FOUNDRY TECHNOLOGY

COMPILED BY :

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Vision and Mission of the Department

VISION: To offer quality technical education In the field of Metallurgical Engineering with orientation towards industry, entrepreneurship, higher education and to strive for developing professionally competent technicians meeting the needs of the global economy.

MISSION:

M1: To develop students in the field of Metallurgical Engineering as highly motivated, skillful and qualified manpower for employment and higher learning

M2: To promote a conducive environment for all round development of students.

M3 : To promote linkages with external agencies to meet changing needs of industry and society.

M4: ToImproveLaboratories

Program Education Objectives (PEOs)

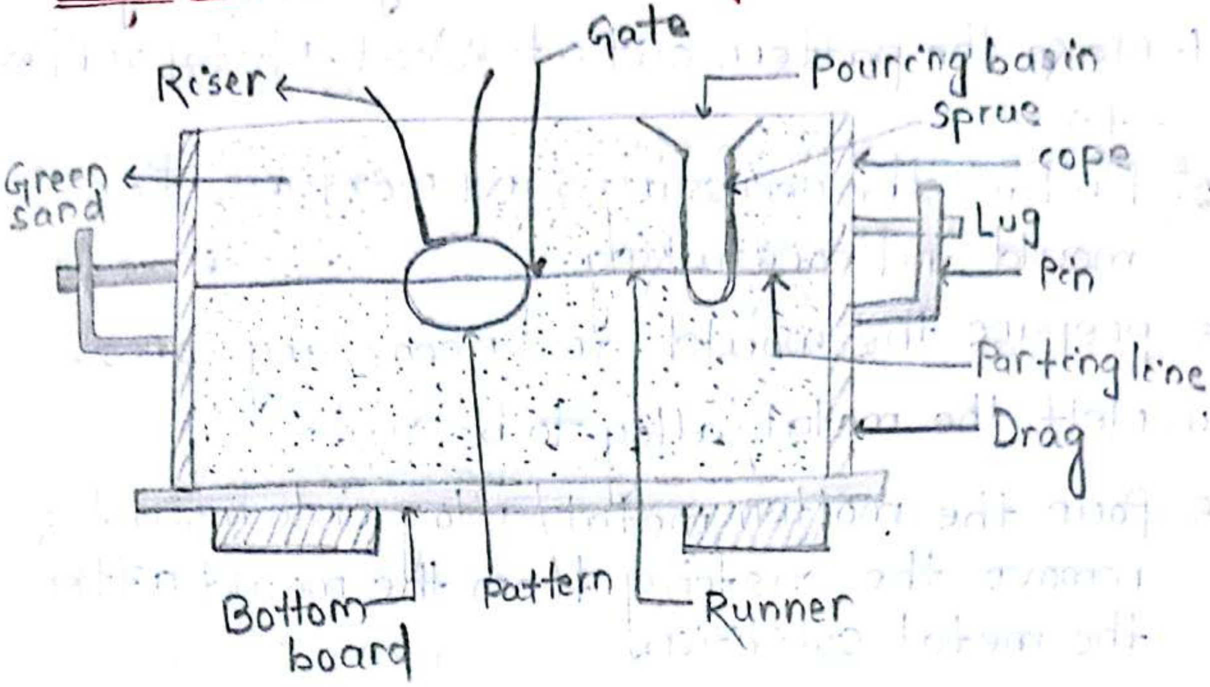
PEO1: Diploma professionals will be able to make a successful career in metallurgical industries or higher studies to meet the need s of future requirements.

PEO2: Diploma metallurgists will have technical and behavioral competencies through adequate exposure to industry.

PEO3: To impart technological knowledge and skills for so living real-time engineering problems.

PEO 4: To develop human resources with capabilities of effective communication, moral values and social responsibilities.

Foundry as a Manufacturing Process :- 1



Foundry :

Foundry is a casting process in which we get our desired size and shape product by melting the metal into liquid & then pouring them into mould where they solidify and take the shape of mould cavity.

Principles of casting :

Principles of casting are .....

A cast product or casting is produced by the pouring of molten metal into a mold where it then solidifies into a geometric shape.

In other instances, molten metal is injected into a die having a cavity in the desired shape of the part.

Basic Steps involved in making a casting :-

1. Make the pattern out of Wood, Metal or Plas--tic.
2. Prepare the necessary sand mixtures for mould and core making.
3. prepare the mould and necessary cores.
4. Melt the metal/alloy to be cast.
5. Pour the molten metal/alloy into mould & 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. Casting is ready for shipping.

Advantages of casting :-

1. We can get complex structure economically.
2. The size of the object doesnot matter.
3. Good strength.
4. cheapest.
5. We can create an accurate object.

Disadvantages of casting :-

1. Poor surface finish.
2. Casting defects.
3. Low fatigue strength compare to forging.
4. It is not economical for mass production.

Applications of casting :-

1. Transportation Vehicles.
2. Turbine Vanes
3. Power generators.
4. Railway crossings
5. Agricultural parts.
6. Sanitary fittings
7. Aircraft jet engine parts.

Pattern and Pattern Making :-

Define pattern :

↳ A pattern is a model or the replica (mirror image) of the object to be cast.

Function of the pattern:

- A pattern prepares a mould cavity for the purpose of making a casting.
- A pattern may contain projections known as core prints if the casting requires a core and need to be made hollow.
- patterns having finished and Smooth Surfaces reduce casting defects.

Materials used for making patterns:

- Wood
- Metal
- plastic
- Wax
- plast

Properties of Pattern material should have:

- Light in weight.
- Strong, hard and durable.
- Easily warmed, shaped and Joined.
- Resistance to corrosion and chemical reaction.

- Dimensionally stable.
- Available at low cost.

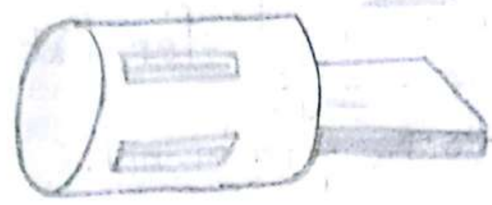
Factors assist in Selecting Proper Pattern Material

- No. of casting to be produced.
- Dimensional accuracy and surface finish.
- Shape complexity and size of casting.
- casting design parameter.
- Type of moulding materials.
- The chance of, repeat orders.
- Nature of moulding process.

Types of Patterns :-

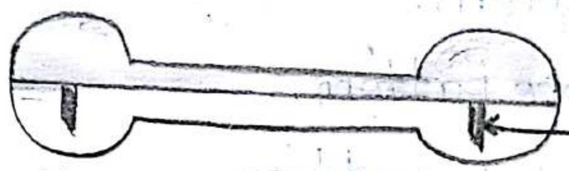
1. Single piece pattern.
2. split pattern.
3. Loose piece pattern.
4. Match plate pattern.
5. Sweep pattern.
6. Gated pattern.
7. Skeleton pattern.
8. Follow board pattern.
9. Cope & drag pattern.

Single piece patterns :



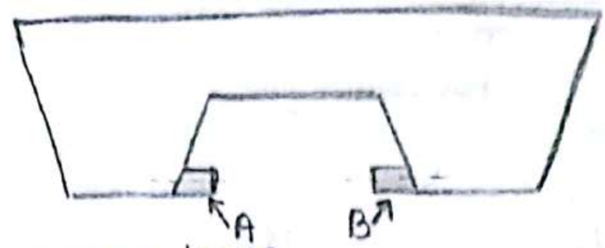
- It is the simplest type of pattern.
- The pattern is made from one piece and doesnot contain loose pieces or joints.
- It is inexpensive.
- It is used for making a few large castings like stuffing box of steam engine.
- One piece pattern is accommodated either in cope or drag.

