Production Technology

* Introduction:-

Production of work piece involves transforming a blank or raw piece into a finish product of the material.

* Manufacturing engineering is a study of the processes required to make parts & to assemble theme into machines & mechanisms.

→ The manufacturing process is the part of the production process directly concerned with changes in dimension, shape & properties of the blank material.

~~→ The assembly process with the consecutive Joining of the finished~~

→ The assembly process is the part of production process concerned with the consecutive joining of the finished parts.

Classification of production process:-

Production process may be classified as

1) primary process
2) secondary process

1) Primary process:-

→ In primary processes, we convert the material into useful standard ~~sets~~ shaped and section.

→ The main primary process are,

i) Metal working
ii) Metal casting

i) Metal working :-

-> In metal working, we changes the shape of raw material into a finished product by plastic deformation.

-> It also known as machining process, which includes processes such as, Forging, Rolling, extrusion, deepdrawing, wire drawing, etc.

Forging :-

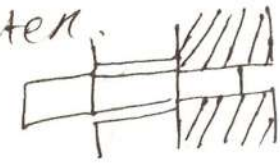
Forging is a production process in which the work piece is generally heated & reshaped by compressive force.

Rolling :-

In Rolling the workpiece is reformed or reshaped either continuously or step by step by the application of pressure using revolving tool (Roller).

extrusion :-

In extrusion the workpiece is entirely or partially forced through an opening in the tool. The reforming process takes place by plastic deformation and involves a Reduction of crossection or diameter.



wire drawing :-

In wire drawing, the workpiece is pulled through a narrow opening in the die.

deepdarwing :-

A sheet metal in

In deep drawing a sheetmetal is shaped into a hollow body without any change in its thickness.

ii) ~~Second~~ Metal casting:-

In casting, a ~~mould~~ mold (which is the replica of the part to be shaped) is first made out of sand and then the cavity of the ~~mold~~ mold is ~~filled~~ filled with molten metal. (Heated liquid metal)

The solidified workpiece is ~~often~~ obtained (अक्सर) by breaking the sand ~~mold~~ mould.

B) Secondary process:-

→ Secondary processing of a workpiece follows they are primary processing.

→ In primary process generally we give an approximate shape & size to a ~~raw~~ raw material. But in secondary process we give an accurate final shape., desired surface finish and tolerance to the same component.

e.g.- i) Chiseling, ii) Filling, iii) Scraping (खरोंचना)

ii) Traditional machining process such as turning, shaping, drilling, milling.

iii) Surface finishing process like grinding, polissing.

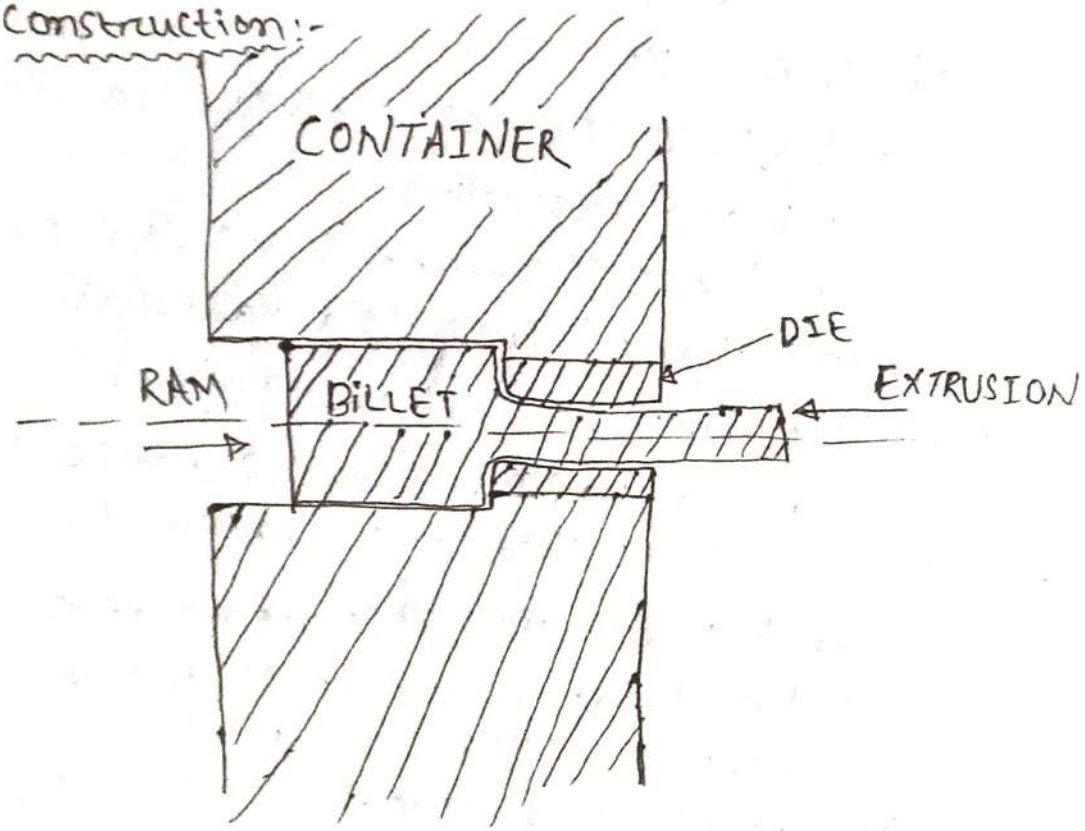
iv) Metal joining process, like welding, soldering.

Extrusion

→ Extrusion is a metal working process that produceses continuous length of uniform, non-uniform crossectional area from a metal billet, solid or hollow.

→ Extrusion is mainly a hot working process, starting generally quick cast billet and producing wrought sections and tubes.

Construction:-



An extrusion process ~~Press~~ are three major components

1) The container
2) DIE
3) RAM

Process of Extrusion:-

→ A heated cyllindrical billet is placed in the container and forced out through a steel die by a RAM or Plunger.

→ The metal takes are the shape of the die.

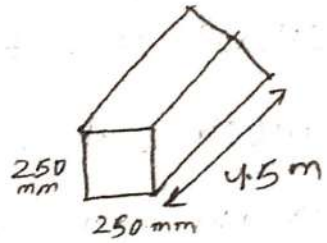
BILLET:-

→ The molten steel from the furnace is either
i) cast into ingots (i.e, large blocks of steel).

ii) cast continuously into semifinish product of varying widths, length and thickness.

-> The semifinished product are in three type

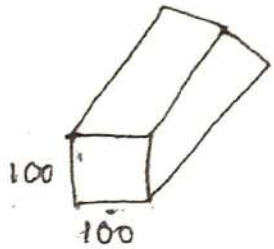
i) Blooms (square or Rectangular in cross-section with area > 232 cm^2).



~~ii) Plats and~~

ii) Plates and Slab

iii) Billet (Generally square in lengths of steel 10-15cm in cross-section).



Application :-

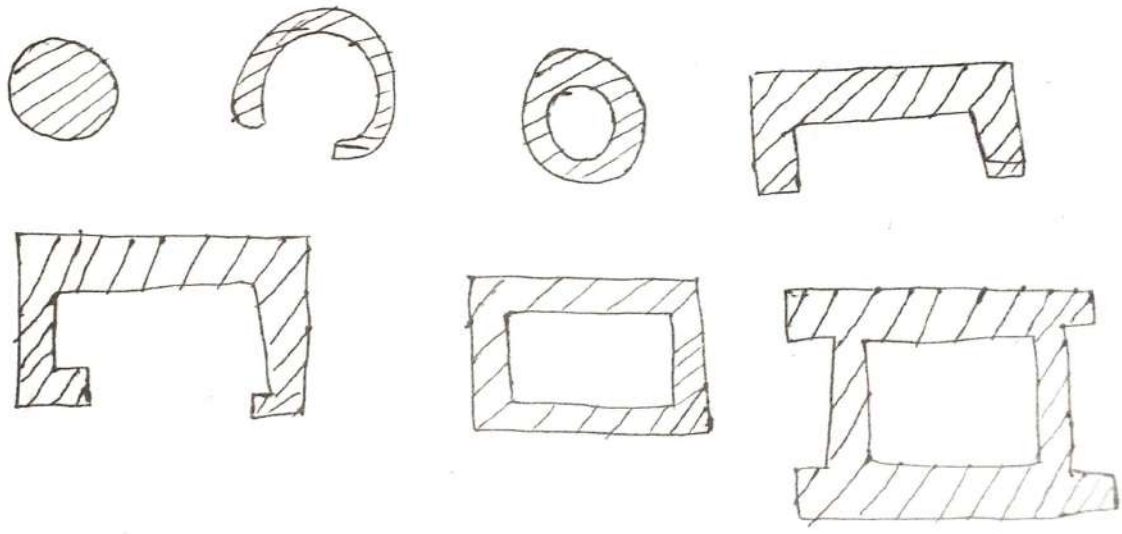
Extrusion process is used to manufacture

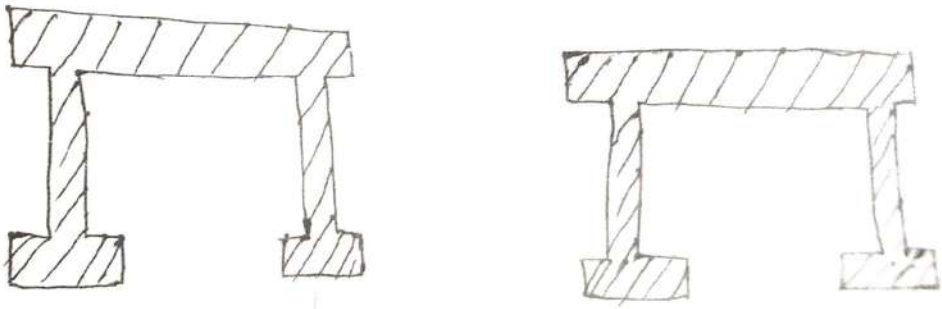
i) Rods

ii) Tubes

iii) A variety of circular, square, Rectangular, hexagonal, and other shapes both in solid or hollow form.

iv) Channel, I, Z, T sections.





Extruded section have infinite uses such as

i) Transportation (ships, automobile, rail road, air craft) industry

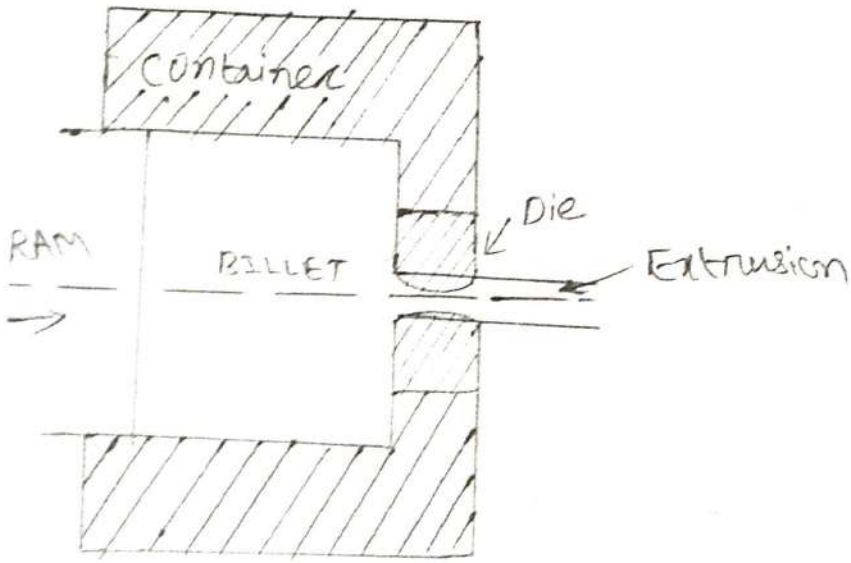
ii) construction industry (making building)

iii) Oil industry.

Methods of Extrusion:-

i) Direct Extrusion:-

→ In this type of extrusion process the flow of metal through the die is in the same direction as the movement of the RAM. RAM is solid.



→ A hot billet is placed with in the container that has a Die at one end.

→ A RAM forces that hot billet through the die opening producing the extruded product.

Indirect Extrusion:-

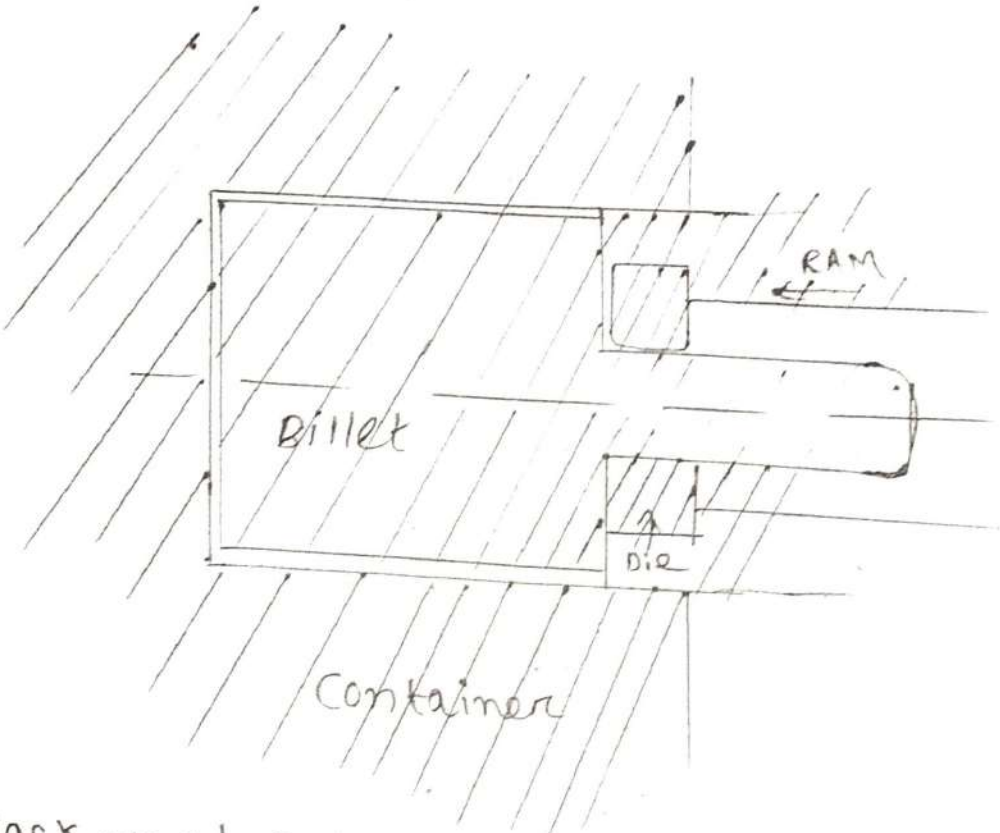
→ In indirect extrusion process the RAM is hollow and the die is mounted over the bore of the RAM. The metal flows in the ~~opposite~~ opposite direction to the movement of the RAM.

→ In indirect Extrusion, the billet remain stationary while the die is pushed into the billet by the hollow RAM or punch, through which the extrusion takes place

→ Indirect extrusion does not required as ~~much~~ Force ~~where~~ as direct extrusion.

→ The length of the billet in indirect extrusion is limited by the column strength of the RAM.

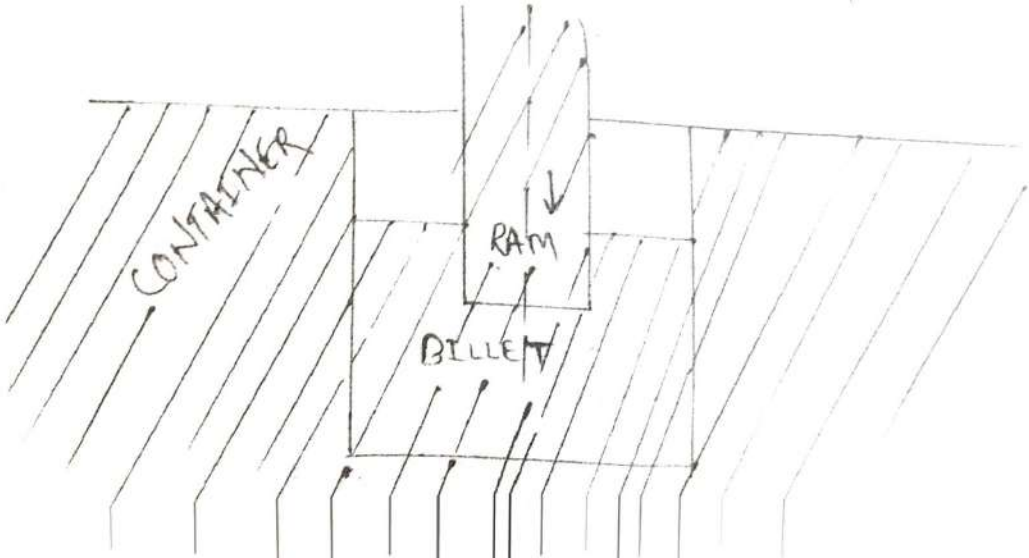
→ Direct extrusion process is more commonly used.



