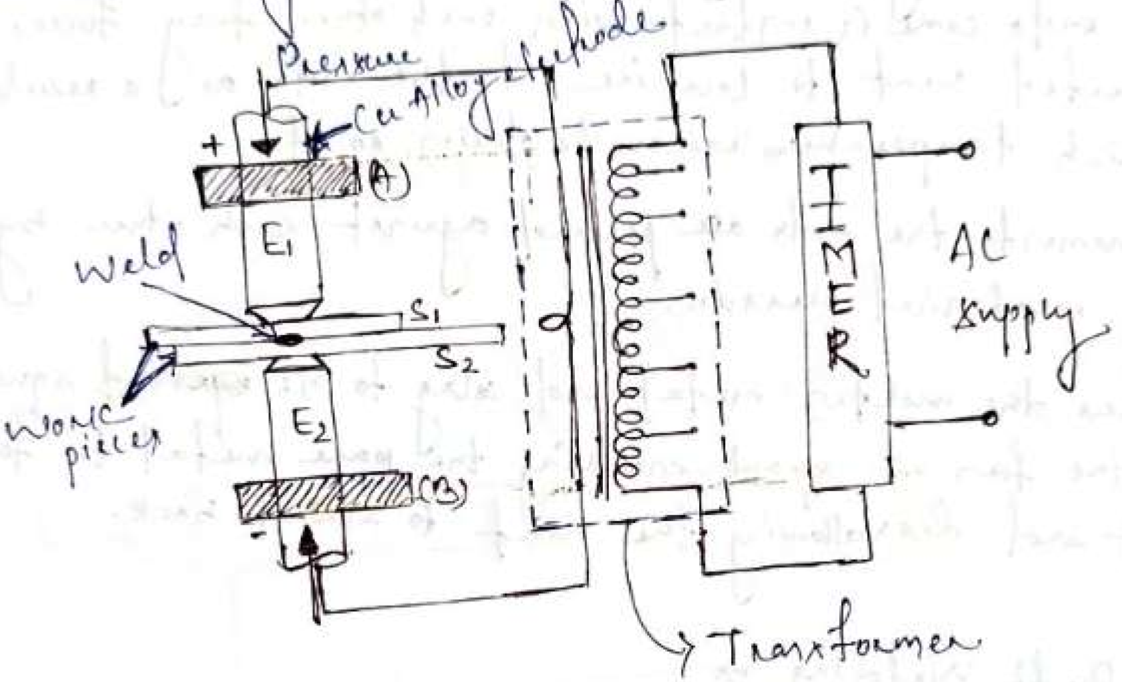
T is the time of current flow, the unit of this is second.

The generated heat can be used to soften the edge metal to shape a tough weld joint with fusion. This method generates weld with no application of any flux, filler material & shielding gases.

Types of Resistance Welding ⇒

(I) Spot welding
(II) Seam welding
(III) Projection welding
(IV) Flash butt welding
(V) Butt welding

Spot Welding ⇒



This welding process is used for making lap welds & thin sheets [Upto a maximum thickness of 12.7mm] using the principle of resistance welding.

In this welding process one end of the secondary winding of the transformer is connected to the upper electrode E_1 carried in the movable copper (or) bronze arm 'A' and the other end of the lower electrode E_2 mounted on the fixed arm B.

The metal sheet S_1 & S_2 are held and pressed between the electrodes and strong current at low voltage is applied.

Developed resistance by the sheet metals to the flow of this current causes heat & raise the temp. at the contact surface to their fusing point and the welding is completed under the contact pressure of electrodes.

Resistance Flash Welding =>

Flash welding is used for joining metal pieces end to end. It replaces butt welding method for welding articles having thin cross-section. It is also used to weld thick section.

In this method first the current is switched on and then the ends of the pieces to be welded are slowly brought closer until they finally come in contact with each other.

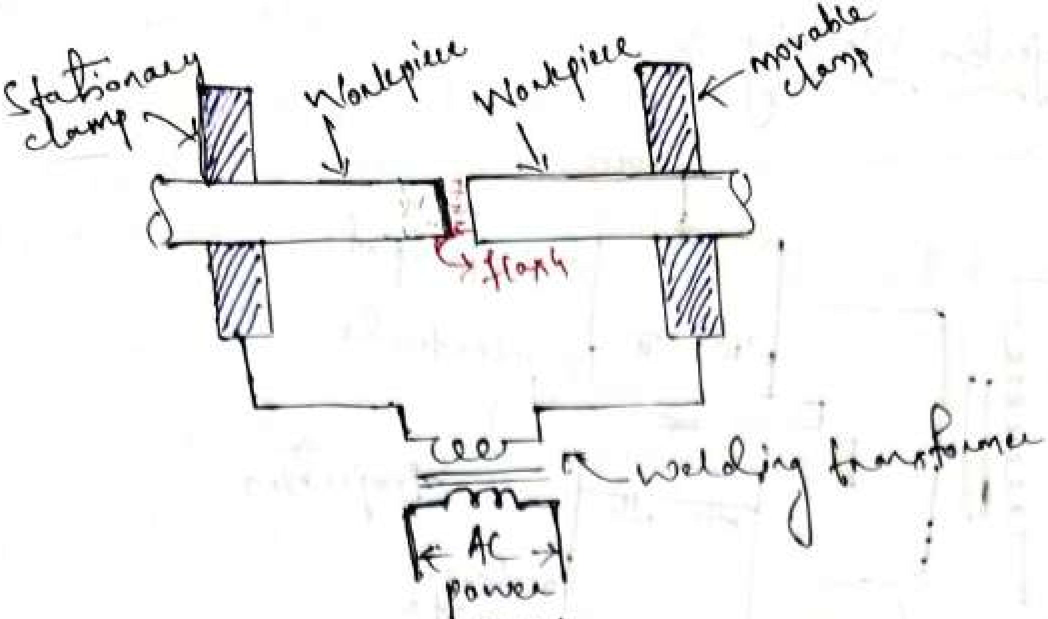
Once the ends come in contact with each other they forces the generated heat to localise at the ends as a results of which temperature raises to fusion point.

At this moment the ends are pressed against each other by applying mechanical pressure.

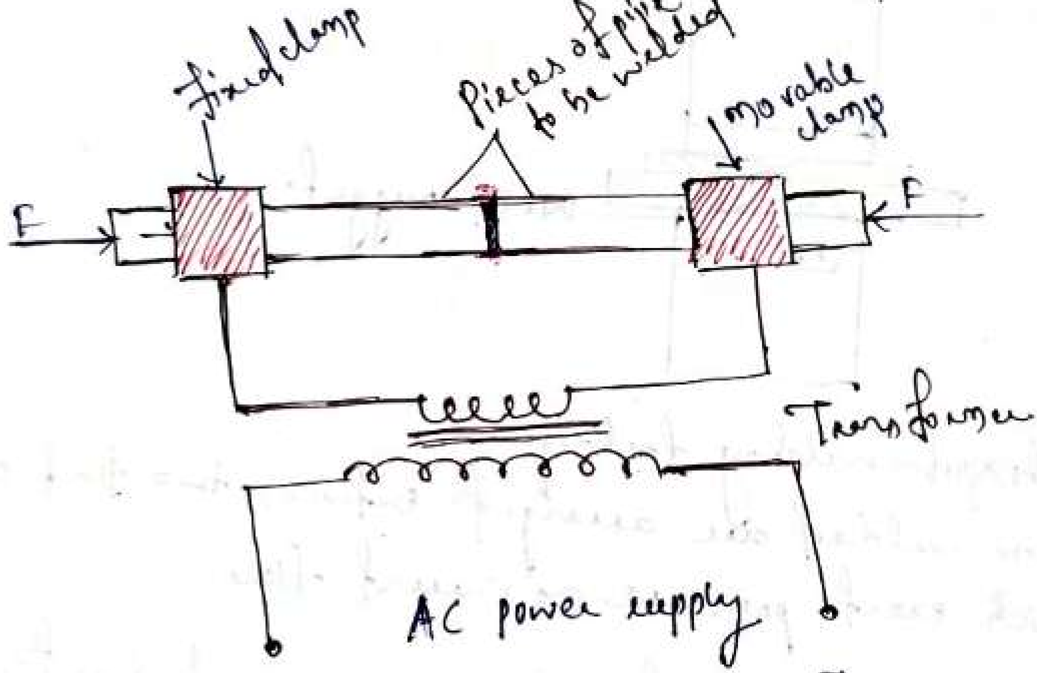
This forces the molten metal and slag to be ~~squeezed~~ squeezed out in the form of spark enabling the pure metal to form the joint and dissallowing the heat to spread back.

Resistance Butt Welding =>

Resistance butt welding is a type of resistance welding process used to join the ends of two metal parts that are aligned and butted against each other. In this process the two ends are clamped together between electrode tips. An electric current is passed through the parts, generating heat at the contact point due to their resistance. The heat melts the metal and pressure is applied to forge the parts together, forming a solid weld joint. This method is often used for joining wires, rods, tubes & other cylindrical components as well as flat sheets. It is known for producing strong, consistent welds with minimal material loss.

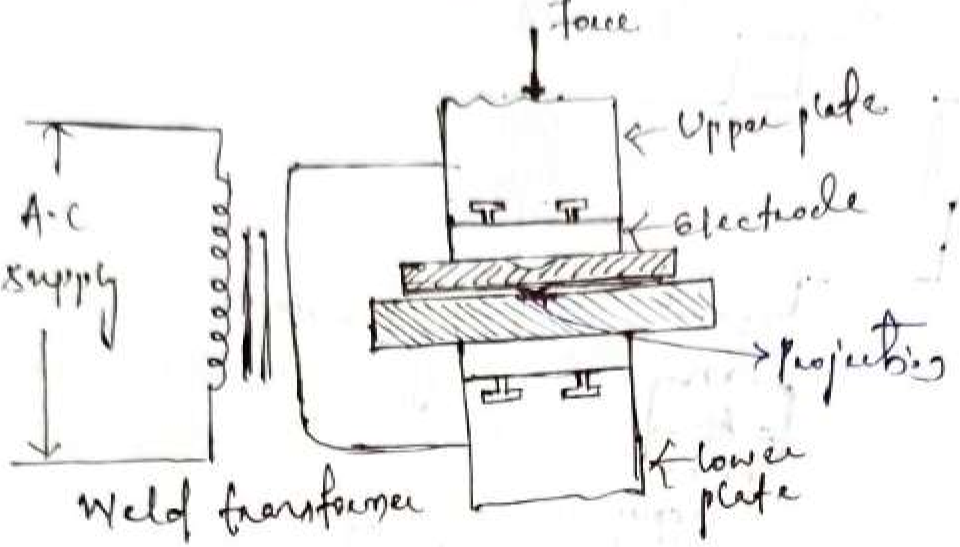


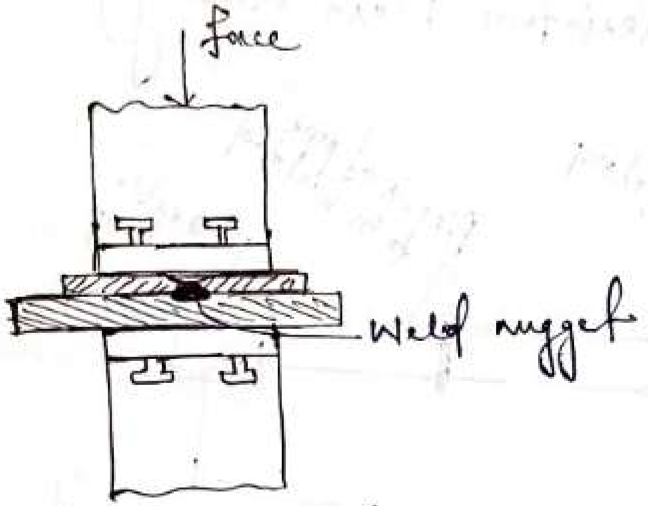
[Resistance Flash Welding]



[Resistance Butt Welding]

Recinfance Projection Welding →





It is a multi spot welding technique.
The pieces to be welded are arranged between two flat copper electrode which exert pressure as current flow.

- In this welding process, projection at the desired locations the surface of one of the workpieces are located. then the surface of the workpieces are in contact with each other at the projection. As per current is switched on the projection are melted at the workpiece pressed together to complete the weld. by pressing the upper electrode downward.

Resistance Seam Welding :-

It is similar to spot welding with difference that the electrode are in the form of rotating roller and workpiece moves in direction of perpendicular to the roller axis.

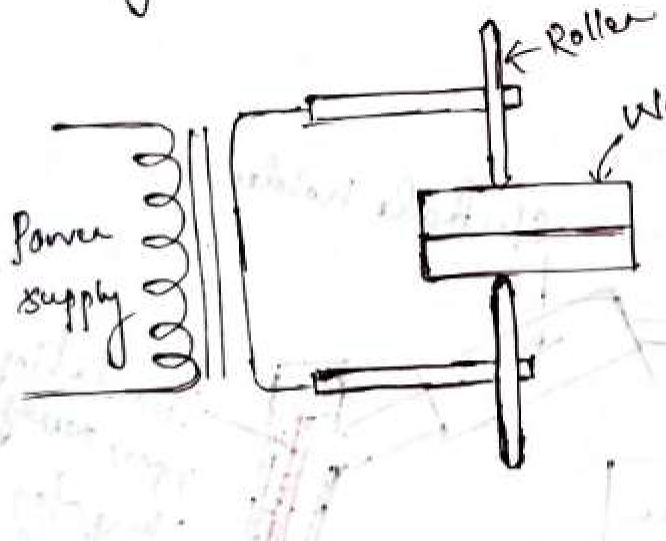
In this welding the current is switched on and the metal pieces pushed together to travel between the revolving electrode. The metal between the electrode get heated to welding heat and welded continuously under constant pressure of rotating electrodes as it passes between them.

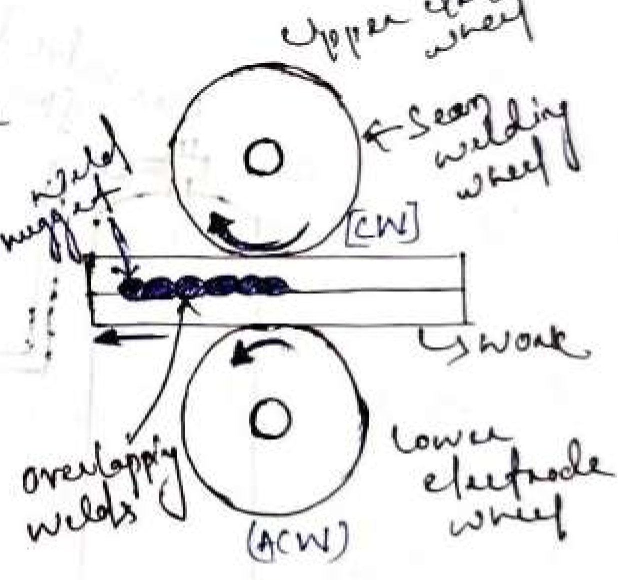
The welding is usually done under water to keeps the heating of welding rollers and the work to a minimum value to give lower roller maintenance

Welding current range from 2000A to 5000A while the force applied to the roller may as high as 5KN to 6KN.