Split pattern :



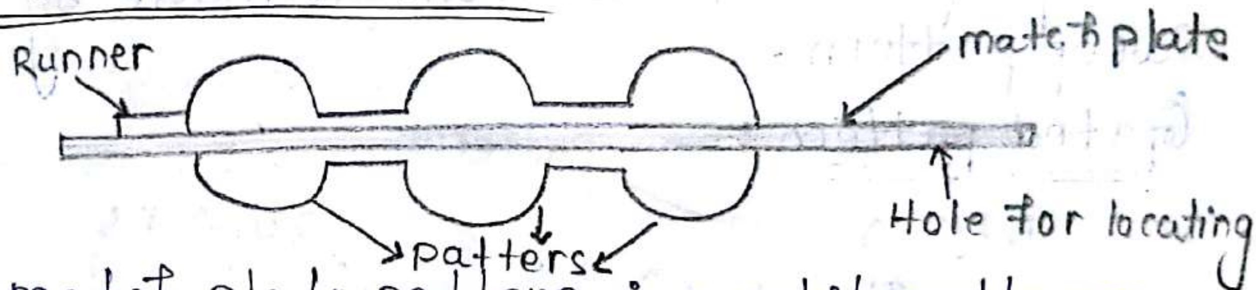
- These patterns are split along the parting plane to facilitate the extraction of mould before pouring operation.
- Upper and Lower parts of the split pattern are accomodated in the cope and drag portion.
- For complex casting, the pattern may be Split in more than two parts
- castings like taps and water stop-cocks are produced with the help of split patterns.

Loose piece patterns :



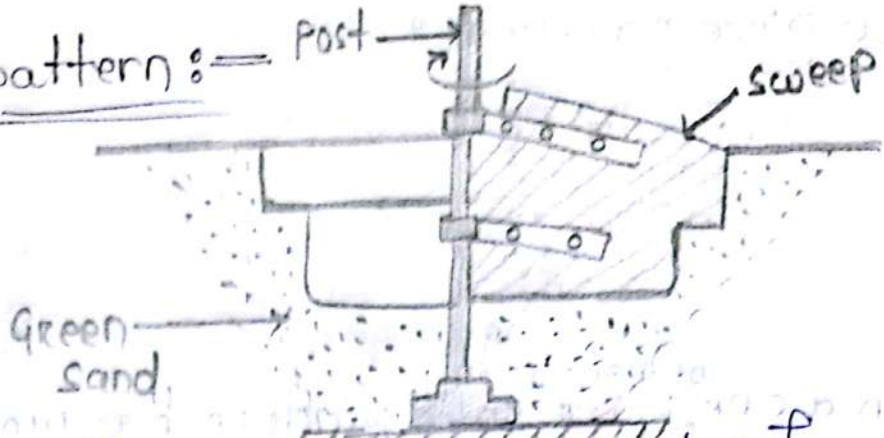
- When a one or more loose piece solid pattern has projections which lie above or below the parting plane, it is impossible to withdraw it from mould
- Loose pieces remain attached with the main body of pattern with the help of dowel pins.
- Loose piece patterns involve more labour & consume more time in the molding operation.

Match Plate Pattern :



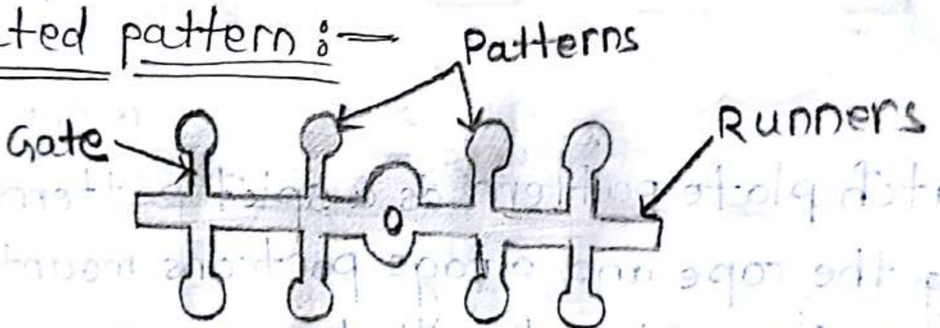
- A match plate pattern is a split pattern having the cope and drags portions mounted on opposite sides of a plate.
- Gates and runners are also mounted on the match plate.
- piston rings of I.C engines are produced with the help of match plate patterns.
- Match plate patterns are used in machine molding. for producing small castings.

Sweep pattern :—



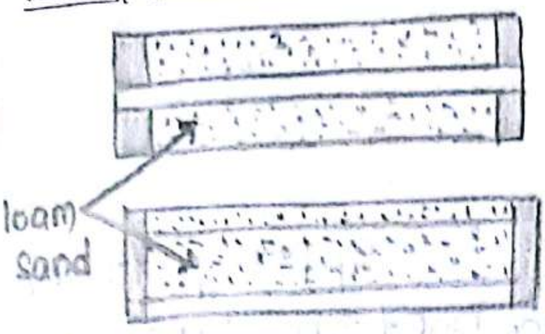
- A sweep pattern is made on a wooden board which sweeps the shape of the casting into the sand all around the circumference.
- Once the mold is ready, sweep pattern and post can be removed.
- Sweep pattern is used for producing large casting in short time.
- Large kettles of cast iron are made by sweep pattern.

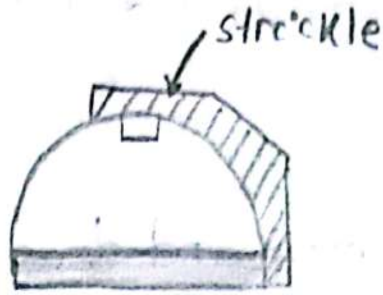
Gated pattern :—



- Gated pattern is one or more loose patterns having attached gates and runners.
- A gated pattern can manufacture many castings at one time on moulding machine.
- Gated pattern are employed for producing small castings.

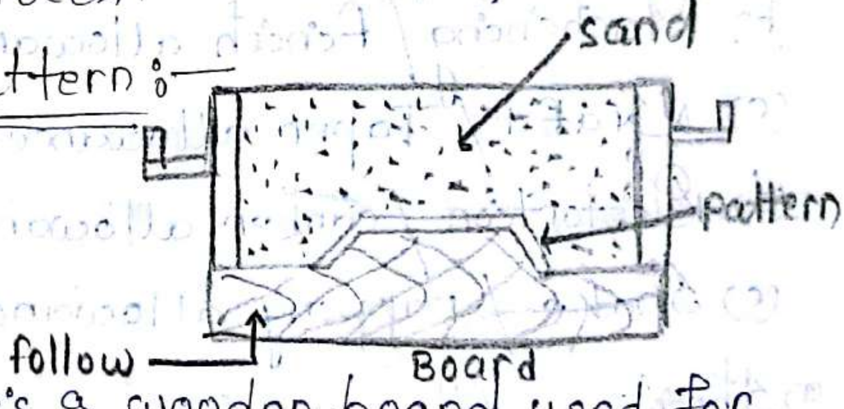
Skeleton Pattern :-





- Skeleton pattern is the skeleton of a desired shape which may be a S-bend pipe or a chute.
- Skeleton frame is mounted on a metal base.
- Skeleton is made from wooden strips.
- cores if necessary can be produced separately.
- Skeleton patterns are used for producing large casting.
- This type of pattern is also used in pit or floor molding process.

Follow board Pattern :-



- Follow board is a wooden board used for supporting a pattern which is very thin.
- With follow board support under weak pattern, the drag is rammed then follow board is withdrawn.
- The pattern is removed & the cope and drag are assembled.
- Follow board are used for casting master Patterns.

Cope & Drag pattern :-

- A cope and drag pattern is a split pattern having the cope and drag portions each mounted on separated match plates.
- Each half of the pattern is fixed and molded separately.
- These patterns are used for producing large casting and complete moulds are too heavy.

Types of pattern allowances :-

(a) Shrinkage / contraction allowance.
(b) Machining / finish allowance.
(c) Draft / Taper allowance.
(d) Distortion / camber allowance.
(e) Shake / rapping allowance.

(a) Shrinkage Allowance :-

- Different metals shrink at different rate.
- Cast iron poured at higher temp^r will shrink more than that poured at low temp^r.
- Harder grades of cast iron shrink more than softer grades of cast iron.

- Wood patterns used to make patterns are given double allowance ; one for shrinkage of pattern and other for cast.

(b) Machining Allowance :—

- castings get oxidized in the mold ~~and~~ during heat treatment and scales formed need to be removed.
- It is intended to remove surface roughness and other imperfections from the castings.
- It is required to achieve exact casting dimensions.
- Surface finish is required on the casting.

(c) Draft or Taper Allowance :—

- It is given to all surfaces perpendicular to parting line.
- Draft allowance is given so that the pattern can be easily removed from molding material tightly packed around it.

(d) Distortion Allowance :—

A casting will warp if :-

- it is of irregular shape.
- all its parts donot shrink uniformly.
- it is U or V shaped.
- it has long flat casting.
- it has arms possess unequal thickness.