Backward Extrusion:-

→ In direct & indirect extrusion process the RAM is of the same diameter as the bore of the container, where as in backward extrusion the RAM is smaller in diameter than the container.

→ In this type of extrusion process the metal flows up the annulus formed by the RAM & container.

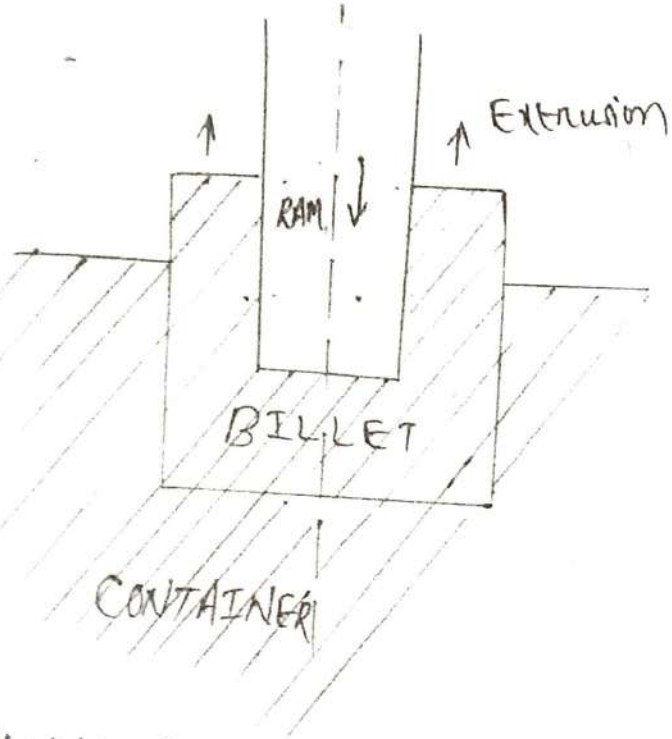


→ Direct Extrusion, Indirect extrusion & Backward extrusion process normally used a hot billet of metal for extrusion process. Hence the extrusion process is known as hot extrusion.

Impact Extrusion (cold extrusion):-

→ cold billet is used here for extrusion process

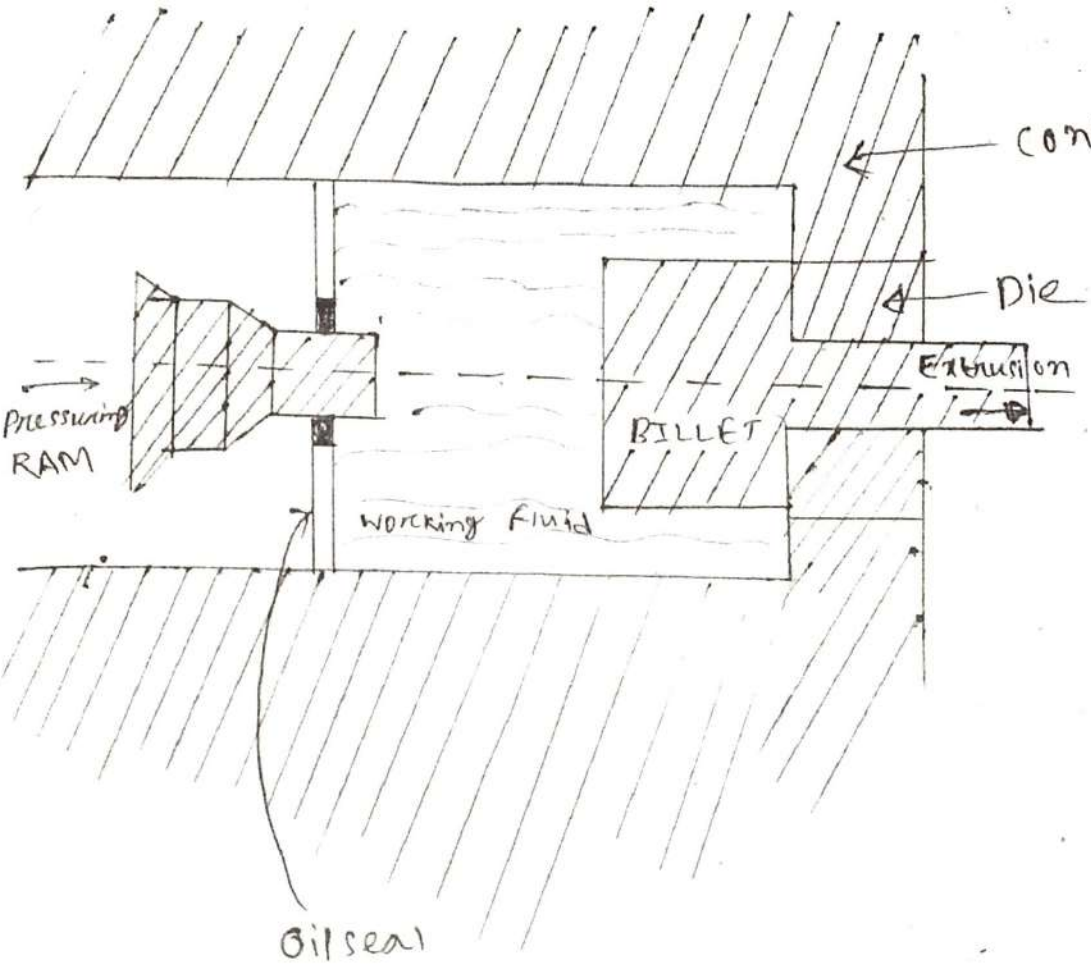
→ The process is similar in principle to backward extrusion but is carriedout at higher velosity.



Hydrostatic Extrusion:-

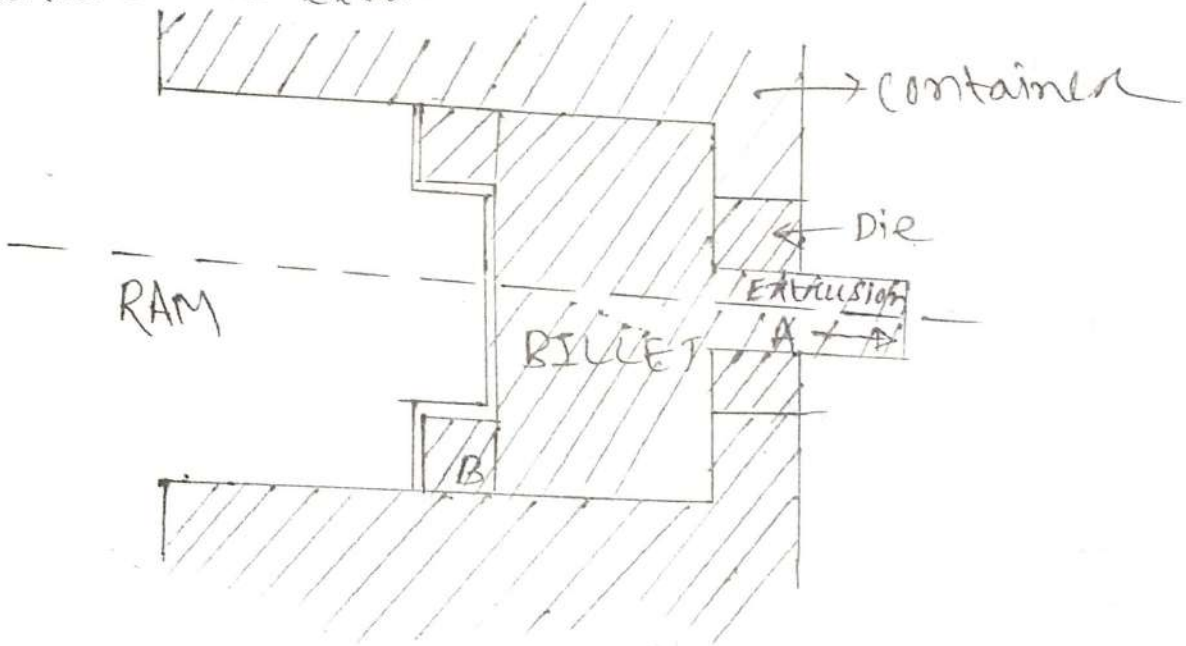
→ The Billet is surrounded by a working fluid which is pressurized by RAM to provide the extrusion force.

→ In hydrostatic extrusion a hydraulic fluid remains between the billet and chamber walls eliminating the contact between theme, ~~walls~~ therefore avoiding friction between the metal billet and the wall of billet containing chamber. The absence of container friction permits extrusion of very long billet or wires. and large reductions can be



Combined Extrusion:-

Direct, Indirect, Backward & Impact extrusion Processes will be combined with each other to achieve this extrusion.



taken.

Hot Extrusion:- ← Types of Extrusion

Introduction:-

Hot extrusion is a process of hot working which is widely applied in non-ferrous field. It has only a limited application in steel manufacture.

Application:-

→ Non-ferrous metals and alloys such as aluminium, copper, Brass, ~~Magnesium~~ Magnesium, lead, etc can be successfully extruded into various shape

→ Solid and tubular (Hollow) products of common cross-section (Round, square or hexagon) are example of extruded pieces.

Principle of operation:-

Metal billets are heated to the extrusion temperature (320°c - ~~400~~ 400°c) and placed in the container of the extruding press, where the pressure on the billet exerted by the moving RAM, which forces the plastic material through a Die of required shape.

Process steps:-

Step-1:-

Lubricate the Die & container.

Step-2:-

Load the billet into the container.

Step-3:-

Put the Dummy block & close the press.

Step-4:-

Apply the pressure on the billet through the RAM to develop a total force as high as 12000 tons.

Step-5:-

After the RAM has reached at the end of its stroke, the RAM is retracted and the press is open. Sort section of billet has left in the container.

Step-6:-

The left over portion of the billet is separated from extruded product by sawing or shearing.

Step-7:-

The extruded product (Bar or tube) is cleaned to remove the lubricant.

[Glass is removed in hydrofluoric acid]

Step-8:-

The cleaned product is annealed. (to be cooled)

Advantages of Hot Extrusion:-

→ Material and shapes which are difficult to roll can be extruded.

→ Shapes can be produced that will eliminate machining operation

→ The directionality phenomenon of mechanical properties is minimize with extruded product.

Process Details:-

→ The Billet should be free from scale and have good surface finish

→ Billet may be heated in a gas fired furnace, salt bath, or low frequency induction furnace

→ Glasses may be used as a lubricant. Both low (500°C) and high melting point (1120°-1260°) glasses are used in extrusion process.

→ The press tooling that come in contact with hot billet most have sufficient resistance to erosion

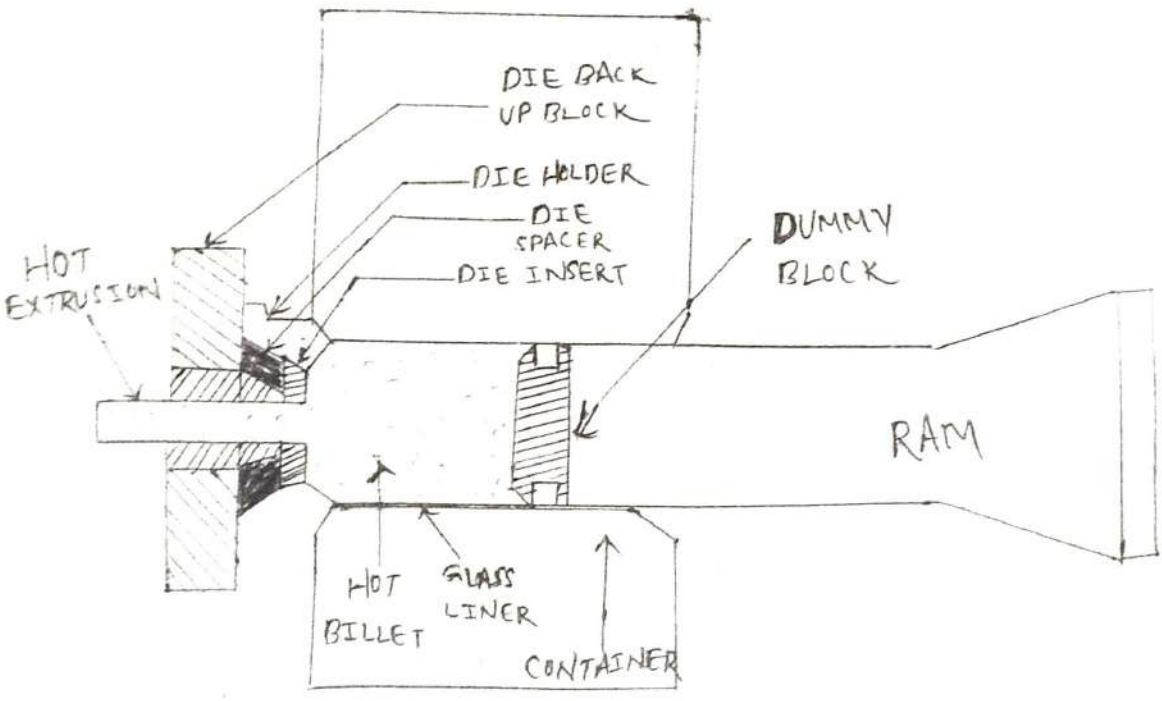
and hot strength.

-> The container provides mechanical support and strength for extrusion process.

Container's innersell, Liner is made up of 9% tungsten type steel, heat treated to about 475 Brinell hardness.

-> Dummy block is made up of 9% W or 5% CrMO type steel.

-> Extrusion Die is made upof 5% CrMO type steel or 9% tungsten steel with ~~rock~~ rockwell Hardness 50 C



[HOT EXTRUSION]

Cold Extrusion:-

Introduction:-

-> Cold extrusion is also known as ~~cold~~ coldforming or Impact extrusion.

-> Cold extrusion process extrudes metals without the application of heat the purpose of cold extrusion is that of producing a finished part.

-> In the cold extrusion process the ~~extru~~ extruded metals have a high degree of ductility.

Principle of operation:-

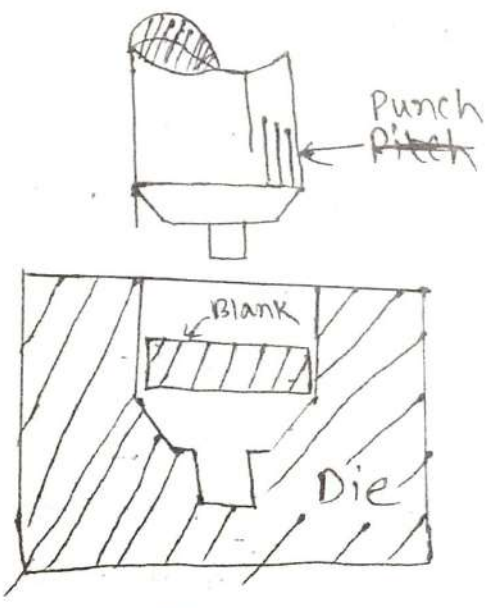
-> The piece of metal known as slug is cut from bar and using punch and die ~~sets~~ sets.

-> The process involves squeezing or flowing of metal and there is no westage of material.

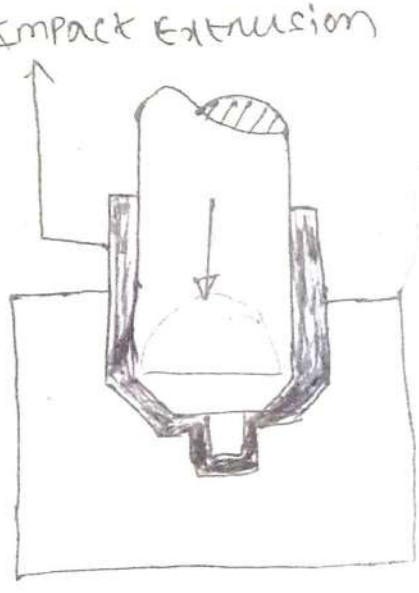
Types of Process:-

-> Cold extrusion is accomplished by Impact and Hooker process.

