LECTURE NOTES

ON

PRODUCTION TECHNOLOGY

3rd SEMESTER MECHANICAL

BY

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Metal Forming process 22/09/2020

Extrusion

→ Extrusion is metal working process that produces continious length of uniform, non-uniform, cross sectional area from a hot metal billet, it may be solid or hollow.

→ The hot metal billet is flow under high pressure that applied at the Ram through a restricted opening called as die.

→ The die is designed according to the product requirment.

→ Extrusion is basically a hot working process which is suitable for tube lite structure manufacturing.

→ An extrusion process has 3 main componeats

1) Container
2) Die
3) Ram

→ A heated cylindrical billet is placed inside the container and forced through a steel die by a ram or a plunger.

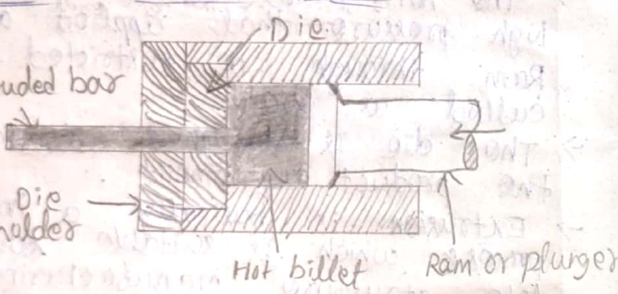
Ex - A tooth paste is coming out of the small front opening of the tooth paste tube.

Application -

Extrusion process is used to manufacture
1. Rods
2. Tubes
3. A veriety of square, circular, hexagonal, rectangular & other shaps both in solid and hollow form.

Method of extrusion

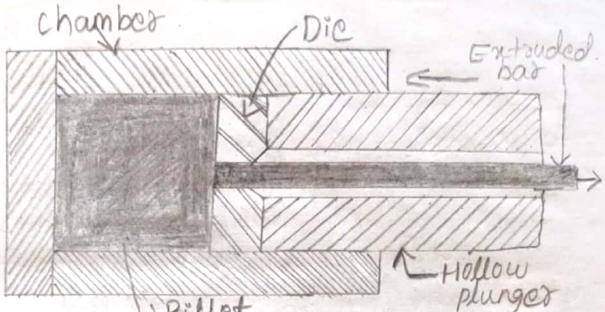
1) Direct extrusion process -



Direct Extrusion

1. In this process the flow of metal through the die is in the same direction of the movement of the ram.
2. In this process the ram which is used is solid.
3. The hot billet is placed inside the container that has a die at one end.
4. Ram forces the hot billet through the die opening that produces the extruded ~~product~~ product.
5. The length of the extruded part will depend upon the size of the billet and the cross section of the die.
6. The extruded part is then cut into the required length.

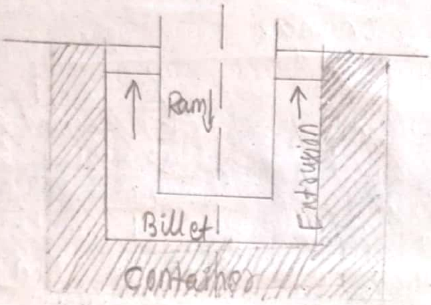
2) Indirect extrusion process -



Backward or indirect extrusion

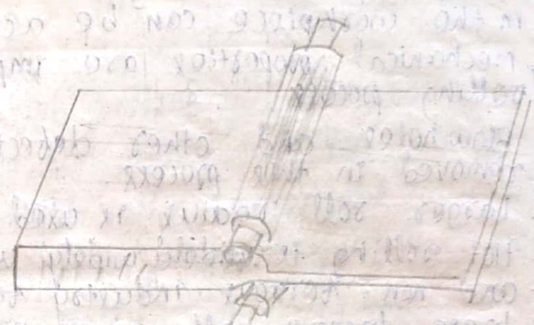
1. In this process the ram which is used is hollow and the die is mounted over the bore of the ram.
2. The metal flows in the opposite direction of the ram.
3. In this process the billet remain stationary while the die is pushed into the billet by hollow ram through which the extrusion process takes place.
4. Indirect extrusion process does not require much force as compared to direct extrusion process ~~bea~~ because no force is required to move the billet through the container.
5. The length of the billet in this process is limited by the column length of the ram as there is no relative motion of the billet inside the chamber wall.

3) Backward Extrusion -



1. In indirect & backward extrusion the process of extrusion are same.
2. In direct & indirect extrusion ram is of the same diameter as the bore of the container where as in backward extrusion process the ram is smaller in diameter than the container and the metal flows through the opening formed by ram and the container.
3. Direct, indirect and back ward extrusion process normally use a heated billet for the extrusion process and hence the process is known as hot extrusion process.
4. The back ward extrusion process which uses a cold billet and carried out a higher velocity is known as cold extrusion process / impact extrusion.

Rolling process -



1. Rolling is a process by passing the metal between the two rolls inorder to reduce the size.
2. After each pass the rolls brought closer together and the metal is fed between the two rolls until the required reduction in size is achieved.
3. The larger ~~direction~~ diameter metal that is used in the rolling process is known as "ingot".
4. When the size of the ingot reduced it changes into bloom and further reduction in size changes it into billet.
5. The billet is finally used for the rolling process.

Hot Rolling process -

1. In this process the metal is fed to the rolls after being heated above the recrystalization temperature.
2. Coefficient of friction between the rolls and the metal is higher. It may ever cause shearing of the metal in contact

with the rolls.

3. In this process heavy reduction of area in the workpiece can be achieved.
4. Mechanical properties are imposed in hot rolling process.
5. Blow holes and other defects can be removed in this process.
6. Larger roll radius is used in this process.
7. Hot rolling is ~~wideld~~ widely used in ferrous and non-ferrous industry for steel, brass, bronze, alluminium, nickel and zinc alloys to change ingot into sheets, slabs, bars, wires and other shapes.
8. Very thin section can't be obtained by hot rolling process. Thickness upto 1.5mm can be hot rolled into sheets.
9. close tolerance on dimensions cannot be achived.

Cold Rolling process -

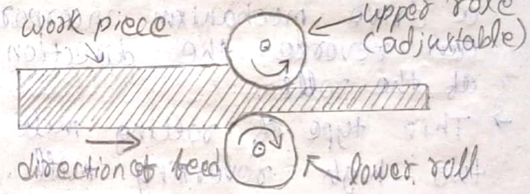
1) In this process the metal is fed between the rolls below the recrystallization temp.
2) co-efficient of friction between the metal and the rolls is comparatively lower.
3) The rolls radius used in the cold rolling process is smaller.
4) Hardness increased but it generates cracks.
5) cold rolling process increases yield strength & tensile strength in steel.
6) very thin section such as aluminium foil upto 0.02 mm can be made.
7) close tolerance can be achieved in the cold rolling process.
8) cold rolling is equally applicable to plain and alloy steel and non-ferrous metals and their alloys.

Rolling Mills -

Rolling mills can be clasified into following types

1. Two-high rolling mills (hot rolling process)
2. Three-high rolling mills (hot rolling process)
3. Four-high rolling mills (cold rolling process)
4. Tandem rolling mill (cold rolling process)
5. cluster rolling mills (cold rolling process)

1. Two-high Rolling mill -



~~→ It consist of three horizontal rolls positioned directly one over the other.~~
~~→ The upper roll & lower roll~~

→ A two high rolling mill may further be classified as a reversing mills and a non-reversing mill.

→ A two-high rolling mill has two heavy rolls placed one above the other. (In a two-high reversing mills the rolls first in one direction and then in other direction so that the rolled metal may pass back.)

→ The rolls are supported on bearings which are housed in the stands.

→ The space between the rolls can be adjusted by raising or lowering the upper roll.

→ The position of the lower roll is fixed.

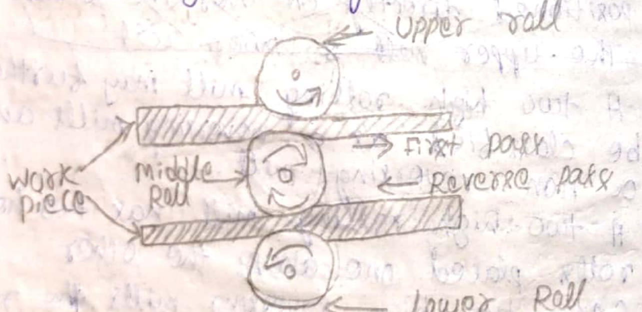
→ Both the rolls rotate in opposite direction to each other. The direction of rotation is fixed and cannot be reversed.

→ Therefore the work can be rolled by feeding from one direction only. (for non-reversing mill)

→ In another type two high rolling mill a drive mechanism incorporates that can reverse the direction of the rotation of the rolls. (for reversing mill)

→ This type of rolling mill is known as two-high reversing mill.

2) Three-high rolling mills -



→ It consist of three horizontal roll positioned directly one over the other.

→ The upper roll & lower roll are same but the intermediate roll rotates in a direction opposite to both the rolls.

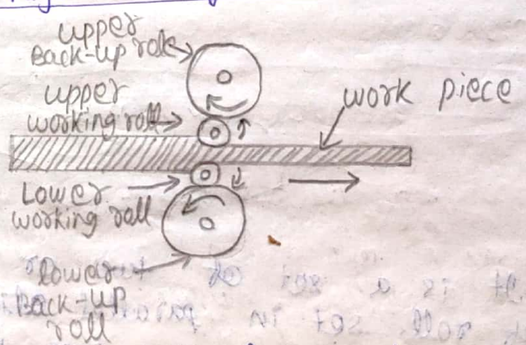
→ All the three rolls continously in the same fixed direction and are never reversed.

→ The work piece is fed in one direction between the upper roll and middle roll, & in reverse direction between the middle and the lower roll.

→ For this reason many work pieces is simultaneously fed in between the rolls which results in a higher production rate.

→ A three-high rolling mill can be used for bloom rolling, billet rolling and finished rolling.

3) Four-high rolling mill -



→ It has a roll stand with four parallel rolls one above the other.

→ The top and bottom rolls are rotating in opposite direction to each other. So as the two middle rolls.

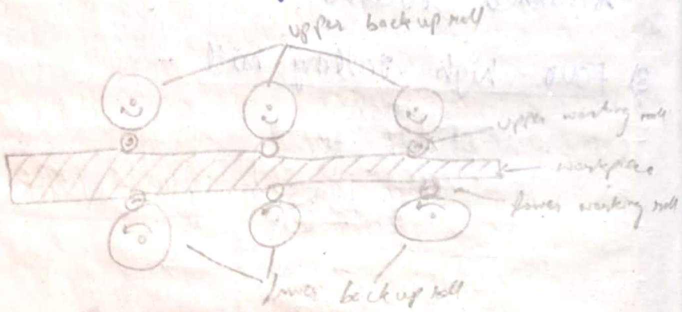
~~→ The two middle rolls are known as back up rolls. and they provide support to the two~~

→ The two middle rolls are known as working rolls and the work piece is fed between them.

→ The top and bottom rolls are known as back up rolls. and they provide support to the two working rolls in order to avoid plates and sheets thicker at the centre position that at the outer edge.

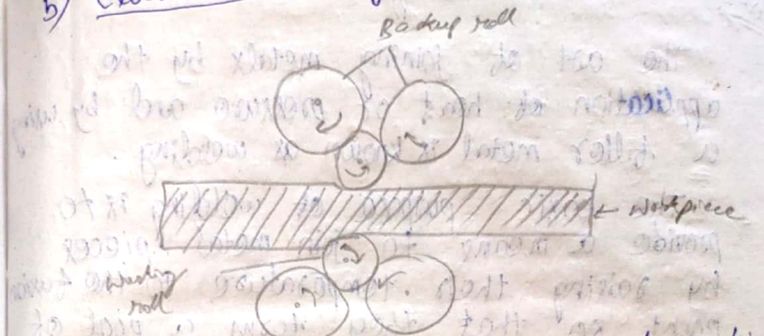
→ A four-high rolling mill is used for hot rolling of armour and cold rolling of sheets and plates.

4) Tandem - rolling mill -



→ It is a set of two or three stands of roll set in parallel alignment. So that a continious pass may be made through each one successively without changing the direction of the material pause in rolling process.

5) Cluster rolling mill -



→ It is a special type of four-high rolling mill in which the two working rolls are supported by two or more back up rolls.

→ For rolling hard thin material there is a need of small diameter rolls.

→ In order to provide adequate support to the working rolls we can omplay a cluster mill.