(e) Shake allowance :—

- A pattern is shaken by striking the same with a wooden piece from side to side. This is done so that the pattern is loosened a little in the mold cavity and can easily removed.
- Shake allowance is normally provided large castings.
- The magnitude of shake allowance can be reduced by increasing the taper.

Pattern Colours :—

Patterns are imparted certain colours & shade in order to :

- identify the main body of pattern.
- indicate the type of metal to be cast.
- indentify core print, loose print etc.

Pattern colour scheme :

- cast surface to be left unmachined – Black.
- cast surface to be machined – Red.
- Loose piece and seating – Red strips on yellow base.
- core print seats – yellow.
- stop-off / supports – Black strip.
- parting surfaces – clear or no colour.

Storing of Patterns :-

- patterns should be stored in buildings.
- Suitable shelves and racks etc can be provided for storing pattern.
- patterns can be easily identified and traced at the time of repeat order.
- store office should file a card for each pattern.

Differentiate between pattern and casting :-

- A pattern is slightly larger in size as compared to the casting.
- A pattern may not have all holes and slots while a casting will have.
- A pattern may be in two or three pieces whereas a casting is in one piece.
- A pattern carries shrinkage allowance it may be of order of 1 to 2mm/100mm.

Molding Materials :-

Molding Sands :-

Sources:

- River beds
- Sea
- Lakes
- Desert

Types:

- Natural Sands
- Synthetic Sands
- Loam Sands.

Ingredients:

- Refractory sand grains
- Binders
- Water
- Additives

Classification of molding sand :-

Natural Sand :-

- Natural Sand is directly used for molding and it contain 5-20% clay (alumina silicate) and 5-18% moisture.
- It has less refractoriness.
- Natural Sand can be used for making molds.
- Natural sand molds can be easily ~~remove~~ repaired.
- Natural Sand may contain organic matter.

Synthetic Sands :—

- Synthetic sand consist of silica sand, with or without clay, binder or moisture.
- It is used for heavy casting steel.
- It is a formulated sand & it has better property than natural sand.
-

Loam Sand :—

- In loam sand, many ingredients are added like fine sand particle, clay, graphite & fiberous reinforcement.
- It contain 50% clay & 20% moisture.
- It is used for mainly making big casting like big bells.
- Loam dries hard.
- Sweep or skeleton pattern are used for loam sand.

Classification based upon grain size :—

- Grain size influence many sand properties like permeability, flowability, refractoriness, Surface fineness and strengths etc.
- Finer the sand grains, finer is molding sand.
- Finer grained sands give surface finess but possess low permeability.
- Coarse and uniformly sands impart high permeability, flowability and max^m refractoriness

- Finer grained sands are used for producing ornamental castings and small sized castings.
- coarse grained sands are used for producing large casting.

Grain shape :

Foundry sand grains can be divided into four shapes:

(a) Rounded sand grains
(b) sub-angular sand grains
(c) Angular sand grains.
(d) compound sand grains.

(a) Rounded sand grains :

- Grains which get rubbed against each other by the action of wind, waves, acquire rounded shapes.
- Round grains impart high permeability.
- Round grain molding sands possess lower strength.
- Round grain molding sands possess greater flowability.

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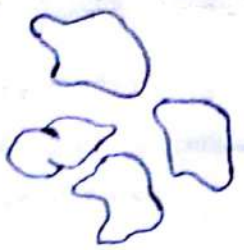
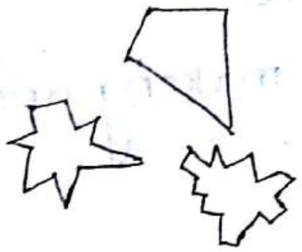
(b) Sub-angular Grains :



- Sub-angular grain sands possess better strength & lower permeability.
- Sub-angular sand grains are formed because of the movement and moderate rubbing of angular grains with each other.

(c) Angular sand grains :



- Angular grains result when the sand is formed owing to the decomposition of rocks without movement.
- Formation of angular sand grains is closely associated with frost and glacial action.

(d) compound grains :

- compound sand grains result when two or more grains stick together so tightly that they donot get separated either during sieving.

or washing operation.

- compound grains tend to dissociate at higher tempr.

Properties of molding Sands :—

(a) Flowability :

- Flowability is the ability of the molding sand to get compacted to a uniform density.
- Flowability increases as clay and water contents increase.

(b) Green Strength :

- Green strength is the strength of the sand in the green or moist state.
- Green strength helps in making and handling the molds.

(c) Dry strength :

- It is the strength of the molding sand in the dry condition.
- Dry sand strength is related to grain size, binder and water content.

(d) Hot Strength :

- It is the strength of the sand above 212°F
- In the absence of hot strength, the mold may
  1. enlarge.
  2. break, erode or
  3. get cracked.

(e) Permeability or Porousness :

- permeability is that property of molding sand which permits the escape of steam and other gases generated in the mold during hot metal pouring ..

(f) Refractoriness :

- It is the ability of molding sand to withstand high temperatures without
    1. fusion
    2. cracking, buckling or scabbing.
    3. experiencing any major physical change.
- refractoriness is more essential in production of high m.p alloy casting

(g) Adhesiveness :

- It is the property of molding sand owing to which it
    1. sticks with the walls of molding boxes.
    2. sticks with gaggers and
    3. make it possible to mold cope and drag.

(h) collapsibility :

- collapsibility is that property of the molding sand which determines the readiness with which the molding sand or mold.

(i) Fineness :

- Finer sand molds resist metal penetration and Produce smooth casting surfaces.
- Fineness and permeability are in conflict with each other.

(j) Bench Life :

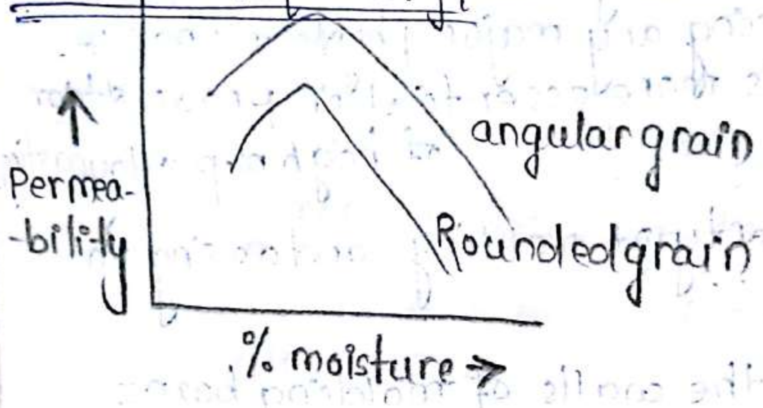
It is the ability of the molding sand to retain its properties during storage.

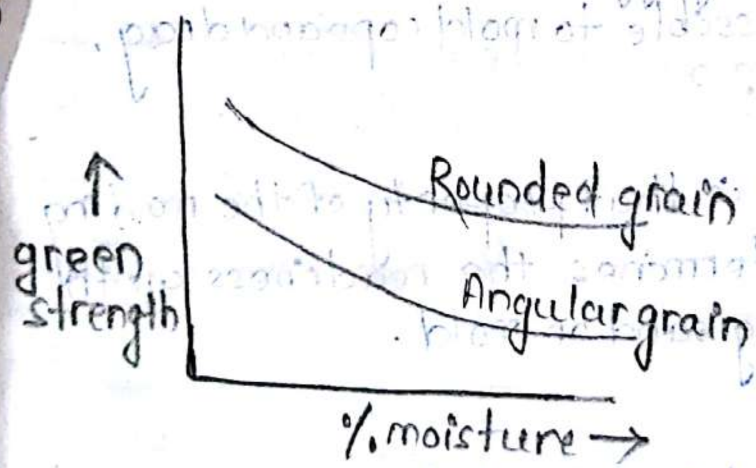
(K) Molding sands should possess low coefficient of expansion.