-> In Impact extrusion process an ~~unheated~~ unheated metal blank is placed in the Die cavity and is pressed rapidely by punch which transmit very high pressure to the metal blank which ~~immed~~ immidieately in the cavity.



Impact Extrusion

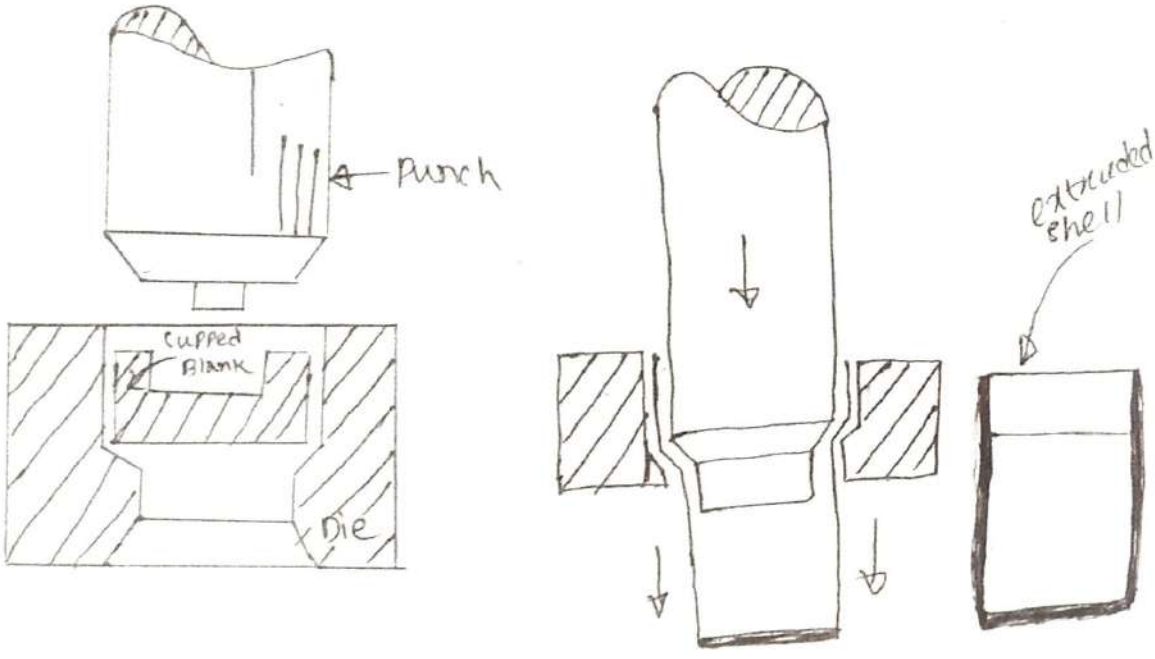


→ Collapsible tubes of ~~lead~~ lead, Tin & Aluminium which are used as containers for shaving cream, tooth Pest, medicine, shoe poli are produce with the impact ~~extru~~ extrusion

Hooker Process:-

→ In Hooker process and unheated cupped blank of metal is placed in the die and pressed by ~~form~~ Punch to form tubular b shaped component.

→ The Hooker process is used to produce small brass cartridge case, copper tubes or radiater and heat exchanger.



Advantage of cold Extrusion:-

→ very little scrap is there in the process.
→ Little trimming or final machining is required because of the fine finish.
→ Tools can be change rapidely.
→ Complex parts can be produce quickly.
→ mechanical property (Tensile & yield strength) of the extruded parts are improved without

need of heat treating.

Disadvantage of cold extrusion:-

-> Tools are expansive.

-> metal blank should be free form internal or external defects, which makes the stock more expansive.

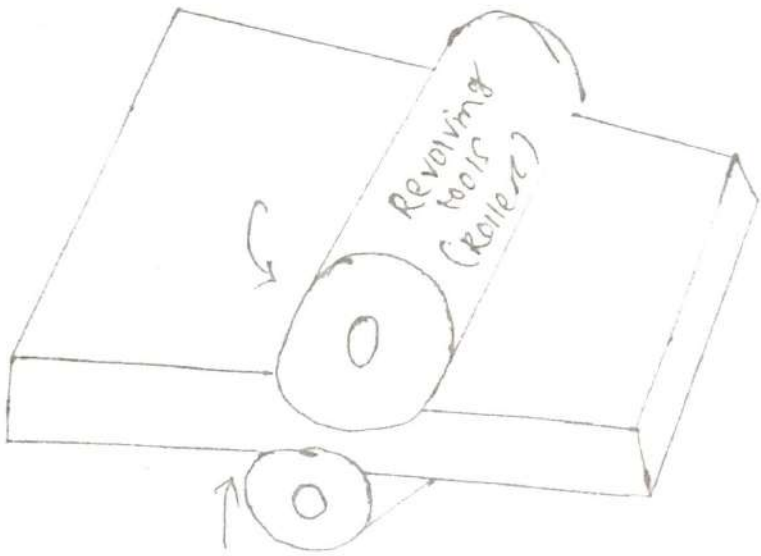
Application of cold Extrusion:-

-> Low carbon steels many alloy steels, stainless steels, Lead, Tin, Zinc, Aluminium, copper, etc can be cold extruded.

-> Gear blank bearing races, housing or caps, copper fittings, radiator tubes, etc can be made by cold extrusion.

ROLLING:-

In rolling the work piece is reformed or reshaped ~~either~~ by continuously ~~or step~~ application of pressure with the help of revolving tools or Rollers.



-> Rolling consist of passing the hot metal (Ingot) between two rollers, which reduces its size after each pass through rollers until the required cross section has been attained.

Ingot :-

A block of steel, gold, Silver or other metal of rectangular with unequal adjacent side in shape.

→

⇒ Ingot → Bloom :-

→ For this the ingot is taken to the cogging Mill or Slabing Mill.

→ In cogging mill rollers are used to grip the hot ingot & rappidely reduced its cross-section to 150mm^2 which is called Bloom.

⇒ Bloom → Billet :-

→ Blooms are still bulky for most purposes. Therefore they are further rolled down to the billet's.

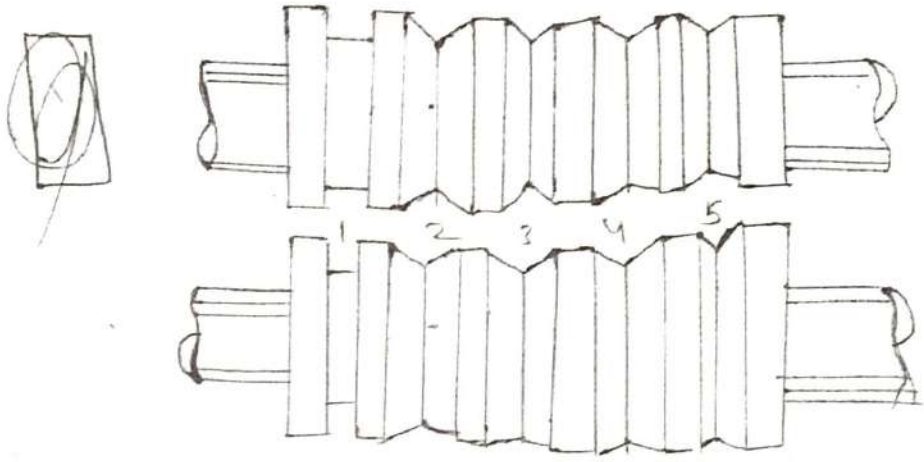
→ Billets are square in section having dimension 37.5 mm x 37.5 mm which is less than shape of Bloom.

→ Billet are used for making,

i) Forging

iii) Extruded section.

iii) Hot Rolled section (Bars & Rods).



Ingot → slab :-

A ingot is Rolled in a ~~stabing~~ slabbing Mill, where the ingot is converted into rectangular slabs of thickness 75 mm to 250 mm and 2000 wide.

Slabs are used for making hot rolled Plates, sheets and strips.

Hot Rolling	Cold Rolling
→ Metal is fed to the Rollers after being heated above the recrystallization temperature.	→ Metal is fed to the rollers when its temperature is bellow the recrystallization temperature.
→ ~~Metal is fed to the rollers when its temperature is bellow~~	
→ Rolled metal doesnot showes work-hardening effect	→ The Rolled metal showes the work-hardening effect after being cold rolled.
→ Coefficient the friction between the rollers and the stock is high	→ coefficient the friction between the rollers and the stock is ~~low~~ comparatively low.

→ Heavy reduction in area of the work piece can be obtained.	→ Heavy reduction in area of the work piece can be not possible.
→ Roller radius is generally larger than that used in cold rolling.	→ Roller radius is smaller.
→ very thin section are not obtained by hot rolling. Hot rolling of sheets less than 1.25 mm in thickness is not economical.	→ very thin sections are can be made. Aluminium foils as thin as 0.020mm can be made.
→ Hot rolled surface has metal oxide on it and its surface finish is not good.	→ The cold rolled surface is smooth and oxidefree
→ close tolerance on dimension can not be attained.	→ section dimension can be finished to close tolerance (within 0.002 mm/m

Metal	Colour	Melting Point °C	Density gm/cc
1) Aluminium	white	659	2.7 (wrought) 2.5 (cast)
2) Copper	Reddish	1081	8.7
3) Iron	Gray	1539	7.2 (cast) 7.7 (wrought)
4) zinc	Elvish white	419	6.87 (cast) 7.2 (wrought)
5) Tin	sivery white	232	7.42
6) Lead	Soft gray	327	11.3
7) Silver	Lustrous white	960	10.5

Types of Rolling Mill :-

Rolling mills may be classified according to the no. and arrangement of rolls,

a) Two high rolling mill
b) Three high Rolling mill
} used for Hot Rolling

c) Four-high rolling mill
d) A Tandem mill of three-four high stands
e) cluster rolling mill
} used for cold Rolling

a) Two high Rolling Mill :-

→ A Two high Rolling mill has two rollers only

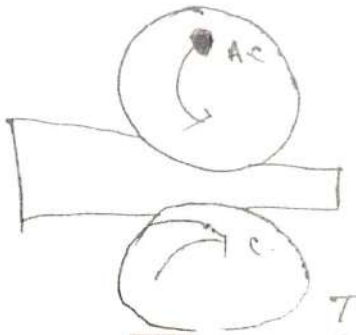
→ A Two high rolling mill is further classified as Reversing mill & Non-reversing mill.

→ In a two high reversing mill the first roller rotate in one direction and other roller rotate in opposite direction.

This type is used in Blooming and Slabbing mill.

→ In a two high non-reversing mill has two rollers which revolve continuously revolve in the same direction. Therefore, smaller and less costly motor power can be used.

~~b) Three hi~~



Two high Rolling mill

B) Three High Rolling Mill:-

-> It consists of a roller stand with three parallel rollers one above the other.

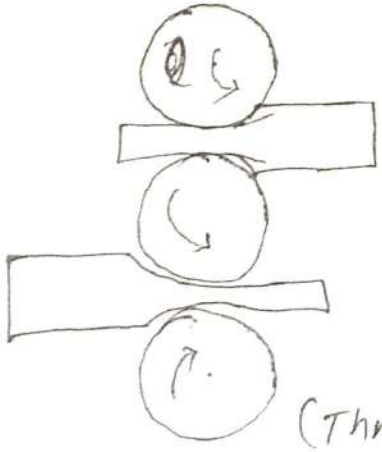
-> In three high rolling mill adjecent rollers rotate in opposite direction. so that material can be passed between the top & middle roller in one direction.

And in the bottom & middle roller material can be pass in opposite direction.

-> In three high rolling mill the work piece is rolled on both forward and return passes.

-> Since the roller run in one direction only a much less powerfull motor and transmission system is required.

-> Three high rolling mills can be used as Blooming mill and Billet mill.



(Three high Rolling mill)

C) Four high Rolling Mill:-

-> It has a roller stand with four parallel roller in one above the other

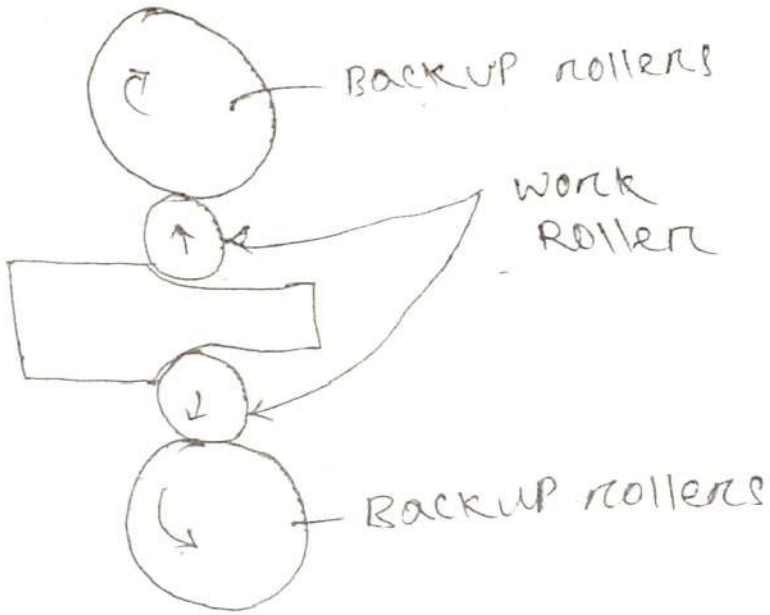
-> The top & bottom roller rotate in opposite direction, as do the two middle rollers.

-> The two middle rollers ~~are~~ as known as work rollers & they are smaller in size. ~~and top~~

And -> The top & bottom rollers are called backup rollers which are bigger in size.

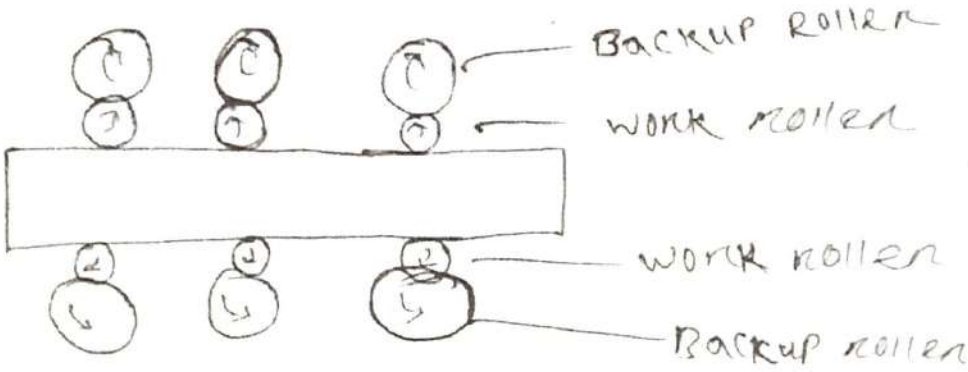
-> The backup rollers provide reinforce ~~to~~ two the smaller roller to minimize roll deflection.

-> This type of milling is used for hot rolling of armour and cold rolling of plates, sheets and strips.



d) Tandem Rolling mill:-

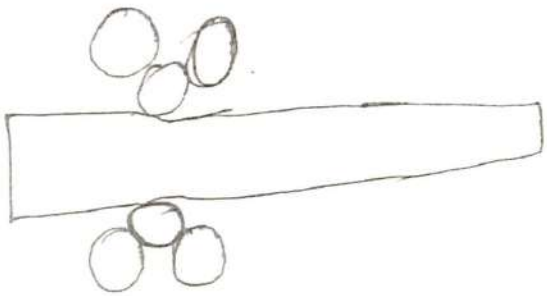
It is a set of two or three stands of rollers set in parallel alignment, so that a continuous passing of material can be made through each one succesively without change in direction of the material or Pause in the rolling process.



e) Cluster Rolling mill:-

→ It is a special type of four high rolling mill in which each of the two working rollers is backed up by two or more larger backup rollers.

→ For rolling hard thin materials can be obtained by using cluster mill.



2nd chapter

WELDING

Introduction:-

-> Welding is a process ~~of~~ For joining different material

-> Welding joins different metal & alloy with the help of no. of process (Gas welding, Arc welding, resistance welding) in which heat is supplied either electrically or by means of gas torch.

-> Many common everyday used items, like automobile cars, ~~hotshold~~ household items, air crafts, ships, electronic equipements, etc depends upon welding process.