Welding speed is 1.5 m/min for thin sheet

#





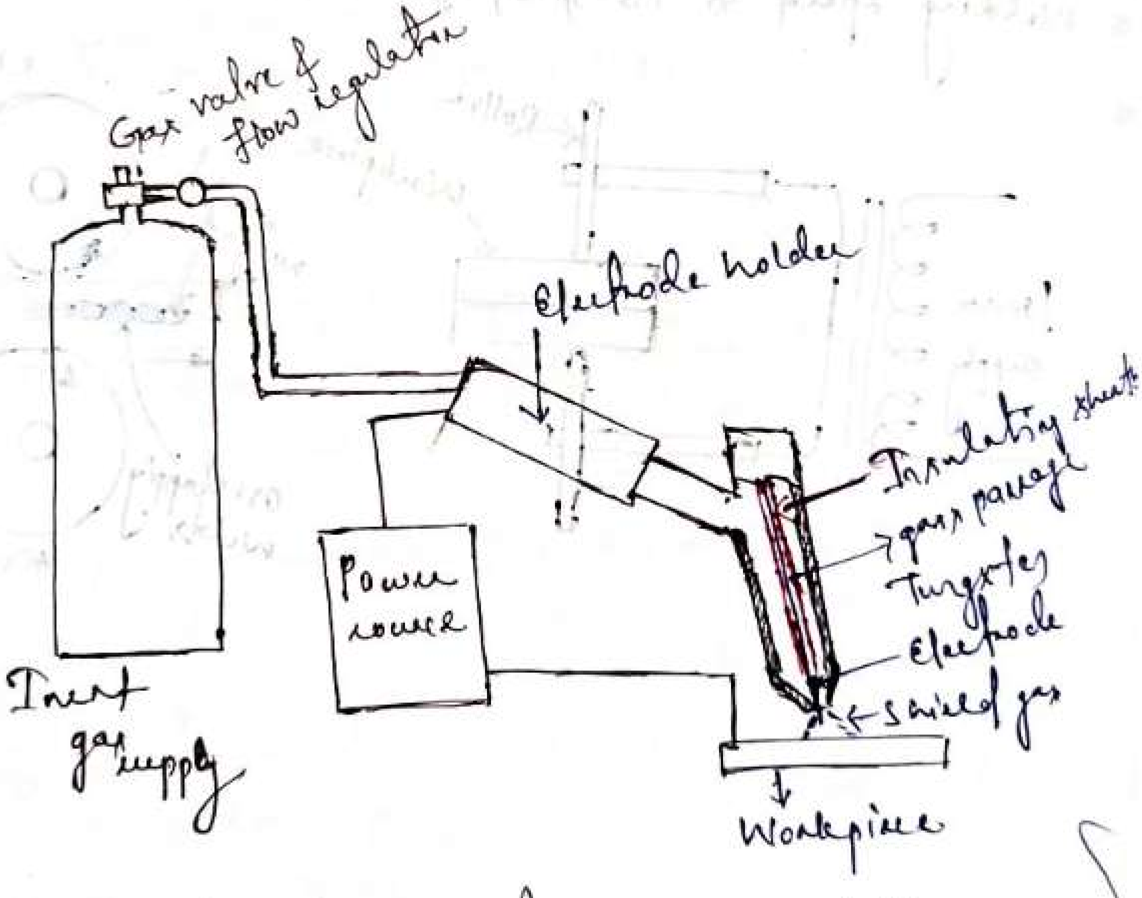
Tungsten Inert gas Welding → (TIG)

In this welding process the arc is struck between a non consumable tungsten electrode and base metal.

The electrode is held in a special type of electrode holder which is so designed that apart from holding the electrode it also carries a passage around the electrode for flow of inert gas to provide the protective shield around the arc.

This gaseous shield protects the electrode, molten metal, the arc and adjacent heated areas of base metal from atmospheric contamination.

The electrode holder also carries a provision for water cooling (or) air cooling



Inert gas → Argon & Helium used in TIG Welding

Advantages

TIG welds are stronger, more ductile & more corrosion resistance than welds made with ordinary shield arc welding

Since no flux is used it is possible to use a wide variety of design joint than conventional shield.

There is a little weld metal splatter that damage the surface of the base metal in traditional welding.

Application

Widely used in aerospace industry.

Used for welding aluminium, magnesium alloys, stainless steel, nickel alloys, copper shield.

~~There is a little weld metal splatter that damages the surface of the base metal in traditional~~

It can also be used for combining dissimilar metals.

TIG welding process →

TIG welding or Tungsten inert gas welding is a welding process that uses a non-consumable tungsten electrode to create a weld.

Setup → A TIG welding machine is used, which provides the necessary power & controls.

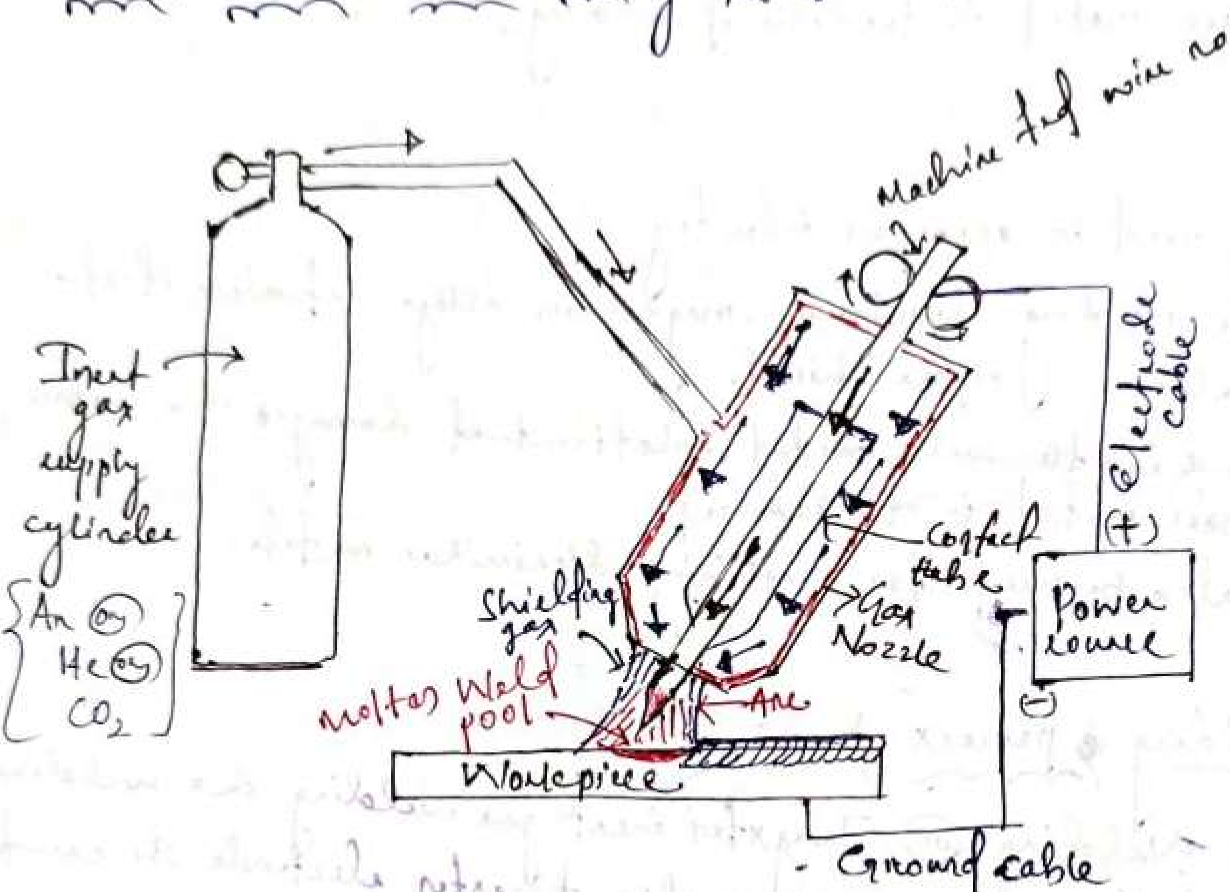
A shielding gas typically argon is used to protect the weld area from the atmospheric contamination.

Electrode preparation → The electrode is inserted into a TIG torch, which also has a gas nozzle.

Welding Technique → An electric arc is created between the tungsten electrode and the workpiece by striking it. The heat from the arc metal melts the base metal.

Shielding gas → The argon gas flow through the torch nozzle to shield the molten weld area from the surrounding air, preventing contamination & oxidation.

Metal Inert Gas Welding (MIG) →



Metal gas arc welding (MIG) is also known as gas metal arc welding. the weld area is shielded by an effectively inert atmosphere of argon helium, carbon dioxide and various other gas mixture. The consumable bare wire is feed automatically through a nozzle into the weld arc.

* MIG welding uses a constant voltage power supply to create an electric arc that fuses the base metal with a filler wire that is continuously fed through the welding torch. At the same time, an inert shielding gas is also fed through the gas to protect the weld pool from atmospheric contaminants.

In this process the power source (DC power) connected to bare metal wire electrode and the workpiece.

The wire electrode is connected to positive pole of power source.

The torch is used in this process where the wire electrode fed from a spool through the torch (welding gun) at a constant speed and the torch is also connected to the hosepipe carrying shielding gas.

Usually argon is used as shielding gas and some time mixture of Argon and Oxygen, Helium Argon & Carbon dioxide or argon & carbon dioxide are used as shielding gas.

Advantages

It is faster than shielded metal arc welding due to continuous feeding of filler metal.

There is no slag formation.

More suitable for welding of thin sheet.

Deeper penetration is possible.

Weld metal carries low hydrogen content.

A MIG torch handles horizontal, vertical or flat welding position with ease.

Disadvantages

MIG Welding equipment has a relatively high initial set up costs.

With limited deoxidants available in the process, all rust must be removed from the workpiece before MIG welding can commence.

Welding Defects →

Welding defects can be defined as the irregularities formed in the given weld metal due to wrong welding process or incorrect welding pattern etc. The defect may differ from the desired weld bead shape, size and intended quality. Welding defects may occur either outside or inside the weld metal.

Welding defects can be classified into two types as external and internal defects.

External defects → (i) Weld crack
(ii) Undercut
(iii) Spatter
(iv) Porosity
(v) Overlap

Internal defects → (i) Slag inclusion
(ii) Incomplete fusion
(iii) Incomplete penetration

(i) Weld crack → This is the most unwanted defect of all the other welding defects. Welding cracks can be present at the surface, inside of the weld material or at the heat affected zones.

Crack can also appear at different temperatures

(i) Hot crack → It is more prominent during crystallization of weld joints where temp. can rise more than 10,000 °C.

(ii) Cold crack → This type of crack occurs at the end of the welding process where the temp. is quite low. Sometimes cold crack is visible several hours after welding or even after few days. These cracks are formed near the weld area due to excessive cooling rate & the absence of hydrogen.

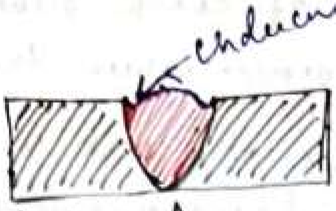
Causes of Weld crack →

(I) Wrong joint design
(II) Use of hydrogen gas a shield gas while welding ferrous metals.
(III) High content of carbon and sulfur in the base metal.
(IV) High welding current
(V) Rapid cooling of weld joint
(VI) Unequal physical property of the parent weld metals
(VII) Inadequate preheating.

Remedies of crack →

(I) Preheat the metal as required.
(II) Provide proper cooling of the weld area.
(III) Use proper joint design.
(IV) Remove impurities.
(V) Use appropriate metal.
(VI) Weld sufficient sectional area

(II) Undercut ⇒



When the base of metal melts away from the weld zone, then a groove is formed in the shape of a notch, then this type of defect is known as undercut. It reduce the fatigue strength of the joint

Causes ⇒

(I) If the arc voltage is very high then this defect may occur.

(II) If we use the wrong electrode or if the angle of the electrode is wrong, then also the defect may form.

(III) High electrode speed is also one of the reasons for this defect

Remedies ⇒

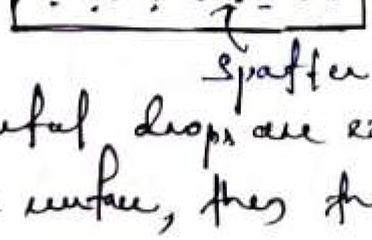
(I) Reduce the arc length or lower the arc voltage

(II) Keep the electrode angle from 30 to 45°

(III) Diameter of the electrode should be small.

(IV) Reduce the travel speed of the electrode

(III) Spatter ⇒



When some metal drops are expelled from the weld & remain stuck to the surface, then this defect is known as spatter

Causes →

(i) High welding current can cause this defect

(ii) The longer the arc the more ~~chance~~ chance of getting this defect

(iii) Improper gas shielded may also cause this defect

(iv) Incorrect polarity

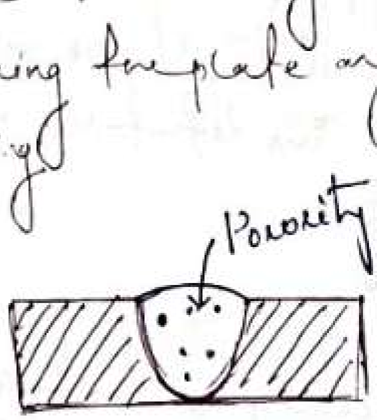
Remedies →

(i) Reducing the arc length and welding current.

(ii) Using the right polarity ~~and~~ according to the conditions of welding

(iii) Increasing the plate angle and using proper gas shielding

(iv) Porosity →



Porosity is the condition in which the gas or small bubbles gets trapped in the welded zone. Porosity is a cavity like discontinuity. Porosity is basically a small pore where as blow holes are comparatively larger holes.

Causes →

(i) In-adequate electrode deoxidant

(ii) Using a longer arc.

(iii) The presence of moisture

(iv) Improper gas shield

(v) Use of too high gas flow.

(vi) Presence of rust, paint, grease or oil.

Remedies ->

(i) Clean the materials before begin welding

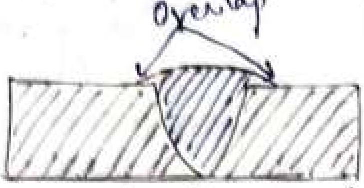
(ii) Use dry electrodes and materials.