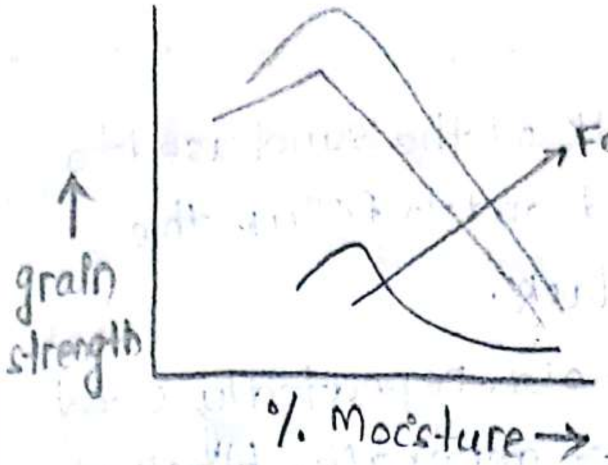
(l) Durability.

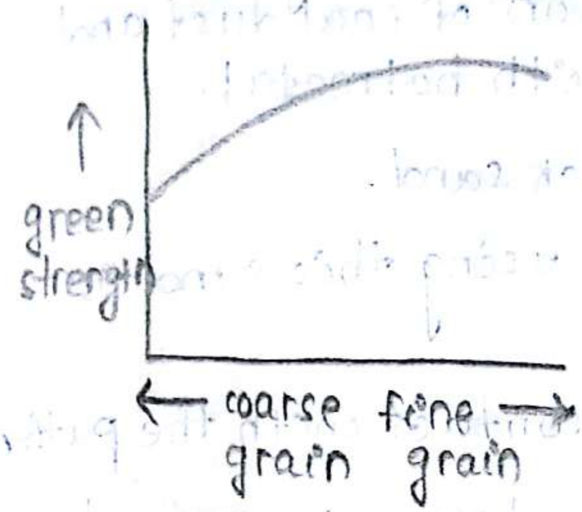
(m) Molding sand should be reusable.

Effect of moisture, grain size and shape on mould quality :-









Differentiate between facing sand and backing sand :—

Facing Sand :—

- Facing sand is the sand which covers the pattern all around it.
- Facing sand forms the face of the mould & comes in direct contact with the molten metal when it is poured.
- High strength and refractoriness are required for this sand.
- It is made of silica and clay without the addition of any used sand.

Baking Sand :-

- Baking Sand is the bulk of the sand used to backup the facing sand and to fillup the volume of the box or flask.
- It consist mainly of old, repeatedly used moulding sand which is generally black in colour due to addition of coal dust and burning on contact with hot metal
- It is also called black sand.
- The main purpose of using this sand is to reduce the cost.
- It doesnot come in contact with the pattern

Differentiate between sand preparation and Sand conditioning :-

Sand conditioning :-

- In order to obtain good casting, sand used for molding must be correctly conditioned.
- The sand must possess all the properties to give good quality of cast product.
- Used sand should be treated appropriately so that it can be further used.
- It means that when we are using the sand for the mold & when the fettling is done on the casting, the sand has to be removed, the sand losses some of the properties

and if it has to be reused :
- It must be reconditioned.

Sand Preparation :-

- For natural bonded sand, it should have following things :
  (i) proper moisture content.
  (ii) Burnt sand to be removed after use.
  (iii) Aeration (there should be separation or gap between sand grains before pouring hot metal and being rammed)
  (iv) Application of facing sand.
  (v) Use of additives like coaldust.

Functions of Sand preparation / conditioning :-

- To develop optimum properties in molding sands.
- To add adequate amount of water to activate clay binder.
- To remove foreign matter from the molding sand.
- To deliver sand at the proper temp^{r}.

Sand Reclamation :—

Reasons of sand reclamation :—

Treatment of used moulding sand so that it regains original condition and can be used again and again with minimum addition of new sand.

Equipment Required :—

- Magnetic Separator
- Muller
- Riddle
- Aerator.

Different sand reclamation techniques :—

1. Mechanical reclamation :

This reclamation remove accumulated coatings on the sand grains.

2. Thermal reclamation :

- Thermal reclamation process involves heating the sand to 1200 - 1500°F.
- This process does not remove clay.
- In this process, sand is heated up to 800°c.
- This process is very suitable for oil bonded sands which contain no clay.
- It uses a unique fluidized gas fired bed design to combust and removed remaining

residual sand coating.

3. Dry reclamation:

- In dry reclamation process, fines, spent and free clay, fractured sand grains and iron oxide particles etc are removed from the used sand by dry classification.
- Dry reclamation does not restore the original quality of the sands.

4. Wet reclamation:

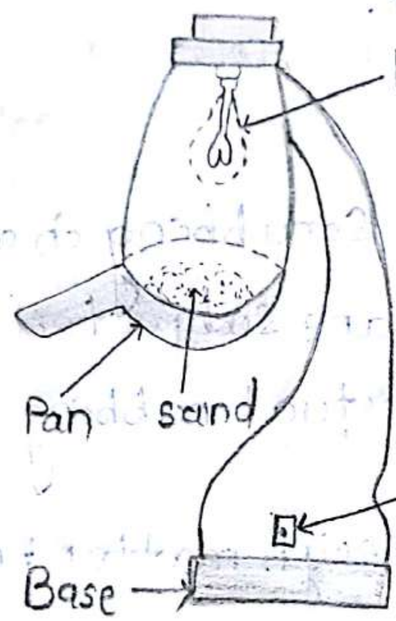
- This technique is wet scrubbing in which suspended sand grains are subjected to vigorous motion and mutual rubbing by water current.
- Removes fines and foreign matter from the sand.
- Removes partly clay coating from the sand grains.

Testing of Molding Sand :-

(a) Moisture contain test :

(i) If moisture will be low, then strength will be low.

(ii) If moisture will be very high, then permeability will be very low.



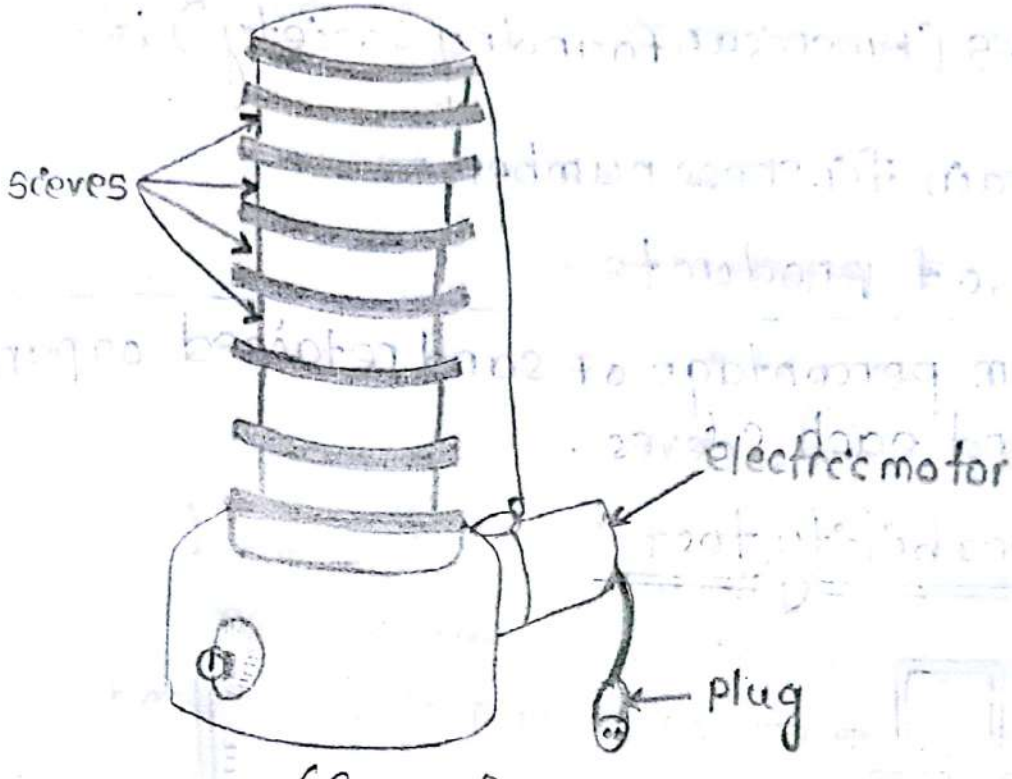
(Moisture determining apparatus)

Step involved :

- 20-50gm of prepared sand is placed in the pan & is heated by an infrared heater bulb for 2-3 min.
- The moisture in the molding sand is evaporated.
- Molding sand is taken out of the pan & reweighed.
- The percentage of moisture can be calculated from the difference in the weights of the

critical moist and final sample.