Classification of welding process:-

1) Gas welding:-

i) Air-acetylene welding
ii) Oxy-acetylene welding
iii) Oxy-hydrogen welding
iv) Pressure gas welding

2) Arc welding:-

i) Carbon arc welding
ii) Shielded metal arc welding
iii) Flux cored arc welding
iv) Submerged arc welding
v) Tig arc welding
vi) Mig arc welding
vii) Plasma arc welding
viii) Stud arc welding

~~iv) Electro~~

iv) Electro slag welding and Electro gas welding

3) Resistance Welding:-

- i) Spot welding
- ii) Seam welding
- iii) Projection welding
- iv) Resistance but welding
- v) Flash butt welding
- vi) High frequency resistance welding

4) Solid State welding:-

- i) Cold welding
- ii) Forge welding
- iii) Friction welding
- iv) Ultrasonic welding

5) Thermochemical welding process

6) Radiant energy welding Process:-

- i) Electron beam welding
- ii) Laser beam welding

Commonly welded Base metal:-

1) Ferrous material

2) Non-Ferrous material

1) Ferrous material:-

- i) Wrought Iron
- ii) Cast Iron
- iii) Carbon steel (Low ~~mild~~ medium carbon steel)
- iv) Cast steel

v) Alloy steel

vi) Stainless steel, etc

2) Non-ferrous material :-

i) Aluminium and its alloys

ii) Copper and its alloys

iii) Magnesium and its alloys

iv) Nickel and its alloys

v) Zinc and its alloys

Advantages of welding :-

i) A good weld is as strong as the base metal.

ii) welding equipements are non costly.

iii) Portable welding equipements are available.

iv) welding permits considerable freedom in design.

v) A large no. of metals/alloys both similar and dissimilar can be joint by welding.

disadvantage of welding :-

i) welding gives out harmfull radiation (Light), fumes and spatter spatter.

ii) Edge preparation of the work piece is generally required before welding theme.

iii) A skilled welder can produce a good welding Job.

iv) welding heat produceses metallurgical ~~metrological~~ changeses so the structure of welded joint is not same as the parent metal.

Gas welding :-

→ Gas welding is a fusion welding process

→ It Joints metal, using the heat of combustion of oxygen/Air and fuel gas (~~Acetylene~~ Acetylene, hydrogen, propen or buten).

→ The intense heat (flame) thus produced melts and fuses togather the edges of welded material with the help of a filler metal.

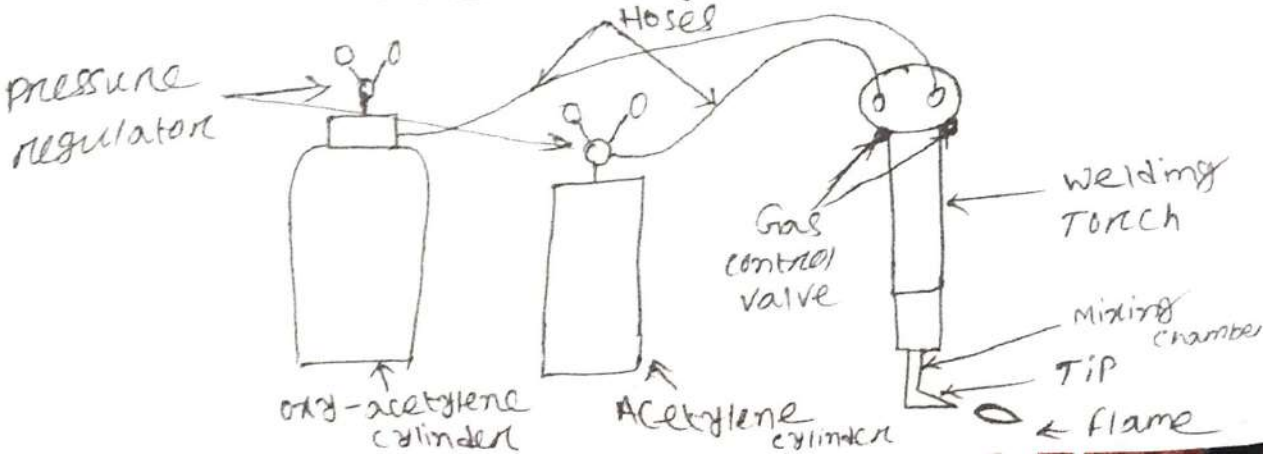
Oxy-acetylene welding :-

Principle of operation :-

when acetylene is mixed with oxygen in a correct proportion in the welding tourch and ignited, the flame resulting at the tip of the tourch is sufficiently hot to melt and Joint parent metal.

→ The oxy-acetylene flame ~~reaches~~ rich a temperature of about 3200°C and so it can melt all commercial metals which actually flow togather to form a complete bond during welding. A filler metal rod is generally added to ~~the~~ the molten metal pool to build of the seam ~~slid~~ slightly for greater strength.

→ oxy-acetylene welding does not require the components to be forced togather under pressure ~~until~~ until the welding is done



To ignite a flame :-

→ Open the acetylene control valve of the welding torch and after the system has been flushed clean of air, the gas is ignited

At the stage enough of oxygen is drawn from the atmosphere to burn acetylene partially.

→ The Acetylene control valve is adjusted until the flame appears.

→ Then the oxygen control valve observe welding torch is opened in order to adjust the proportion of two gases to mix and burn.

→ This results three distinct type of flame.

Types of welding flame :-

i) Neutral flame (Acetylene & oxygen in equal proportion)

~~ii) or~~

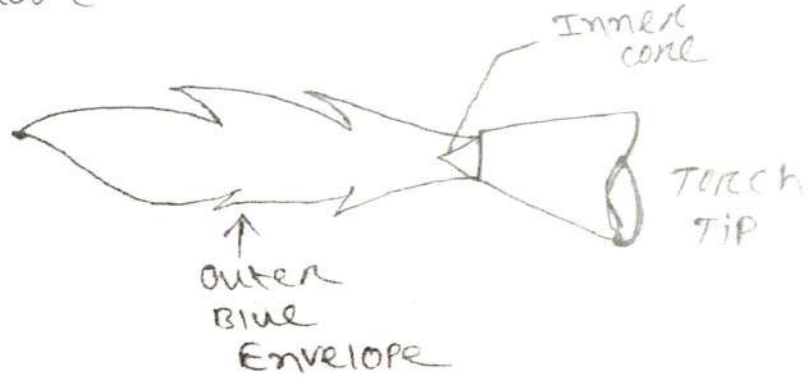
ii) oxidising flame (excess of oxygen)

iii) Reducing flame (excess of Acetylene)

~~iv)~~ Neutral flame :-

→ A neutral flame is produced when equal volumes of oxygen and acetylene are mixed in the welding torch and burnt at the torch tip. ($\frac{O}{A}$ = 1:1 or 1)

→ The temperature of the neutral flame is 5900°F or 3260°C



→ The flame has a inner cone which is light blue in colour. It is surrounded by an outer flame envelope which is a darker blue then the inner cone.

→ A neutral flame is named so because it affects no chemical change on the molten metal Therefore, it will not oxidise or carburize the metal.

→ Neutral flame is commonly used for welding of 1) mild steel, 2) Stainless steel, 3) Cast Iron, 4) copper, 5) Aluminium.

ii) Oxidising flame:-

→ If the supply of oxygen is increased compare to the acetylene gas in the torch, and burn, the result will be an oxidising flame.

An oxidising flame can be recognized by the small cone which is shorter, much bluer and more pointed than the neutral flame

→ The outer flame envelope in much shorter and tends to fan out at the end.

→ An oxidising flame burns with a loud roar.

→ An oxidising flame as a temperature of 6300°F or 3482.2°C.

→ An excess of oxygen causes the weldbete and the surrounding area to half a dirty or scummy appearance. And it forms hard, brittle low strength oxides. So it is not used in welding of steel.

→ It is used for welding of copper base metal, zinc base metal, manganese steel.

iii) ~~Reducing~~

iii) Reducing Flame :-

→ The volume of oxygen is reduced compare to the acetylene gas, resulting flame will be carburising or reducing flame and that is rich in acetylene.

→ In reducing flame the outer flame envelope is longer than the neutral flame and is usually much brighter in colour.

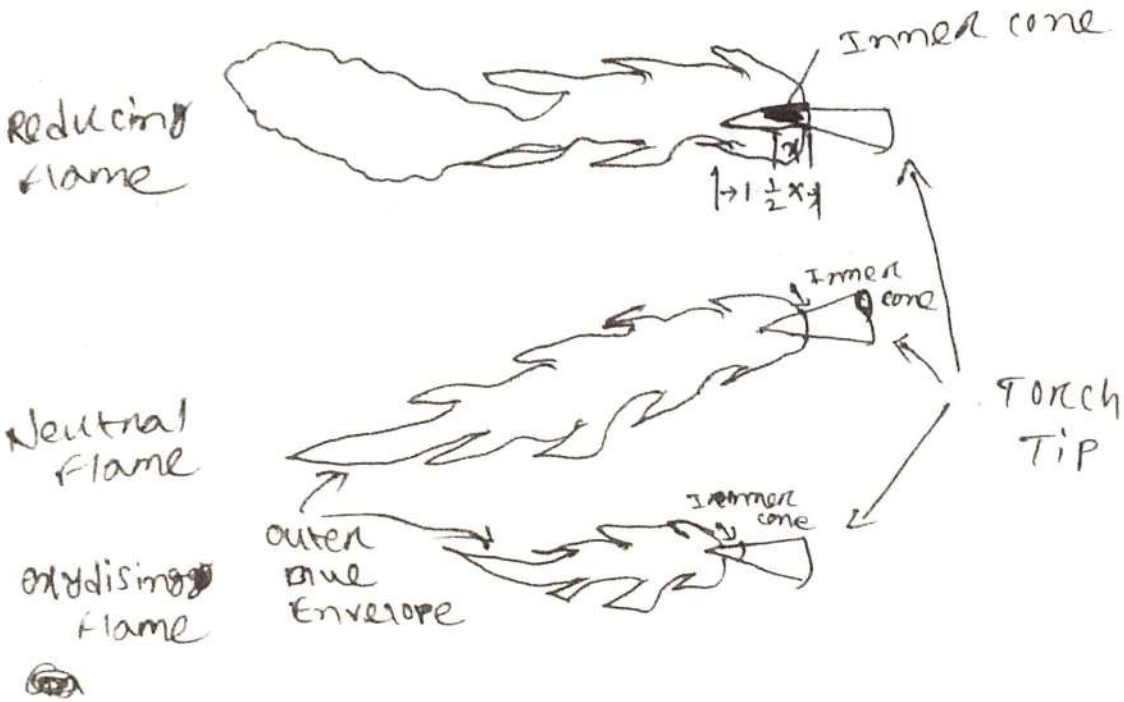
→ The reducing flame has approximately temp. of 5500°F (3038°C)

→ Reducing flame is used for welding with low alloy steel rod. This flame is used for welding high carbon steel.

NOTE :- A reducing flame may be distinguished or differ from carburising flame by the fact that a carburising flame contains more Acetylene (C_2H_2) than a reducing flame. A carburising flame is used to welding and for carburising (surface hardening) purpose.

TO conclude for most welding operation, the neutral flame is correct. But the other types of flames are sometimes needed for special welds. (Non-ferrous alloy & high carbon steels require a reducing flame.)

Oxidising flame are used for welding purpose of ~~nic~~ zinc, copper alloy



Gas welding equipements :-

The basic equipements are,

1) oxygen gas cylinder.
2) Acetylene gas "
3) oxygen Pressure regulator.
4) Acetylene Pressure regulator.
5) ~~Hose Pipe~~ oxygen, Gas hose pipe. (Blue)
6) Acetylene gas Hose pipe. (Red)
7) welding torch or Blow pipe with a set of Nozzles and gas lighter.
8) A set of keys and spanners
9) Filler rod & Fluxes
10) Protective cloth for welder (Asbestos apron, gloves, goggles, safty shoes, face mask)

Filler metals rod:-

→ Filler metal is the material that is added to the weld pool to assist in filling the gap.

→ Filler metal forms an integral part of the weld.

→ Filler metal is usually available in rod form. This rods are called filler rod.

→ Filler rods have same or nearly same chemical composition as the base metal.

→ Welding filler rod are available in a variety of composition and sizes for welding different materials.

Figure:-

Flux:-

→ During welding, if the metal is heated/molted in air, oxygen from the air combines with the metal to from oxides which result in poor quality, low strength welds or in same cases, may even make welding impossible. In order to avoid this difficulty, a flux is employed during welding.

→ A flux is a material used to prevent, dissolve or facilitate removal of oxides and other undesirable substance.

A flux prevents the oxidation of molten metal.

→ The flux material is fusible and non-metallic

→ During welding, Flux chemically reacts with the oxide and ~~covers the~~ a slag is formed. that floats to and covers the top of the molten puddle of metal and thus keep out atmospheric oxygen and other gases.

→ Fluxes are available as powder, pastes or liquids.

→ Fluxes are used either by applying it directly on to the surface of the base metal or by dripping 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, filing or grinding.

→ Flux for welding of cast iron are Borates or boric acid, soda ash, etc.

→ Flux for Aluminium and its alloys welding are compounds of Lithium, sodium and pottassium.

→ Flux for welding of copper alloys may contain Borax, Di-sodium phosphate, magnessium silicate, Lime, etc.

★) What is slag and How it can be removed from welded surface?

→ slag is a nonmetallic by product of the mutual dissolution of flux with non metallic impurities in welding and brazing process.

→ slag is formed when flux is used in welding process.

→ slag is the solid shielding material formed on the top of the weld zone while welding.

→ By using chipping, hammer, Grinders, wire brush wheels, can remove the slag from the welded surface.

* Soldering and Brazing :-

→ Soldering and Brazing process differ from welding in the sense that there is no direct melting of the base metal being joined.

→ Both soldering and Brazing process are particularly useful for joining two dissimilar metals.

→ Both the brazing alloy or the solder have lower melting point than the metal to be joined.

→ Brazing and soldering process differ in the following ways,

a) Filler metal used in soldering has a melting point below 800°F (427°C). where as that in brazing has a melting point above 800°F (427°C).

b) Brazing produces joints stronger then those made by soldering and they can be used in service ~~used~~ at ~~high~~ higher temperatures.

* Soldering :-

→ Soldering is a common process for joining steel, copper and other material at a lower temperature.

→ soldering is defined as a group of joining process of two dissimilar metals by heating to a suitable temperature and by using a filler ~~add~~ metal have melting point not exceed to 800°F.

→ The filler metal (solder) is usually distributed between the two surfaces of the joint by capillary action.

Steps or stages of soldering process:-

1) selection of base metals to be soldered.
2) Joint design for proper bond formation.

Example of solders:-

1) Tin-lead solder.
2) Tin-antimoney-lead solders.
3) Tin zinc solder
4) Lead-silver solder
5) cadmium-silver solder
6) cadmium-zinc solder
7) zinc-aluminium solder.

★ Brazing:-

→ Brazing is defined as a group of joining process by heating filler metal above 800°F (427°C) and let it rest for solidify base metal.

→ The filler metal is distributed between the closely fitted surface of the joint by capillary action.

→ most metals and alloys such as ~~combined~~ carbon steel, cast iron, stainless and alloy steels, copper, bronze and brass, aluminium and some of alloys can be ~~brazed~~ brazed.

→ copper & aluminium can also be joined if an aluminium-silicon alloy is used as the brazing filler metal.

→ In brazing process metallic parts are joined by a ~~non-metallic~~ non-ferrous filler metal.

→ Brazing is used where a ductile joint is required which will have not only ~~good~~ strength but also resistance to fatigue and corrosion.

→ Such joints are also able to withstand higher service temperature than soft soldered joints.

Brazing process:-

Brazing may be carried out by the following techniques,

1) Torch Brazing.
2) Furnace Brazing.
3) Induction "
4) Resistance "
5) Dip Brazing
6) Inforced Brazing.
7) Exothermic Brazing.

★ Examples of filler metal for Brazing:-

Filler rod	Brazing
1) Aluminium-silicon	1) copper & aluminium.
2) ~~Mag~~ magnessium filler rod.	2) magnessium alloys.
3) copper & copper-zinc.	3) steel, Nickel and its alloys, copper, Nickel alloys.
4) copper & phosphorous - (w) Tungsten, siver, molybdenum	
5) Gold filler metal	5) Fe, Ni & Co
6) Nickel filler metal.	