(iii) Use correct arc distance

(iv) Use the right electrodes.

(v) Use a proper weld technique

Overlap =>



When the weld face extends beyond the weld toe, then this defect occurs. In this condition the weld metal rolls and forms an angle less than 90°. This defect can weaken the weld joint and reduce its integrity.

Causes ->

(i) Using a higher welding current than necessary can lead to excessive molten metal and overlap.

(ii) Moving too slowly during welding can cause excess deposition of weld metal leading to overlaps.

(iii) Holding the electrode at the wrong angle can result in improper control of the weld pool and overlap.

Remedies ->

(i) Use less welding current

(ii) Use small electrode

(iii) Maintain a consistent and appropriate travel speed.

Slag Inclusion ⇒

If there is any slag in the weld, then it affects the toughness and metal weldability of the given material. This decreases the structural performance of the weld material.

Causes ⇒

(I) Improper cleaning
(II) The weld speed is too fast
(III) Incorrect welding angle
(IV) welding current is too low.
(V) The weld pool cools down too fast

Remedies ⇒

(I) Increase current density
(II) Reduce rapid cooling
(III) Adjust the electrode angle
(IV) Adjust the welding speed.

Incomplete fusion ⇒

This type of welding defect occurs when there is a lack of proper fusion between the base metal and weld metal. It can also appear between adjoining weld beads. This creates a gap in the joint that is not filled with molten metal.

Causes ⇒ (I) It occurs because of the low heat input
(II) When the weld pool is very large and runs ahead of the arc
(III) When the angle of the joint is too low.
(IV) Incorrect electrode and torch angle may also lead to incomplete fusion.

Remedies ⇒
(I) Use sufficiently high welding current with the appropriate arc voltage
(II) Before beginning of welding clean the metal
(III) Use correct electrode diameter and angle
(IV) Reduce deposition rate

Incomplete penetration ⇒

These defects occur only in the butt weld where the groove of the metal is not filled completely. It is also called an incomplete penetration defect.

Causes ⇒
(I) Less deposition of the weld metal
(II) Use improper size of the electrode
(III) Improper welding technique

Remedies ⇒
(I) More deposition of the weld metal
(II) Use the proper size of the electrode
(III) By using a proper Welding technique

CHAPTER-3 CASTING

Casting is a manufacturing process that involves the creation of solid objects by pouring molten material into a mold, allowing it to cool and solidify. Steps involved in casting process -

(I) **Pattern creation** ⇒ The process begins with the creation of a pattern which is a replica of the desired object. Patterns are usually made from wood, metal (or) other materials.

(II) **Mold making** ⇒ A mold is created around the pattern using materials such as sand, clay, metal and plaster. The mold is designed to have two (or) more parts to allow for the removal of pattern.

(III) **Pattern removal** ⇒ The pattern is removed from the mold, leaving a cavity in the shape of the desired object

(IV) **Melting and pouring** ⇒ The material to be cast, often a metal (or) alloy is melted in a furnace to a specific temperature. The molten material is poured into the mold cavity through a gate (or) sprue

(V) **cooling & Solidification** ⇒ The molten material inside the mold cools and solidifies taking the shape of the mold cavity.

(VI) **Mold Breakout** ⇒ After the material has solidified, the mold is broken (or) opened to reveal the cast object.

(VII) **cleaning and finishing** ⇒ The cast object is removed from the remaining mold material, which may require sand blasting, grinding or other cleaning processes.

(VIII) **Inspection & Quality control** ⇒ The cast object is inspected for defects, such as porosity, cracks (or) surface irregularities. Non-destructive testing methods may be used for quality control

(IX) Post processing → Depending on the application, the cast object may undergo additional processes like heat treatment, coating to enhance its properties and appearance.

(X) Final product → The finished casting is now ready for use in various industries including ~~[illegible]~~ automotive, aerospace, etc.

Types of casting →

1. Sand casting
2. Investment casting
3. Plaster casting
4. Die casting (metal casting process)
5. Centrifugal casting
6. Permanent mold casting.

Steps in making sand casting →

1. Pattern making
2. Core making
3. Molding
4. Melting and pouring
5. Cleaning
6. Inspection

Pattern Making =>

Pattern making is a crucial initial step in the sand casting process, as it involves creating a replica of the desired object to be cast. Patterns are used to form the mold cavity into which molten metal is poured.

The first step is to design the object or component you want to cast. The pattern should be exact replica of this object, accounting for any necessary allowances for shrinkage, machining, and draft angles.

The pattern must include all necessary details, such as fillets, drafts and core prints. Core prints are extension of the pattern that create spaces for cores in the mold.

Patterns can be made from a variety of materials, including wood, metal, plastic or a combination. The choice of material depends on factor like the complexity of the pattern, the number of casting needed.

Core making =>

Cores are usually made up of sand which are placed into a mold cavity to form cavity of desired shape and size in a casting.

Cores are prepared usually from green sand using core boxes.

The material for a green sand mould is a mixture of sand, clay, water and some organic additives e.g. wood flour, dextrin and sea coal

Molding =>

Molding in sand casting is a pivotal process that involves creating the mold into which molten metal is poured to form a casting.

A pattern, which is replica of the desired object, is placed into the bottom part of the mold box known as the drag.

To prevent the molding sand from sticking to the pattern, a parting compound is applied to the pattern's surface

The drag is filled with specially prepared molding sand typically called green sand. Green sand is mixture of silica sand, clay and water

The molding sand is compacted or rammed around the pattern to ensure it takes the shape of the object and maintains structural integrity.

The top part of the mold box, known as the 'cope' is placed over the drag to enclose the mold. Proper alignment is crucial.

Channels and a pouring basin are created on top of the cope to facilitate the controlled flow of molten metal into the mold cavity.

Molten metal is poured into the pouring basin, allowing it to flow through the channels & fill the mold cavity.

Melting and Pouring ⇒

The raw material is melted using a furnace and the molten metal is poured into the mold using laddle

Clearing →

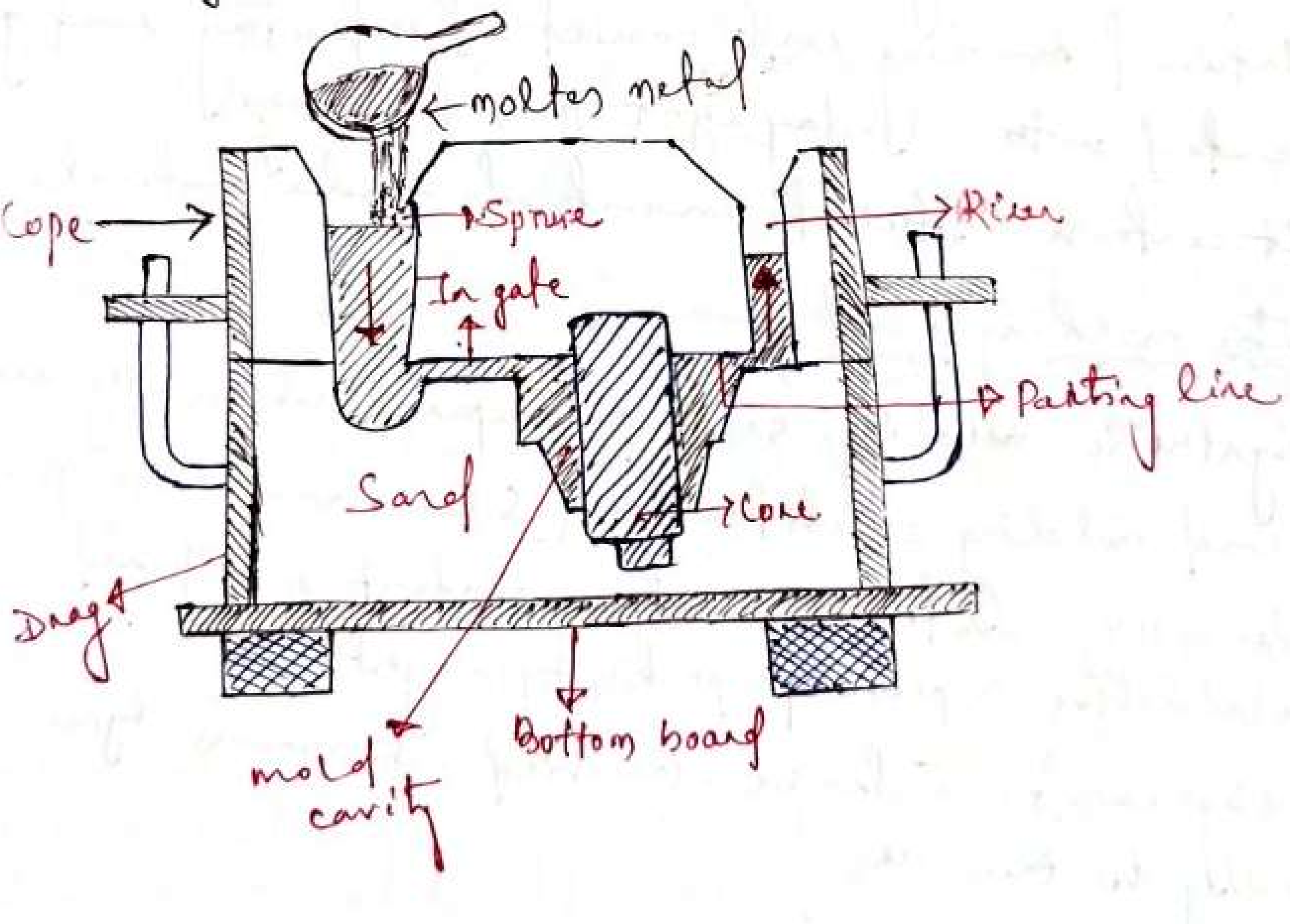
After proper solidification of casting the molds are broken to obtain the casting. This operation is called shake out operation. This casting carries risers, runners, gates, chills and nails etc attached to it. Also a lot of sands remain adhering to its surface in the form of core etc. Removal of sands, excess metals in form of fins, risers, runners, gates, chills and nails is done for clearing the casting.

Repair & heat treatment of casting →

Before use the required repairing is done and by heat treatment process, the required structure and mechanical properties of the casting is obtained.

Inspection →

Inspection of the casting to detect internal and external defects and general quality is done



Advantages of Sand Mold Casting ⇒

① Relatively low cost of production
② Large component can be fabricated
③ Both ferrous and non ferrous material can be casted

Disadvantages of Sand mold casting ⇒

① Low degree of accuracy.
② Rough surface finish.

Different Types of molding sand ⇒

① Natural molding sand
② Synthetic molding sand.

Natural molding sand ⇒

Natural molding sands consist of refractory sand grains associated with clay right from their origin

It contains sufficient amount of binder material

Synthetic molding sand ⇒

Synthetic molding sands are prepared artificially using basic sand molding constituents [Silica sand is 85-91%, binder 6-11%, water or moisture content 2-8%] and other additive in proper proportion by weight

Molding sands can also be classified into various types according to their use

(I) Green Sand ⇒

Green sand is known as tempered or natural sand. This is a prepared mixture of silica sand with 18 to 30% clay, having moisture content from 6 to 8%. The clay and water furnish the bond for green sand.

Green sand is commonly employed for production of small and medium casting of non-ferrous metal & alloys.

(II) Dry sand ⇒

When the moisture is removed from green sand it is known as dry sand. The mould produced by dry sand has greater strength, rigidity & thermal stability. This sand is used for large and heavy casting.

(III) Facing sand ⇒

A sand used for facing of the mould is known as facing sand. It consist of silica sand and clay, without addition of used sand. It is used directly next to the surface of the pattern. Facing sand comes in direct contact with the hot molten metal. therefore it must have high refractoriness and strength. It has very fine grains.

(IV) Core Sand ⇒

Core sand is used for making core. It is known as oil sand. Core sand is highly rich silica sand mixed with oil binder such as linseed oil, resin, light mineral oil and other bind materials.

(V) Backing Sand ⇒

Backing sand or floor sand is used to fill the whole volume of the molding flask. Backing sand is also called black sand because of old, repeatedly used molding sand is black in colour due to addition of coal dust.

Basic Properties of Molding Sand ⇒

① **Plasticity** ⇒ It is ability of molding sand to flow and get compacted all round the pattern when rammed & take up the required shape.

② **Refractoriness** ⇒ It is the ability of the molding sand to withstand the high temp. of the liquid metal to be poured without breaking down.

The refractoriness of silica sand is highest.

③ **Permeability** ⇒ It is the ability of the molding sand to allow air and ~~dry~~ any hot gases to pass through it even in compacted condition.

④ **Green strength** ⇒ The molding sand that contains moisture is termed as green sand. Green strength is the ability of green sand to retain the shape of constructed mold.

⑤ **Dry strength** ⇒ It is the ability of molding sand to retain the exact shape of the mold cavity in the dry condition [When the molten metal is poured in the mold]

The dry strength prevents the enlargement of mold cavity.

⑥ **Hot strength** ⇒ It is the ability of the molding sand to ~~retain~~ obtain the exact shape of the mold cavity at an elevated temp.

⑦ **Adhesiveness** ⇒ It is the ability of the molding sand to stick with the wall of the molding boxes.

(8) Cohesiveness ⇒ Cohesiveness is the property by virtue of which the sand grains attract eachother within the molding box.

(9) collapsibility ⇒ Collapsibility is the property by virtue of which molding sand is easily stripped off the casting after the molten ~~metal~~ metal in the mold get solidified.

Pattern ⇒

It is the replica of the final object to be made.

The mold cavity is made with the help of pattern.

Function of pattern ⇒

It prepares the mold cavity.

It makes provision for runner, gate & riser

properly made patterns having smooth surface, reduce casting defects

A properly constructed pattern minimizes the overall cost of the casting.

Pattern materials ⇒

Wood, metals and alloys, plastic, plaster of paris, rubber, wax and resin are used for pattern making. Each material has its own advantages, limitations and field of application.

characteristic of pattern material ⇒

(I) Light in weight

(II) Strong, hard and durable

(III) Resistant to wear abrasion.

(IV) Resistant to corrosion and chemical reaction.

(V) Dimensionally stable and unaffected by variation of temp. and humidity.

(11)

Pattern Allowance ⇒

The pattern should made larger as compared to the required size of the casting.
The difference between the actual size and required size is known as pattern allowance.

→ There are following types of pattern allowance

1. (I) Shrinkage allowance
2. (II) Draft allowance
3. (III) Machining allowance
4. (IV) Deformation (or) Camber allowance
5. (V) Shake or Rapping allowance

I) Shrinkage allowance ⇒

Most of the metal contract during cooling from pouring temperature to room temperature. This contraction takes place in three forms i.e liquid contraction, solid contraction & solidifying contraction.