Ch-2

Welding

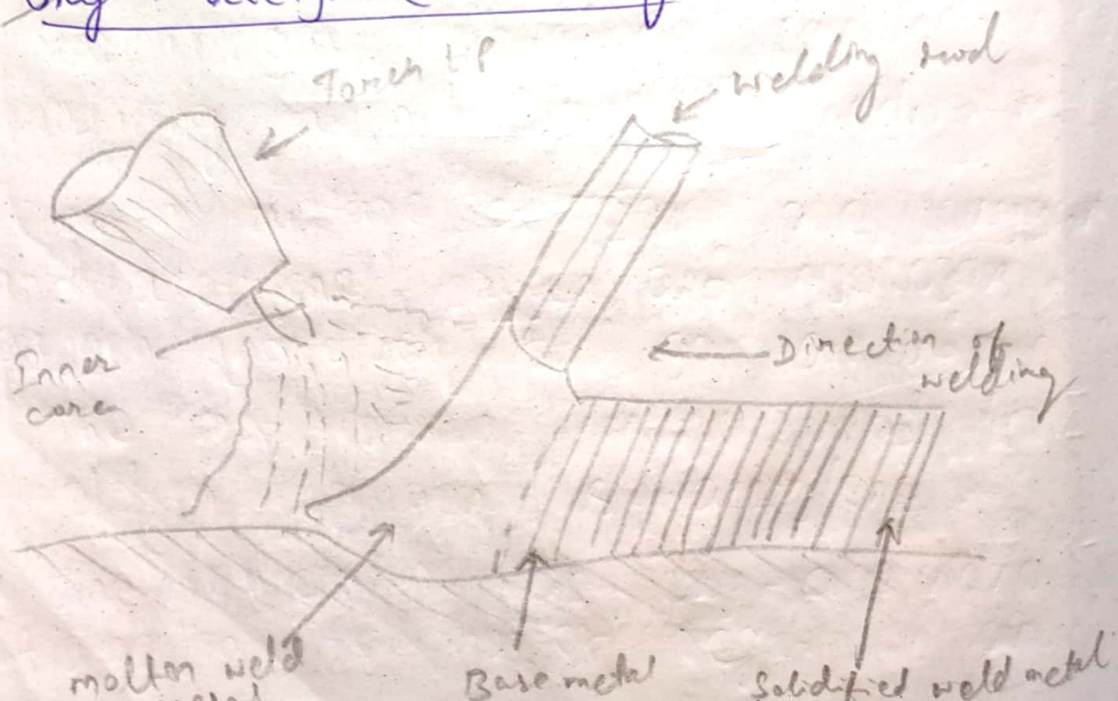
The art of joining metals by the application of heat or pressure and by using a filler metal is known as welding.

The basic purpose of welding is to provide a means to join metal pieces by raising their temperature to the fusion point so that they form a pool of molten metal at the ends to be joined.

In addition to that a filler metal which is nearly the same composition of the parent metal is allowed to heat at the end of the joint to form a homogeneous mixture and the ends got joined which is called as a weld.

classification of welding process -

oxy - acetylene welding -



oxy - acetylene welding diagram

Scanned with CamScanner

→ oxy - acetylene gas welding is done by melting the edges or surface to be joined by gas flame and allowing the molten metal to flow together which will form the continious joint upon cooling.

→ This process is particularly suitable for joining metal sheets and plates having thickness of 2 to 50 mm

→ Metal having thickness more than 15mm requires an additional metal called as filler rod which is added to the welding process in form of welding rod.

→ composition of the filler rod is usually same or nearly same as that of the part of being welded.

→ To remove the impurities and oxides present on the surface of metal to be joined a flux is always employed during welded.

→ various gas combinations can be used for producing a hot flame for welding metals.

→ common mixture of gases are oxygen and acetylene, oxygen and hydrogen, oxygen and other fuel gas, air and acetylene.

→ The most common mixture used for welding oxygen & acetylene.

→ The temperature of oxy-acetylene flame in its hottest region is about 3200°C.

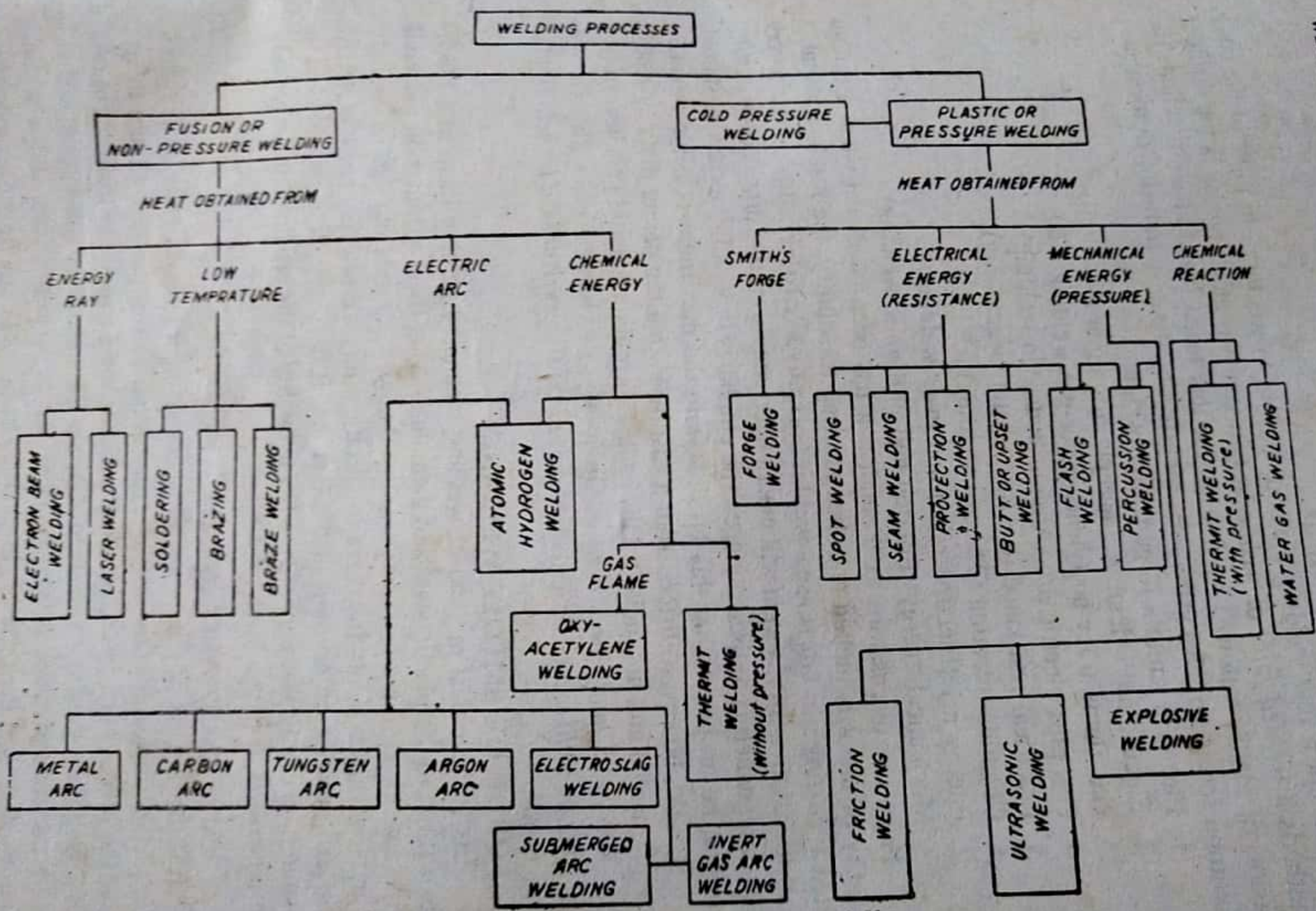
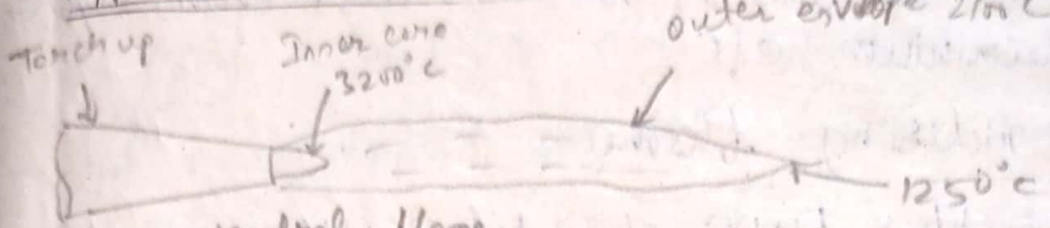
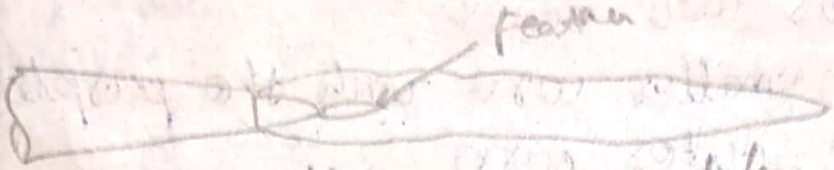


Table 24.1. Classification of Common Welding Processes

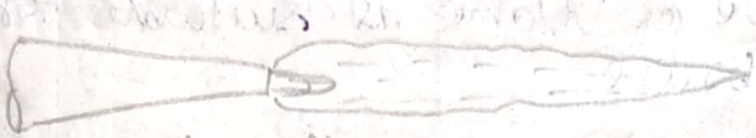
Types of flames



Neutral flame



Carburising flame (excess acetylene results temp 2000°c to 2700°c)



oxidising flame (excess oxygen results high temp upto 3400°c)

1. Neutral flame :-

-> In a neutral flame has a equal mixture of oxygen & acetylene.

-> The maximum temp of ~~net~~ neutral flame is 3200°c.

-> It has two definite zones

i) A short sharp core near the tip of the torch.

ii) The outer core which is of a bluish colour.

-> The first one develops heat & the second one protect the molten metal from oxidation because the oxygen in the surrounding atmosphere is consumed by the gases from the flame.

-> This flame is widely used for welding steel, stainless steel, cast iron, copper, aluminium etc.

2 Oxidising flame

-> In this type of flame the quantity of oxygen is more than acetylene.

-> It has two zones

i) the smaller core with the purplish

& ii) the outer core

-> In the case of oxidising flame the inner zone is not exactly define as in case of a neutral flame.

-> This type of flame is suitable for welding brass.

3. Carburising flame

-> In this flame the content of acetylene is more

-> The flame has 3 zones.

(i) The sharply define inner core

ii) The intermediate core is whitish colour

iii) The bluish outer core

-> The length of the intermediate core is an indication of the position of excess acetylene

-> This type of flame is suitable used to weld steel.

Fluxes used in welding process

-> Except for common ~~grade of~~ mild steel, a flux is commonly used for succesful welding of different metal & alloys.

-> The blux should be lighter in weight as compare to the molten metal so that it may float on the top of the metal surface

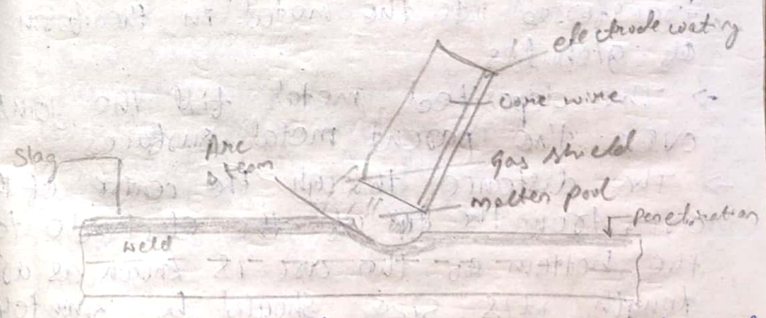
-> It may deposit on the upper surface of the solify metal after cooling & can be removed by chipping

-> It should be stored in a dry place should'n't be allowed to mix with other place

-> Boron and sodium carbonate are good fluxes for ferrous metals

-> The fluxes should'n't be allowed to remain on the finished weld as there presence will lead to a quick corrosion of the joint, which may result in its failure. Therefore it should be cleaned well soon after the welding is finished

Arc: Welding process



-> The arc welding process is extensively exployed welding technique for the joining of different metals.

-> The principle of arc welding is to establish a arc betn the electrode & the work piece.

-> The source of heat is an electric arc
-> The arc is generated betn an anode which is a DC power supply is a +ve pole and a cathode (-ve) which is the workpiece serve as negative pole
-> When these two conductors of an electric circuit are brought together and separated for a small distance from 2mm to 4mm the arc is created.
-> Heat is generated as the ions strikes the cathode
-> The temp at the centre of the arc is in the range of 6000°C to 7000°C. However the temp of the arc depends upon the types of electrodes used.
-> The heat of the arc raises the temp of the parent metal which is melted forming a pool of molten metal
-> The electrode is also melted and is transferred into the metal in the form of globules
-> The deposited metal fill the joint over the parent metal surfaces
-> The distance through the centre of the arc, from the tip of the electrode to the bottom of the arc is known as arc length it's size should be 3mm to 4mm

Arc welding Equipments

The most com used equipments for arc welding consists of the following
1. AC or DC machine
2. Electrode
3. Electrode holder
4. cables ; cable connector
5. cable plug
6. chipping hammer
7. Earthing clamps
8. Wire brush
9. Helmet
10. safety goggles
11. Hand gloves
12. Apron ; etc.

Arc Welding Machine -

-> Both DC and AC current are used for electric arc welding, each having its particular applications.
-> DC welding supply is usually obtained from generates driven by electric motor.
-> For AC welding supply transformers are predominatly used where electric supply is available
-> By the help of the transformer the usually supply voltage (200-400 volts) can be stepdown to a open circuit welding (50 - 90 volts)
-> Some machines have an arc booster that provides a momentary surge of current to give an arc a good start when it is struck
-> A regular arc welding machine consists of a rectangular steel box maintained on a three tyred wheels, the front wheel swivelling and steerable by means of a draw bar

Electrodes for Arc welding -

-> Both consumable & non-consumable electrodes are used for arc welding process

-> Non-consumable electrodes may be made of carbon, sulphite or tungsten which do not consume during the welding process.

-> consumable electrodes made of various metal, depending upon their purpose and chemical composition of the metals to be welded.

-> The consumable electrodes may be classified into two types

1. Bare electrodes
2. Coated electrodes

-> By using the bare electrodes, the globules of the metal from the electrode that deposited on the work piece are exposed to oxygen & nitrogen in the surrounding air which can lead to oxidation of metal.

-> coated electrodes can be very use in establishment and maintenance of the arc.