4) Flux shielded Metal Arc welding :-
(MMAW or SMAW)

(Manual metal Arc welding) (shield metal Arc welding)

Defination:-

→ It is an arc welding process where in wleded joint is produced by heating the work piece with an electri arc set up between a flux coated electrode and the work piece.

→ The flux covering decomposes due to arc heat and performs many functions like arc stability, weld metal protection, etc.

→ The electrode itself melts and supplies the necessary filler metal.

Principle of process:- (working principle)

→ Heat required for welding is obtained from the arc struck between coated electrode and the workpiece.

→ The arc temperature, thus the arc heat can be increased or decreased by employing higher or lower arc current

→ The arc melts the electrod end and the job. Material droplets are transfered from the electrode to the job, through the arc and are deposited along the joint to be welded.

→ The flux coating melts, produces a gaseous shield and slag to prevent atmospheric contamination of the molten weld metal.

Preparation :- (Operation)

→ Before welding, edge of the workpieces are suitably prepared.

The edge and the area Joining them is cleaned of all the rust, dust, paint, grease by using either chemically or mechanically (using wire brush, grinding wheel).

→ The workpieces to be welded are positioned and spaced with respect to each other by help of fixtures to maintain correct root gap during welding.

→ welding leads or cables are properly connected to power, source and workpiece.

→ Power ~~switch~~ switch is switched on and suitable welding current are set.

→ Electrode is gripping in the holder and the operator is ready for welding.

Welding Equipments :-

1) AC or DC welding supply
2) Electrode holder
3) welding cables
4) welding electrodes
5) Ground connections or connectors.
6) Hand shieldds.

Advantages :-

1) SMAW is the simplest of all the arc welding processes.
2) The equipment can be portable and the cost is fairly low.
3) This process is widely used because of the availability of a wide variety of electrodes

4) A big range of metals and their alloys can be welded.

5) welding can be carried out in any position with highest weld quality.

Application:-

1) Today, almost all the commonly employed metals and their alloys can be welded by this process.

2) Shielded metal arc welding is used both as a fabrication process and for maintaince and repair Jobs.

3) This process is used in application of
   i) Air receiver, tank, boiler and pressure vessel fabrication.
   ii) ship building
   iii) Pipes and penstock Joining
   iv) Building and bridge construction
   v) Automatic and Aircraft industry, etc.

4) Tungsten Inert gas (TIG)
   OR
   Gas Tungsten Arc welding (GTAW)

Defination:-

→ It is an arc welding process where in welded Joining is produced by heating the Job with an electric arc struck between a tungsten electrode and the Job.

→ A shielding gas (argon, helium, nitrogen, etc) is used to avoid atmospheric contamination of the molten weld pool. A filler metal may be added, if required.

Principle of operation:-

-> Welding current, water and inert gas supply are turned on.

-> The arc is struck either by touching the electrode with a tungsten piece or using a high frequency unit.

-> A high frequency current is supplied to the tungsten electrode and the welding torch is brought near to the Job with in a distance of 2 to 3 mm, then a spark jumps across the airgap to the Job from the Tungsten electrode. Their path is ionized and arc is established.

-> After stricking the arc, there is a molten weld pool is created. The welding is started by moving the torch along the joint like in a leftward welding Technique.

-> The inert gas are act as a sheilding gas to avoid atmospheric contamination of the weld surface.

-> The welding torch and filler metal are generally kept inclined of angle of 70°-80° and 10°-20° respectively with the flat workpiece.

Equipments:-

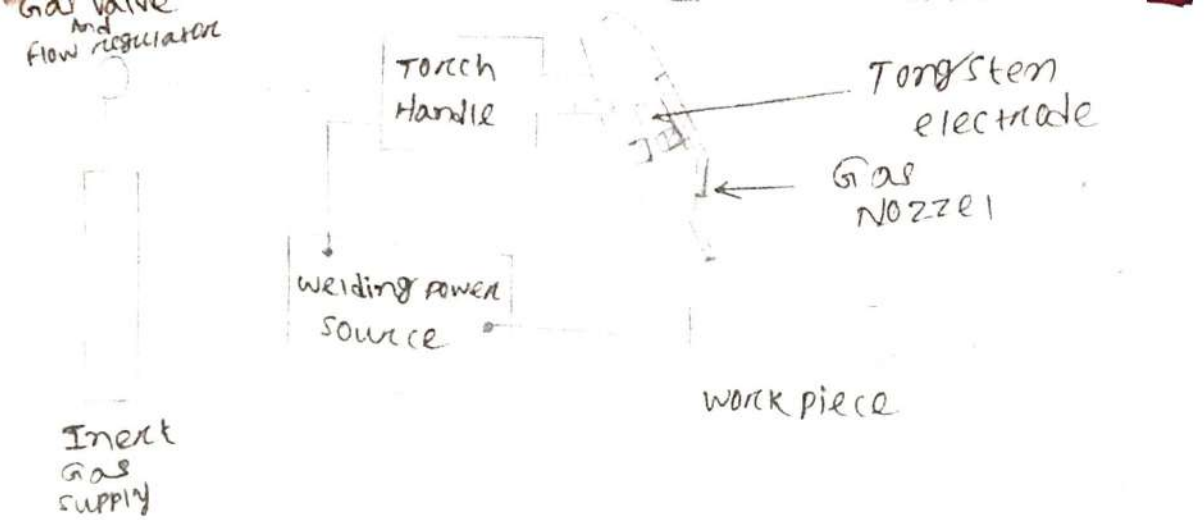
1) Welding Torch, tungsten electrode and filler metal.

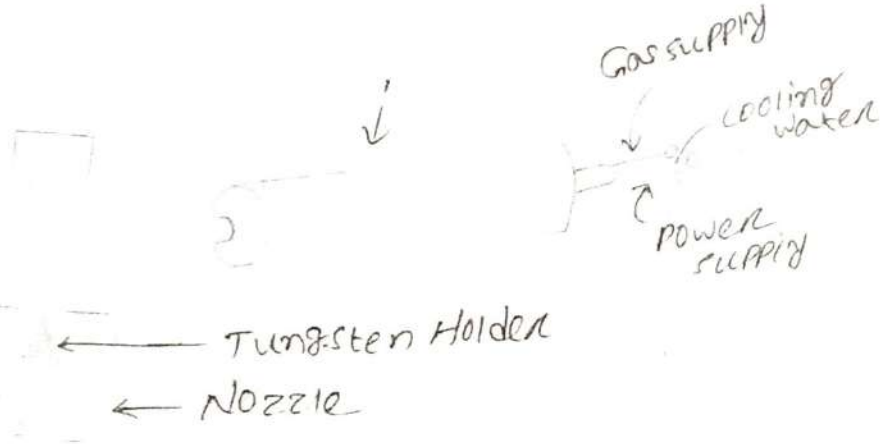
2) welding power source, High frequency unit, DC suppressor unit and cables.

3) Inert gas cylinder, pressure regulator and flow meter.

4) Cooling water supply.

5) water and gas solenoid valves.





→ welding torch may be air or water cooled. when welding above 150 Amps., generally a water cooled torch is prepared.

→ DC welding machine prefered for welding of stainless steel, nickel, copper, and copper alloys.

AC welding machine is used for welding of Aluminium and magnesium alloys.

Reverse polarity of current remove oxides film on Aluminium and magnesium.

→ Inert gases are used in TIG welding,

i) Argon
ii) Helium
iii) Argon - Helium mixture
iv) Argon - oxygen mixture
v) Argon - Hydrogen mixture.

Base metal welded:-

i) carbon and alloy steels.
ii) stainless steels.
iii) Heat resisting Alloys.
iv) Refracting metals.
v) Aluminium alloys.
vi) copper alloys.
vii) magnesium alloys
viii) Nickel alloys, etc.

user:- Aerospace
Nuclear
power station
or
Nuclear
missile

TIG welding is adapted to weld thickness up to 6mm.

A) Joint design:-

→ Butt, Lap, corner, edge and T-Joints are all used in TIG welding.

A) V.V.Imp:-

Metal Inert GAS (MIG)
or
Gas metal ARC welding (GMAW)

Defination:-

It is an arc welding process where in welding joint is produced by heating the job with an electric arc established between a continuously fed metal electrode and the job.

NO flux is used but the arc and molten metal are shielded by an inert gas, which may be argon, helium, carbon dioxide or a gas mixture.

Principle of Operation:-

→ Before igniting the arc, gas and water flow is checked.
→ Proper current and wire feed speed is set and electrical connections are ensured.

-> The current and shielding gas flow is switched on and the electrode is scratched against the job as usual for striking the arc.

-> About 15 mm length of electrode is projected from the torch before striking the arc.

-> During melting, torch remains about 10-12 mm away from the job and the arc length is kept between 1.5 to 4 mm.

Equipment:-

a) welding power source and cables.

b) welding torch and wire electrode coiled on a spool.

c) wire feed mechanism and controls consisting of a pair of driving mills, electronic motor, etc.

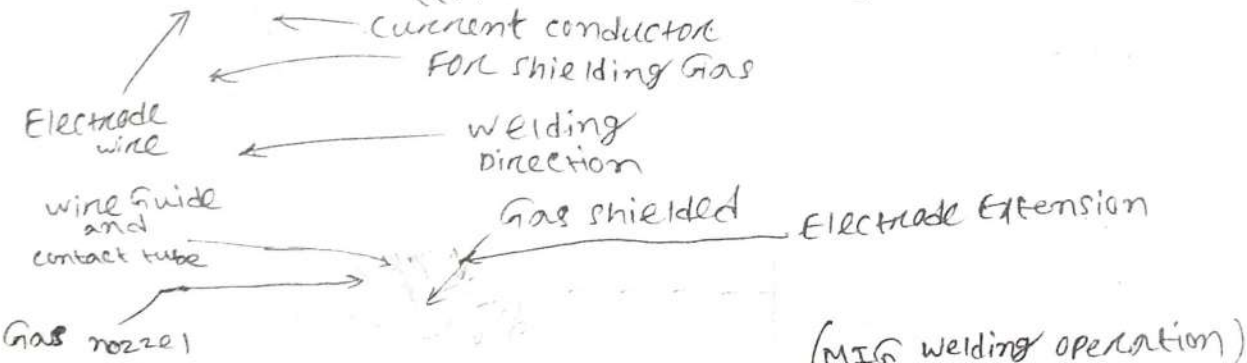
d) shielding Gas cylinder, pressure regulator and flow meter.

e) controls for switching on and off the current, electrode wire and inert gas.

•) In MIG welding electrode wire have different diameter of 0.8, 1.2 and 1.6 mm, etc.

•) Steel wires are generally copper coated are used as electrode wire.

(a) MIG welding set up



(MIG welding operation)

•) Power source for MIG welding process is DC generator with 400 Amps. can be used.
•) Torches working above 300 Amps. are generally water cooled.

Metals welded or (Application)

Base metals commonly welded by MIG welding are

1) Carbon and low alloy steels
2) Stainless steels
3) Heat resisting alloys
4) Aluminium and its alloys
5) copper and its alloys
6) Magnesium alloys.

Joint Designs:-

MIG welding is applicable to the following types of joints.

i) Butt, ii) Lap, iii) corner, iv) T-Joints, v) Edge.

★) Resistance welding:-

Defination:- Resistance welding is a group of welding processes where-in welded joints is produced by the heat obtained from resistance of the work to the flow of electric current in a circuit of which the work is a part and by the application of pressure.

No Filler metal is needed.

Fundamentals of Electric Resistance welding:-

The two factors are mainly responsible for resistance welding,

1) Generation of heat at the place where two pieces are to be joined.

2) The application of pressure at the place where a weld joint is to be formed.

*) Spot welding :- (Resistance spot welding)

Introduction and use :-

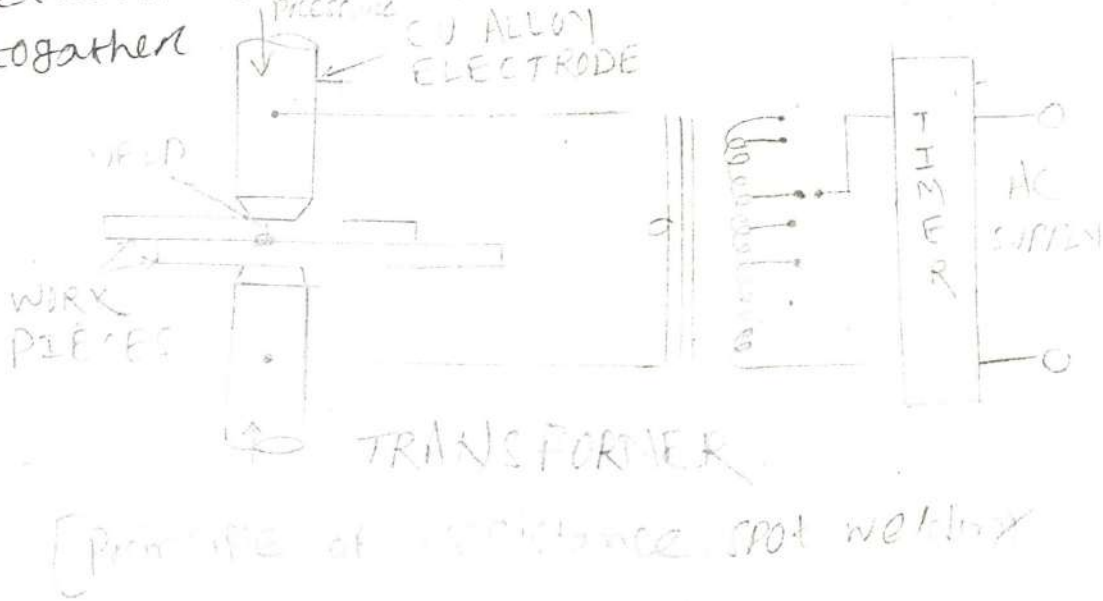
→ Spot welding is now most widely used of resistance welding processes.

→ Spot welding is employed for joining sheet to sheet, sheets to rolled sections or extrusions, wire to wire, etc.

→ Spot welding is used for joining relatively ~~light~~ hight gauge parts (upto 3mm thick sheet) as a lap joint.

Defination:-

→ Spot welding is a resistance welding process in which overlapping sheets are joined by local fusion at one or more spots by heat generated due to resistance of current flow between two electrodes which are forced together



[Principle of resistance spot welding]

Procedure:-

1) Clean the job free from grease, dirt, paint, scale, oxides, etc.

2) Clean the tip of two electrodes.
3) Proper welding current current has been set on the current selector switch.
4) Proper time has been set on the weld timer.
5) Electrodes are brought together against over laping workpiece and pressure applied so that surface of the two workpiece are joined.
6) welding current is switched on for a definite period of time.

The current may be the order of 3000 Ampere to 100,000 Amp. for a fraction of second.

7) The temp. of weld zone is increases upto 815°C to 930°C. At this stage the welding current is cutoff. And the force is applied by electrode at the weld zone to merge together.
8) The electrode pressure is ~~rotated~~ released and collect the welded workpiece.

Advantage of spot welding:-

1) Low cost.
2) High speed of welding
3) Less skilled worker will do
4) High uniformity of products
5) Operation may be automatic or semiautomatic.
6) No edge preparation is needed.

Application:-

-> It is used in application of automobile and Aircraft industries.
-> The attachments of braces, brackets, pads or clips to formed sheet metal parts such as cases and covers.