The shrinkage allowance in the pattern varies with variation in cast metal.

Shrinkage allowance is the adjustment made in the casting pattern (or) mold to account for the reduction in volume that occurs as molten metal cools and solidifies during the casting process. It ensures that the final casting meets the desired specification.

(II) Draft allowance ⇒

Slight taper is provided on the vertical surface of the pattern so that it can be removed from sand without damaging the sides of the sand mold. This taper is known as draft allowance. It can be expressed in degrees

(III) Machining allowance ⇒

Machining allowance in the casting refers to the additional material intentionally left on the surface of a cast part to allow for subsequent machining (or) finishing operation. When a metal casting is produced it may have surface imperfections, excess material (or) irregularities that need to be removed to achieve the desired final dimension and surface quality. Machining allowance ensure that there is enough material available for these post casting process

(IV) Deformation / camber allowance ⇒

Sometimes casting gets distorted during solidification due to their critical shape

Non uniform contraction of casting during cooling cause thermal stress, which result distortion.

To eliminate this defect an opposite distortion is provided in the pattern so that the effect is neutralized and correct casting is obtained.

(V) Rapping allowance ⇒

Rapping means shaking the pattern from side to side so that its surface may be free of the adjoining sand wall of the mold. By this action the volume of the mold cavity increases

To avoid this increase in the dimension of the casting, the pattern is made slightly smaller than the casting. These small changes in the dimension of the pattern in the casting process are called shaking (or) rapping allowance.

Core ⇒

Core comes into picture when we have to make component of hollow cavity.

It is made up of sand, metal, plaster and ceramics.

A core can be defined as a body of sand, which is used to form a cavity of desired shape and size of casting.

The core is divided into three types

(i) Green sand core
(ii) Dry sand core
(iii) No bake sand core

Green sand core ⇒

I These are used in metal casting to create internal cavities in the final product. These are obtained by the pattern itself during molding. This is used only for those type of cavities which permit the withdrawal of the pattern, leaving the core as the part of mold.

Dry sand core ⇒

Dry sand core [Unlike green sand core] are not produced as a part of the mold. Dry sand cores are made separately and independent of the mold. A dry sand core is made up of core sand which differ very much from the sand out of which the mold is constructed. These cores are located in the mold in the seats formed by the core print provided on the pattern.

No bake sand core ⇒

No bake sand core are formed using a sand mixture with a liquid resin binder, often containing catalyst. Unlike green and dry sand core, no bake cores don't required heat for curing. Instead they set and harden at room temp. (or) with the use of gas. This process offers flexibility and faster production time.

⇒ Depending on the shape and position in the prepared mold, the cores are classified into following types

(i) Horizontal core
(ii) vertical core
(iii) Balanced core
(iv) Hanging (or) cover core
(v) Stop off core
(vi) Ram up core

CUPOLA FURNACE ⇒

For melting of cast iron in foundry the cupola furnace is used.

Construction of Cupola furnace ⇒ [Pig iron → Cast iron]

The parts of cupola furnace are

(i) Shell
(ii) Foundation
(iii) Tuyer
(iv) Wind belt
(v) Blower
(vi) Metal tapping hole
(vii) Slag hole
(viii) Charging door
(ix) Chimney (or) Stack

(I) **Shell** ⇒ The outer cylindrical structure made of steel. providing the framework for the cupola

It is in the form of a hollow vertical cylinder made up of ~~strong~~ steel plate with lining of refractory bricks and clay. The inner surface is lined with refractory material to withstand high temp. and protect the shell.

The bottom door is hinged to supporting leg. When the cupola is in operation, the bottom door is supported by a prop.

(II) **Foundation** ⇒

Brick wall (or) steel column foundation is provided to support the shell.

(III) **Tuyer** ⇒ Opening at the lower part of the ~~cupola~~ cupola where air is injected. These injector facilitate the combustion of coke and provide the necessary oxygen for the process.

Tuyers are provided all around the shell and have a definite number and size depending upon the amount of air required

(IV) **Wind belt** ⇒ A chamber that directs the air to the tuyeres. ensuring uniform distribution for efficient combustion.

This belt is connected to the furnace blower by means of blast pipe

(V) **Blower** ⇒ A blower plays a crucial role in the combustion process. The blower supplies air to the furnace through the tuyers. promoting the burning of coke and maintaining the high temp. required for melting metal

(vi) **Metal tapping hole** →
Metal tapping hole exist just above the sand bed.

(vii) **Slag hole** → Slag hole may be kept at a height of about 25 to 30 cm from the bottom of the cupola and located above metal tap hole.

(viii) **Charging door** → An opening at the top for charging the cupola with coke, iron ~~ore~~ ore and metal scrap.

(ix) **Stack** → The vertical portion of the cupola that allows the escape of the combustion gases.

Working Principle of Cupola furnace →

To operate the cupola 1st the drop door at the bottom are closed and a sand bed with gentle slope towards the metal tap hole is rammed. Then a coke bed of suitable height is prepared above the bottom sand bed and ignited through the tap hole.

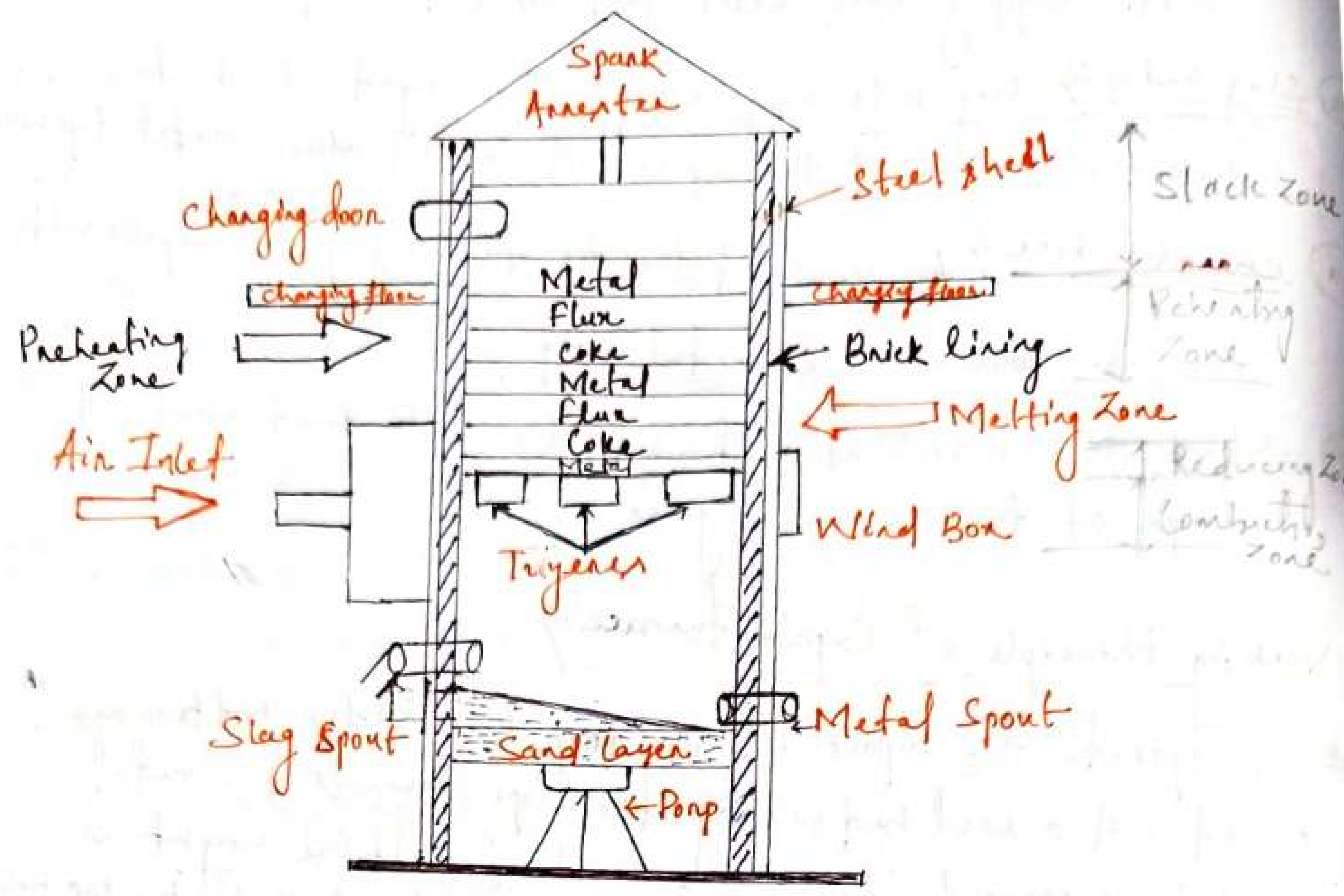
When the coke bed is properly ignited, alternate charge, flux and coke is fed into through the charge door until the level of the charging door

Then the air blast is turn on and forced air comes through the tuyeres. Combustion occurs rapidly within coke bed.

Within 5-10 min after the blast is turned on, molten metal is deposited near the tap hole.

When enough molten metal is deposited the slag is bared up to the slag whole before opening the tap hole.

The molten metal is collected in the ladle and then transferred to the cavity into which it is to be poured.



[CUPOLA FURNACE]

Flux → limestone

CRUCIBLE FURNACE ⇒

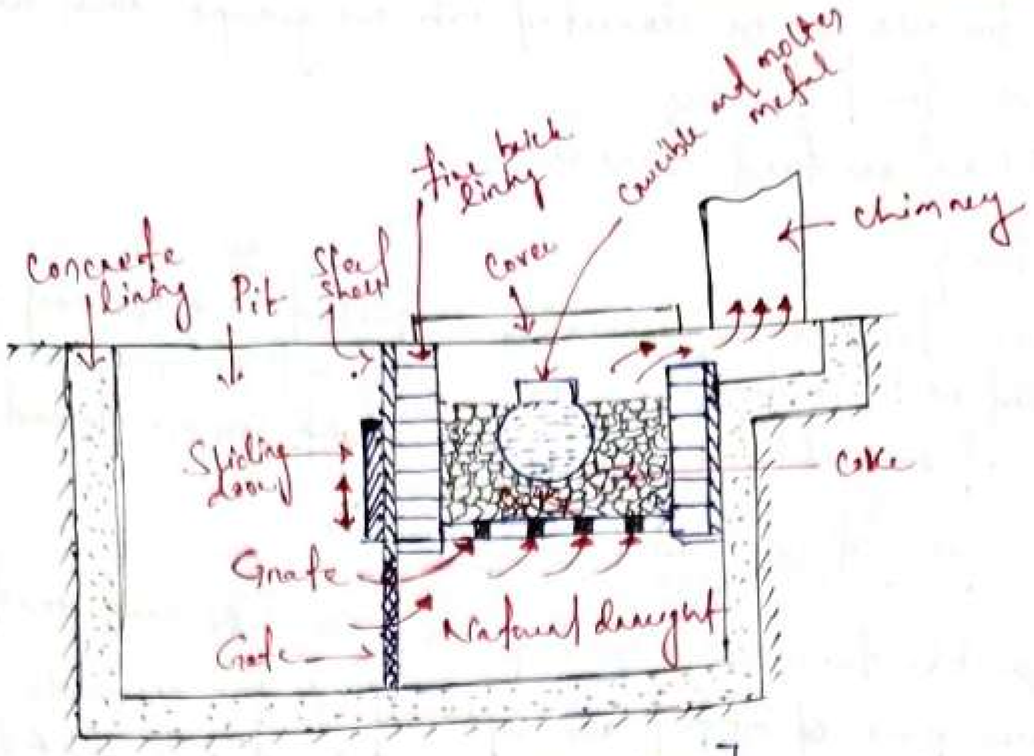
- → These are simplest form of all the furnace used in foundries
- → They are used in most of the small industry where the melting is not continuous and large variety of metal can be melted in small quantities.
- → In these furnaces the entire melting of metal takes place in a melting pot which is called crucible, which is made of clay and graphite
- → There is no direct contact between the flame and the metal charge. These furnaces are used for melting non ferrous metal and their alloy to produce small and medium size of casting in foundries.

These furnaces can be classified into two groups such as
(i) Coke fired furnaces
(ii) Oil and gas fired furnaces.

Construction →
These furnaces are generally installed in a furnace pit. They are provided with refractory lining inside and chimney at the top. Both natural as well as artificial draught can be used.

Working of coke fired crucible furnaces →
A crucible furnace is a melting device used to heat materials to high temp. Broken piece of metal are placed in the crucible. Bed coke is fired in the furnace and the crucible placed into it. Afterward more coke is placed all around the crucible. The heat generated by burning of the coke melts the metal inside the crucible.
coke is used as a fuel.

Oil or Gas fired furnace →
These furnaces utilise oil or gas as a fuel. A mixture of gas and air or oil and air is fed into the furnace which burns inside to produce the desired temp. The mixture usually enters tangentially and encircles the crucible while burning.
The heat generated due to burning of fuel gas rises temp. of the metal inside the crucible and melt the metal.
These furnace may be of stationary type or tilting type.



[CRUCIBLE FURNACE]

Die Casting Method ⇒

Die casting is a type of permanent mold casting. In this process the molten metal is forced into the permanent cavity of steel mold called die under very high pressure. The die casting is also called pressure die casting.

* The dies are usually made in two halves one is fixed and another is movable. The two halves must be locked perfectly during pouring and solidification of molten metal. After solidification the two halves are to be opened for ejecting the casting.
* The die casting is suitable only for low melting point ~~metal~~ metals and alloys.

Types of Die Casting :->

(I) Hot chamber die casting
(II) Cold chamber die casting.

Hot chamber die casting :->

The melting unit or heating furnace for the liquid metal is an integral part of this die casting machine, that's why it is called hot chamber die casting machine.

The molten metal from the metal container is forced inside the die with the help of a plunger which operates hydraulically.