(b) Grain finest test:



(Grain fineness tester)

- There are eleven standard sieves mounted one above the other and under the bottom most sieve is placed a pan.
- The top sieve is the coarest and the bottom most sieve is the finest.
- A sample of dry sand out of which clay has been removed is placed in the uppermost sieve, sand is vibrated for a definite period of time and the amount of sand retained on each sieves is weighed and the percentage distribution of grains is computed.
- To obtain the AFS grain finest number, each percentage is multiplied by a factor.

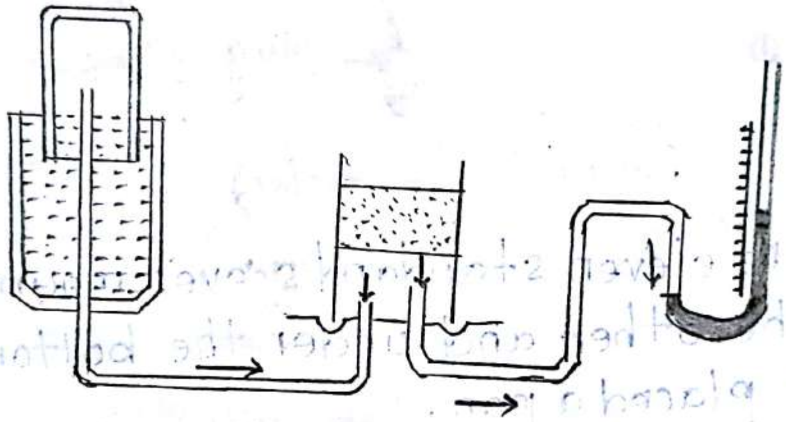
- The resulting products are added & divided by total percentage of sand grain retained.

(ii) AFS (American foundry society) :-

AFS grain fineness number =

$$\frac{\text{Sum of products}}{\text{total sum percentage of sand retained on pan and each sieves}}$$

(C) permeability test:



- 2000 Cc of air held in the inverted bell jar is forced to pass through the sand specimen.
- A situation comes when the air entering the specimen equals the air escape through the specimen.
- This gives a stabilised pressure reading on the manometer and the same can be read on the vertical scale.

- simultaneously using a stopwatch the time required the 2000 cc of air to pass through the sand of specimen is also recorded.

$$\text{permeability number} = \frac{V \cdot H}{A \cdot P \cdot T}$$

where, V = volume.

H = Height of specimen

A = Area of specimen

T = Time (minutes)

P = Air pressure (gm/cm²)

Q. Determine the permeability no. if 2000 cc of air takes 90 sec to pass through a standard specimen (5.08 cm height and 5.08 cm diameter) and the manometer indicates an air pressure reading of 5 gm/cm².

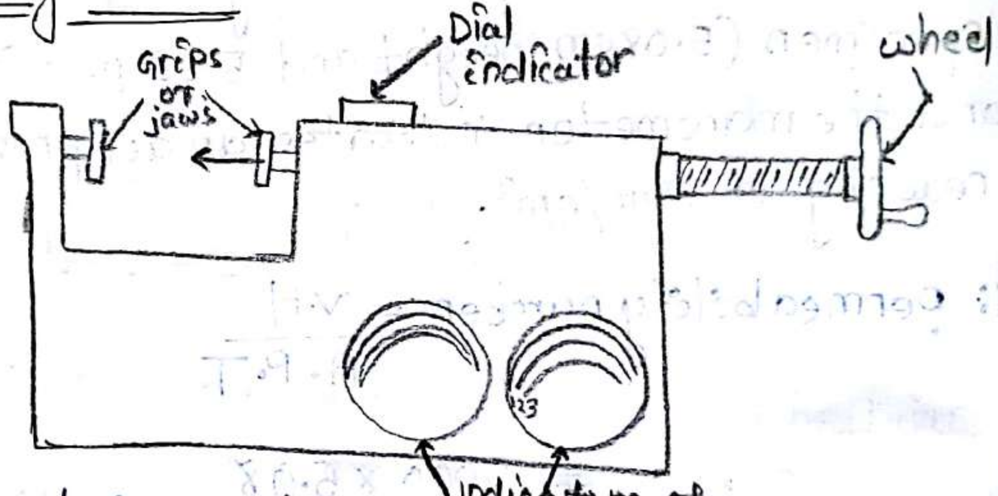
Sol:- $$\text{permeability number} = \frac{V \cdot H}{A \cdot P \cdot T}$$

$$= \frac{2000 \times 5.08}{\frac{\pi}{4}(5.08)^2 \times 5 \times 1.5} = 67$$

(d) Mold hardness test :—

- Hardness of the mold surface can be tested with the help of an indentation hardness tester.
- The depth of penetration (achieved by the indenter) with respect to the flat reference surface of the tester is indicated on the dial of the instrument in terms of hardness unit.
- The full hardness scale is divided into 100 units.

(e) Strength test :—



- The most commonly used test is compression strength test.

(i) The specimen is held between the grips.
(ii) Handwheel when rotated accurates a mechanism which builds up hydraulic pressure.
(iii) Dial indicator fitted on the tester measures the deformation occuring in the specimen.

(iv) There are two indicators :

→ One is meant for use when testing low strength sand and

→ other is for high strength .

(v) Each indicator has three scale :

- compressive .
- tensile .
- shear.

Binder :-

- Binder produced cohession between the molding sand grains .
- Binder gives strength to the molding sand .
- clay binder are most commonly used for molding sand .
- Binder should be added as optimal minimum.
- clay binders can be classified as :
  (i) fire clay .
  (ii) bentonite .
  (iii) Illite .
  (iv) Kaolinite .

(i) Fire clay :-

Fire clay is a one type of binder and it is a refractory clay usually found in the coal majors.

(ii) Bentonite :-

- The most commonly used clay binders are bentonite as they produce strongest bonds in the foundry sands.
- Bentonite are the weathered product of volcanic ash and are soft, creamy, white powder.

(iii) Illite :-

- Illite is the decomposition product of micaceous material due to weathering.
- It is found in natural molding sands.
- Illite particles have thickness and width of 20 and 100 - 250 millimicrons respectively.

(iv) Water :-

- The amount of water may vary from 1.5-8%
- Water is responsible for the binding action of clays.
- It improve moldability.
- The free water act as lubricant.
- Too little water will not develope proper strength and plasticity.

- Too much water will result in excessive plasticity.

Additives :-

Materials other than the basic ingredients are also added to molding sand in small quantities to enhance or increase the existing properties, to give special qualities like resistance to sand expansion, defects etc.

(i) facing materials :-

- Facing materials tends to obtain smoothen and cleaner surfaces of casting.
- A few facing materials are seacoal, graphite coal, silica floor etc.

(ii) cushion materials :-

- cushion materials burn when the molten metal is poured and thus give rise to space for accomodating the expansion of silica sand at the surface of mold cavity.
- In the absence of cushion material, large flat surfaces of castings may buckle due to thermal expansion of silica sand grains.
- Few cushion materials are : wood floor, cellulose etc.

Core :-

- Core is a product which is required to create hollow space, recesses and interior cavities that are often a part of casting.
- A core may be define as a sand shaped or formed which max the contour of a casting for which no provision has been made in the pattern for molding.
- core has a sand shape is generally produced separate from the sand mould and is then baked (harden) to facilitate handling and setting into the mold.
- cores may be made of sand, metal, plastic, ceramic.

Different function of core :-

- For hollow castings, cores are required for the formation of internal cavities.
- cores may provide external undercut features.
- cores may be used to improve the mold surface.
- cores may be used to strengthen the molds.
- cores may be used to form the getting

system of large size mold.

Characteristics of mold :—

A core must possess:

- Sufficient strength to support itself and get handel without breaking.
- High permeability to left the gases escape through the mold wall.
- Smooth surface to ensure a smooth casting.
- High refractoriness to withstand hot molten metal.
- High collapsibility in order to assist the free contraction of the solidifying metals.

Types of cores :—

Cores may be classified according to the

a) state or condition of core:

- Green sand core.
- Dry sand core.
- No bake sand core.

b) The nature of core materials employed:

- Oil bonded cores.
- Resin bonded cores.
- shell bonded cores.
- Sodium silicate cores.

c) type of core hardening process employed:

- CO_2 process
- Hot box process
- cold set process,
- fluid sand process
- Furan - No bake process.
- Oil - no bake process:

d) shape / position of the core:

- Horizontal core
- Vertical core
- Hanging or cover core.
- Balanced core.
- Drop core or stop off core.
- Ram up core.
- Kiss core.