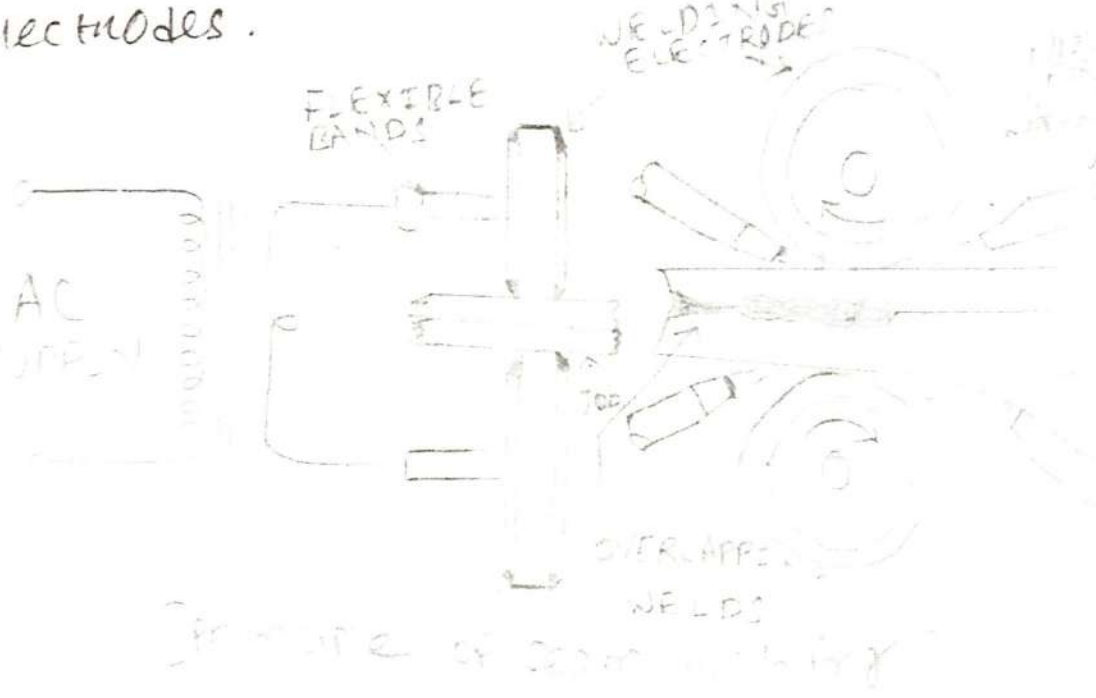
→ Manufacturing of fuel tanks.

→ Spot welding of ~~[illegible]~~ to 12.5 mm thickness of steel plates can be welded easily.

A) Seam welding :-

Defination :-

Seam welding is a resistance welding process where in metal joint is ~~formed~~ produced by the heat obtained from resistance to electric current through the work parts held together under pressure by rotating circular electrodes.



Principle of Operation :-

→ The seam welding is similar to spot welding, except that circular rolling electrodes are used to produce a containeous air tight seam of overlapping welds.

→ The workpiece are to be cleaned, overlopped suitably and placed between the two circular electrodes which clamp the workpieces together by the electrode force.

→ A current impulse is applied through the rollers to the material in contact with them.

→ A heat generated in the contact point of rollers and the pressure from the electrods completes the weld.

Applications:-

Transformers, paint containers, Gasoline tank, Automobile mufflers, sheet metal tanks.

Advantages:-

1) Generate a leak proof weld.
2) production rate is high.
3) Dissimilar metals can be welded.
4) NO filler metal or flux is needed.
5) Process can be automatic or semiautomatic.
6) Possible to weld thin metal sheets.

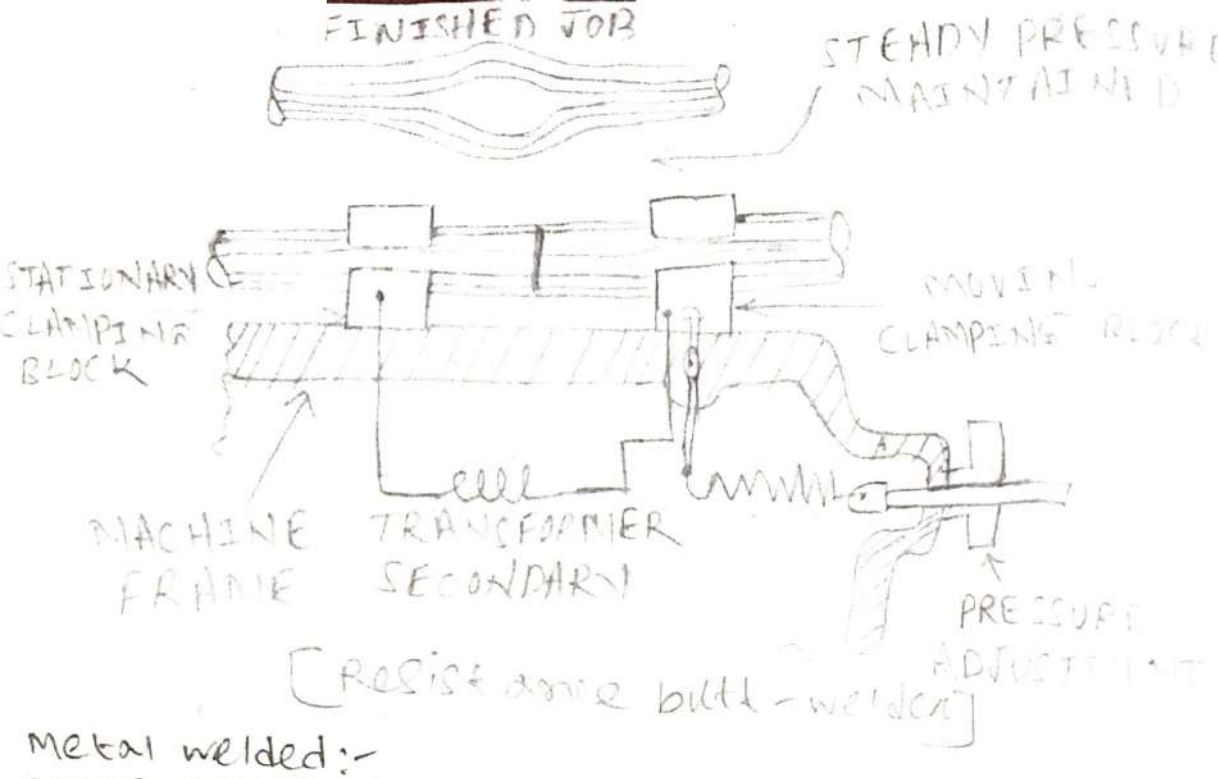
*) Butt welding:-(Resistance Butt welding)

→ Butt welding is a resistance welding process where a metal joint or welding joint is produced simultaneously over the entire area of abutting surfaces by the heat obtained from the resistance to electric current flow through the area of contact of these surface.

→ Pressure is applied before heating is started and maintained throughout the heating period.

This pressure or force is later on increased to give a forging squeeze when the welding temperature is reached.

→ When sufficient upset has been produced, the welding current is cut off and the force is removed.



[Resistance butt-welder]

Metal welded:-

Following materials are butt welded in wire, bar (upto 30 mm dia) strip or tube form.

i) Copper alloy
ii) Stainless steels
iii) Nickel alloys
iv) Low and high carbon steel
v) Aluminium
vi) Resistance alloys.

Flash welding :-

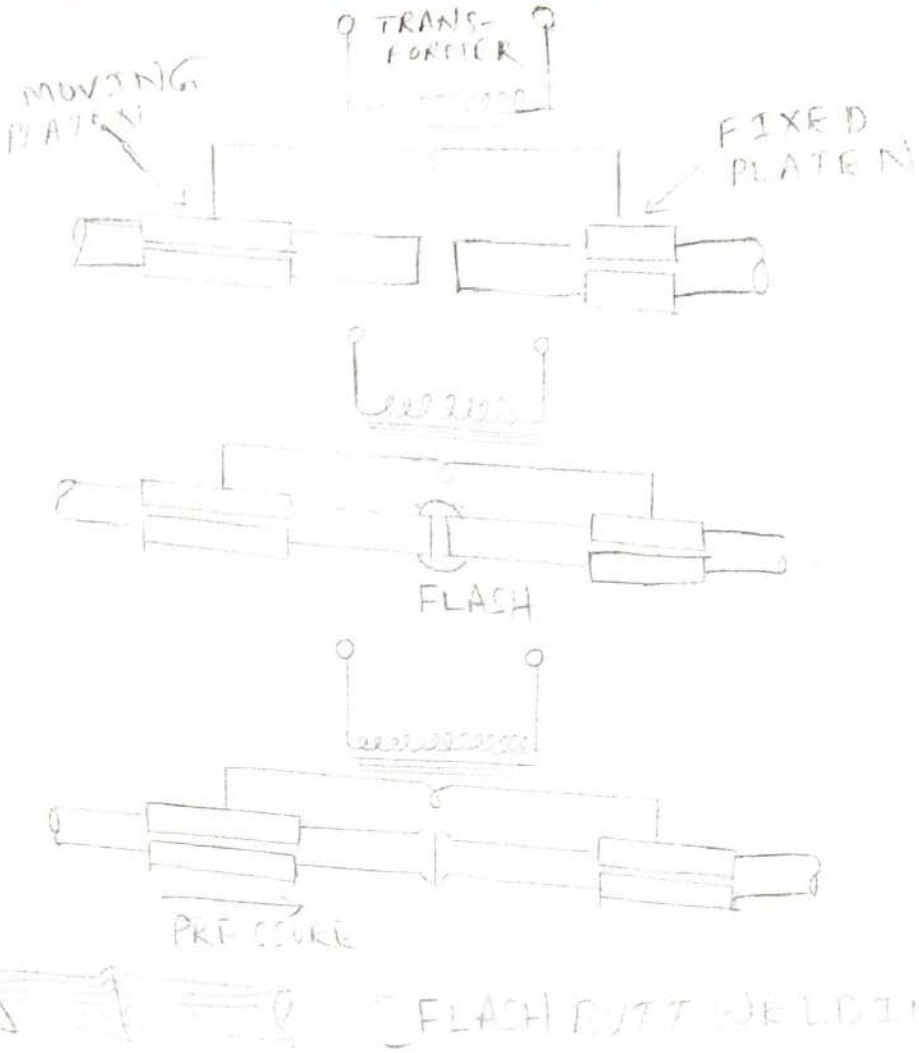
Introduction:-

-> The term flash welding derives its name from the flash produced during the process.

Defination:-

-> Flash welding is a resistance welding process where a welded joint is produced, simultaneously over the entire area of abutting surfaces, by the heat obtained from resistance to electric current flow between two surfaces, and the application of pressure after heating is sub-stantially completed.

Flashing and upsetting are accomporied by expulsion of mold from the joint.



Metals welded by Flash welding :-

i) Low carbon steel.
ii) Medium strength and high strength, Low alloy steel.
iii) Tools steel.
iv) Stainless steels.
v) ~~Al~~ Aluminium alloy (with thickness greater than 1.25 mm)
vi) Magnesium alloys.
vii) Nickel alloys.

~~Types of welding~~ What is welding defect:-

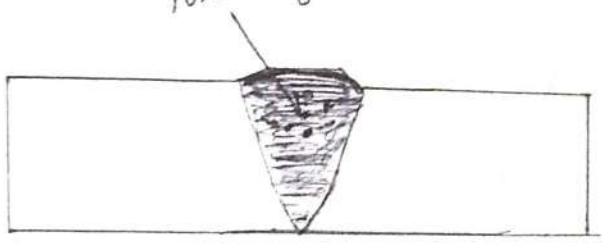
Welding defects are formed in a welding work due to the weak or poor technique used by the inexperienced or untrained welders or due to structural problems in welding operation.

Types of welding defects:-

Following are the types of welding effect,

1) Porosity and Blowholes
2) undercut
3) Weld crack
4) Incomplete fusion
5) Slag inclusion.
6) Incomplete Penetration
7) Spatter
8) Distortion.
9) Hot Tear.

#1 Porosity and Blowhole:-



Porosity is a group of small bubble and blowholes are relatively large hidden holes or Pores. They are mainly caused by trapped gases. Porosity is a result of ~~weld~~ weld metal contamination.

Cause of porosity:-

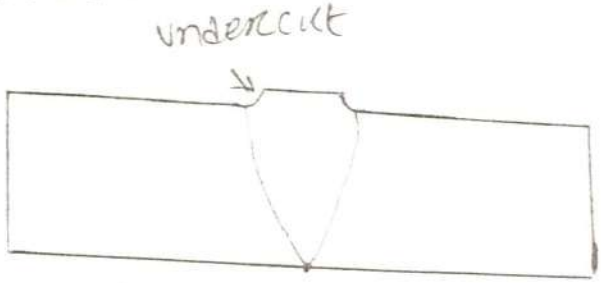
→ Using insufficient electrode de oxidant.
→ Applying too large gas flow.
→ Using a larger arc
→ Existence of moisture in the process

-> Unsuitable gas shield.
-> Dirty Job surface i.e. the occupation of scales, rust, oil, and grease, etc. on the surface of the Job.

Remedies of Porosity:-

-> Choosing suitable electrode and filler materials.
-> Checking the gas flow meter and ensure that it is adapted as needed with appropriate pressure and flow settings.
-> make sure that arc distance is correct.
-> Cleaning the metal before starting the welding process.
-> Decreasing welding speed, it will allow the gas to escape.
-> Individual cleaning and prevention of pollution from entering the weld zone.

#2 Undercut:-



Undercut in welding makes imperfection, it is the formation of grooves in the weld toe, which decreases the cross-sectional thickness of the base metal. As a result of this weld and workpiece get weakened.

Causes:-

-> Incorrect use of angle, which will deliver more heat to the free edges.
-> Because of too fast weld speed
-> Using poor welding methods
-> use of incorrect gas shielding and filler metal
-> Doing too high weld current

→ using larger diameter electrodes.

Remedies of undercut:-

→ using of suitable electrode angle, with more heat delivered towards thicker components.

→ Decreasing the travel speed of the electrode, but it should not be too slow.

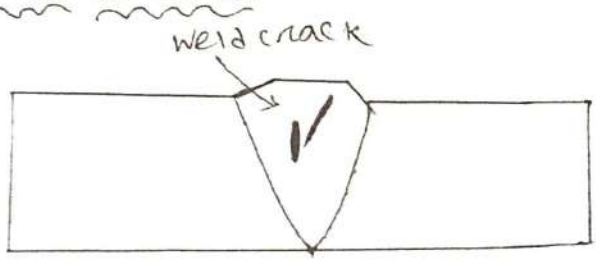
→ Applying the multipass technique.

→ selecting the shielding gas with the right structure for the material you are welding

→ when approaching thin areas and free edges, use an appropriate stream to reduce them.

→ Decreasing the arc length.

3 Weld crack:-



This are the most dangerous types of welding defects It is almost not allowed by all standards in the production. It can appear on the surface, in the weld metal or in an area affected by strong heat.

There are different types of crack that occur during welding, it depends on the temperature.

i) Hot crack:- Hot cracks happen while the welding process or during the crystallization process of the weld joint. Temperatures at this point can exceed 10,000C.

ii) Cold cracks:- These cracks occur after the weld is created and the metal temprature has passed down. They can also be made hours or days after welding steel. This mostly occurs when the deformation is made in the steel-structure.

iii) crater crack:- These cracks occur at the end of welding process before the operator completes the weld joint. They are usually made near the end of the process.

When the weld pool cools and freezes, the weld must be sufficient in volume to overcome the metal shrinkage, otherwise, it will make a crater crack.

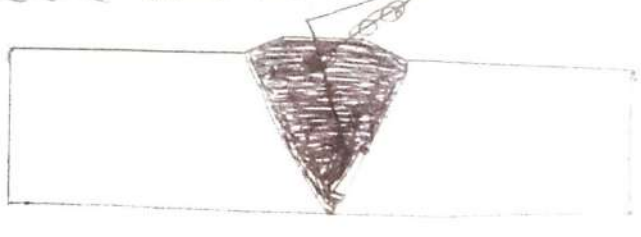
causes:-

-> Using hydrogen while welding ferrous metals.
-> Applying low current with high welding speed.
-> The design concept is poor.
-> Not doing preheating before starting welding.
-> Contamination of base metal.
-> The high mixture of sulfur and carbon in the metal.
-> Improper filling of the crater in welding.

Remedies of weld crack:-

-> Using suitable metals.
-> Utilizing the appropriate welding speed and current.
-> Using proper design concept.
-> Preheating the metal before welding.
-> Cleaning the metal surface before welding.
-> Giving decent cooling of the weld area.
-> Using a correct mixture of sulfur and carbon in the metal.
-> Ensure that the crater is properly filled to prevent crater cracks.

#4 Incomplete fusion:-



These types of welding defects occur when there is a shortage of suitable fusion between the metal and weld. It may also be visible between adjacent weld beads. This produces a gap inside the joint that is not filled with molten metal.

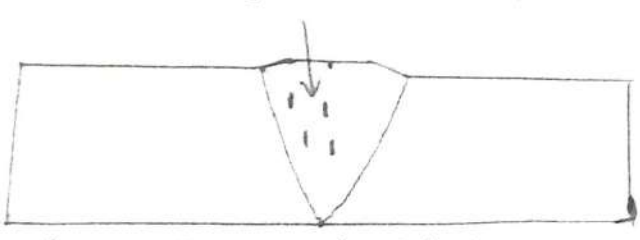
Causes of Incorrect Fusion:-

-> contamination of metal surface
-> using low heat input.
-> The diameter of the electrode is wrong for the thickness of the material you are welding.
-> Incorrect electrode angle
-> Employing too fast travel speed.
-> The weld pool is very large and it moves ahead of the arc.