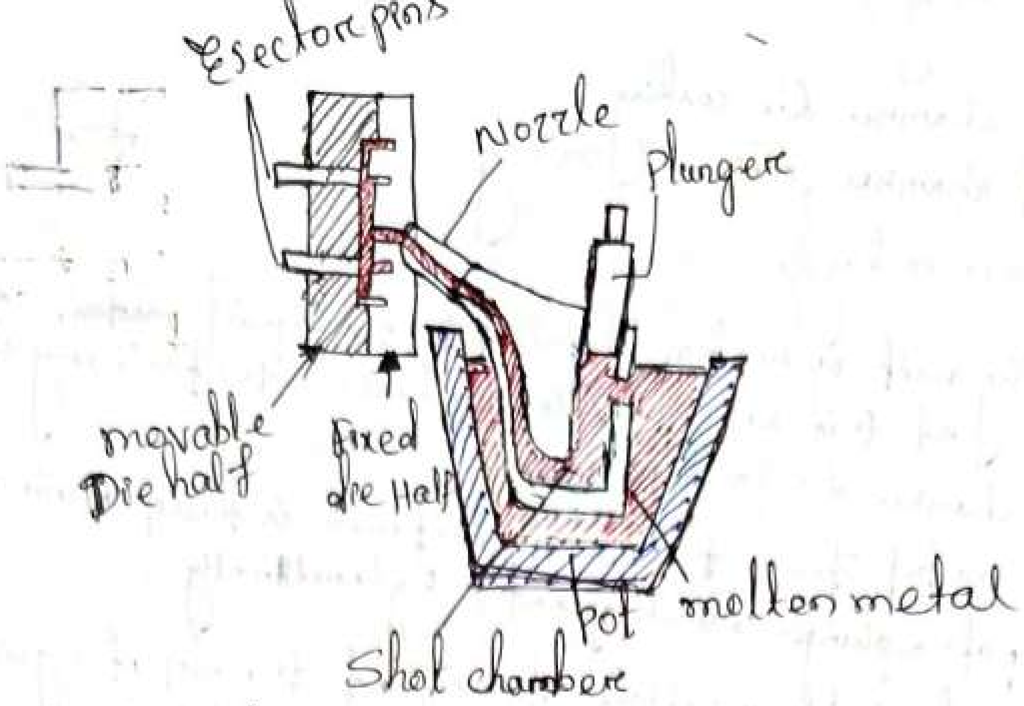
This plunger acts inside a cylinder formed at the end of a gooseneck type casting which is submerged in the molten metal.

A port is provided near the top of the cylinder to allow the entry of the molten metal into it. When the bottom of the plunger is above the ports the cylinder is connected to the melting pot through this port.

When the plunger moves down, it closes this port and cutoff the metal supply. The molten metal is forced into the die through the injecting nozzle by the pressure applied by the plunger on the molten metal present in the gooseneck.

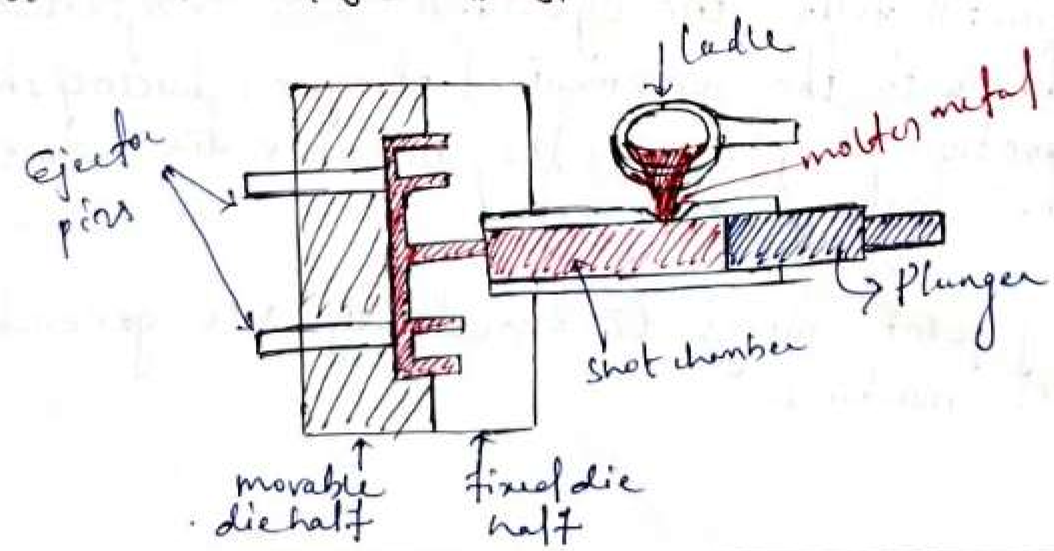
After a certain period of time, in the next cycle when the plunger moves up, the remaining molten metal in the nozzle falls back and when plunger uncovers the port, molten metal fills the cylinder. Due to synchronisation of movable die with the movement of plunger, during the upward motion of plunger, the movable die moves away and the casting is ejected.

low melting point alloys (Zn based only) are generally cast in this machine.



cold chamber die casting

In this machine the metal is melted separately in a farnance and transferred to this by means of small hand ladle.
After closing the die, the molten metal is poured into the horizontal chamber through the metal inlet and is forced into the die cavity by a hydraulic operated plunger.
After solidification the die is opened and the casting is ejected.
These machines are widely used for casting a good no. of aluminium alloys and ~~bas~~ brass. So in this process comparatively higher melting point alloys can be processed.
carburatore, handle bar, different parts of scooter, motor cycle, and jeep.
other decorative items.



Advantages

Very small thickness can easily cast.
High production rate.
Better surface finish.
possible to obtain fairly complex casting.

Disadvantages

* Not suitable for all materials.
* The die and the machine are very expensive
* The maximum size of the casting is limited.
* Sometimes cold shut defects can be seen.

centrifugal casting ⇒

As the name suggests, the centrifugal ~~ca~~ casting process utilizes the centrifugal force developed by the rotation of the mold to distribute the molten metal into the mold.

In other words, this is a process where the mold is rotated rapidly about the central axis when the metal poured into it; because of the centrifugal force the molten metal is directed outwards from the centre towards the inside surface of the mold, with high pressure.

As a result of this a uniform thickness of metal is deposited all along the inside surface of the mold.

During solidification, the impurities being lighter remain nearer to the axis of rotation. Greater accuracy and better physical properties of the casting are obtained in this process.

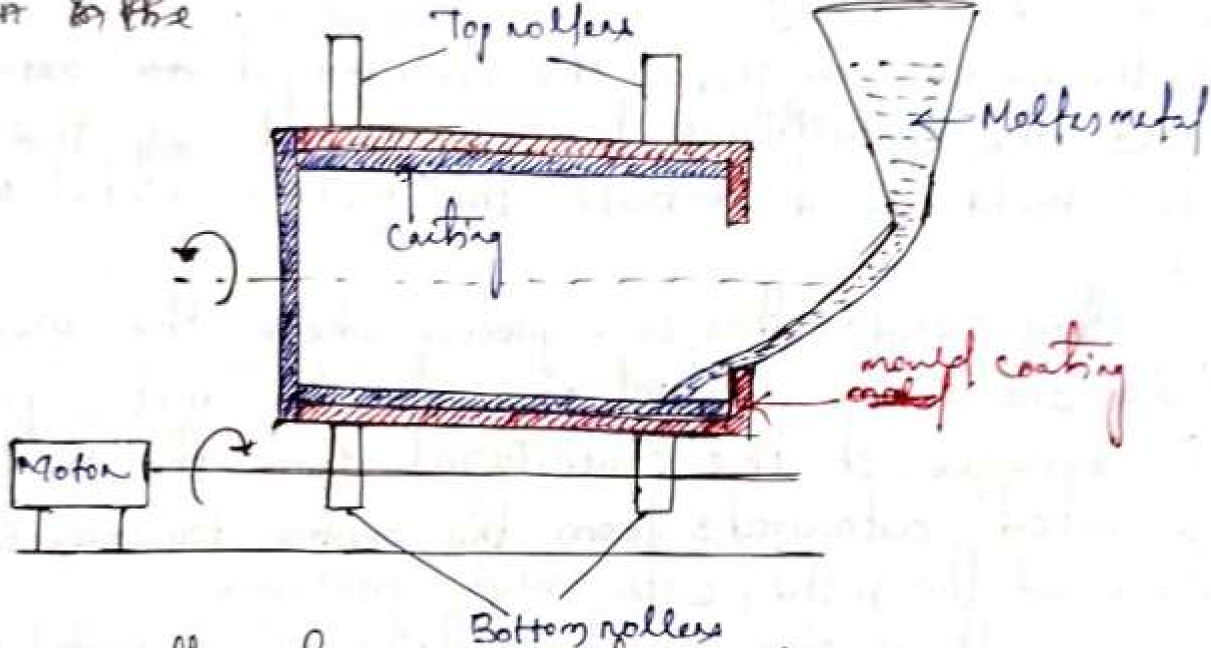
The centrifugal casting method can be classified as follows:-

1. True centrifugal casting
2. Semi- centrifugal casting
3. centrifuging

True centrifugal casting →

* In true centrifugal casting the axis of rotation of the mold and the axis of the casting are the same. The axis of rotation of the mold may be horizontal, vertical or inclined at an angle between 70° and 90°.
* End cores are usually used at the two ends of the mold to prevent the splashing of molten metal. The central hole through the casting is produced by the centrifugal force without the use of a central core.
* If the axis of rotation of the mold remains horizontal then the casting method is known as horizontal true centrifugal casting.

* ~~As shown in the~~



* As shown in the figure an outer metallic flask with rammed sand lining inside is used as mold and is rotated by two sets of rollers. A variable speed motor which is mounted at an end, is used to drive the rollers. Through the pouring basin, molten metal is poured and during pouring the mold is rotated at a slow speed.
* After the pouring is over, the mold is rotated at a very fast speed for even distribution of the metal and for proper directional solidification, wall thickness is controlled by the volume of molten metal poured into the mold.

* Pouring temperatures range between 1482°c to 1649°c and speed of rotation vary from 50 to 3000 revolutions per minute.

* In vertical and inclined axes true centrifugal casting methods, the axes remains vertical and at an angle between 70° to 99° respectively. Here the molten metal is poured towards the centre of the mold bottom.

* Covenience in metal pouring and ejection of casting is obtained but here the central hole produced is not ~~truely~~ truly cylindrical. This defect can be minimised by high spinning speed.

Advantages :-

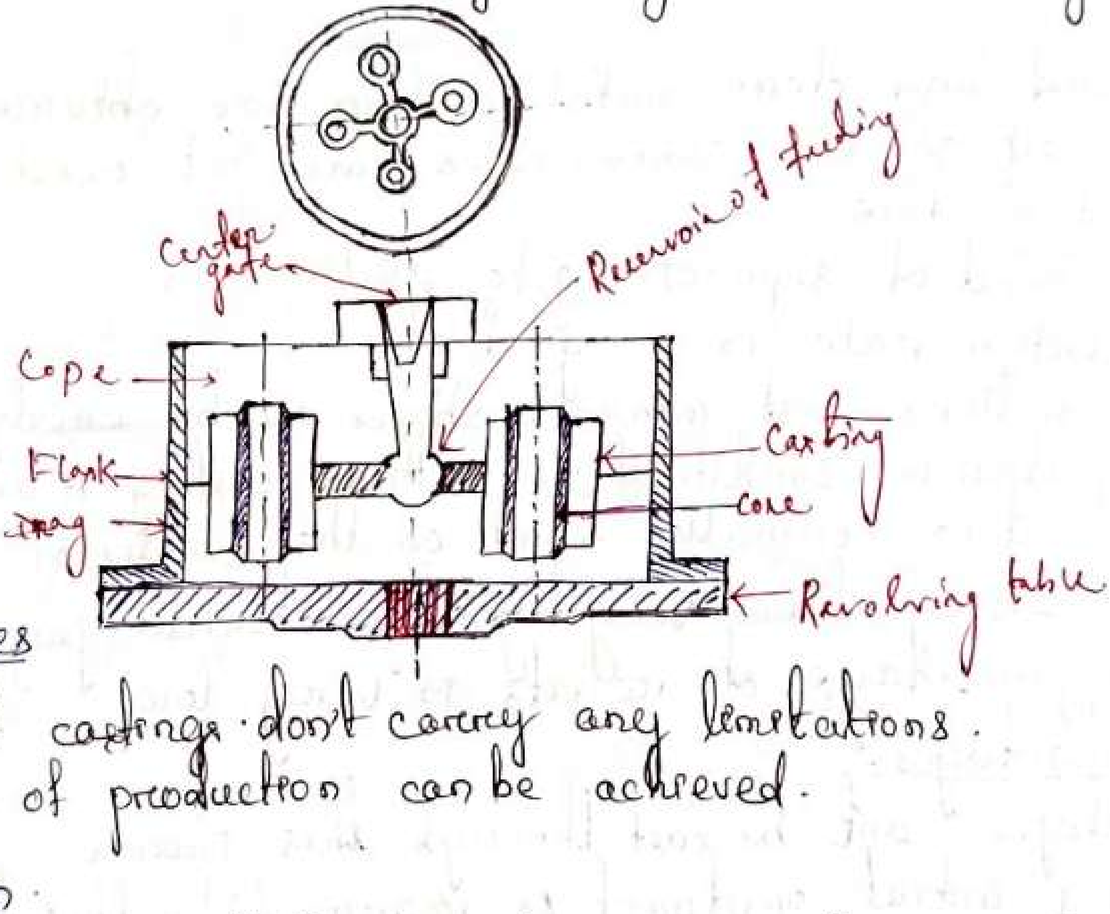
* Sound and clean metal casting are obtained.
* In most of the cases, cores are not used to produce a central hole.
* No need of separate gates and risers.
* Production rate is very high.
* Thin sections and intricate shapes can be easily cast.
* Inspection is simplified as in these casting if any defect occurs, it is normally found on the surface of the casting.
* The casting have very good mechanical properties.
* The percentage of rejects is very low.

Disadvantages :-

* All shapes cant be cast through this process.
* Heavy initial investment is required for this type of casting.
* Its maintenance is expensive and skilled labour is required.

Centrifuging

* This is also known as pressure casting. This casting process is similar to true centrifugal casting process but in this case the axis of rotation and the axis of the mold do not coincide with each other.
* Here the molds are situated at a certain distance from the central vertical axis of rotation. A common central sprue and radial gates are used for feeding molten metal to the molds.
* Like semi centrifugal casting, here also the mold assembly is rotated about a vertical axis and the generated centrifugal force forces the molten metal from the central sprue into the mold cavity through the radial gates.



Advantages

* shapes of castings don't carry any limitations.
* High rate of production can be achieved.

Application

* Horizontal true centrifugal casting is normally used for making hollow pipes, tubes, gun barrels, hollow bushes etc. which are symmetric with a concentric hole. vertical or inclined axes true centrifugal casting is used for production of short length casting.

casting deffects with there causes and remedies

(1) Blow holes : Appear as cavities in a casting

Possible causes	Remedies
(a) excess moisture content in molding sand.	(a) control moisture content.
(b) Rust and moisture on chills, chaplets and inserts used.	(b) use clean and rust free chills, chaplets and metal inserts.
(c) cores not sufficiently baked.	(c) Bake cores properly
(d) Excessive use of organic binders.	(d) use organic binders with restraint.
(e) Molds rammed very hard.	(e) provide adequate venting in moulds and cores.
	(f) Ram the moulds less hard.