-> coated electrode can also protect the molten metal from oxygen & nitrogen in the surrounding air by creating a layer of gas around the weld structure

-> coated electrode can be ~~de~~ divided into 2 types

(i) Lightly coated electrodes with coating layer several length of mm

(ii) Heavily coated electrodes with relatives thik coated upto 1 to 3mm

Resistance Welding

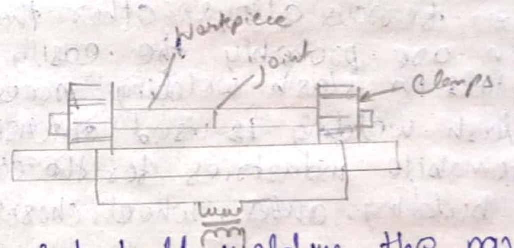
The resistance welding method can be subdivided into several welding process

1. Butt welding
2. Spot welding
3. Seam welding
4. projection welding
5. percussion welding

1. Butt welding - It can be classified into 2 types :

(i) Upset butt welding
(ii) Flash butt welding

(i) Upset Butt welding -



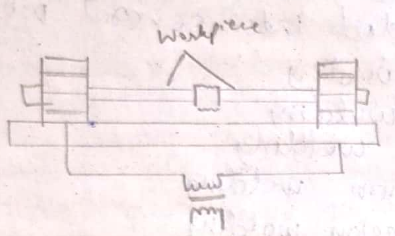
-> In upset butt welding the parts to be welded are clamped as to as by the copper joint of the welding machine and brought together in a solid contact.

-> Due to this their points of contacts forms a locality of liquid electric resistance / current. while current flows to heat the joint.

-> At this point the pressure is applied to forge the parts ~~to~~ together

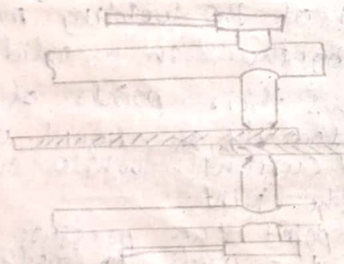
-> Upset welding is used principally on non-ferrous metals for welding brass, rods, etc.

(ii) Flash Butt Welding



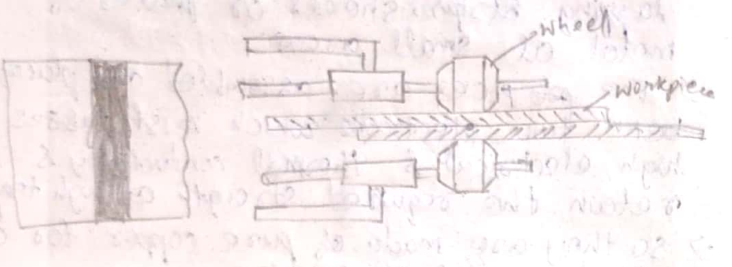
-> In flash butt welding edges are brought together in a light contact.
-> A high voltage starts a flashing action betn the two surfaces and continues as the parts advances slowly & the forging temp. is reached.
-> Many different materials like steels & other ferrous alloys other than cast iron are probably the easily welded metals in flash welding process.
-> Flash welding is used extensively in automobile industries for the construction of building, axles, wheel, chosis, frames etc.

2. Spot Welding



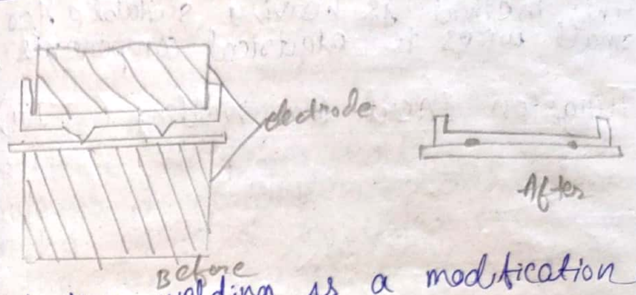
-> Spot welding is employed to join over-lapping strips, sheets or plates of metal at small areas.
-> The ~~pe~~ pices are assembled and placed betn two electrodes which must passes high electrical & thermal conductivity & retain the required strength at high temp.
-> So they are made of pure copper for a limited amount of service.
-> Alloys of copper or tungsten, copper or chromium can be used for continious working process.
-> When the current is turned on, the pieces are heated at their ~~areas~~ areas of contact to a welding temp & by the application of mechanical pressure the electrodes are forced against to the metal to be welded.
-> The pressure may be developed by the foot lever or by air pressure or by hydraulic cylinder.
-> This process is suitable to weld steel & other metals upto a thickness of 12mm.
-> Pratically ductile metals and alloys can be spot welded.
-> This process can be used for fabricating fabrication of mechanical structures, can be applied to all types of boxes, canes & enclosing cases, etc.

3. Seam Welding



-> Seam welding is a method of making a continuous joint betn two overlapping pieces of sheet metal
-> The normal procedure for making a seam weld is to place the work betn the wheels which serves as the conductor for continious weld.
-> As pressure is applied the drive is started the welding current is switched on.
-> Then at the same time the overlapping surfaces of the metal are forced together as fast as they are heated.
-> A coolant is applied to cool the work repidly to speed up the operation.
-> All the metals which are spot welded can be seam welded.
-> steel plates upto thickness 10mm can be seam welded.
-> seam welding can be used for pressure tight or leak proof tanks.

4. projection Welding



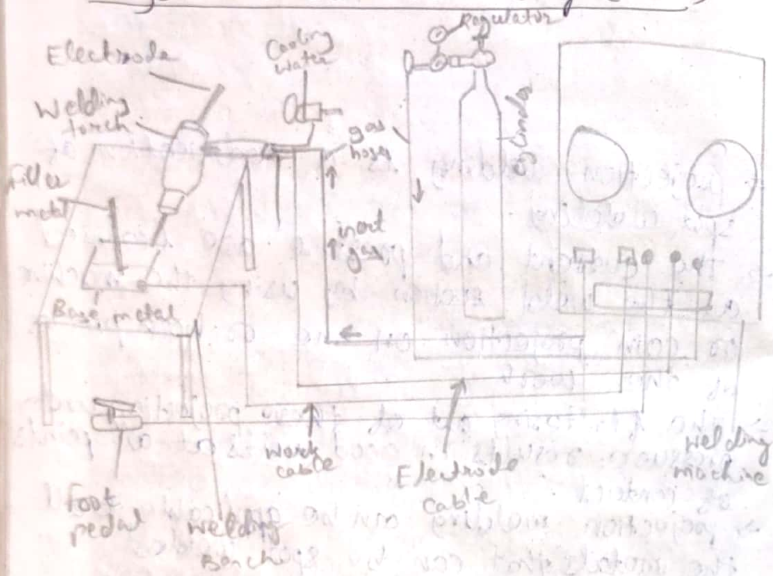
-> projection welding is a modification of spot welding.
-> The current and pressure are localised at the weld section by using the machine or coin projection on one or both pieces of the work.
-> The flattering out of these projection under pressure results in good welds at all points of contact.
-> projection welding can be applicable to all the metals that can be spot welded

5. percussion Welding

-> The operation is performed with one part held in a stationary holder & the other in a clamp mounted on a slide which is backed up against pressure from a heavy spring.
-> In the operation the moveable clamp is released repidly carrying the part foreward
-> When the two parts are approximately 1.5 mm apart a sudden discharge of electric energy is released causing an intense are betn the two surfaces.
-> This process takes about 0.1 sec to accomplish the operation.

-> This method is very fast & can handle dis-similar metals.
-> This method is highly suitable for welding small wires to electrical components.

Tungsten Inert Gas Welding (TIG)



-> It is a basically an arc welding process in which an arc is struct between the non-consumable and the 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 inert gasses to provide a protective shield around the arc.
-> This gasses shield protects the electrode, molten metal & the base metal from atmospheric contamination.
-> This electrode holder also carries a provision for water cooling or air cooling.
-> This process is capable of producing continious intermitent or spot welds.
-> Due to non-consumable nature of the electrode no filler metal is needed. However it needed additional filler metal can be provided by using the filler rod in the same way as in the case of arc welding process.
-> Thin metal foils upto a minimum thickness of 0.125 mm can be easily welded with this process.
-> It is suitable for welding most of the metals and alloys ~~expe~~ except lead and zinc.
-> Magnesium alloys, aluminium alloys, nickle, zirconium alloys, titanium alloys, berilium carbon steel, stainless steel alloys can be applicable for TIG welding.

TIG Welding equipments -

The following equipments are required in TIG welding process

i) An inert gas cylinder
ii) An inert gas regulator & flow meter
iii) Inert gas hoses & hose connection
iv) An inert gas shut off values
v) An arc welding machine
vi) Welding cables for electrodes & ground conections
vii) A welding bench
viii) Electrode holder
ix) Tungsten electrode

-> In most of the cases the inert gas, welding cables for electrode & water, hoses are all enclosed in a common jacket to form what looks like a single cable.

-> Welding current both AC & DC are used in TIG Welding.

Welding Procedure -

-> Before starting welding the joint should be throughly clean to remove dirt grease oil etc from the work surface.

-> Edges of thicker section should be bevelled & lighter gauze metal should be provided with suitable boxing.

-> The workpiece should be firmly held in a suitable fixture.

-> Select a suitable electrode size hold it firmly in the holder, set the current & proper polarity with DC supply.

-> Turn on the cooling water & air cooling supply.

-> Turn on the gas & adjust the flow meter & then switch on the power supply.

-> After striking the air make so small puddle of molten metal at the place where the welding is to be connected commenced ~~& the filler if needed as 15-20 with the work piece~~

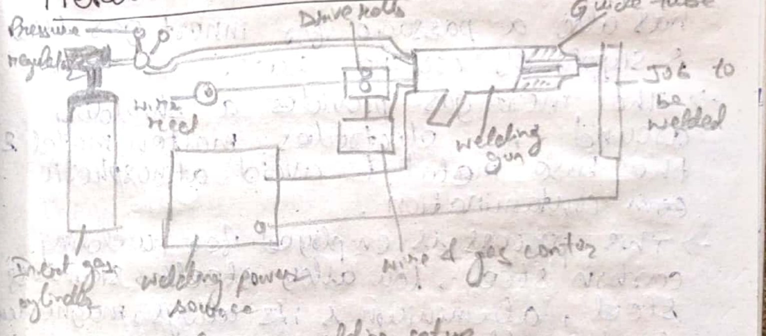
~~-> Then the welding may be proceeded in the same way as in oxyacetylene~~

-> welding The electrode should be held at an angle 60°-80° with the work piece & the filler if needed as 15-20° with the work piece.

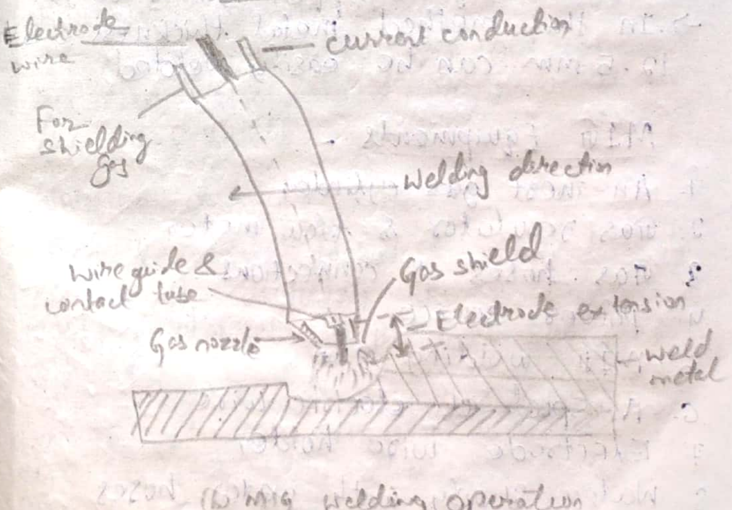
-> Then the welding may be proceed in the same way as in oxyacetylene welding.

-> After the desired length has been welded the order to break the arc & the current flow is switched off however the inert gas flow should be continued till the electrode cools down.

Metal Inert Gas Welding (MIG)



(a) MIG welding setup



(b) MIG welding operation

-> In this process the arc is struck between the metal electrodes & the work piece.

-> The metal electrode, which is used is a consumable one.

-> The electrode is in the form of a continious wire which is fed into the arc by one adjustable speed electric motor.

-> A special designed electric holder which has also a passage for innert gas flow & supply of cooling water.

-> The inert gas provides a shielding around the electrodes molten metal & the base metal to avoid atmospheric ~~com~~ contamination.

-> This process is employed for welding carbon steel, low alloy steels, stainless steel, aluminium & its alloys, magnesium & it's alloys, copper & it's alloys.

-> In this method metal thickness 0.5 to 12.5 mm can be easily welded.

MIG Equipments -

1. An inert gas cylinder
2. Gas regulator & flow meter
3. Gas hoses & connections.
4. power source
5. MIG welding gun
6. A spool of electric wire
7. Electrode wire holder
8. Water supply with water hoses

-> DC with reverse polarity is used in MIG welding method. AC is never used in this method, & even DC with straight polarity is not often used.

-> DC with straight polarity is only used sometimes when a very small pentration is required.

-> Inertgases like argon, He, CO_2 or a mixture of these gases can be used inthis process.

Advantages of MIG Welding -

-> Deeper penetration is possible
-> Welds is produced are of better quality
-> There is no slag formation.
-> more suitable for welding thin sheets

Disadvantages of MIG Welding

-> Equipment used is costlier & lessp portable
-> It is less suitable for out door work because strong wind may blow away the gas shield.

Welding defects -

-> Due to some technical errors or fault-nature of welding, these may be some welding defects appear in the weld structure.