Remedies of incorrect Fusion:-

-> Cleaning the welding area of the metal surface before welding.
-> Utilizing the proper heat input for welding.
-> using the correct diameter of the electrode to fit the thickness of the material that you are welding.
-> Ensure the angle of the electrode is suitable for welding.
-> Decreasing the speed of arc travel.
-> make sure the weld pool that you are using is proper according to the movement of the arc.

#5 Slag Inclusion:-



Slag inclusion is welding defects that are usually visible in welds. The slag is a dangerous substance that appears as a product of stick welding. Flux-core

arc welding, and submerged arc welding.

It is can occur when the flux, which is a solid shielding material applied when welding, melts in the weld or on the surface of the weld region. slag inclusion decreases the strength of the joint and hence makes it weaker.

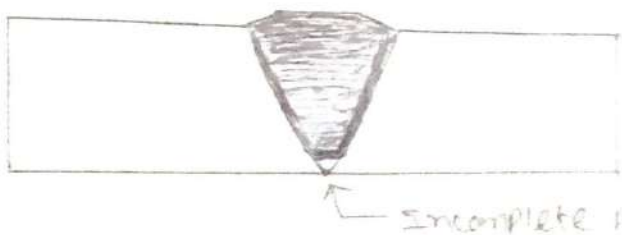
Causes of slag inclusion:-

-> Poor chipping and cleaning of previous passes in multipass welding.
-> Due to the incorrect angle of electrode.
-> Using too low welding current.
-> Insufficient space for puddle of molten weld metals.
-> May be cooling is very fast.
-> Cleaning of the metal may be improper.
-> The speed of welding is fast.

Remedies of slag inclusion:-

-> Through the wire brush, cleaning the weld bed surface before the next layer is deposited.
-> Adjusting the angle of the electrode.
-> Increasing the current density.
-> Redesigning the joint to allow to sufficient space for proper use of puddle of molten weld metals.
-> Decreasing the rapid cooling.
-> Proper cleaning of the metal before welding.
-> Reducing the speed of the welding.

#6 Incomplete penetration:-



In these types of welding defects, penetration is defined as the distance from the uppermost surface of the base plate to the maximum extent of the weld nugget.

Incomplete penetration happens when the metal groove is not entirely filled, which means that the weld metal does not fully spread through the joint thickness.

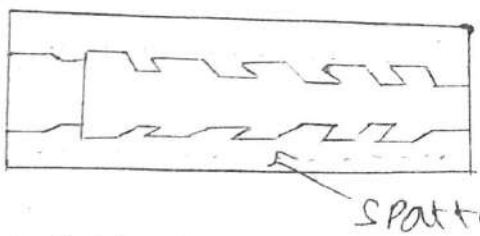
Causes of Incomplete penetration:-

-> There was too much space between the metal that you are welding with.
-> You are moving the bead too fast, which does not allow sufficient metal to accumulate in the joint.
-> You are using a low ampere setting, which result in the current not being strong enough to melt the metal properly.
-> Using position of the electrode.
-> using of larger diamer electrode.

Remedies of Incomplete penetration:-

->Assuring that the surface is jointly fine.
-> Decreasing the arc travel speed.
-> selecting a decent welding current.
-> Improving the design of the joint
-> Make sure the position of electrode is very accurate.
-> You must need to use proper of diameter electrode as suitable for your welding.

#7 Spatter:-



Spatters are tiny metal particles that are ejected from the arc during welding and accumulate on the base metal throughout the weld bead along

its length. This is particularly common happens in gas-metal arc welding.

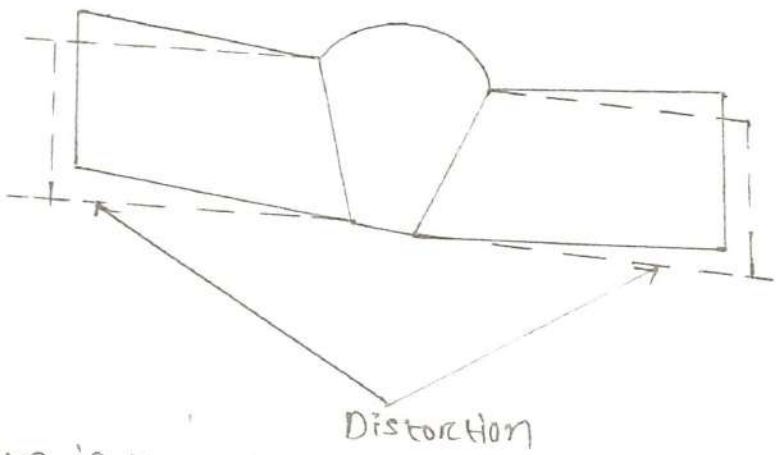
Causes of spatter:-

-> contamination of metal surface,
-> The working angle of the electrode is much more rigid.
-> Utilizing too high amper current and too low voltage settings.
-> Using the longer arc and wet electrode.

Remedies of spatter:-

-> Cleaning metal surfaces before welding.
-> Decreasing the arc length and increasing the electrode angle.
-> Using proper polarity with adjusting the weld current.
-> make sure to use proper arc and electrode according to the welding.

#8 Distortion:-



Distortion

Distortion is the difference in size and location between the positions of the two metal plates before and after welding due to the temperature grade present at several points along the weld joints

Or in other words, you can say that the distortion is due to uneven extension and reduction of the weld metal and that all kinds of distortion rise with the number of metal deposition.

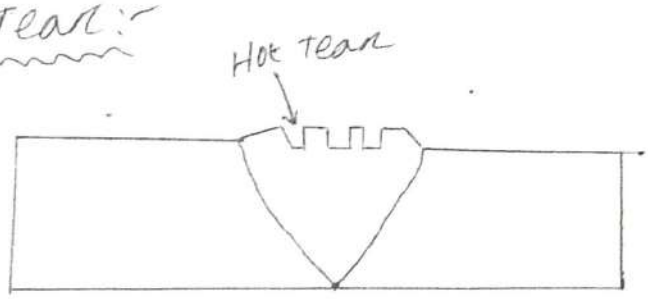
Causes of Distortion :-

-> Employing incorrect welding orders.
-> Using a large number of passes with small diameter electrodes.
-> Because of high residual stresses in the plate to be welded.
-> Due to the slow speed of arc travel.
-> Not using any measuring instrument for dimension purpose.
-> using too much time for working process.

Remedies of Distortion :-

-> Ensure to use the correct welding orders.
-> Using the appropriate number of weld passes.
-> Make sure you use the appropriate amount of weld metal as required by the joint. This will decreases contraction forces.
-> Maintaining the speed of arc travel.
-> If required you can use a measuring instrument, so that dimensional accuracy is accurate.
-> Decreasing the time of the welding process so that the volume around the metal is not even expanded.

#9 Hot Tear :-



In these types of welding defects, the deposited metal starts to develop crack from the nearby edge so that it will solidify the crack increase.

Due to the tearing of grain boundaries of the weld metal before it freezers and the metal is still in plastic condition. Therefore, it is also known as solidification cracking.

Causes of Hot tear:-

-> The thickness of the electrode is may be wrong.
-> Not using a suitable welding current.
-> It is due to the incorrect choice of proper materials.

Remedies of Hot Tear:-

-> Using the right thickness of the electrode according to the base metal to be welded.
-> Ensure the use of suitable welding current as needed.
-> Using a suitable type of material for the electrodes.

Casting

Casting is the process of producing metal or alloy components parts of desired shapes by pouring the molten metal or alloy into a prepared mold and then allowing the metal / ~~alloy~~ alloy to cool and solidify. The solidified piece metal / alloy is known as a casting.

procedure of casting:-

Steps:-

1) Make a pattern out of wood, metal or plastic.
2) In case of sand casting, select, test and prepare the necessary sand mixtures for mold and core making.
3) With the help of patterns prepare the mould and necessary cores.
4) Melt the metal / alloy to be cast.
5) Pour the molten metal / alloy in to the mould and remove the casting from the mould after the metal solidifies.
6) Clean and finish the casting.
7) Test and Inspect the casting.
8) Remove the defects, if any.
9) Relieve the casting stresses by heat treatment.
10) Again inspect the casting.
11) The casting is ~~ad~~ ready for shipping.

Advantages of metal casting:-

i) casting is one of the most versatile manufacturing process.

ii) casting provides the greatest freedom of design in terms of shape, size and the product of quality.

iii) casting produces machinable parts.

iv) Better vibration damping capacity of the cast part.

v) A product can be cast as one piece thereby eliminating the need of metal joining process.

vi) very Heavy and bulky parts (Power plant and mill housing) can be cast.

vii) metals (like cast iron) difficult to be shaped by other manufacturing process may be cast

viii) castings can be designed for equal distribution of loads and have more strength and increased service life.

ix) casting process can be mechanised and usefully employed for mass production of components.

Application of metal casting:—

i) Transportation vechiles (Engine).

ii) Machine tool structures (Planner bed).

iii) Turbine vanes.

iv) Power generators.

v) Mill Housing (cast steel)

vi) Railway crossings (Mn steel cast section).

vii) Super-chargers casing (Mg alloy).

viii) Pump filter and valve (Mg alloy)

ix) Paper mill stock breaker (steel casting).

x) Aircrafts Jet engine blades.

xi) Agricultural parts.

xii) communication, construction, and Atomic energy application

Raw metals for casting:-

a) Metals and alloys

i) Ferrous

-> Gray cast iron, Malleable castiron, Ductile castiron, white castiron.

-> Plain carbon steel, Low carbon steel, High alloy steel, stainless steel.

ii) Non-Ferrous

-> copper alloys.
-> Aluminium alloys.
-> magnesium alloys.
-> zinc alloys
-> Nickel alloys.

b) Fuels (For melting the metals).

i) Coal, ii) oil, iii) Gas, iv) Electricity, v) Coke

c) Fluxes

i) A Flux is a low melting point material.

ii) when heated up it melts and combines with ash, viscous, slags, sand, metallic oxides, etc

d) It makes a fluid and easy flowing slag

e) Slag protects molten metal from furnace atmosphere.

f) Lime stone is used as a flux in cupola when melting cast iron.

Refractories:-

i-) Refractories are heat resistant materials.

ii) They can withstand high temperatures without being fused.

iii) Crucibles and furnace sides and bottoms containing molten metal are made up of refractories.

iv) Refractories are used as ladles for pouring metal into the mould.

v) The main constituents of foundary refractories are MgO, SiO_2, Al_2O_3 and their mixtures.

vi) The newer refractory materials are magnesia and zirconia.

What is Mould?

A mould is a container (of sand or metal) having a cavity of the shape to be cast.

What is core:-

A core is a body (of sand) which is employed to produce a cavity in the casting. (Hollow shape)

Introduction to Pattern Making:-

Pattern:-

i) A Pattern is a mould forming tool in the hands of foundary men.

ii) A Pattern is a model or Replica of the object to be cast.

iii) Except for the various allowences a pattern exactly resembles the casting to be made.

iv) A pattern is required even, if one object has to be cast.

v) A Pattern may be defined as a metal around which sand is packed to create a cav a cavity known as mould cavity in, which when molten metal is poured, the result is the metal cast object.

9) Segmental pattern.
10) Follow board Pattern.

★ Pattern Allowances:-

1) Shrinkage or contraction Allowance
2) Machining or finish Allowance.
3) Draft or Tapper Allowance
4) Distortion Allowance
5) Shake allowance.

★ Mould Materials:-

i) A mould material is one, out of which the mould is made.
ii) A mold material should be such that the mould cavity retain its shape till the molten metal has solidified.
iii) casting can be made in

a) Permanent moulds:-
made of ferrous metals and alloys (steel, Gray cast, iron).

b) Temporary moulds:-
made of refractory sands and resins.

iv) Types of sands used in moulds:-

1) Green sand
2) Dry sand
3) Loam sand
4) Synthetic sand
5) core sand
6) Parting sand
7) Facing sand
8) Backing sand
9) Sharp sand
10) System sand
11) Heap sand
12) oil and molasses sand

✱ Core:-

Introduction:-

i) A core may be defined as a sand shape or form which makes the ~~casting~~ contour of a casting for which no provision has been made in the Pattern ~~has been made in the~~ pattern for moulding.

ii) Core as a sand shape is generally produced separate from the sand mould and is then backed (Hardened) to facilitate handling and setting in to the mould.

iii) Cores may be made up of sand, metal, Plaster or ceramics.

iv) Core is an obstruction which when positioned in the mold, naturally does not permit the molten poured metal to fill up the space occupied by the core.

In this way a core produces Hollow casting.

v) Cores are used to

a) Make the air space between the ~~co~~ cooling fins, of an air cooled engine cylinder.

b) make the water cooling chamber in internal combustion engines.

✱ Purpose of cores:-

i) For Hollow casting

ii) Cores may from a Part of green sand mold.

iii) Cores may be employed to improved the mold surface.

iv) Cores can be used to strengthen the mould.

v) Cores can be used to form the gating system of large size moulds.

★ Core making Procedure:-

Steps involved,

1) Core sand preparation
2) Making the cores
3) Baking the cores.
4) Finishing of Cores.
5) Setting the cores.

★ Making the cores:-

i) Small cores can be made manually in hand rammed core boxes.

ii) Cores can be made rapidly on the core making machines.

a) Jolt machines
b) Core rollover machine
c) Sand slinger.
d) Core extrusion machine
e) Core blower
f) Shell core machine.

★ Core Boxes:-

i) A core box is a basically pattern for making core.

ii) Core boxes are employed for ramming cores in them.

iii) Core boxes ranges from simple wooden structures to precision metal, assemblies.

iv) Core boxes impart the desired shape to the core sand.

v) A few commonly used type of core boxes are,

1) Half core box
2) Slab or dump core box
3) Split core box
4) Left and Right hand core box
5) Stricle core box

6) Gang core box
7) Loose piece core box.

★ Types of core Sand

Cores can be classified according to.

1) Green-sand core
2) Dry sand core
3) Oil bonded core
4) Resin bonded core
5) Shell core
6) Sodium silicate cores
7) Horizontal core
8) Vertical core
9) Hanging or cover core
10) Blanced core.

★ MOLDS:-

Defination:-

i) Prepared molding sand is packed rigidly arround the pattern and when the pattern is withdrawn, a cavity corresponding to the shape of pattern remains in the sand and is known as 'Mold'.

ii) Thus a mold is sort of container which when poured with molten metal produces a casting of the shape of the mold.

Types of Molds:-

a) Green sand mold
b) Dry sand mold
c) Skin drilled mold
d) Air dried mold
e) Core sand mold
f) Loam mold

g) Shell mold
h) cement bonded sand mold.
i) metal mold or dies.
J) Investment mold.
K) ceramic mold.
L) plaster mold.
M) Graphite mold.
n) sodium silicate - CO_2 mold.

Greensand moulding:-

i) It is most ~~usually~~ widely used moulding process.
ii) The green sand used for moulding consists of silica sand, clay, water and additives.
iii) one typical green sand mixture contains 10 to 15% clay binder, 4 to 6% water and remaining silica sand.
iv) Green sand moulding is prefered for making small and medium sized castings.
v) Green sand moulding is specially employed for producing non ferrous casting.

Hand moulding Equipement:-

1) Bellow
2) Brush
3) Lifter or cleaner
4) Dust bag
5) Gaggers
6) Heart and square
7) Peen rammer
8) Hand rammer
9) Floor rammer
10) Hand riddle
11) Sprue pin
12) Sprue cutter
13) Springs and nails
14) swab
15) Spray Gun
16) Sprit level
17) Trowels
18) shovels
19) vent wire
20) Strike off bar
21) Draw spike
22) Draw screws and Rapping Plate
23) smoothers and corner slics
24) Gate cutter

Molding Box or Flasks:-

i) A molding box or flask is a container which
a) (Create) imparts rigidity and strength to the sand rammed in it.
b) holds molten metal till the solidification rammed in it.

ii) A molding box may be in two or three parts. The top part is called cope, the middle part is called cheek, and the lower part is called as drag.

iii) Molding boxes can be made of
a) wood, b) cast, c) Fabricated from steel section.