(2) Porosity :- Appear in the form of ~~micro~~ microscopic pores

~~Pos~~ causes	Remedies
(a) High pouring temp.	(a) Regulate pouring temperature
(b) Gas dissolved in metal charge.	(b) control metal composition.
(c) less flux used.	(c) Increase ~~to~~ flux proportion
(d) molten metal not properly degassed.	(d) Ensure effective degassing
(e) slow solidification of casting.	(e) Modify gating and risering.
(f) High moisture and low permeability in mould.	(f) Reduce moisture and increase permeability of mould.

(3) shrinkage : Appear in the form of voids due to volumetric shrinkage of molten metal during solidification.

causes	Remedies
(a) Faulty gating and rising	(a) Ensure proper directional solidification by modifying gating, risering and chilling.
(b) Improper chilling.	

(4) Misrun: Appear in the form of incomplete casting as certain section of the mold remains unfilled. This defect is known as misrun.

Causes

(a) lack of fluidity in molten metal.
(b) Faulty design.
(c) Faulty gating.

Remedies

(a) Adjust proper pouring temperature.
(b) modify design.
(c) modify gating system.

(5) cold shuts: Discontinuity between two streams of molten metal.

Causes

(a) lack of fluidity in molten metal.
(b) faulty design.
(c) faulty gating.

Remedies

(a) Adjust proper pouring temp.
(b) modify design.
(c) modify gating system.

(6) Inclusions: These inclusions may be in the form of oxides, slag, dirt, sand and gas.

Causes

(a) Faulty gating.
(b) Faulty pouring.
(c) Inferior molding or core sand.
(d) soft ramming of mold.
(e) Rough handling of mold and core.

Remedies

(a) modify gating system.
(b) Improve pouring to minimize turbulence.
(c) use a superior sand having more strength.
(d) provide harder ramming.
(e) Take care in handling.

(7) Hot tears or hot crack or pulls

Causes

(a) lack of collapsibility of core.
(b) lack of collapsibility of mold.
(c) Faulty design
(d) Hard ramming of mold.

Remedies

(a) Improve core collapsibility
(b) Improve mold collapsibility
(c) modify design.
(d) Provide softer ramming

(8) cuts and washes

causes

(a) low strength of mold and core
(b) ~~lack~~ lack of binders in facing and core stand.
(c) faulty gating.

Remedies

(a) Improve mold and core strength.
(b) Add more binders to facing and core stand.
(c) Improve gating system.

(9) metal penetration

causes

(a) large grain size and used.
(b) soft ramming of mold.
(c) molding sand or core have low strength.
(d) molding sand or core have high permeability.
(e) pouring temperature of metal too high.

Remedies

(a) use sand having finer grain size
(b) provide harder ramming
(c) increase the strength to required ~~to~~ extent.
(d) Reduce permeability with the help of (a) and (b) above
(e) suitably adjust pouring temp.

(10) Drops

causes

(a) low green strength in molding sand and core.
(b) Too soft ramming.
(c) Inadequate reinforcement of sand projections and core.

Remedies

(a) Modify sand composition for increased green strength
(b) provide harder ramming.
(c) provide adequate reinforcement to sand projections and cope by using and gaggers etc.

(11) Fusion :

Causes

(a) low ~~refraction~~ refractoriness in molding sand.
(b) Faulty gating
(c) Too high pouring temperature of metal.
(d) Poor facing sand

Remedies

(a) Improve refractoriness
(b) modify gating system.
(c) use lower pouring temperature
(d) Improve quality of facing sand.

(12) Shot metal

Causes

(a) Too low pouring temperature.
(b) Excess sulphur content in metal.
(c) Faulty gating.
(d) High moisture content in molding sand.

Remedies

(a) use higher pouring temperature.
(b) Reduce sulphur content
(c) modify gating system.
(d) Reduce moisture content.

(13) Shifts :

Causes

(a) Worn-out or bent clamping pins.
(b) Misalignment of two halves of pattern.
(c) Improper support of core.
(d) Improper location of core.
(e) Faulty core boxes.
(f) Insufficient strength of molding sand and core.

Remedies

(a) Repair or replace the pins.
(b) Repair or replace dowel causing misalignment.
(c) Provide adequate support to core.
(d) locate the core properly.
(e) Repair or replace the core boxes.
(f) Increase strength of molding sand and core.

(14) Rattails or Buckles

Causes	Remedies
(a) continuous large flat surface on casting.	(a) Break continuity of large flat surface by providing grooves and depressions.
(b) Excessive mold hardness.	(b) Reduce mold hardness.
(c) lack of combustible additives in molding sand.	(c) suitably add combustible additives to sand.

(15) Swells

Causes	Remedies
(a) Too soft ramming of mold.	(a) provide harder ramming
(b) low strength of mold and core.	(b) increase strength of mold and core.
(c) mold not properly supported.	(c) provide adequate support to mold.

(16) Hard spots

Causes	Remedies
(a) Faulty metal composition	(a) suitably change the metal composition.
(b) faulty casting design.	(b) modify the casting design.

(17) Run outs

Causes	Remedies
(a) Faulty molding	(a) Improve molding technique
(b) Defective molding boxes.	(b) change the defective molding boxes.

(2) crushes

Causes	Remedies
(a) Defective core boxes producing over-sized cores.	(a) Repair or replace core boxes.
(b) worn out core prints on patterns producing under sized seats for cores in the mold.	(b) Repair or replace core prints.

Causes	Remedies
(c) careless assembly of cores in the mold.	(c) Take adequate care in setting of cores in the mold.

(9)

warpage

Causes	Remedies
(a) continuous large flat surfaces on castings, indicating a poor design.	(a) modify the casting design to break the ~~contin~~ continuity of the large flat surfaces and facilitate proper directional solidification
(b) no directional solidification of casting.	

CHAPTER-4 Powder metallurgy

4.1 Powder metallurgy is a metal forming process performed by heating compacted metal powders to just below their melting point.

4.2 Advantages of powder metallurgy

1. The powder metallurgy parts require very little finishing process.
2. Powder metallurgy process doesnot cause any wastage of material during processing.
3. Reasonably complex shapes which cannot be economically machined or casted can be produced by powder metallurgy.
4. It is possible to produce parts with a combination of metals and ceramic. Thus permits a wide variety of alloy system.
5. Produces good surface finish.
6. Automation of the powder metallurgy process can be easily accomplished reducing the labour required.
7. This process provides controlled porosity.

4.3 Method of production using powder metallurgy technique

The basic stages of production are:

1. Production of metal powders.
2. Mixing or blending of the metal powders in required proportion.
3. Pouring of blended powder into die desired shape and size.
4. Pressing and compacting the blended powder in the die.
5. Sintering the compacted parts in a controlled furnace atmosphere.
6. Secondary processing of the part, if required.

Methods of Producing metal powder =>

(I) Atomisation =>

In this process the molten metal is forced through an orifice into a stream of air, water (or) inert gas. As it comes in contact with stream the molten metal solidifies into small particles of metal due to extremely rapid cooling.

In air and water atomisation process metal oxides are formed but in gas atomisation process the particles are not oxidised.

(II) Gaseous Reduction =>

It consist of grinding the metallic oxide to a finely divided state and then reducing it by hydrogen or carbon monoxide. it is employed for metals such as iron tungsten, nickel, cobalt and molybdenum.

(III) Electrolysis Process =>

In this process of producing powder the condition of electrode position is controlled in such a way that a soft spongy deposit is formed which is then pulverized to form powder

(IV) Milling and Grinding (or) Mechanical Pulverisation =>

This process involves pulverizing the metal by crushing (or) impact through ball mills (or) stamper. By this process the metal breaks down into small particles. The ball mill is employed for brittle materials while stamp mill for ductile materials.

The cost is generally high and the powder produced by these methods are usually treated to remove the cold

hardening received in this process.

Shotting ⇒ It consists of dropping the molten metal through a sieve into water to produce spherical particles. This process can be applied to most of the metals but size of the particles is usually large. This may be followed by mechanical means to produce finer particles.

Machining ⇒ It is mainly used for producing magnesium and beryllium particles. The particles produced are however coarse which can be converted into fine powder through ball milling and impact grinding.

(V) Blending (or) Mixing ⇒

Blending is not required when only one metal powder is used to produce the part. When different metal powders are used (or) when non metallic particles are added to impart certain properties, blending (or) mixing of constituent are required. The process consists of a thorough mixing of the constituents either wet (or) dry. Wet mixing reduce dust and minimizes the danger of explosion. Lubricant are added during blending to reduce friction during pressing. Common lubricants are graphite, stearic acid and lithium stearate

(VI) Briquetting (or) Compacting ⇒

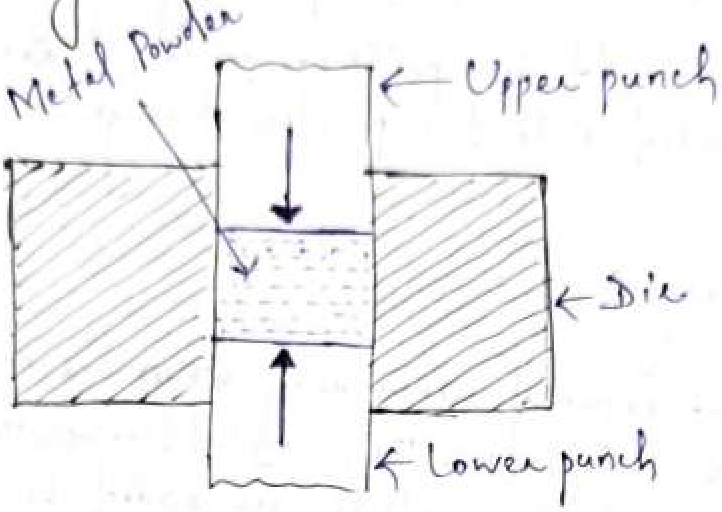
It is the process of converting loose powder into a green compact of accurate shape and size. It is done in steel dies and punches. Here two punches are employed, one from the top and the other from the bottom of the powder.

The dies and punches are highly polished one having minimum clearance between them to maintain proper alignment. The punches should be sufficiently tough. High carbon steel, high chromium-vanadium steel and tungsten carbide are the principle die materials

During the process, the powder is compressed to nearly one-third of its original volume. Either mechanical (or) hydraulic (or) a combination of both presses are used for this purpose.

The metal powder can also be compacted into the form of a sheet by passing a continuous stream of powder through a pair of rolls rotating in opposite direction. It is known as roll pressing.

#



Pre sintering ->

Presintering is the process by which the green compact is heated to a temperature below the sintering temp. It increases strength of green compact and removes the ~~lubricants~~ lubricants and binder added during blending. For materials which can't be machined after sintering, the machining is done after presintering.

Ex -> Tungsten carbide.

4.4

Sintering ->

Sintering of briquetted parts is done in large continuous furnace having controlled atmosphere for protection against oxidation and other chemical reactions.

The important factors governing sintering are temperature time and atmosphere

The sintering temperature for most materials lie between 70 to 80 percent of their melting point. It is however quite high incase of ceramics i.e 90% of melting point

+ In case of mixture of two or more materials the sintering temp. of the compacted part may be more than the melting point of some of the constituent.

Sintering operation has three distinct stages. To carry out these three stages, most of the furnace have three distinct areas

These are · (I) Purge (or) burn off chamber

(II) High temp. Zone

(III) cooling Zone.

(I) Purge (or) burn off chamber → In the first stage i.e the purge chamber, volatile substances, air, lubricants and binder are burnt off from the compacted part as its temp. is slowly raised.

(II) High temp. Zone → In the second stage i.e in the high temp. Zone, the temp. is raised to sintering temperature. The part is held here for sufficient time to complete solid state diffusion and bonding between the particles.

(III) Cooling Zone → In the third stage i.e cooling zone the sintered part is gradually cooled down in the controlled atmosphere of the furnace

The furnace atmosphere for sintering is either neutral (or) reducing. A mixture of nitrogen gas with hydrogen, methane provide an ideal reducing atmosphere for this operation.

By sintering the strength, thermal and electrical conductivities and compact density of the material increases.

The main objective of sintering are

1. Achieving high strength.
2. Achieving good bonding of powder particles
3. Producing a dense and compact structure
4. Producing parts free of oxides.
5. obtaining desired structure and improved mechanical properties.

Secondary Processes →

To achieve close tolerance and better surface finish, secondary processes are performed. these processes include sizing, coining, machining, plating, heat treatment etc.

4.5 Economics of Powder Metallurgy →

Powder metallurgy's cost competitiveness against other technologies is based on two factor

1. Lower energy consumption
2. Maximum utilization of raw materials.

However the process will be economical if:-

1. Relatively small and high parts are to be manufactured due to limitation of powder metallurgy compacting process.
2. The thickness (or) height of the part must be small.
3. A large number of products is to be produced.

CHAPTER-5 PRESS WORK

Press work is a method to form sheet metal into various shapes by using a press machine.

A press machine has two parts. The ~~upper~~ upper part which is fastened to the ram, lifts the workpiece, during pressing and lower part of the machine press contains a tool which corresponds to the upper part. The upper part is known as the punch and the lower part is known as the die set.

Punch → The male member of the die assembly is called punch. It is usually that part of the unit which is fastened (or) attached to the ram and is forced into the die.

The female member of the die assembly is called die.

Die → The female member of the die assembly is called die. It is usually rigidly held on the bed of the press. It carries an opening in the perfect with the punch through which the punch enters into the die alignment.

Piercing →

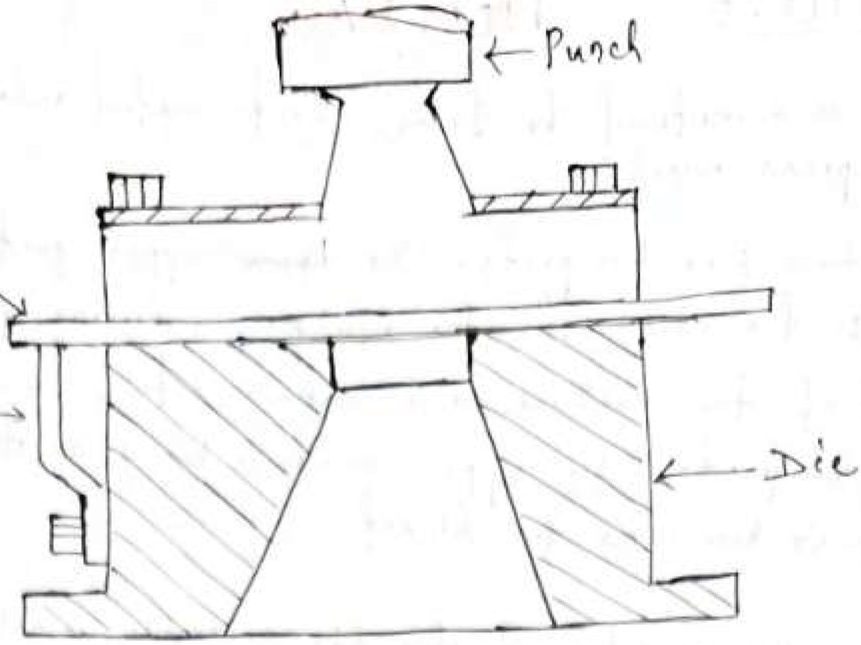
Piercing is the operation of producing a hole in a sheet metal by the help of a punch and a die.