-> Since of these defects are apparent i.e. those are visible to the necked eye while the other ~~def~~ defects are concealed & can be found out by non destructive testing (NDT)

Some causes for Welding Defects -

Some common factors ~~reps~~ responsible for defects in the weld are as follows :

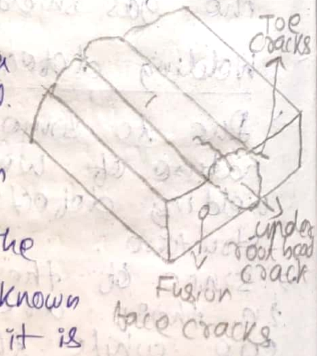
1. Lack of welding skills in operator
2. Use of poor quality welding consumables
3. Un favourable characteristics of the parent metal.
4. Faulty welding technique & procedures
5. poor cleanliness
6. Low welding temperature
7. Humid ~~att~~ atmospheric condition around the weld structure

Common Defects -

1. Inclusions -

Normally slag being lighter is expected to the float over the molten metal surface. But sometimes it is fully squeezed & a portion entrapped in the weld metal & it is known as slag inclusion.

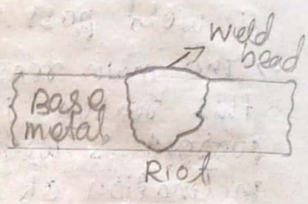
2. Cracks - A crack is a discontinuity of the metal. The discontinuity may be in the base metal or in the weld metal or at the fusion place if the crack is visible to the necked eye it ~~the~~ is known as macro crack & if it is not visible by the eye ~~seen~~ can be



identified by a microscope then it is known as a micro crack.

The crack can broke the weld structure weak & unsound & may result in the failure at the weld joint.

3. Distortion -

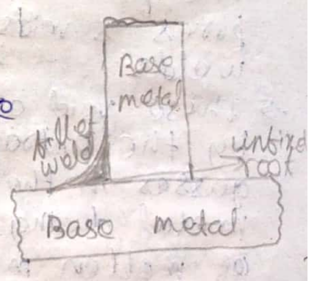


-> Distortion indicates a changes in the intended shape & size in the weld structure.

-> This happens due to uneven constraction.

-> This shrinkage or contraction happens due to uneven heating or cooling of the weld structure.

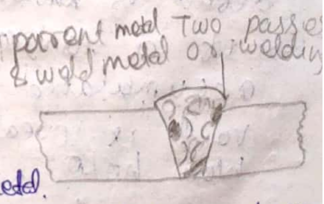
4. poor penetration -



-> It indicates the failure of the weld metal to reach the root of the joint consequently the root face don't fuse with the weld metal.

-> This defect results in a sort of permanent void along the seam, making the joint weak.

5. Inadequate Fusion -

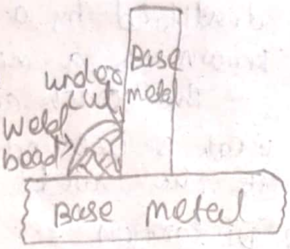


-> sometimes the deposited weld metal by the electrode dosen't fuse fully with the base metal.

-> The leads to an insufficient fusion betn the weld metal & base metal.

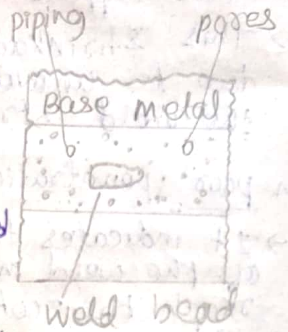
6. Under cut -

-> Undercut is a grave formed in the parent metal at the toe of a weld pass.



-> The main reason for this reason is high cussont & wrong inclination of the electrode.

7. porosity -



-> This defect is due to the presence of small pores & voids in the welds.

-> These void are created by the entrapment of gasses in the weld metal during solidification of molten metal try to evolve, creating the voids, which are the actually their pores for exits.

-> When these porous are quite small the defect is known as porosity.

-> If a larger amount of gas is accumulated at a single place, bigger void is created which is known as blow hole.

~~8. Over lapping~~

8. Over lapping -

-> Sometimes the molten metal flows over the surface of the base metal without fusing at the proper place. It is known as overlap.

-> In appearance it looks like an unitended extensions of the weld bead without fusing to the base metal.

-> The main reasons of this defact is by using the oversize electrode, vary low welding speed, too high current, too long arc, etc.

9. Spatter -

-> During welding tiny electrode metal particles are blown out of the arc which get deposited over the surface of the base metal or the weld metal.

-> These extra deposited metals over the surface are known as spatter.

-> The main reason of this defect are use of damp electrode too high current wrong composition of the flux coating.

10. Fulty profile & weld size -

-> A weld known to be have a faulty profile when it differs from the specified shape & size.

-> The main reason of this defect are lack of skill in the welder, inconsisten arc length, wrong electrode, wrong welding speed, etc.

ch-3

Casting

Introduction

-> The casting process is defined as the process in which a hot molten metal is passed into the moulding box & let it be free for solidification in order to get the desired shape of the product.

-> The moulding sand is rammed in the moulding box & the molten metal is poured having the arrangement of gate, runner & riser for pouring and checking the level of molten metal in the molding box.

-> A pattern is the main tool for the casting process.

-> A pattern is nothing but a replica or a model that will create an impression known as mould on the sand moulding.

-> When the mould is filled with molten metal and the metal is allowed for solidification, it forms a reproduction of the pattern & it is known as casting.

Types of casting

The various types of casting process are as follows

1. sand mould casting
2. Die casting
3. centrifugal casting
4. Investment casting etc.

Moulding sand - The common sources of collective foundary are rivers, seas & deserts.

All the foundary sands can be mainly grouped into two types

i) Natural sand -

Which contains sufficient amount of clay content & hence no more binder is required to add on it.

ii) silica sand -

Which don't posses the clay content & addition of a suitable binder to make them usable for foundary work

These silica sand are sometimes known as sharp sands. When they mixed with some other constituents like binder & additives then they are known as synthetic sands

Characteristics of Foundary sands.

1. Refractoriness -

It is that property of the moulding sands which enables it to withstand high temp of the moulding metal without fusing which results in a clean casting.

-> This property of the moulding sand can be enhanced by the presence of quartz content or silicon oxide (SiO_2)

2. Permeability -

-> It is also termed as porosity. It is that property of the sand which allows the gasses & steam to escape through the sand mode. When the hot molten metal is cold in mold a very large volume of gases & steam is formed due to ~~go~~ heating & if these gases are not allowed to go out they will either make the casting unsound or blast in the mould therefore this is a very important property required in a moulding sand.

3. Flowability or plasticity -

It is that property of the sand due to which it flows during ramming to all the portion of the moulding flask, packs properly around the pattern to aquire the desired shape & distribute the ramming pressure evenly to all the parts of the moulding box.

4. Adhesiveness -

It is that property of the sand due to which it is capable of adhering to the surface of the other meterial.

5. Cohessiveness -

It is that property of the sand due to which its rammed particle bind together firmly the pattern is withdraw from the mould without damaging the mould surface or edges.

6. collaspsibility -

It is that property due to which sand mould automatically collapse after the solidification of the casting to allow a free contraction of the metal.

→ If the property is absent then it will results in tears & cracks in the casting.

Terminology of Foundary sands -

Different terms are used to denote foundary sands in diff. conditions & in different uses.

1) Green sands -

It is also known as tempered sand.

→ It is a well prepared foundary sand which content just enough moisture to give it a sufficient bend.

→ Molds prepared from this sands are known as green sands mold & don't required any baking before pouring the molten metal into them.

2) Dry sand -

This term indicates that moulding sand which was originaly having excess moisture content but same has been evaporated from it by drying it in a suitable oven.

3) Facing sand -

This term is used for that ~~wh~~ sand which forms the face of the mold i.e. ~~sem~~ rammed around the pattern surface.

4) parting sand -

This term denotes that sand which is sprinkled on the pattern & the parting surface of the mold so that the sand mass of one flask doesn't stick with the other.

→ Dry silica sands are used for this purpose.

5) Floor or backing sand -

This term denotes the sand which left on the floor after the casting has been removed from the mold.

-> Again the sand collected from the floor & riddled to remove foreign materials like nails, pins etc & then again used for the casting processes.

6) Core sand -

The sand which carries a high silica content & used for making cores is known as core sand.

7) Oil sand -

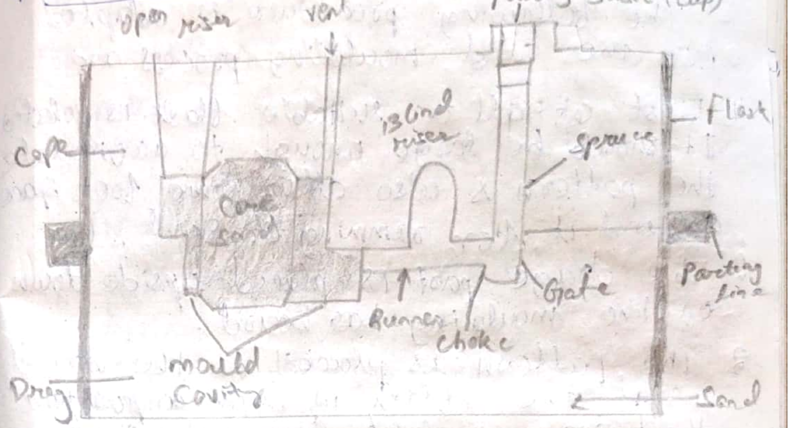
The silica sand using oil binders is known as oil sand.

8) Molasses sand -

The sand which carries mollasses as binder is known as molasses sand.

-> It is very useful for makig molds of small casting having intricate shapes.

1) Sand Moulding / sand casting -



cope - It is the upper part of the moulding flask.

Drage - It is the lower part of the moulding flask.

Runner - It is the ~~passage~~ passes through which molten metal is poured.

Gate - It is a small passes connecting the runner to the mould cavity.

parting line - It is the line along which the sands surfaces of the drage & cope meet with each other.

Riser - It is the passage through which the molten rises up after filling the mould cavity.

Moulding procedure

The following procedure is adapted for the sand moulding process are

1. First of all a suitable flask is selected. It should be large enough to accomodate the pattern & also allow some free space around it for ramming of sand.
2. The drage part is placed upside down on the moulding ~~bas~~ board.
3. The pattern is placed on the board inside the flask in such a position that space is left for gate cutting.
4. If the pattern is used in two parts, the lower part is placed in the drage.
5. If facing sand is used it is placed inside the pattern surface to a suitable depth.
6. The drage is then filled with ordinary moulding sand & rammed properly.
7. The excess sand is cut off to bring it in level with the edges of the flask.
8. A small amount of dry loose sand is sprinkled over the top surface.
9. The cope is then placed over the drage & the top part of the pattern assembled in position.
10. Runner & riser are put in positions & supported vertically by the moulding sand.
11. Then the molten metal is poured through the pouring basin in the moulding cavity is fixed & allow it for solidification.
12. Then runner & riser pins are removed & the pattern parts are then removed from the both drage & cope.
13. Repairs & dressings if needed, is then applied.

Pattern –

→ A pattern may be defined as a replica or fasimile model of the desired casting which packed in a suitable moulding material produces a cavity called mould.

→ This cavity when filled with molten metal produces the desired casting after solidification of the poured metal.

Types of pattern –

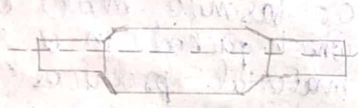
The type of pattern to be used for a particular casting depends upon many ~~dat~~ factors like the bulk of casting, types of moulding process & design of the casting etc. The following types of patterns are commonly used –

1. Solid or single piece pattern
2. Two piece or split pattern
3. Multipiece pattern
4. Match plate pattern
5. Gated pattern
6. Sekeleton pattern

7. Sweep pattern
8. pattern with loose piece
9. cope & drage pattern
10. Follow board pattern
11. segmental pattern

1) Solid or singe pi pattern

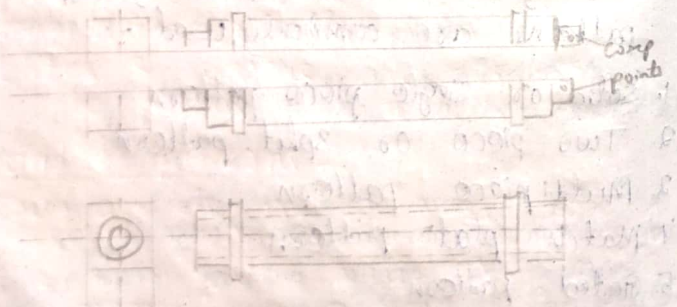
-> A single piece pattern is the simplest of all the patterns.



-> It is made up of in one piece & carries no joints.

-> This pattern is the cheapest but it's use can be done to a limited extent of production only since it's moulding involves a large no. of manual operations like gate cutting, providing to runners & risers, etc.

2) Two piece or split pattern -



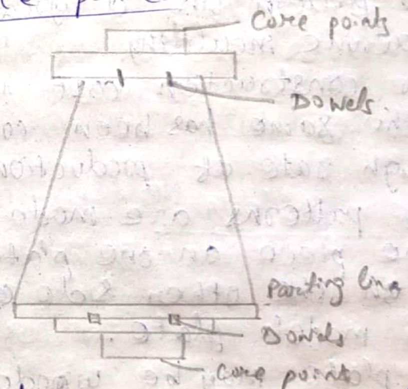
-> Many times the design of casting occurs difficulty in mould making & withdrawl of pattern, if a solid pattern is used.

-> For such casting split or two piece patterns are employed.

-> They are made in two parts which are joint at the parting line by means of dowels (connecting pins).

-> While moulding one part of the pattern is contained by the drage & the other by the cope.