★ Methods of Ramming Molding Boxes:-
a) Hand Ramming b) squeezing, c) Jolting
d) Sand shinging.

★ Chills:-
i) Chills are metal shapes inserted in mold to speed of solidification of a particular portion of the casting.

ii) Chills the equalise the cooling rate of thin and thick sections and thus prevanted hot tears.

★ principle of Gatting System:-
i) The term Gatting system is refers to all passageways through which the molten metal passes to enter the mold cavity.

ii) The Gatting system is composed of
a) Pouring cups and basins.
b) Sprue
c) Runner

d) Gates
e) Risers

★ a) Pouring cups:-

i) A pouring cups make easier for the ladle or crucible operator to direct the flow of metal from crucible to sprue.

ii) A pouring cup is a funnel shaped cup which forms the top portion of the sprue.

b) sprues:-

i) A sprue feeds metal to the runner ~~runner~~ which ~~in turn~~ then reached the casting through the gates.

ii) A sprue is tapered with its bigger end at the top to receive the liquid metal. The smaller end is connected to the runner.

c) Gates:-

i) A Gate is a channel which connects runner ~~runner~~ with the mold cavity and through which molten metal flows to fill the mold cavity.

d) Riser:-

i) A riser is a passage of sand, made in cope during ramming the cope.

ii) The molten metal rises in the raiser ~~feeder~~ head after the mold cavity is filled up.

★ Cupola Furnace:-

Introduction:-

i) Cupola is employed for melting scrap metal or pig iron used in the production of iron casting.

ii) It is an economical furnace for the production of gray cast iron, nodular casting and some malleable iron casting.

iii) cupola is obtained in different sizes.

iv) cupola can be operated for as long a time as may be required to produce a given amount of iron.

v) cupola does not produce metal of unifrom quality.

vi) Fuel for cupola is generally a good grade low sulphur coke, anthracite coal.

Construction:-

i) A cupola is a cylindrical shell constructed (welded or riveted) from boiler plate (6 to 10mm thick) is open at both its top and bottom and is lined with firebrick and clay.

ii) At bottom the cupola is supported on cast iron legs, the bottom opening of cupola is closed by cast iron doors which can be made to open or close and are supported by an iron prop.

iii) The bottom opening doors swing out after the melting operation is over and thus the content left in the cupola drop down through the opening.

iv) Air from the blower comes through the blast pipe and enters wind box which surrounds the cupola and supplies air evenly to all the tuyeres.

Press work

Press work operation:-

→ Press work materials:-

Mild steel, brass and copper are the chief material used in Presswork-operations.

→ Press work operation may be classified as,

A) cutting or shearing operation
   i) Blanking, ii) Punching, iii) Piercing
   iv) Notching, v) Trimming.

b) Bending operation
   i) Angle Bending

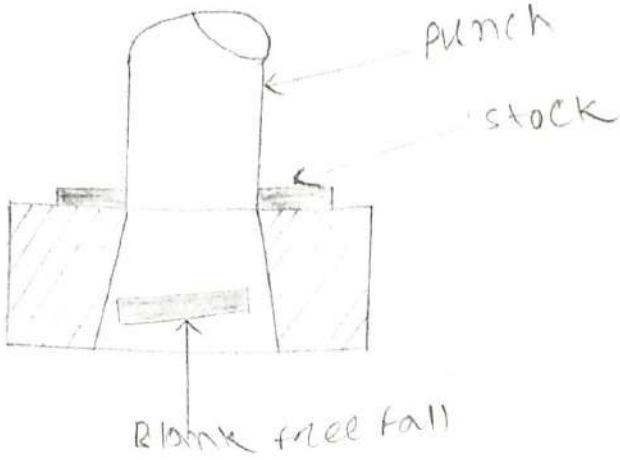
c) Forming operation
   i) Flanging, ii) Cutting, iii) Tube forming

d) Drawing operation
   i) Cupping, ii) Redrawing,
   iii) Deep Drawing.

Blanking:-

→ Blanking is the operation of cutting a shape (a die) from a metal strip. The piece detached from the strip is known as Blank. The remaining metal strip is scrap.

→ A blanking die must have clearance, otherwise the blank would not fall forcefully, it might remain stuck in the die blank.

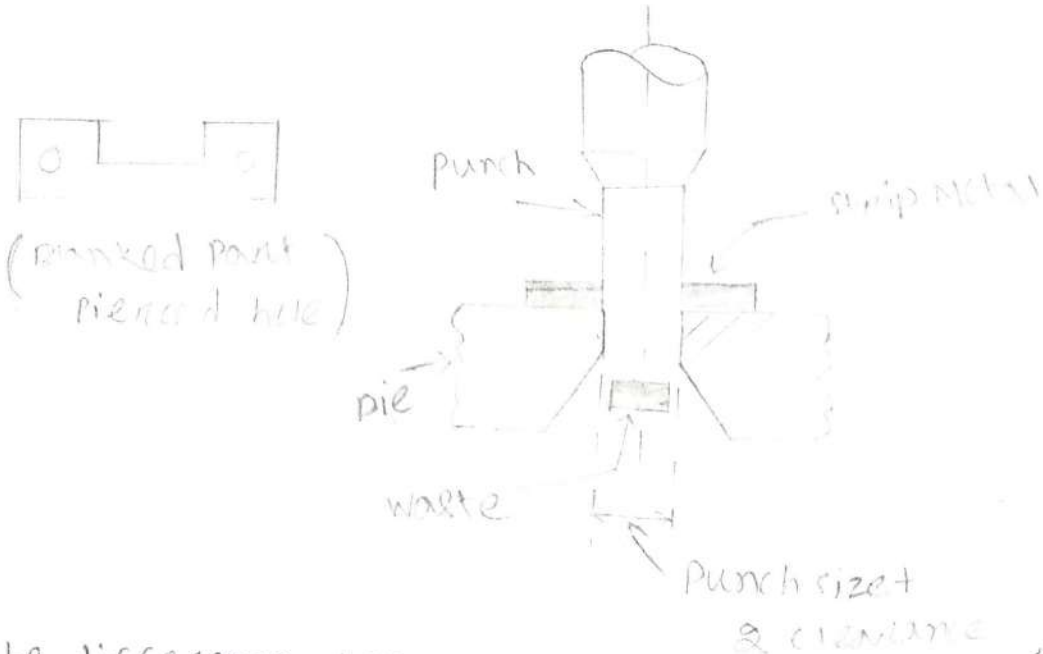


Punching:-

-> As blanking, punching is also basic die cutting operation.

-> Punching is the cutting of a slug from the metal to produce a hole.

The meatal with the hole is the required product and the slug is waste (scrap).



-> The difference between Blanking & punching is that in blanking, the blank is the useful product and leftout strip is waste. In punching, the blank (or slug) is the waste product and the punched sheet in which the hole has been made is useful product.

Piercing:-

-) Piercing is a punching operation. However piercing is a distinct hole making process characterized by lack of ~~sco~~ scrap from the hole.

-) In piercing, a pointed, bullet shaped punch is forced through the sheet metal to produce a hole with a rough flange around the hole.

Trimming:-

-) During any ~~process~~ press working operation, in which the part must be held in place by the press, the outer edge of the part, becomes marked and scored.

Trimming is the cutting off of this excess metal edge.

-) Trimming dies are similar to blanking dies.

-) Trimming may be performed horizonentally or vertically, depending upon the configuration of the part.

List of various types of die & Punch:-

1) simple operation Dies.
2) compound Dies.
3) combination Dies.
4) Progressive Dies.
5) ~~Tra~~ Transfer Dies.
6) Forming Dies.

1) Single operation Dies:-

-> A single operation die are used when there are only piercing or simple trimming and cutting operations.

A simple forming die might also be considered a single operation die.

-> A single operation die may be a

i) Blanking Die, ii) piercing die

iii) shaping dies such as Bending die, curling die, waiving die and bulging die.

-> Both Blanking and piercing are used in cutting operation.

2) compound die:-

-> compound dies perform two or more operations (at one time) in a single stage and assure the greatest accuracy of the product.

-> A compound dies does only cutting operations, like Blanking and punching.

-> compound dies make close tolerance and concentric parts, as all work is done in one stroke.

3) Progressive Die:-

-> A progressive die is multiple station die.

-> It performs a number of sheet metal operations at two or more stations during each stroke of the press.

-> A progressive die can perform very complex work, doing piercing, blanking, forming, lancing and notching.

Jigs And Fixtures

-> Jigs and Fixtures are production tools used to hole components rigid and prevent movement during working.

-> Jigs and Fixtures are designed and build to perform a manufacturing operation ~~location, to perform a~~ (drilling & tapping & reaming) on the workpiece.

-> Jigs and Fixtures are precision tools. They are expensive to produce because they are made from materials with good resistance to wear.

Jigs :-

-> Jig is a work holding device that holds, supports and locates the workpiece and guides the one or more tools to perform specific operation (drilling, tapping and reaming).

-> In the otherwards, Jigs are defined as used to holding the tools and guiding the cutting tool.

-> Jigs are usually fitted with hardened steel bushings for guiding drills ~~for~~ making holes at the desired positions in the workpiece.

Fixture :-

-> Fixture is the work holding device, which holds, supports and locates the workpiece but not guides the cutting tool to perform a specific operation.

→ In other words, the fixtures are only work holding device that holds, supports and locates the workpiece in desired position to perform any operation.

→ Fixtures are used in multi-dimensional machining like milling, grinding, turning, etc.

→ Fixtures are heavy in weight have simple design.

But Jigs are light weight and has complex shape.

→ Fixtures are having specific tool that use particularly in the milling machine, shapers and slotting machines.

→ Fixtures are fixed to the machine tables, but Jigs are not fixed to the machine table.

Advantages of using Jigs and Fixtures:-

i) Manufacturing costs are reduced when large number of identical parts are produced using Jigs and fixtures.

ii) Jigs and fixtures eliminate marking out of the workpiece before machining, thereby reducing the production time.

iii) Since workpiece is automatically located in the right position and the tool is guided;
   a) Machining accuracy is improved.
   b) semiskilled worker can be employed.

iv) Production work is rapid.

v) productivity is improved.

vi) High power machines can be used at higher speeds, feeds and depth of cut.

vii) quality of the component points improved.

List various types of Jigs and Fixture :-

-> Jigs are classfied as.

i) Tamplate Jig.
ii) Plate Jig.
iii) Sand which Jig.
iv) Angle plate Jig.
v) Box Jig.
vi) ~~can~~ channel Jig.

-> Types of Fixtures :-

i) welding Fixture.
ii) Milling Fixture.
iii) Braching Fixture.
iv) Tapping Fixture.
v) Profiling Fixture.
vi) Duplex Fixture.

3-2-1 Principle of Location and in Jigs And Fixture

-> It is also known as a six pin ~~Point~~ or six point location principle.

-> In this, the three adjecent locating surface of the blank (work piece) are resting against 3, 2, and 1 pin respectively, which prevent 9 degrees of freedom.

-> The rest three degrees of freedom are arrested by three external forces usually provided by clamping.

3-2-1 Principle Statement :-

-> The 3-2-1 principle states that the six locations are sufficient to restrict the required degree of freedom of any workpiece.

-> In this, the motion is restricted using clamps and locators.

-> A three-pin base can restrict five motions and six pins restrict nine motions.

Methodology of 3-2-1 Principle:-

-> The workpiece is resting on three points A, B, C which are inserted in the base of the fixed body.

-> The workpiece cannot rotate about the XX and XY and also cannot move downward.

-> In this way, the five degrees of freedom 1, 2, 3, 4 & 5 have been arrested.

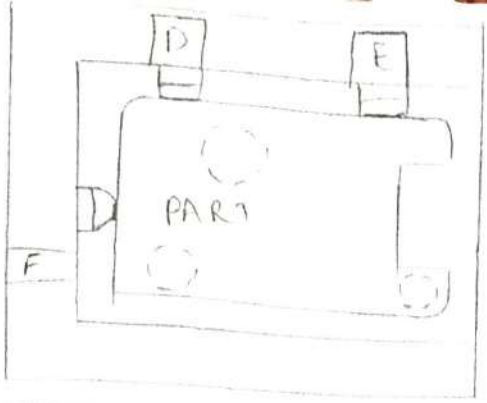
-> Two pins D & E are inserted in the fixed body. in a plane perpendicular to the plane containing point A, B, C.

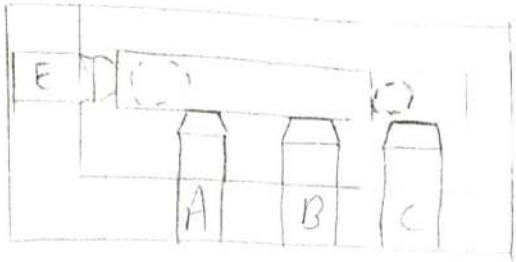
-> Now the workpiece cannot rotate about z-axis and also it cannot move towards the left.

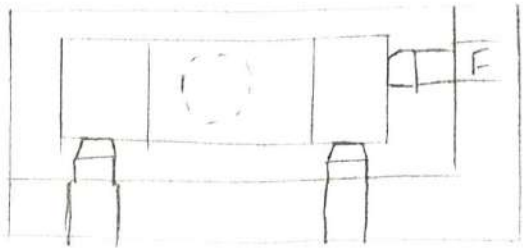
-> Hence the addition of pins D & E restricts three more degree of freedom, namely 6, 7 & 8.

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

The above method of Locating a workpiece in a Fixture is called 3-2-1 Principle.







Summery of 3-2-1 principle:-

A workpiece will be completely confined when blanked against.

i) 3 points in one plane:-

The "3" in 3-2-1 refers to 3 locator on the primary locating surface.

ii) 2 points in another plane:-

The "2" in 3-2-1 refers to 2 locators on the secondary locating surface

iii) 1 points in a third plane:-

The "1" in 3-2-1 refers to 1 locator on tertiary locating surface.

Types of Locator:-

Types of Locators used in Jig and Fixture for supporting are,

1) Flat locator
2) cylindrical locator
3) conical locator
4) Jackpin locator
5) Drill bush locator

Powder metallurgy

(i) Powder metallurgy is an art and science of producing fine metal powders and then making objects from individual, mixed or alloyed metal powders with or without the inclusion of non-metalic constituents.

(ii) Componets are produced in their final form by pressing metal powders into the desired shape usually in a metal mold and then heating the compacted powder.

(iii) For making a compound by powder metallurgy,

a) The metal in the powder form must be able to respond to solid phase welding.

b) The metal powder must be capable of sufficiently close packing under pressure to permit welding to take place and be capable of being sufficiently mixed.

Application :-

(i) Porous products, eg- bearing & filters.

(ii) Refractory parts, eg - Components made out of Tungsten, Tantalum and molybdenum and used in electric bulbs, radio valves

(iii) Toothed components such as gears.

(iv) Automobile components such as electrical contants, crankshaft drive or camshaft, sprocket, gears.

(v) products made from Tungsten carbide. compounts such as gauges, wire drawing, wire guids, stamping & blanking toal. (die)

(vi) use as parts in military and defence. eg- in military.

Advantages of powder metallurgy :-

(i) The powder metallurgy products have dimensional accuracy and good surface finish.

(ii) cleaner and quieter operation and longer life of the components.

(iii) High production rates.

(iv) Control of grain size, relatively much uniform, structure and, defects free components.

(v) No material is wasted as scrap, the process makes use of 100% raw materials

(vi) ~~Components shapes obtained possess excellent reproducing~~

(vii) Porrous parts can be produced.

(viii) Highly qualified or skilled labour is not required.

Powder metallurgy Process :-

1⇒ ~~obtaining~~ / producing metal powders in a suitable degree of fineness and purity.

2⇒ weighing and mixing of the necessary powders.

3⇒ Pressing the powder in a suitable mold to cause cohesion to occur between the powder particles.

4⇒ Presintering the ~~powder compact~~ Compact powder by heating and holding it at a moderate temp.

Presintering develops additional green ~~structure~~ strength and drives off mixing lubricants & maistune.

5⇒ sintering the compacted mass at a temperature. High enough to cause diffusion and integranular crystal growth to occur.

6⇒ finishing and sizing the final product.

Presintering And sintering :-

(i) Powder metallurgy is used to make parts from materials that are very difficult to machine. when some machining is required on such parts, one goes for presintering before the actual sintering operation.

(ii) After presintering the compacted parts are heated for a short time at a temperature considerably below the final sintering temperature.