Green sand core :-

- Green sand core are formed by the pattern itself.
- A green sand core is a part of mold.
- It is made out of the same sand from which the rest of the mold has been made i.e. molding sand.

Dry Sand core :—

- Dry sand core are not produced as a part of mold.
- It made separately and independently of the mold.
- It is made of core sand which differ very much from the mold sand.
- A dry sand core is made in a core box & it is baked after ramming.
- A dry sand core is positioned in the mold on core sheets formed by core prints on the patterns.
- A dry sand core is inserted in the mold before closing the sand.

No bake sand core :—

- The sand used for preparing no bake core is similar to that of used for making no bake sand molds.
- Synthetic resins like phenol or formaldehyde are used as binder for bonding silica sand.
- certain chemicals are used as hardness catalyst to bring about a chemical reaction with the binder value to which bonding of sand grains takes place.

Oil bonded cores :-

conventional sand core are produced by mixing silica sand with a small percentage of linseed oil.

Resin bonded cores :-

- Phenol resin bonded sand is rammed in a core box.
- The core is removed from the core box & baked in a core oven at 375-450°F to harden the core.

Sodium silicate cores :-

- These core use a core material consisting of clean, dry sand mixed with a solution of Sodium silicate.

Hot box process :-

- It uses heated core boxes for the production of cores.
- The core box is made of cast iron, steel and posses vents for removing gases.

Cold set process :-

- While mixing the core sand, an accelerator is added to the binder.
- This process is used for making large cores

Castable sand process :-

- A setting or hardening agent such as di-calcium silicate is added to sodium silicate at the time of core sand mixing.
- The sand mixer possess high flowability and it chemically hardens after a short interval of time.

Horizontal core :-

- A horizontal core is positioned horizontally in the mold
- It may have any shape.
- A uniform section horizontal cores are generally placed at the parting line.
- It is very commonly used in foundries.

Vertical core :-

- On the cope side, a vertical core need more taper so as not to tear the sand in the cope while assembling cope & drag.
- A vertical core is named so because it is positioned in the mold cavity with its axis vertical.

Hanging or cover core :—

- It is known as hanging core because it hangs, it also called cover core if it covers the mold and rest on a seat made in the drag.
- It has no support from bottom.
- It is supported from above and it hangs vertically in the mold cavity.
- It can be made up of either green or dry sand.

Balanced core :—

- A balanced core is one which supported and balanced from its one end only.
- A balanced core requires a long core seat so that the core doesnot fall into the mold.
- It is used when a casting doesnot want a through cavity.

Dropcore or stop off core :—

- It is employed to make a cavity which cannot be made with other types of core.
- It is used when a hole cavity required in a casting is not in line with the parting surface, rather it is above or below the parting line of casting.

Scanned by CamScanner

Ramup core :-

- It is one which is placed in the sand along with the pattern before ramming the mold.
- It cannot be placed in the mold after the mold has been rammed.
- It is used to make internal or external details of a casting.

Kiss core :-

- It doesnot require core seats for getting supported.
- It is held in position between drag & cope due to the pressure exerted by cope and drag.
- A number of Kiss core can be simultaneously positioned in order to obtain a number of holes in a castings.

Methods of making cores :—

Steps involved :—

(1) core sand preparation
(2) Making the cores
(3) Baking the cores
(4) finishing the cores.
(5) Setting the cores.

1. Core sand preparation :—

The core sand of desired type and composition along with the additives is mixed manually.

2. Making the cores :—

Cores are prepared manually or using machines depending on the need.

Machines like – Jolt machine, sand slinger, core blower etc are used for large scale continous production, while small size cores are manually made in hand filled core boxes.

A core box is similar to a pattern that gives a suitable shape to the core.

3. core baking :—

cores are baked in oven in order to drive away the moisture in them & also to harden the binder.

The temperature and duration for baking may vary from 200 to 450°F & from a few minute to hours respectively. Depending upon size of the core & binder used.

4. core finishing :—

The baked core are finished by rubbing or filling with special tools to remove fins, bump, loose sand.

The cores are also checked for dimensions and cleanliness.

Finally if cores are made in parts, they are assembled by using suitable post, pressed and dried in air before placing them in the mold cavity.

Core Binders :—

A core binder —
→ holes;
→ Sand grains together.
→ give strength to core.

→ Make core to resist errosion & braking.
→ Impact adequate collapscibity to core.

Core binders are of following types:-
↳ Organic binder.
↳ Inorganic binder.
↳ other binder.

Organic binder :-

(1) core oil :
They may be : Vegetable (Linseed oil)
Marine animal (Whale oil).
Mineral oil.

(2) cereal binders:

They are : Gelatinized starch.
Gelatinized cornflour.

(3) Water soluble binders:

They are : Dextrin made from starch
Molasses.

(4) Wood Product binders :
They are : natural resin (thermoplastic)
Sulfite binder

Inorganic binder :-

- They are fireclay, bentonite, silica flour, ironoxide etc.
- These binder developes green strength, baked strength, hot strength & give smooth surface finish.

Other binders :-

They are portland cement, cements, sodium silicate.

Mold & Mold making :-

A mold is a one kind of container which when poured with a molten metal produces a casting of the shape of the mold.

The process of making mold is referred as mold making.

Mold characteristics :-

- A mold most possess refractoriness to bear the high heat of molten metal.
- posses strength to hold the weight of molten metal.
- Produce a minimum amount of mold gases.
- Be able to resist the errosive active of the molten metal being poured.

- Resist metal penetration into the mold walls.

Types of mold :-

- Green sand mold.
- Dry sand mold.
- Skin-dried mold.
- Air-dried mold.
- core - sand mold.
- Loam sand mold.
- shell mold.
- Cement bonded shell mold.
- Metal mold.
- Investment mold.
- Ceramic mold.
- Plaster mold.
- Graphite mold.
- Sodium silicate - CO_2 mold.

Method of molding method :-

Various molding method are:

- Bench molding.
- Floor molding.
- Pit molding.
- Machine molding.

Bench molding :-

- Molding is carried out on a bench of convenient height.
- Small & light molds are prepared on benches.
- The molder makes the mold wild standing.
- Both green and dry sand mold can be made by bench molding.
- Both ferrous and non-ferrous castings are made by bench mold.
- Both cope & drag are made on bench mold.

Floor molding :-

- Molding work is carried out on foundry floor when molds size is large & molding cannot be carried out on a bench.
- Medium and large size castings are made by floor molding.
- The mold has its drag portion in the floor and cope portion may be rammed in a flask and inverted on the drag.
- Both green and dry sand molds can be made by floor molding.

Bench molding :-

- Molding is carried out on a bench of convenient height.
- Small & light molds are prepared on benches.
- The molder makes the mold while standing.
- Both green and dry sand mold can be made by bench molding.
- Both ferrous and non-ferrous castings are made by bench mold.
- Both cope & drag are made on bench mold.

Floor molding :-

- Molding work is carried out on foundry floor when molds size is large & molding cannot be carried out on a bench.
- Medium and large size castings are made by floor molding.
- The mold has its drag portion in the floor and cope portion may be rammed in a flask and inverted on the drag.
- Both green and dry sand molds can be made by floor molding.

Pit molding :—

- Very big castings which cannot be made in flask are molded in pits on the floor.
- Very large job/product can be cast easily through pit molding.
- The mold has its drag part in the peat and a separate cope is rammed and used above the pit (drag).
- In pit molding, the molder may enter the drag & prepare it.
- A pit is of square or rectangular shape.
- The sides of the pit (drag) are lined with brick and the bottom is covered with molding sand.
- Gates, runner, pouring basins, sprue etc are made in the cope.

Machine molding :—

- Whereas in bench, floor, pit molding the operation is carried out manually by the hands of the molder, incase of machine molding all the operations are done by machines.
- Machines perform these operations much

fact, more efficiently and in a better way.

- Molding machine produce identical and consistant product.
- It produce casting of better quality and at lower cost.
- Molding machines are preferred for mass production of the casting whereas hand molding (bench, floor, pit) is used for limited production.

Few types of molding machines are :—

(a) Jolt machine.

(b) Squeezer machine.

(c) Jolt - Squeezer machine.