3) Multipiece pattern -



-> casting having a more complicated design then the multiple pattern in more than two parts in order to fasciliate an easy moulding & withdrawl of pattern.

-> Their pattern make consists of three, four or more no. of parts depending upon their design.

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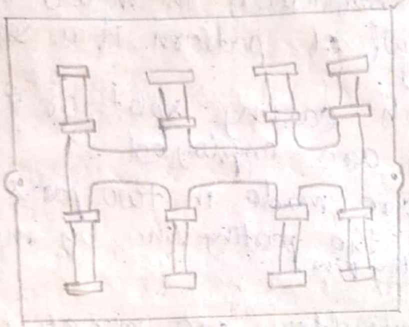
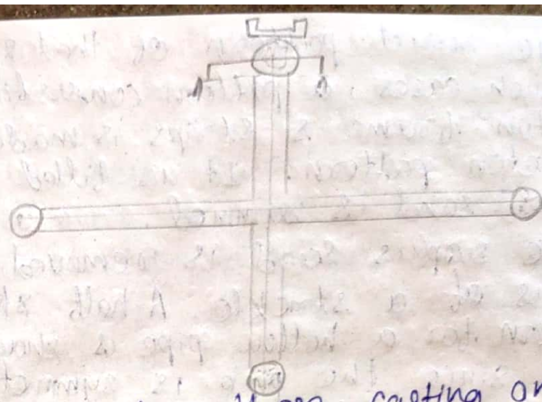
4) Match plate pattern -



-> These patterns are used when a rapid production of small & ~~acum~~ accurate casting is desired on a large scale.
-> These pattern find a great application in machine moulding.
-> Their construction cost is quite high but the same has been complanted by the high rate of production.
-> These patterns are made in two pieces i.e. one piece on one plate & the other piece on the other side of a plate called match plate.
-> The plate may be wooden, steel, magnesium or alluminium.
-> Gates & runners are also attached to the plates along with the patterns.

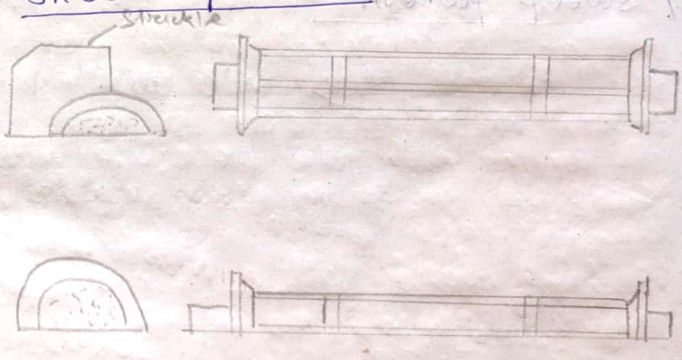
5) Gated patterns -

-> They are also used in mass production of small quantities.
-> For such casting multi cavity molds are prepared i.e. a single sand mold carries a no. of cavities.



-> patterns for these casting one connected by means of gate for filling the molten metals to these cavity.
-> A single runner may be used for filling all the cavities.
-> For small quantities these pattern can be made of cuped but for large casting metallic patterns are preferred.

6) Skeleton pattern

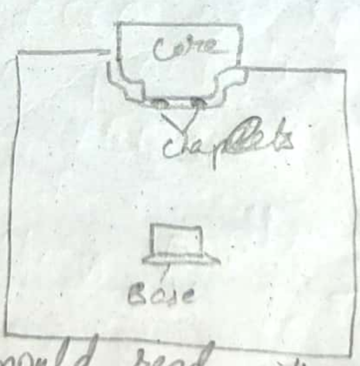


When the size of the casting is very large, but easy to shape & only a few numbers are to be made, it is in economical to make a large solid pattern of that size. In such cases, a pattern consisting of a wooden frame & strips is made called skeleton pattern. It is filled with loam sand & rammed.

The surplus sand is removed by means of a strickle. A half-skeleton pattern for a hollow pipe is shown in fig. since the pipe is symmetrical about the parting line, the same pattern will serve the purpose of moulding both the ~~hol~~ holing in two different flasks which can be prepared separately either with the help of a core box or another skeleton made for that & assembled in position in the mould.

7) Sweep pattern

a Sweep pattern in action

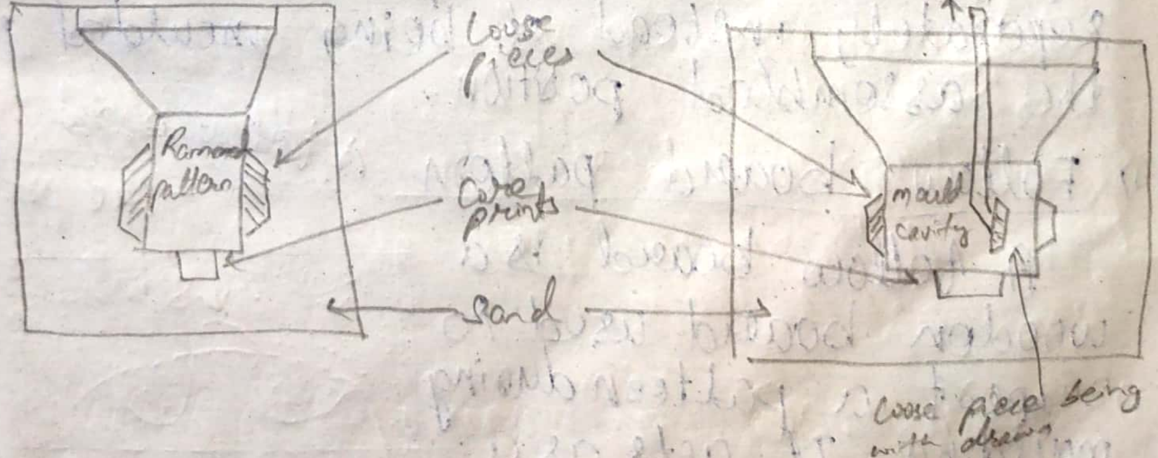


mould ready with core in position

Sweeps can be advantageously used for preparing moulds of large ~~sym~~ symmetrical castings, particularly of circular cross-section. This effects a large saving on time, labour & material. The full equipment consists of a base, suitably placed in the sand mass, a vertical spindle & a wooden template called sweep.

The outer end of the sweep carries the contour corresponding to the shape of the desired casting. The sweep is rotated about the spindle to form the ~~casting~~ cavity. Then the sweep & spindle are removed, leaving the base in the sand. The hole made by the removal of spindle is patched up by filling the sand. Separately prepared core is placed in the mould, gates cut, the mould is ready for pouring. Chaplets are employed for supporting the core.

8) pattern with loose pieces



A pattern with loose pieces being moulded

Some patterns, usually single piece are made to have loose pieces in order to enable their easy withdrawl from the mould. These pieces form an integral part of the pattern during moulding. After the mould is complete, the pattern is withdrawn leaving the pieces in the sand which are later withdrawn separately through the cavity formed by the pattern.

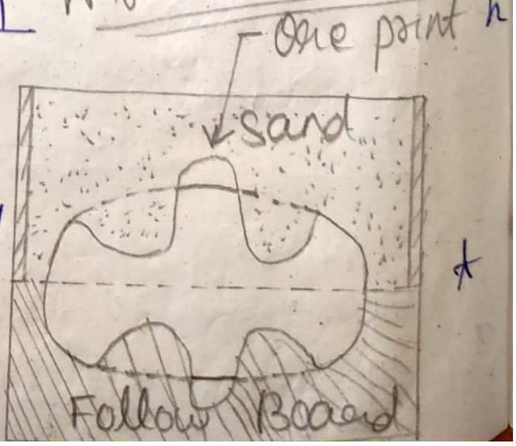
9) Cope & Drag pattern

When very large castings are to be made the complete pattern becomes too heavy to be handled by a single operator. Such a pattern is made in two parts which are separately moulded in different moulding boxes. After completion of the moulds, the two boxes are assembled to form the complete cavity, of which one part is contained by the drag & the other in cope. Thus, in a way, it is nothing but a two-piece or split pattern of which both the pieces are moulded separately instead of being moulded in the assembled position.

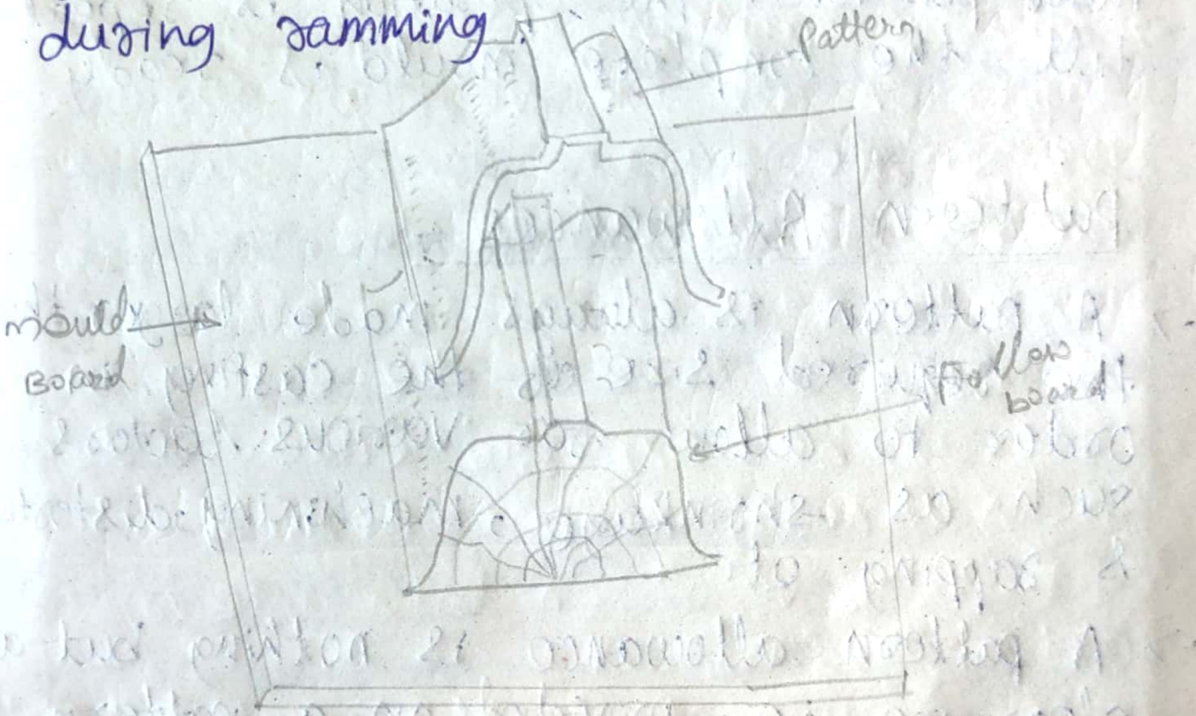
10) Follow board pattern

A follow board is a wooden board used to support a pattern during moulding. It acts as a seat for the pattern. Such single piece

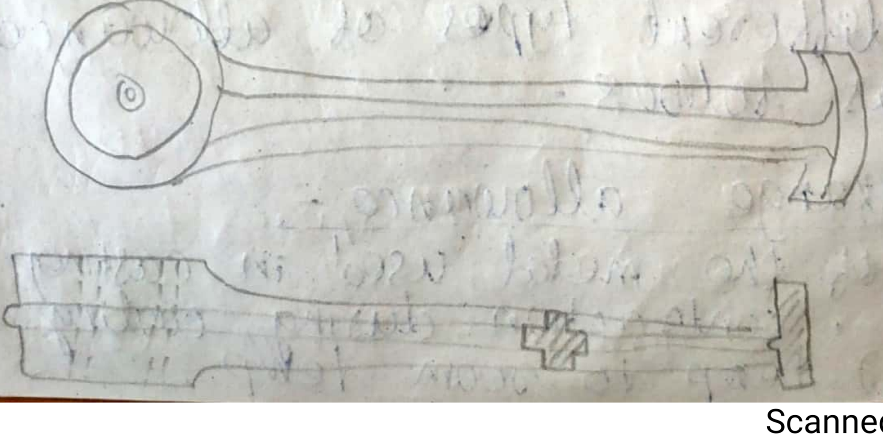
A follow board pattern



patterns, which have an add shape or very thin wall require a follow board. In the former case, the follow board is provided with a cavity corresponding to the shape of the pattern in which the pattern is seated for moulding. In the latter case, the follow-board carries a projection conforming to the inside shape of the thin-walled pattern to support it during moulding. If such a support is not provided, the pattern may sag or get broken, due to less wall thickness, during ramming.



11) Segmental pattern -



These patterns are used for preparing moulds of large circular castings, avoiding the use of a solid pattern of the exact size, In principle they work like a sweep, but the difference is that a sweep is given a continuous revolving motion to generate the desired shape, where as a segmental pattern is a portion of the solid pattern itself & the mould is prepared in parts by it. It is mounted on a ~~contra~~ central pivot & after preparing the part mould in one position, the segment is moved to the next position. The operation is repeated till the complete mould is ready.

Pattern Allowances -

-> A pattern is always made larger then the required size of the casting in order to allow for various factors such as shrinkage, machining, distortion & rapping etc.

-> A pattern allowance is nothing but a clearance i.e. provided on a pattern surface for the easy withdrawl of the desired casting.

-> The different types of allowances are as follows -

1) Shrinkange allowance -

-> Most of the metal used in casting process contraction during cooling from pouring temp to room temp.

-> This contraction takes place in three forms i.e. liquid contraction
solid contraction
& solidifying contraction

-> The first two contraction are compansated by gate & riser and the last one by providing adequate allowance in pattern.