The material punched out to form the hole constitute the waste.

The punch point diameter is equal (or) less than to the work material thickness.

The punch and die ~~position~~ set up are used for the piercing operation.

A stripper plate is attached to the die by the help of a piercing punch the hole is produced in the plate.



~~Punching~~ Blanking →

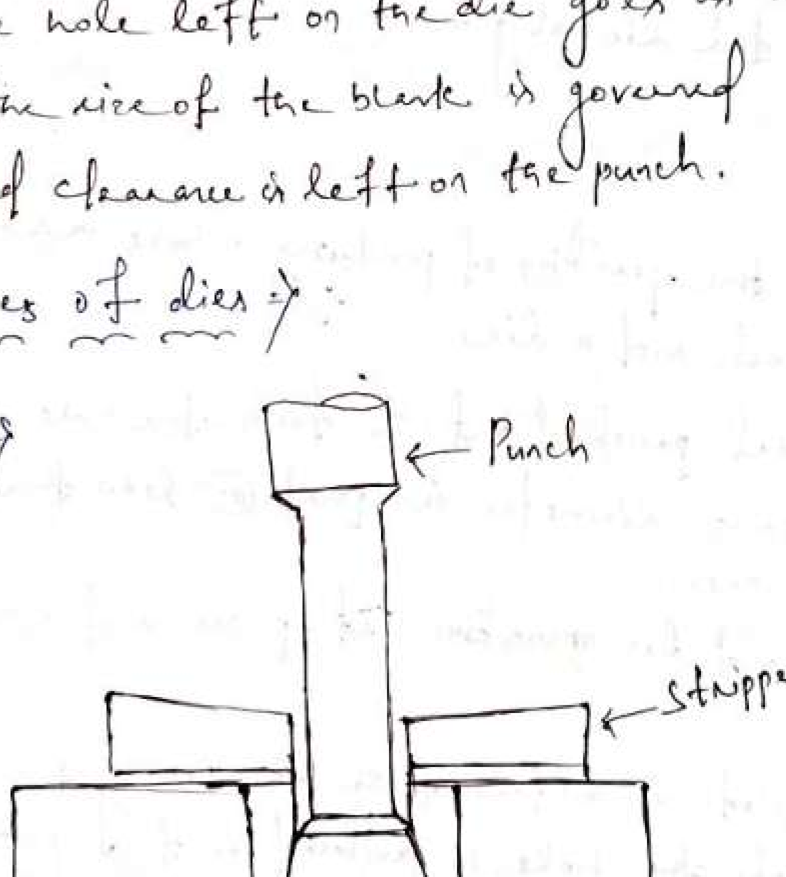
Blanking is the operation of cutting of flat sheet to the desired shape.

→ The metal punched out is the required product and the plate with the hole left on the die goes as waste.

→ In blanking the size of the blank is governed by the size of the die and clearance is left on the punch.

Different types of dies →:

① Simple die →



A simple die is one in which only one operation is performed at each stroke of the ram.

A single operation die may be a blanking die, piercing die, a trimming die.

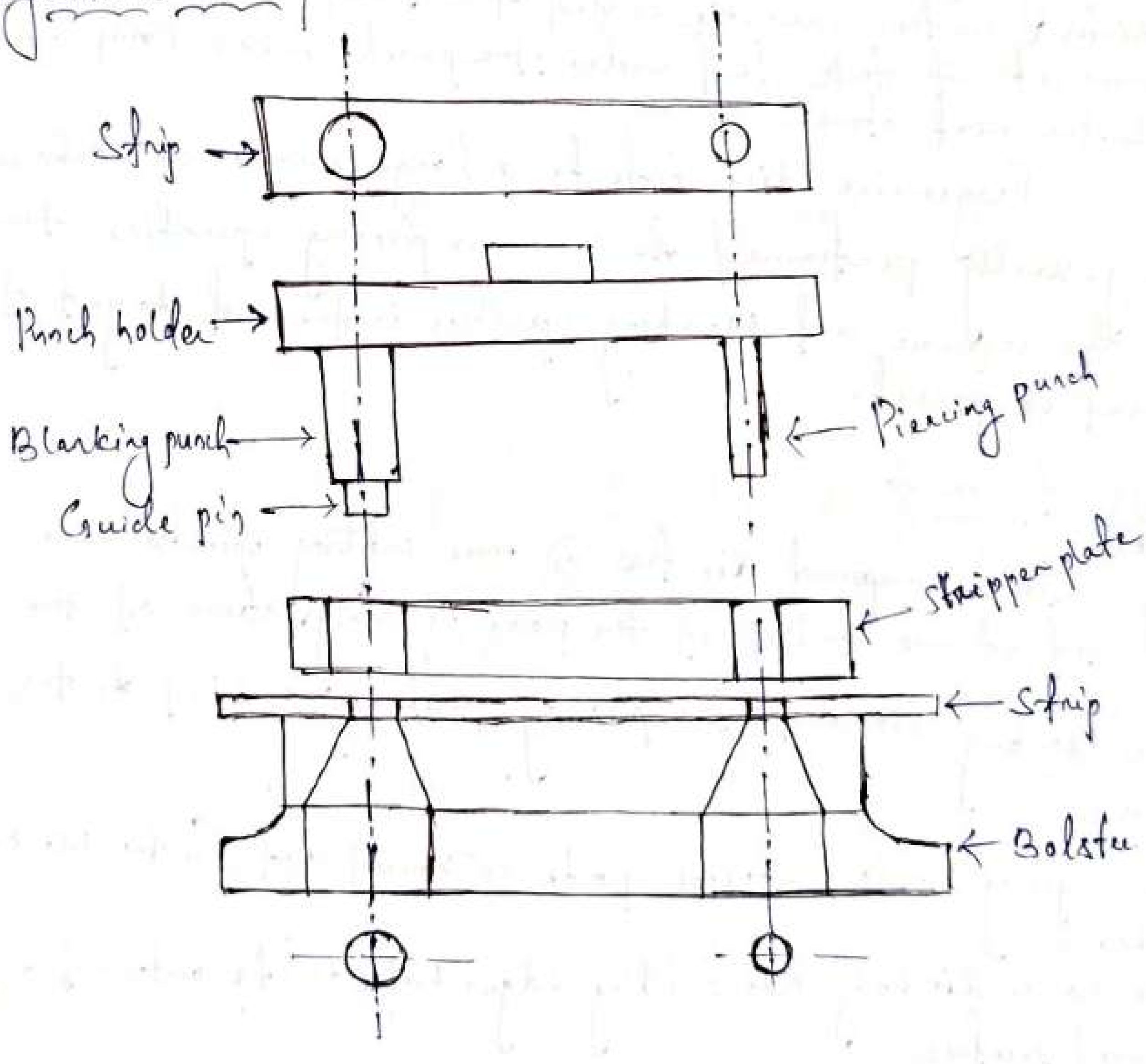
The shank portion is held in the ram where the punching or blanking is attached.

The metal sheet is held between the stripper plate and the die block resting against the stop.

As the punch descends down it cuts the metal sheet

The stripper plate helps removal of the stuck from the punch as it moves up after doing the operation.

② Progressive Die :-



In a progressive die two (or) more operations are performed simultaneously at a single stroke of ~~the plate~~ punch press so that a complete component is obtained for each stroke. The place where each of the operation carried out are called station.

At the start of the operation the sheet is feed into the first station after undergoing the operations at this station the ram of the press moves to the top and the stroke is advanced from the 1st station to the second station the distance moved by the strip from station 1 to station 2. so that it is properly registered under the station is called advanced distance another variable called the field distance is the amount of stock feed under the punch when RAM comes to the next stroke.

Progressive dies consists a large number of stations it is generally performed to have a piercing operation first in the sequence and blanking operation in the end to get the final component

Compound die ⇒

In a compound die two (or) more cutting operations are performed at one station of the press in every stroke of the ram.

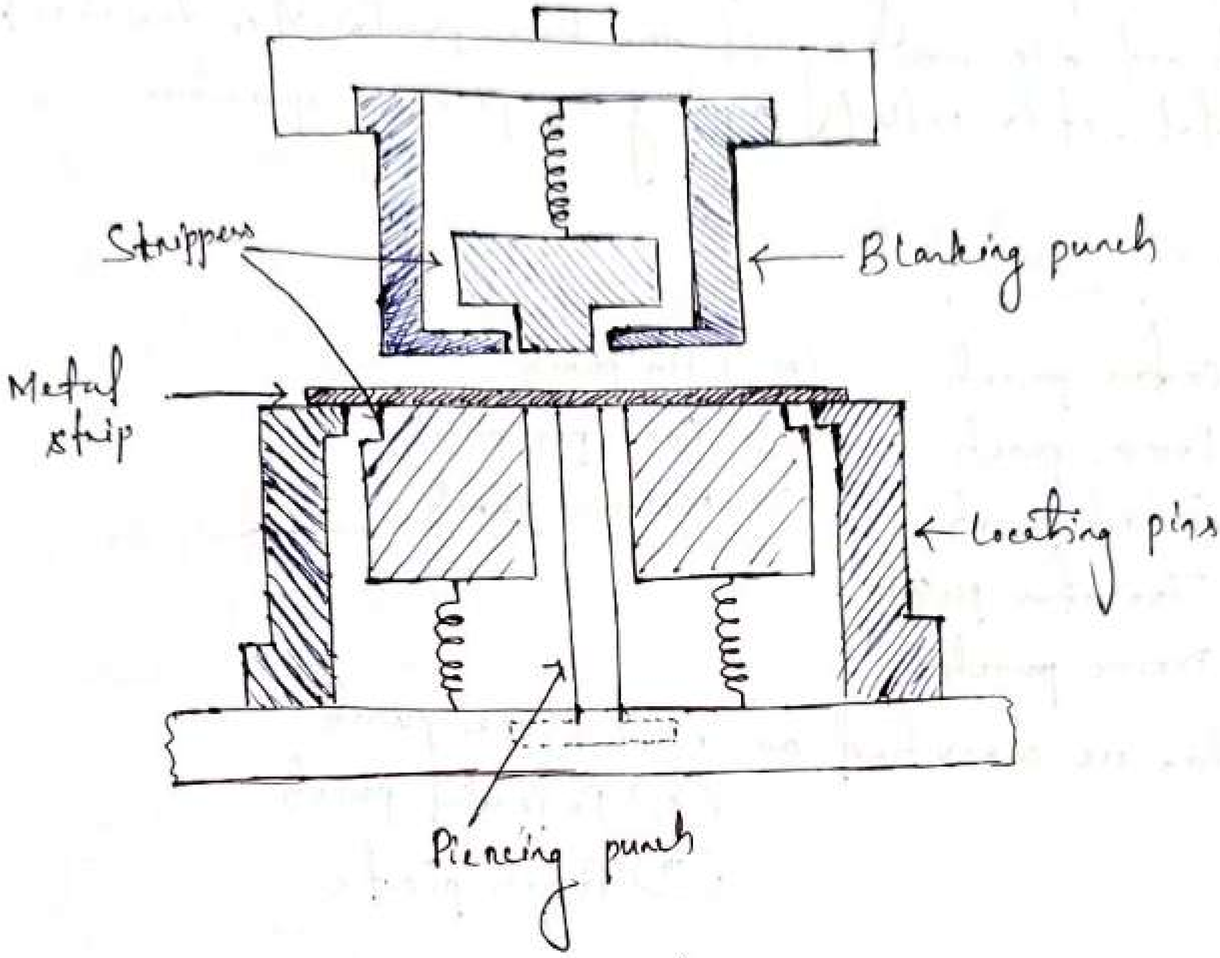
The blanking die and the piercing punch are bolted to the ram.

This spring loaded stripper plate is housed within the blanking die

The lower die body has cutting edges both on its outward and inward surface.

The outside cutting edge serve as a punch for the blanking operation and the inside cutting edge operate as a die for the piercing punch.

The sheet metal is placed in the lower block. as the ram descends the plate is first blanked and then pierced by the successive dies.
At the end of the operation the stripper plate fitted in the upper die block discharge the wharee and the knockout plate fitted on the lower die is eject the blank



Trimming ⇒ Trimming is the operation for cutting of the excess metal from the edge of the sheet metal which is originated from the other cutting operation.

Trimming dies are similar to the blanking dies the part is forced to the die by a suitable punch to carried out trimming operation.

Trimming may be the last operation performed in a progressive die

Piercing Operation ⇒

When the force is applied by using the punch on to the sheet the cutting (or) shearing action will be taking place in the sheet producing a piece/blank leaving a hole. In punch and die working if the hole produced in the sheet is useful, it is called punching (or) piercing operation.

Types of punch ⇒

1. ~~Centre punch~~
2. ~~Prick punch~~
3. ~~Solid punch~~
4. ~~Transfer punch~~
5. ~~Drive punch~~
6. ~~Pin punch~~
7. ~~Roll pin punch~~
8. ~~Hollow punch~~

Punches are classified as
1. Plane punch
2. Pedestal punch
3. Punch plate

Plane punch ⇒

These are the simplest type of punches. These are made of solid tool steel block and are directly mounted to the punch holder, the punches are joined together by mean of dowels and screw. These must be large enough to provide necessary space for dowel and screw as well as necessary strength to withstand the punching force. The length and width of this punches should be greater than the height of the punch

Pedestal punch ⇒

It is also called flanged punch (or) shoulder punch. These are characterized by large base surface compared to the cutting face. The flanged portion, which is an integral part of the punch, offers excellent stability of the punch.

The method of mounting is similar to plane punch. In fact the flange portion of the length and the width of the base should be larger than (or) equal to the highest of the punch.

The flange thickness and the fillet radius are to be largely provided to withstand the large force.

Punch plate ⇒

A punch plate is used generally to locate and hold the punch in position. The punch plate design determine the final outcome of the product being manufactured.

Advantages of progressive die ⇒

(i) Speed of production
(ii) Less scrap material
(iii) Quicker setup.
(iv) Production of more geometries within a single tool.
(v) Longer production runs.
(vi) Production of close tolerance
(vii) Higher repeatability.