(d) Sand slinger.

Different methods of ramming :—

*Hand ramming :—

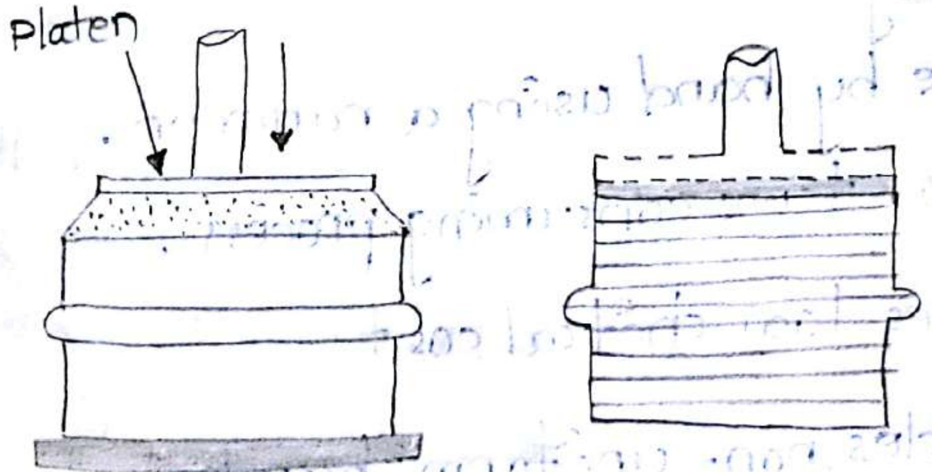
- It is done by hand using a rammer.
- It is slow, time consuming process.
- It involves low initial cost.
- It provides non-uniform hardness.

★ Machine ramming :-

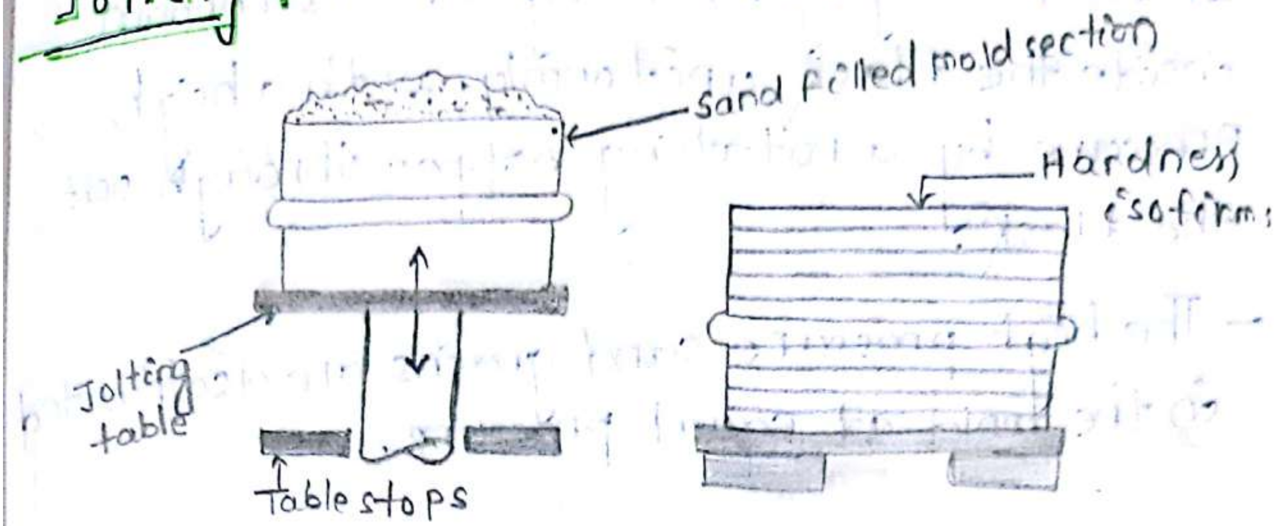
- Squeezing.
- Jolting.
- Sand slinging.

Squeezing :-

1. Flask is filled with loose sand.
2. A platen which can closely enter the flask, contact the upper surface of the loose sand filled in the flask.
3. An air pressure is applied with the help of a piston cylinder arrangement.
4. Squeezing is suitable for relatively small work.
5. Sand is more compact in the upper portion of the flask as compare to its lower portion.

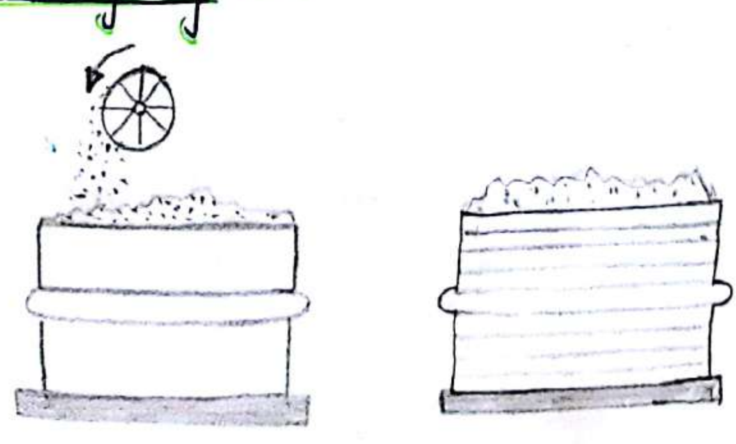


Jolting :—



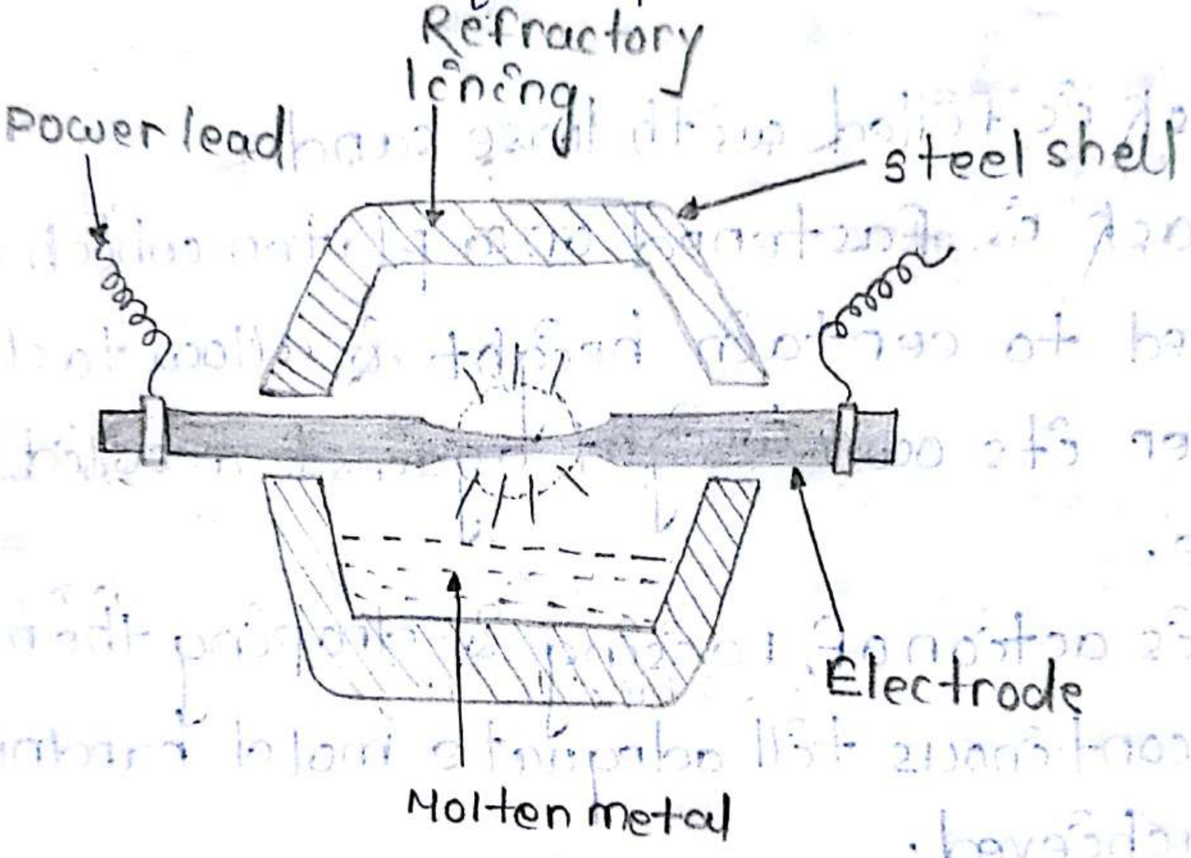
1. Flask is filled with loose sand.
2. Flask is fastened on a platen which is raised to certain height & allow to drop under its own weight against a solid bed plate.
3. This action of raising & droping the molding box continous till adequate mold hardness is achieved.
4. Jolting is based for ramming horizontal surface.
5. Sand is more compact in the bottom portion of the flask as compare to its upper portion.