-> The amount of contraction varies with different metals & therefore their ~~corp~~ corresponding allowance are also differ.

-> The prominent factors which influence the metal contraction are as follows

-> pouring temp of the ~~molt~~ molten metal

-> design & dimension of casting

-> Type of mould material

-> moulding method

-> The metal of which the casting is to be made.

2) Machining Allowance

-> The casting may require machining all over or a certain specified & the operation it has to perform.

-> Such a portion or surface are market dully in the working drawings.

-> The corresponding portion or surfaces on the pattern are given adequate allowance in addition to shrinkage allowance, by increasing the metal thickness to compensate the laws of the metal due to machining on those surfaces.

- The amount of allowance depends upon ~~the~~ the metal of casting, method of machining, method of casting used, size & shape of the desired casting & the degree of finish require on the machine portions.
- Ferrous metal need more allowance than the non-ferrous metal.
- The amount of allowance varies from 1.5 mm to 16mm but 3mm is commonly used for small & medium size casting.

3) Draft Allowance

- All the patterns are given a slide tapper on all the verticals surfaces i.e. the surfaces parallel to the direction of their withdrawl from the mould.
- This taper is known as draft or draft allowance.
- It can be expressed either in degrees or in linear measures (mm, cm)
- It is provided on both internal or external surfaces.
- The amount of draft in internal surface is more then on the external surfaces.
- The purpose of providing drafts is to facilitade easy withdrawl of the pattern from the mould without damaging the surface or edges of the mould.
- The amount of draft varies from ~~100mm~~ 100 nm to 25mm per meter on external surfaces & 40mm to 70mm per meter on internal surfaces.

4) Rapping or Shake Allowance -

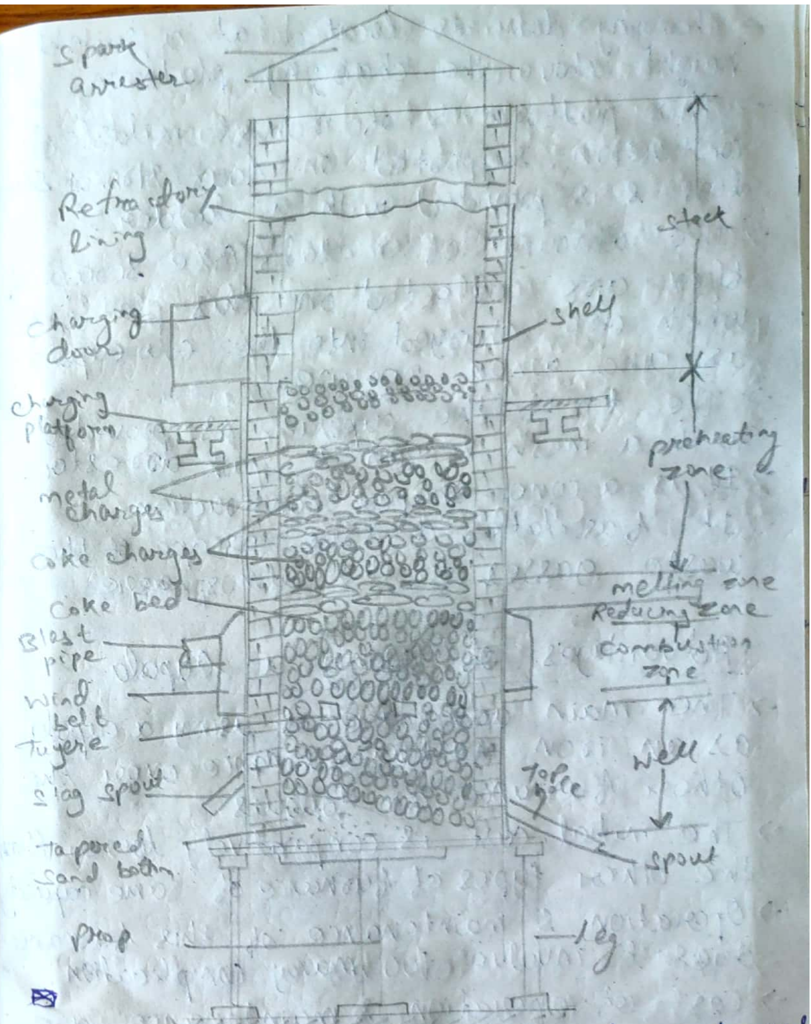
- When a pattern is to be withdrawn from the mould it is first rapped or shaken by striking over it from slide to slide, so that it's surface may be free from the adjoining sand wall of the mould.
- As a result of this the size of the moulding cavity increases a little & therefore a negative allowance is provide on the pattern to compesate the same.

5) Distortion Allowance -

- The tendency of distortion is not common in all the casting.
- Only casting which have an irregular shape & the contraction is not uniform throughout will distract on cooling by setting of thermal stresses in them.
- Such an effect can be easily seen in 'V' shaped casting.
- To eliminate this defect the distortion allowance is provided in the pattern so that the effect is neutralised & the correct casting is obtained.

Cupola Furnance

-> For melting of cast iron in foundary the coupola furnance is used.
-> On construction wise it is hollow vertical cylinder made of strong mild steel plates & reveted or welded at the seams.
-> In large cupola the lower portion is made of comparatively thicker plates so as to make of strong enough to hold the upper structure & fine brick line. Thus the stress in the whole structure is distributed uniformlly.
-> The battom door of the sate can be in one piece ~~higed~~ hinged to a supporting leg.
-> When the cupola is in operation the battom door is supported by a prop so that it mayn't collapse due to the large weight of the charge & the coke etc it carries.
-> When we don't need the cupala for further operation the charge feeding is stop, air supply is cut off & the prop is removed.
-> A so soon as the prop is removed the door drops down providing a clear space for the coke fire, residue of the molten metal with slag & the sand bed fall down thus the fire inside ceases gradually.
-> A wind chamber is placed a little above the bottom of the shell. This wind best is connected to the furnance blower of a blast pipe.



-> The amount of air required is forced into the chamber by the blower, which enters the furnance through the opening called Tuyeres.
-> The tuyeres are provided all along the shell & have a definite no. & size depending upon the amount of air required.

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-> changing door is located at a suitable height above the charging platform.
-> This platform is of robust mildsteel construction, supported on four strong steel legs & is provided with a ladder.
-> The amount of metal, coke scrap of flux are collected on this platform which are charged into the ~~coke~~ cupola as and when require.
-> The top of the cupola is provided with a mesh screen & spark arrester.
-> It is a cone shaped construction.
-> It fascilates a free escape of the waste gasses to the atmosphere.

Advantages of using a Cupola -

-> The main advantage of using a cupola as an iron melting furnance over the other furnance as follows.
-> The initial cast is comparatively lower than the other types of furnance of same capacity.
-> Operation & maintenance of this furnance doesn't involve too many complication.
-> Cast of operation & maintenance are comparatively lower.
-> The floor are require is hardly a fraction of that required for the other furnance of similar capacity.
-> It can be operated for a no. of hours at a strech.
-> It doesn't involve very complicated problem in it's design which is comparatively simpler.

Crucible Furnance -

-> These are simplest form of all the furnance used in foundries.
-> They are used in most of the small industry where the melting is not continuous & a large variety of metal can be melted in small quantities.
-> In these furnances the entire melting of metal takes place in a meting pot which is called crucible, which is made of clay & graphite.
-> The sizes of the crucible veries from no 1 to no 400 rate, each no representing a definite quantity of metal that can be held conviniently by the crucible.
-> These furnances can be classified into two types
1. Coke fired furnance
2. Oil & gas fired furnance

Die casting Method -

-> Die casting method is also known as pressure die casting or permanent mould casting method.
-> The main advantage of this process is the speed its operation & the mechanism used for the cycle of operation.
-> The complete process can be made automatic ~~pro~~ except that the

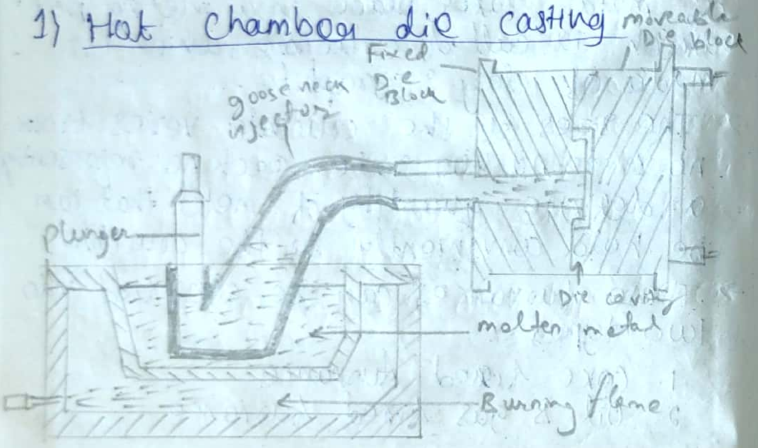
operation has to coated the die furnance with refractory coating in order to prevent die wears sticking of casting to it.

Types of die casting Method

There are 3 types of die casting method

1. Hot chamber die casting
2. Cold chamber die casting
3. Air blown or goose-neck type die casting

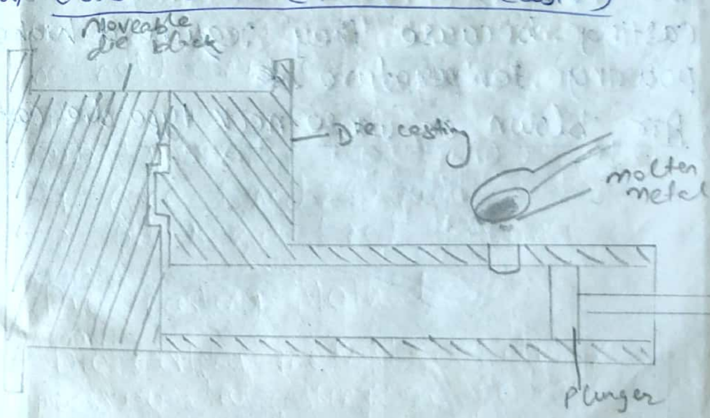
1) Hot chamber die casting



-> This is operated by a hydraulic plunger
-> This plunger acts inside a cylinder formed at one end of the Goose-neck type submerged in the molten metal.
-> A part is provided near the top of the cylinder to allow the entry of the molten metal into it.

-> The down stroke of the plunger closes this part. Cut off the molten metal supply & applies pressure in the molten metal present in the goose-neck to force it into the die casting through the injecting nozzle.
-> After a certain period of time the dies are opened & the casting is ejected.
-> Again the cycle of operation after the first casting is done by raising up the plunger.
-> Zinc based alloys whose melting point is very low are generally cast in these machines.

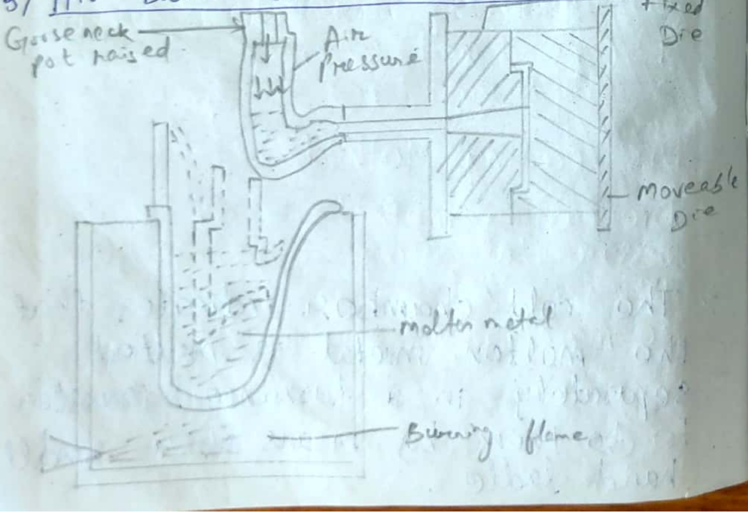
2) Cold chamber die casting



-> The cold chamber indicates that the molten metal is melted separately in a furnance & transfer to them by means of a small hand ladle.

-> A horizontal plaunger with cylinder is used to inject the molten metal into the die ~~cast~~ cavity.
-> After closing the die the molten metal is poured into the horizontal chamber to the metal inlet.
-> The plunger is pushed forward hydrolically to force the metal into the die.
-> After solidification the die is opend & the casting is acted
-> The plunger again drawn back & the cycle is repeated for the next casting.
-> These machines are used for casting aluminium alloys & brass which can't be casted in the hot chamber die casting because they require a higher pouring temperature.

3) Air blown or Goose neck type die casting



-> In this type of method a similar Goose neck type is provided as in hot chamber die casting but in this machine there is no cylinder plaunger arrangement.
-> A suitable mechanism is ~~incominteospor~~ incorporated in it to raise or lower the goose-neck casting according to the need.
-> These casting is submerged in the molten metal pot.
-> During operation the casting is lowered in to the pot to fill the molten metal into it. Then it is raised up & held in a position against the nozzle.
-> compressed air at a pressure of about 25 kg/cm² to 50 kg/cm² is then injected to goose-neck to force the molten metal into the die cavity.
-> After solidification the goose-neck casting is lowered into the pot the dies are opened & the casting is ejected the whole cycle is repeated again for the next casting.
-> This method is suitable to cast pb, zn & tn.
-> The rate of production is very low as compared to hot chamber die casting.

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Centrifugal Casting -

-> The process of centrifugal casting is also known as liquid forging.

-> It consists of rotating the mould at a high speed as the molten metal poured into it.