Disadvantages of progressive die ⇒

They can be complex and expensive to design and manufacture. The initial setup costs are relatively high compared to simpler tooling method.

Advantages of Compound die =>

* Compound tooling is less costly and faster to build than progressive tooling.

\# compound stamping will result in flatter parts because the part is made in one stroke

Disadvantages of Compound die =>

A disadvantages of building a compound blank die is the limited space which ends to leave die component thin and weak. This concentrates the load and shock on punches and matrixes resulting tooling failures.

CHAPTER-6 JIGS & FIXTURE

JIG → A Jig may be defined as a device which holds and positions the work, locates and guides the cutting tool relative to the workpiece and usually is not fixed to the machine table. It is usually lighter in construction.

Jigs are used on drilling, reaming, tapping and counterboring operations, while fixtures are used in connection with turning, milling, grinding, shaping, planning and boring operations.

Constructionwise a jig is a plate structure or a box made of metal or non metal having the provision for holding the component in identical positions one after the other and then guide the cutting tool in correct position on the work in accordance with drawing specification or operation layout.

Fixture →

A fixture does more or less the same work as jig in that it holds and locates the successive workpiece in identical position but differs from a jig in that it does not guide and locate the tools.

A fixture does not guide the cutting tool.

Constructionwise fixture may be of different standard or specially designed work holding device which are clamped on the machine table to hold the work in correct position.

Difference between Jig and Fixture →

A fixture hold and position the work but doesn't guide the tool. But whereas a jig locate, hold and guide the tool.

The fixtures are generally heavier in construction and are ~~bolted~~ rigidly bolted on machine table. whereas Jigs are made lighter for quicker handling and clamping with the table is not necessary.

Fixtures are employed for holding over in milling, grinding, planning and fairing operations whereas the jigs are used for holding work & guiding the tool ~~particularly~~ particularly in drilling, reaming & tapping operations.

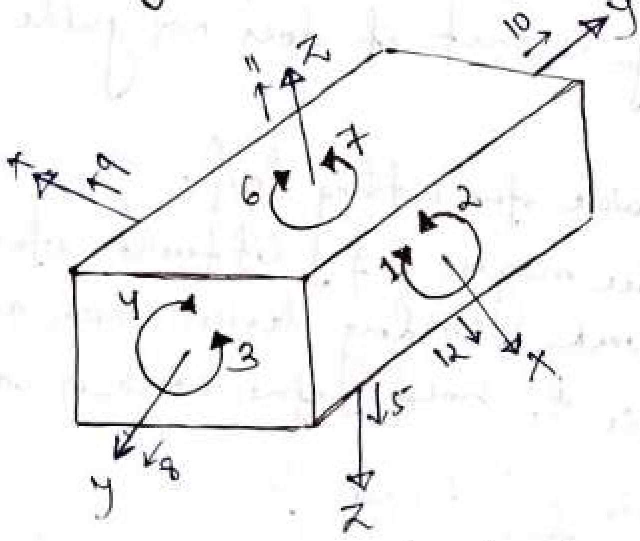
Principle of location ⇒

Location refers to the establishment of a desired relationship between the workpiece within a jig or fixture.

Correct location influence the accuracy of the finished product.

The jigs and fixture are so design that all possible movement of the components must be restricted.

The locating points are determine by first finding out the possible degrees of freedom ~~of~~ of the workpiece which are then restricted by suitable arrangement



Suppose the workpiece is a cube having perfectly flat and true faces and is located in space to act as a free body. Let us consider 3 mutually perpendicular axis x-x, y-y, z-z pass through the center of the body. Now this free body in space can have the following movement

Translation movement
- along the x-x axis
- along the y-y axis
- along the z-z axis

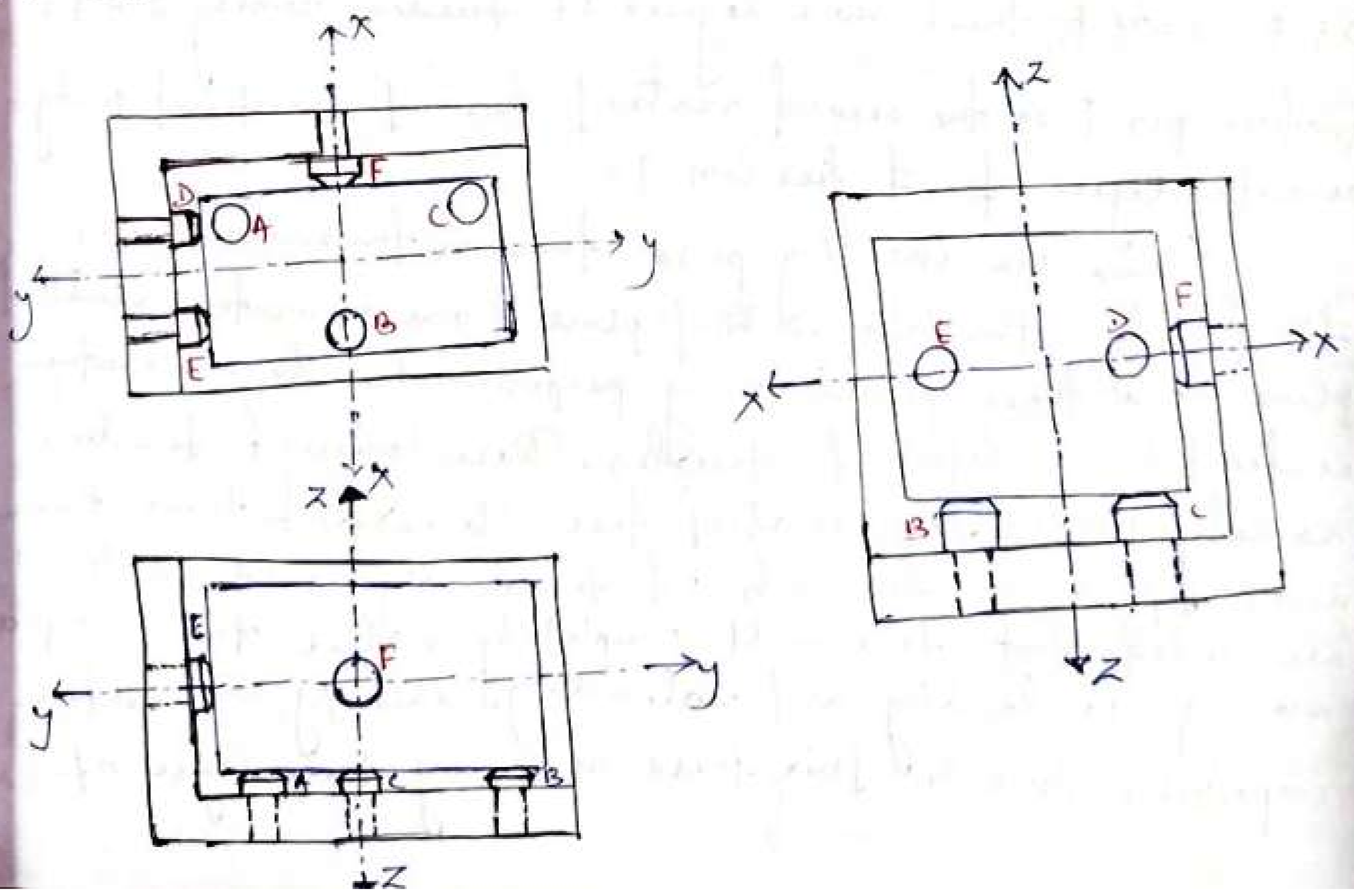
Rotational movement
- along the x-x axis
- along the y-y axis
- along the z-z axis.

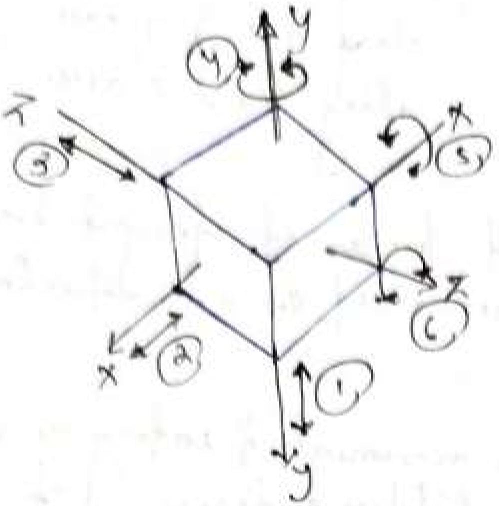
Thus a free body in space has 3D of freedom of straight line movement and 3D of freedom of rotation. These are called 6D of freedom movement of a free body in space.

But in some cases both translation movement & rotary in opposite direction along the 3-axis as 2 different degree of freedom thus making total number of degree of freedom movement as 12.

So in final locating a work piece in a fixture each to confine it with the help of suitable locating pins and by means of clamping in such a way that all or as many as degree of freedom are checked only then it can be assured that the workpiece will not be dislocated from its position during the operation and therefore the operation will be completed with the desired accuracy.

6 Point location / 3-2-1 Point location Principle :-





The workpiece is resting on three pins A, B, & C which are inserted in the base of the fixed body. The workpiece cannot rotate about the axis XX & YY and also it cannot move downward in this way the five degree of freedom 1, 2, 3, 4 & 5 have been arrested.

Two more pins D & E are inserted in the fixed body in a plane perpendicular to the plane containing the pins A, B & C. Now, the workpiece cannot rotate about the Z-axis and also it cannot move towards the left. Hence, the addition of Pins D & E restrict three more degrees of freedom, namely 6, 7 & 8

Another pin F in the second vertical face of the fixed body arrests degree of of freedom 9.

Thus six locating pins, three in the base of the fixed body, two in a vertical plane & one in another vertical plane, the three planes being perpendicular to one another restrict nine degree of freedom. Three degrees of freedom namely 10, 11 & 12 are still free. To restrict these three more pins, one for each of three degrees of freedom are needed. But this will completely enclose the workpiece making its loading and unloading into jig (or) fixture impossible. Due to this these remaining three degree of freedom may be arrested by means of clamping device. The above method of locating a workpiece in a jig or a fixture is called the "3-2-1 principle" or "Six point location" principle.

Types of Jigs ⇒

1. Template Jig
2. plate Jig
3. Diameter Jig
4. channel Jig
5. Ring Jig
6. Box Jig
7. Leaf Jig
8. Angle plate Jig
9. Indexing Jig

① Template Jig ⇒

This is simple type of drilling Jigs. It is simply a plate made to the shape & size of the workpiece with the required a number of holes made in it accurately. It is placed on the workpiece & the holes in the workpiece will be made by drill, which will be guided through the holes in the template.

② plate Jig ⇒

This is a improvement over template jig. A plate jig is a template jig with an added clamping arrangement. A plate having drill bushes and suitable means to hold and locate the work so that it can be clamped to the plate and holes drilled directly through the bushes in correct position.

③ Diameter Jig ⇒

A diameter type jig is used for cylindrical work piece. It enclose the work piece in 'V' shape groove. The diameter jig may have a cover person that contains guide holes for drill operation.

④ channel Jig ⇒

A channel jig is a simple type of jig having channel like cross section. The component is fitted on the channel is located & clamped by rotating the knurled nut. The tool is guided through the drill bush

Ring Jig ->

The ring jig is employed to drill holes on circular flanged parts. The work is ~~used~~ securely clamped on the drill bush and the holes are drilled by the tool through drill bushes.

Box Jig ->

It is named so because of its box shape construction. It is normally closed from most of the sides such jigs are normally designed and used for those component which carry as occured shape and need machining more than one plane such components are usually difficult to be held on supported during the operation by hand or ordinary jigs of other types. They need a very rigid support from many sides which can be provided only by box type jigs.

Leaf Jigs =>

The leaf jig has a leaf or a plate hinged on the body & the leaf may be open or closed on the work for loading and unloading purpose

The work is located at the bottom & is clamped by screw.

The drill bush guides the tool

Types of Fixture ->

1. plate fixture
2. Angle plate fixture
3. Vise-jaw fixture
4. Indexing fixture
5. Multistation fixture
6. Profile fixture

1) Plate fixture ->

A plate fixture typically refers to a device (or) arrangement designed to secure (or) hold plates in place. This could apply to various contexts, such as a fixture for mounting electrical plate, a fixture in carpentry for joining plates of wood, (or) even in manufacturing for securing metal plates during processing.

2) Angle plate fixture ->

An angle plate fixture is a device used in machining and manufacturing. It consist of a metal plate with precision machined angles usually 90 degree on its surface.

Machinists use angle plate fixtures to hold workpiece at specific angles for milling, drilling (or) other machining operation.

3) Vise-Jaw fixture ->

A vise jaw fixture refers to a tool used in conjunction with a vise. It typically involves specialized jaws that can be attached to the vise to securely hold & position a workpiece. These fixtures are designed to provide a stable grip on the material, allowing for various machining.

4) Indexing fixture ->

An indexing fixture is a tool used in machining and manufacturing to precisely position and rotate a workpiece at specific interval. It allows for accurate angular positioning during task such as milling, drilling (or) cutting. The fixture typically includes a mechanism that enables the user to set and lock the workpiece at predetermined angle, facilitating the creation of precise, repetitive patterns.

(5) Profile fixture ⇒

A profile fixture in the context of jigs and fixture refers to a tool used in manufacturing to hold, support and locate a workpiece during machining.

Difference Between Jigs and Fixtures ⇒

Jigs	Fixtures
(1) It holds and locate the workpiece as well as guides the tool.	(1) It holds and locates the workpiece but does not guide the tool.
(2) These are lighter in construction and clamping with the table is often unnecessary.	(2) These are heavier in construction and bolted rigidly on the machine table.
(3) Used for holding the work and guiding the tool in drilling, reaming (or) tapping operations.	(3) Used for holding the work in milling, grinding, turning (or) planning operations.
(4) Gauge blocks are not necessary.	(4) Gauge blocks may be provided for effective handling.
(5) The cost is more.	(5) The cost is less as compared with the jigs.
(6) Their designing is complex.	(6) Their designing is simple as compared to jigs.

Advantages of Jigs and fixture :-

They enable easy means for manufacture of inter changeable parts and thus facilitated easy and quick assembly.

The machining operations like marking, measuring etc required in case of individual parts are totally eliminated with the use of jigs and fixture.

Once a properly designed jigs and fixture is setup in position any number of identical parts can be produced without any additional setup.

Production capacity is increased with their use because any number of parts can be produces in a single set up.

They enable quick setting in proper location of work. Hence the work handling time is reduced.

They occur a clamp rigidity. Therefore high speed. field and depth of curve can be used for machining.

Because of automatic location of the work and guidance of the tools, the machining accuracy is increased.

The parts produced with their use are very accurate. As such the expand each other due to inspection quality control of finished component is considerably reduced.