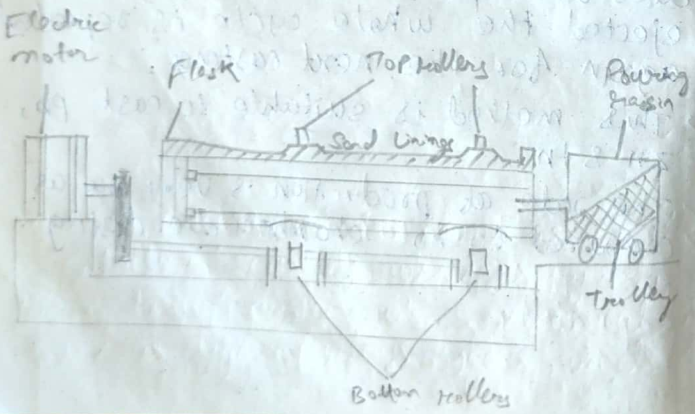
-> Due to centrifugal force the molten is directed outwords from the centre towards the inside wall of the mould.

-> As a result a uniform thickness of metal is deposited all along the inside surface of the mould where it ~~solid~~ solidifies & later the casting is removed.

-> The centrifugal casting method can be classified as follows

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

1) True Centrifugal Casting



-> The main features of a true centrifugal casting are that the axis of rotn of the mould & the casting are same.

-> The central hole through which the casting is produced by the centrifugal force without the use of central core.

-> The axis of rotation of the mould may be horizontal, vertical or inclined at any angle betn 70° ~~to~~ & 90°.

-> End cores are usually employed at the two ends of the mould to prevent the molten metal from being through out at the ends.

-> A horizontal true casting machine having a large cylindrical mould for casting cast iron pipes.

-> The mould consists of an outer metalic flask provided with a ramed sand lining inside.

-> The mould is rotated betn two sets of rollers.

-> The bottom rollers are mounted on a shaft which is driven by a variable speed motor mounded at one end.

-> pouring is done through a pouring basin formed on the body of a trolly.

-> Initially during pouring the mould is rotated at a slow speed. After the pouring is over the mould is rotated very high speed to effect even distribution of the metal all along the inside surface of the mould.

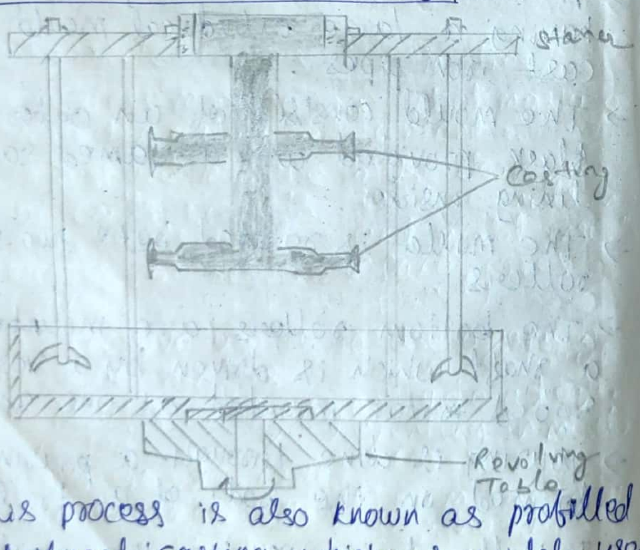
→ After solidification the casting is removed & the flask is replaced by a new one & the process is repeated.

→ The pouring temp range is betn 1482°C - 1649°C.

→ For correct casting the main factor is to maintain the correct spinning speed.

→ The spinning speed may vary from 150-3000 rpm.

2) Semi Centrifugal Casting -



→ This process is also known as profilled centrifugal casting which is widely used for large casting of symmetrical shapes such as disk, pulleys, gears, wheels etc.

→ In this method the mould is rotated about a vertical axis & the metal is poured through a central sprue.

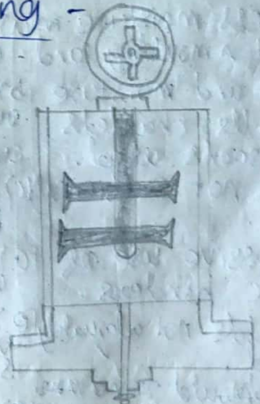
→ Several moulds can be stacked together one above the other & fed simultaneously through a common central screw.

→ This provision increases the rate of production considerably.

→ The centrifugal force is used to feed the metal outward to fill the mould cavity completely.

→ The speed of rotation of these moulds is much lower than the centrifugal casting.

3) Centrifuging -



→ This is also known as pressure casting method.

→ In this method the axis of rotation & the mould axes donot coinside with each other as the moulds are situated at a distance from the central vertical axis of rotation

-> Any design of shapes can be casted in this process.
-> All the mould cavities are connected from the central screw to the radial gets.
-> For higher of production a no. of moulds can be stacked together as in case of semi centrifugal casting.
-> In this method also the mould assembly is rotated about the vertical axis & centrifugal force is used to force the molten metal from the central screws into the moulding cavities through radial gets.

Casting defects, their causes & remedies

Defects	possible causes	Remedies
Blow holes (1)	(a) Excess moisture content in moulding sand (b) Rust and moisture on chills, chaplets and inserts used. (c) cores not sufficiently baked. (d) Excessive use of organic binders. (e) Moulds not adequately vented. ~~(f) Mould rammed~~ (f) Mould rammed very hard	(a) control moisture content. (b) Use clean and rust free chills, chaplets and metal inserts. (c) Bake cores properly. (d) Use organic binders with restraint (e) provide adequate venting in moulds & cores (f) Ram the moulds less hard
Misrun and cold shuts (4)	(a) Lack of fluidity in molten metal (b) Faulty design. (c) Faulty gating	a) Adjust proper pouring temperature (b) Modify design. (c) Modify gating system
porosity (2)	(a) High pouring temp. (b) gas dissolved in metal charge. (c) less flux used (d) Molten metal not properly degassed. (e) slow solidification of casting. (f) high moisture and low permeability in mould	(a) Regulate pouring temp. (b) Control metal composition (c) Increase flux proportion. (d) Ensure effective degassing. (e) Modify gating and risering. (f) Reduce moisture & increase permeability of mould.
shrinkage (3)	(a) Faulty gating and risering. (b) Improper chilling.	Ensure proper directional solidification by modifying gating, risering and chilling.
Inclusions (5)	(a) Faulty gating. (b) Faulty pouring (c) Inferior moulding or core sand. (d) Soft ramming of mould (e) Rough handling of mould and core.	a) Modify gating system (b) ~~Modify design~~ Improve pouring to minimise turbulence. (c) ~~Mod~~ Use a superior sand having more strength (d) provide harder ramming (e) Take care in handling
Hot tears or hot cracks or pulls (6)	(a) Lack of collapsibility of core. (b) Lack of collapsibility of mould. (c) Faulty design (d) Hard Ramming of mould.	(a) Improve core collapsibility. (b) improve mould collapsibility. (c) Modify design (d) provide softer ramming.
Metal penetration (8)	(a) Large grain size sand used (b) soft ramming of mould. (c) Moulding sand or core have low strength. (d) Moulding sand or core have high permeability. (e) pouring temperature of metal too high	(a) Use sand having finer grain size. (b) provide harder ramming (c) increase the strength to required extent. (d) Reduce permeability with the help of (a) and (b) above. (e) suitably adjust pouring temperature

Cuts & washes (7)	(a) Low strength of mould and core (b) Lack of binders and core stand. (c) Faulty gating	(a) improve mould & core strength (b) Add more binders to facing & core sand. (c) improve gatting system
Drops (9)	(a) Low green strength in moulding sand & core. (b) Too soft ramming. (c) Inadequate reinforcement of sand projections & core.	(a) Modify sand composition for increased green strength. (b) provide harder ramming. (c) provide adequate reinforcement to sand projection & cope by using nails and gaggers etc.
Fusion (10)	(a) Low refractoriness in moulding sand. (b) Faulty gating (c) Too high pouring temp of metal (d) poor facing sand.	(a) improve refractoriness. (b) Modify gatting system. (c) Use lower pouring experience temp. (d) improve quantity of facing sand.
Shot metal (11)	(a) Too low pouring temp. (b) Excess sulphur content in metal. (c) Faulty gating (d) High moisture content in moulding sand.	(a) use higher pouring temp. (b) Reduce sulphur content (c) Modify gating system. (d) Reduce moisture content.
Shifts (12)	(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 moulding sand and core.	(a) Repair or replace the pins (b) Repair or replace dowels causing misalignment (c) provide adequate support to core (d) locate the core properly. (e) Repair or replace the core boxes (f) increase strength of moulding sand & core
Rattails or buckles (13)	(a) continuous large flat surfaces on casting. (b) Excessive mould hardness (c) Lack of combustile additives in moulding sand	(a) Break continuity of large flat surface by providing grooves and depressions (b) Reduce mould hardness (c) suitably add cumbustible additives to sand.
Swells (14)	(a) Too soft ramming of mould. (b) Low strength of mould & core. (c) Mould not properly supported.	a) provide harder ramming. (b) increase strength of mould & core (c) provide adequate support to mould
Hard spots (15)	(a) Faulty metal composition (b) Faulty casting design	(a) suitably change the metal composition (b) Modify the casting design
Run outs (16)	(a) Faulty moulding. (b) Defective moulding boxes	(a) improve moulding technique. (b) change the defective moulding boxes.
Crushes (17)	(a) Defective core boxes producing over sized cores (b) Worn out core prints on patterns producing under-sized seats for cores in the mould. (c) careless assemby of cores in the mould.	(a) Repair or replace core boxes. (b) Repair or replace core prints. (c) Take adequate care in setting of cores in the mould.
Warpage (18)	(a) continuous large flat surfaces of castings, indicating a poor design (b) No directional solidification of casting	Modify the casting design to break the continuity of the large flat surfaces and facilitate proper directional solidification.

Press Work

Piercing -

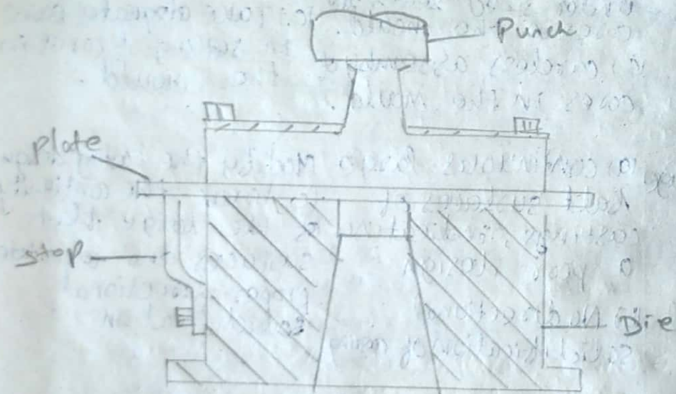
-> Piercing is the operation of producing a hole in a sheet metal by the help of a punch & a die

-> 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 & die 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 -

-> The punching operation is similar to the piercing operation while in punching the formation of the hole is the desired result.

-> The difference between punching & piercing is the, hole in case of punching a cylindrical hole is produced whereas in case of piercing the ~~bot~~ hole may be produced in any shape.

-> The size of the hole is determine by the size of the punch & the clearance allowed on the die.

Blanking -

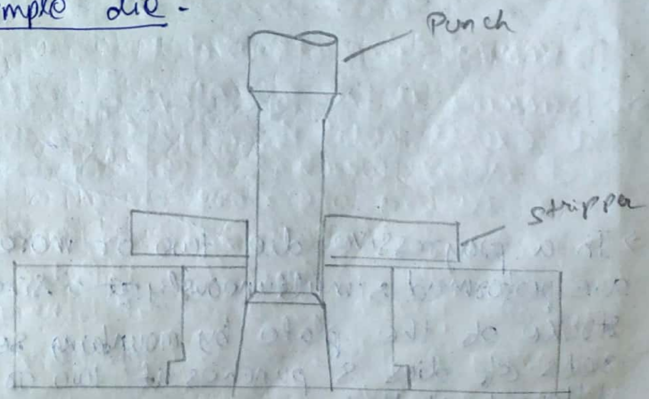
-> Blanking is the operation of cutting of flat sheet to the desired shape

-> The metal punched out is the required product & 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 & clearance is left on the punch.

Different types of dies -

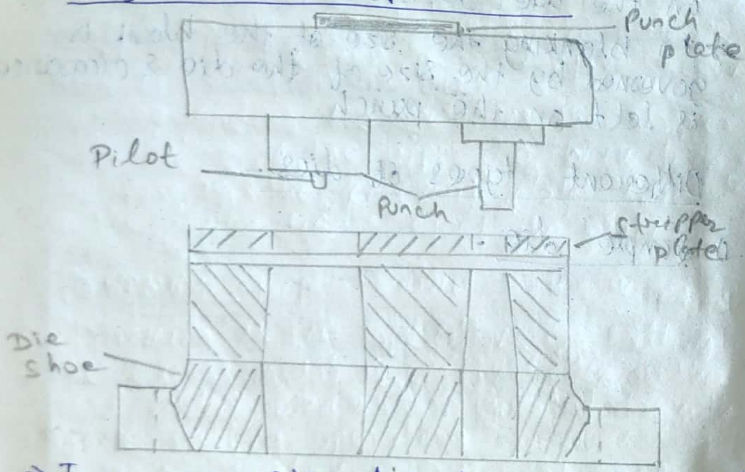
1) Simple die -



-> 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, a 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 betn the stripper plate & 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.

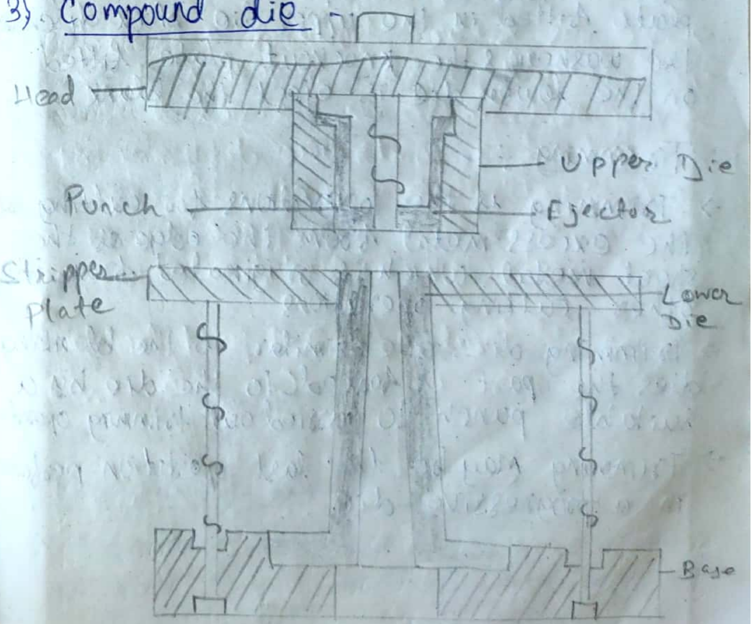
2) progressive or follow die



-> In a progressive die two or more operation are performed simultaneously at a single stroke of the plate by mounting separate sets of dies & punches at two or more different stations.
-> The metal is progressed from one station to another till the complete part is obtained.

-> In case of a progressive punching & blanking die, the sheet metal is fed into the first die where the hole is produced by the piercing die in the first cutting stroke of the ram.
-> The plate is then advanced in the next station & the correct spacing is obtained by the stop.
-> In the second cutting stroke of the ram the pilot enters into the pierced hole & correctly locate it.
-> At the same time the blanking punch descent & shear the plate to form the washer.
-> By the time, the blanking operation is formed the hole for the next washer is also pearced at the first station.

3) 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 & the piercing punch are bolted to the ram.
-> This spring loaded stripper plate is housed with in the blanking die.
-> The lower die body has cutting edges both on it's outward & inward surface.
-> The outside cutting edge serve as a punch for the blanking operations & the inside cutting edge operate as a die for the piercing punch.
-> The sheet metal is placed in the lower block & as the ram descents, the plate is first blanked & then peirced by the successive dies.
-> At the end of the operations the stripper plate fitted in the upper die block discharge the washer & the knockout plate fitted on the lower die is eject the blank.

Trimming -

-> Trimming is the operations for cutting of the excess metal from the edge of the sheet metal which is originated from the other cutting operations.
-> 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.

Jigs & Fixture

Jig

-> A jig may be defined as a device which holds & locates a work piece & guides & control one or more cutting tools.
-> The holding of the work & guiding of the tool are such that they are located in true position relative to each other.
-> construction wise a jig is a plate, structure or a box made of metal or non-metal having the provision for holding the components in identical positions are after the other & then guiding the cutting tool in correct position on the work inaccordance with drawing, specification or operation layout

Fixture -

-> A fixture may be defined as a device which holds & locates a work piece during an inspection or for a manufacturing process.
-> The fixture doesn't guide the cutting tool
-> construction wise fixture may be of different standard or specially designed work holding device whichare clamped on the machine table to hold the work in correct position.

Difference between Jig & a Fixture -

-> A fixture hold & position the work but doesn't guide the tool but whereas a jig locate, hold & guide the tool.

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-> The fixtures are generally heavier in construction & are rigidly bolted on machine table whereas the jigs are made lighter for quicker handling & clamping with the table is not necessary.

-> Fixtures are employed for holding over in milling, grinding, planning & turning operation whereas the jigs are used for holding work & guiding the tool particularly in drilling, reaming & tapping operation.

Principle of Location :-

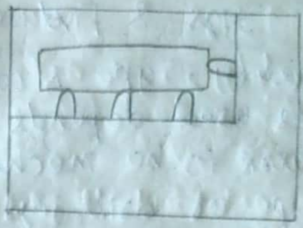
-> Location refers to the establishment of a desired relationship betn the workpiece & jigs or a fixture.

-> correct location influences the accuracy of the finished product.

-> The jigs & the fixtures are so design that all possible movement of the components must be restricted.

-> The locating points are determine by first findingout the possible degrees of freedom of the workpiece which are then restricted by suitable arrangments.

6 point location / 3-2-1 point location principle



-> As shown in the fig. a rectangular block is free to move along the axis AB, CD & EF.

-> The body can also rotate about those three axis & thus the total degrees of freedom of a body along which it can move is 6.

-> In order to locate the block correctly within the jig, all these six movements must be restricted by ~~avoiding~~ arranging suitable locating points & then clamping the block in position.

-> The bottom of the block is supported against three points the rear face of the block is supported by two points & the side of the block is supported by one point, all projected from the jig body.

-> It is now clear that the downward movement of the block along CD is restricted by three points & the movement along EF & AD axis are restricted by double & single point respectively.

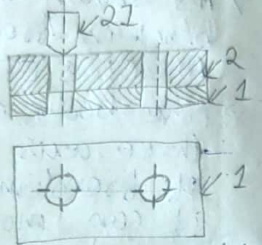
-> The rotary movement of the block about AB, CD & EF & also restricted by bottom, back & side pins.

-> In this way all the six points are restricted in 3-2-1 arrangement therefore it is know as 6 point location or 3-2-1 point location

Types of Jigs & Fixtures -

The quality, type & complexity of jigs & fixtures used depends solely on the type of work to be mechined. A few typical type of drill jigs are as follows

1) Templete jig -



1. work, 2. Template 21. Drill

-> The template jig is the simplast types of jig.

-> A plate having holes at the desined positions solve as a template which is fixed on the component to be drilled.

-> The drill is guided through these holes of the template & the required holes are drilled on the workpiece.

2) plate jig -

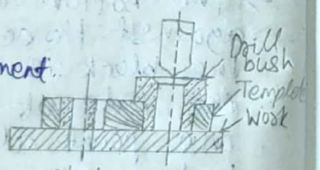
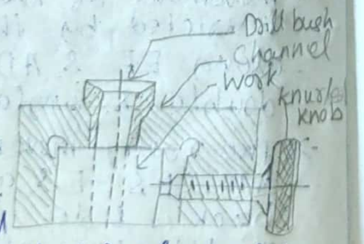


Plate Jig

-> A plate jig is an improvement of the templete jig by providing drill bushes on the template.

-> The plate jigs are employed to drill holes on larger.

3) Channel jig

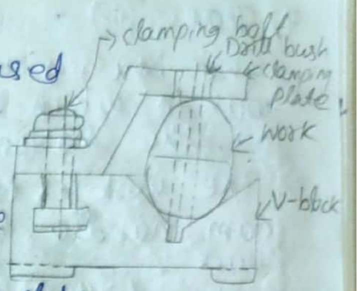


-> A channel jig is a simple type of jig heving channel like crossection.

-> The component is fitted on the channel & is located & clamped by rotating the knurled nut.

-> The tool is guided through th drill bush.

4) Diameter jig -

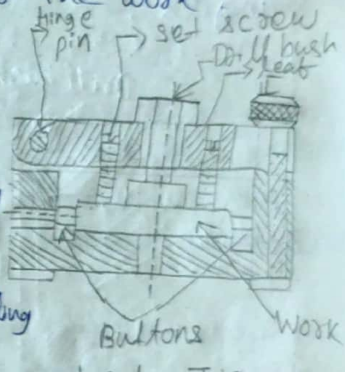


-> The diameter jig is used to drill the radial holes on a cylindrical or spherical workpiece.

-> The work is placed on the fixed V-block & then clamped by the clamping plate.

-> The tool is guided through the drill bush which is radially to the work

5) Leaf Jig -



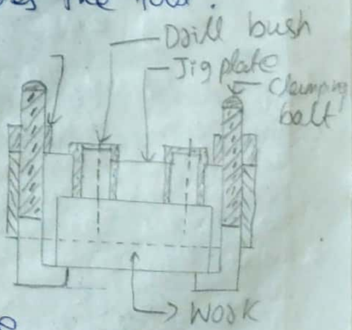
Leaf Jig

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

-> The work is located at the bottom & is clamped by the screws.

-> The drill bush guides the tool.

6) Ring Jig



-> The ring jig is employed to drill holes on circular flanged parts

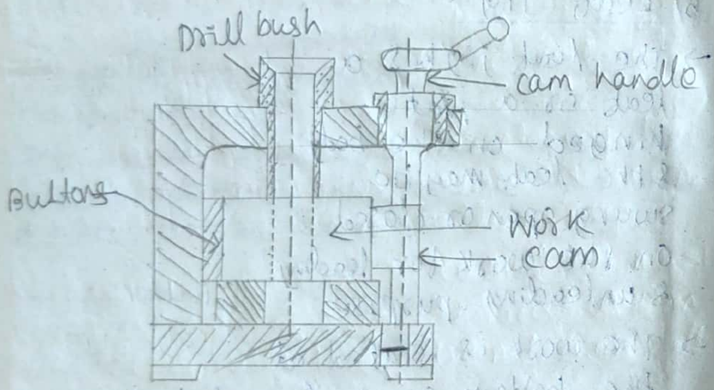
-> The work is securely clamped on the drill bush & the holes are drilled by the tool through drill bushes

7) Box Jig -

-> The box jig is a box like construction with in which the components is located at the bottom.

-> The work is clamped by rotating the cam handle which also locate the work.

-> The drill bushes guide the tool for drilling a no. of holes in different angles.



Box Jig

Powder Metallurgy

In is an art of manufacturing commercial articls from powdered metals by ~~plast~~ placing these powders in moulds & applying pressure. The compressed parts are then heated to bind together & improve their strength & other properties, this process is called sintering.

-> The temp during the process is kept below the melting point of powder.

-> The products are made through this process are very castly on account of the high cost of metal powders as well as dies used.

-> It is economically feasible only when the no. of required product is very high

ex - Tungsten carbide cutting tools, oilless self lubricating bearings, special electrical contacts and Turbine blades

-> The components made through this technique made from single metal powder or alloyed metal powder or non-metalic powder

-> These powdered metals are successfully converted into solid metals through powder metallurgy process it is essential that it should be possible to weld metal in solid phase & pack them closely under pressure.

Sintering -

Sintering of briquetted parts is done in large continious furnaces having controlled atmosphere for protection against oxidation & other chemical reactions.

-> The parts are kept at the correct temp for a certain period during which thee particles are strongly bonded together by atomic forces.

-> The important factors governing sintering are the temperature, time and atmosphere.

-> The process of sintering is carried out at substantially high temp but below the melting points of the material being sintered.

-> the actual value of sintering temp for most materials range between 70 to 80% of their melting temp.

sintering operation is carried out in 3 stages. For this most of the furnaces used in this process carry three distinct areas called

1. purge or Burn-off chamber.
2. High temp zone
3. cooling zone

1. purge / Burn-off Chamber - In the first stage i.e. purge chamber. ~~vol~~ volatile substances, air, lubricants, & binders are burnt off from the compacted part & its temp. is ~~sl~~ slowly raised.

2. High temp zone - In the second stage i.e high temp zone the temp of the compact is raised to sintering temp. The part is held there for sufficient time to enable solid diffusion & bonding between the particles.

3. 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 main objectives of sintering are as follows -

a) Achieving high strength
b) Achieving good bonding of powered particles
c) producing a dence and compact structure.
d) producing parts free of oxides
e) causing metallurgical diffusion and facilitate alloying of constituent materials
f) obtaining desired structure and improved mechanical properties.

Advantages of powder metallurgy.

1) It facilitates production of many such parts which cannot be produced through other methods, such as sintered carbides and self-lubricating bearings.

2) It also facilitates mixing of both metallic and non-metalic powders to give products of special characteristics.

3) The products carry very high dimensional accuracy, thus eliminating the need for further machining in most ~~cases~~ cases. If at all needed, it is not much.

4) Layers of different metal powders can be moulded together to obtain multi-metalic products.

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5) The products of powder metallurgy are highly pure.

6) The process facilitates saving in materials as no material loss occurs during fabrication.

7) It is possible to ensure uniformity of composition, since exact proportions of constituent metal powders can be used.

8) The rate of production is quite high.

9) It enables production of parts from such alloys which prossess poor castibility.

10) The process does not require highly skilled workmen.

11) Hard to process materials, like diamond and ceramics, can be converted into usable components and tools through this process.

12) The process enables an effective control over several properties, like purity, density porosity, particle size, etc., in the parts produced through this process.

13) The phase diagram constraints, which do not allow an alloy formation betn mutually insoluble constituents in liquid state, such as in case of copper and lead, are removed in this process and mixtures of such metal powders can be easily processed and shaped through this process.

14) This process enables production of parts in their finished forms out of such metal alloys which cannot be readily machined to shape them in their final forms.

Disadvantages and Limitations -

1) The metal powders and the equipment used are very costly.

2) There is a limitation to the size of the product as the same will depend on the capacity of the press used and the compression ratio of the powders.

3) Storing of powders offers great difficulties because of the possibilities of fire and explosion hazards.

4) Design restrictions, due to low flowability of metal powders, restrict the production of intricate shapes.

5) Sintering of low melting point metal powders, like those of lead, zinc, tin, etc offers serious difficulties.

6) A completely dense and compact metal structure cannot be produced through this process.

7) The process is not found economical for small scale production.

8) Physical properties of parts produced through this method are generally not comparable to cast or wrought parts.

9) It is not easy to convert brass, bronze and a number of steels into powdered form.

End