Sand Slinging :—

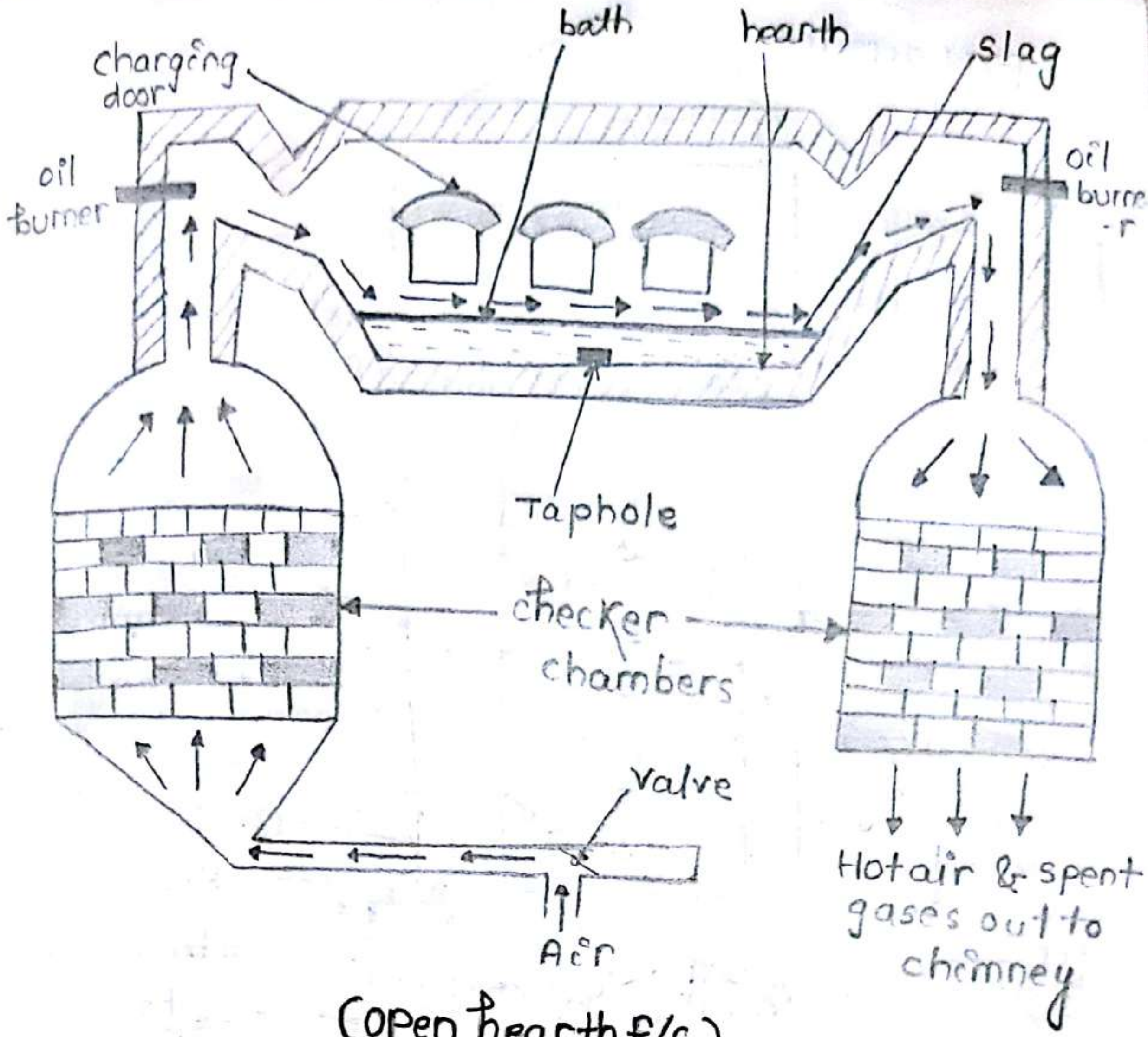


- In sand slinging, molding sand is thrown inside the flask uniformly with a high pressure by a rotating hopper through out the flask.

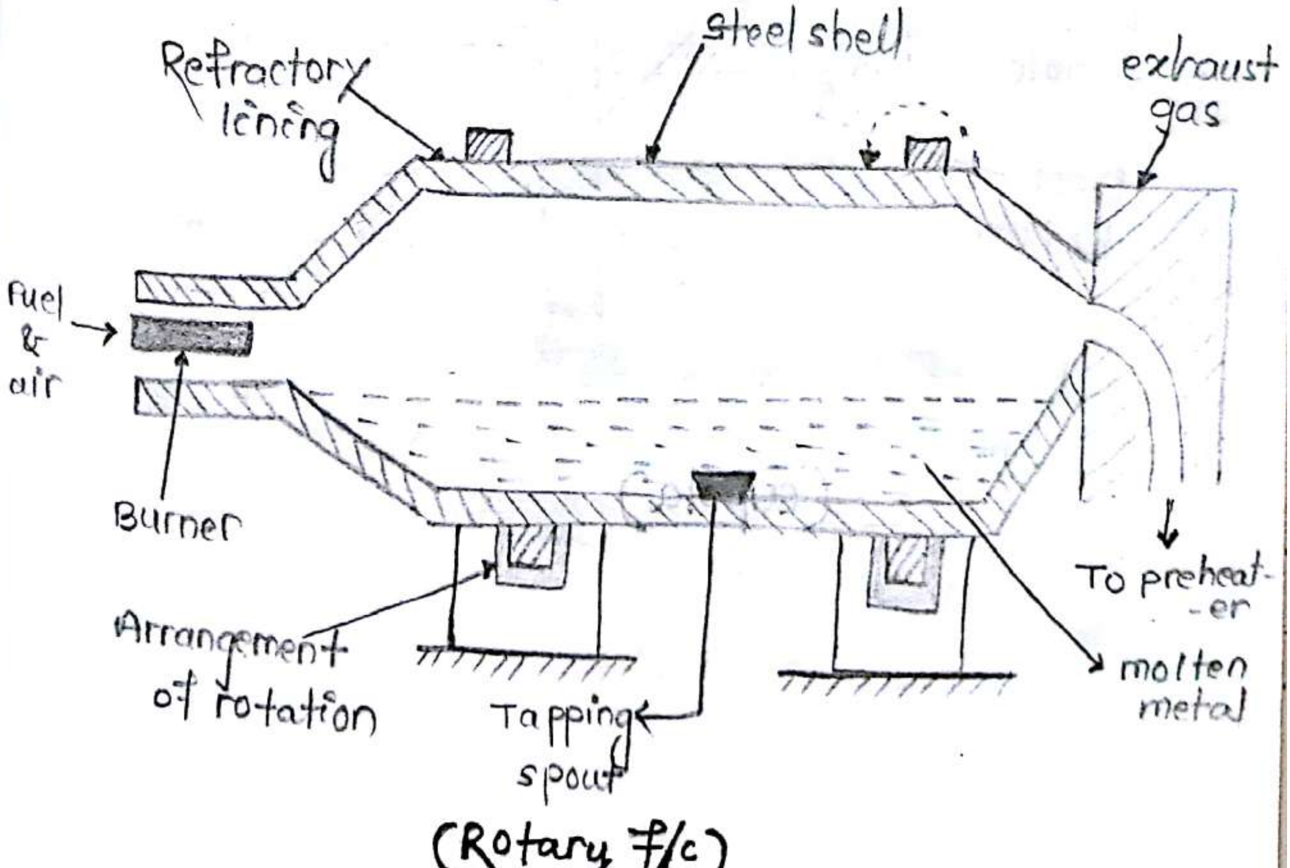
- The high pressure sand grains are distributed in the mold at equal pressure.



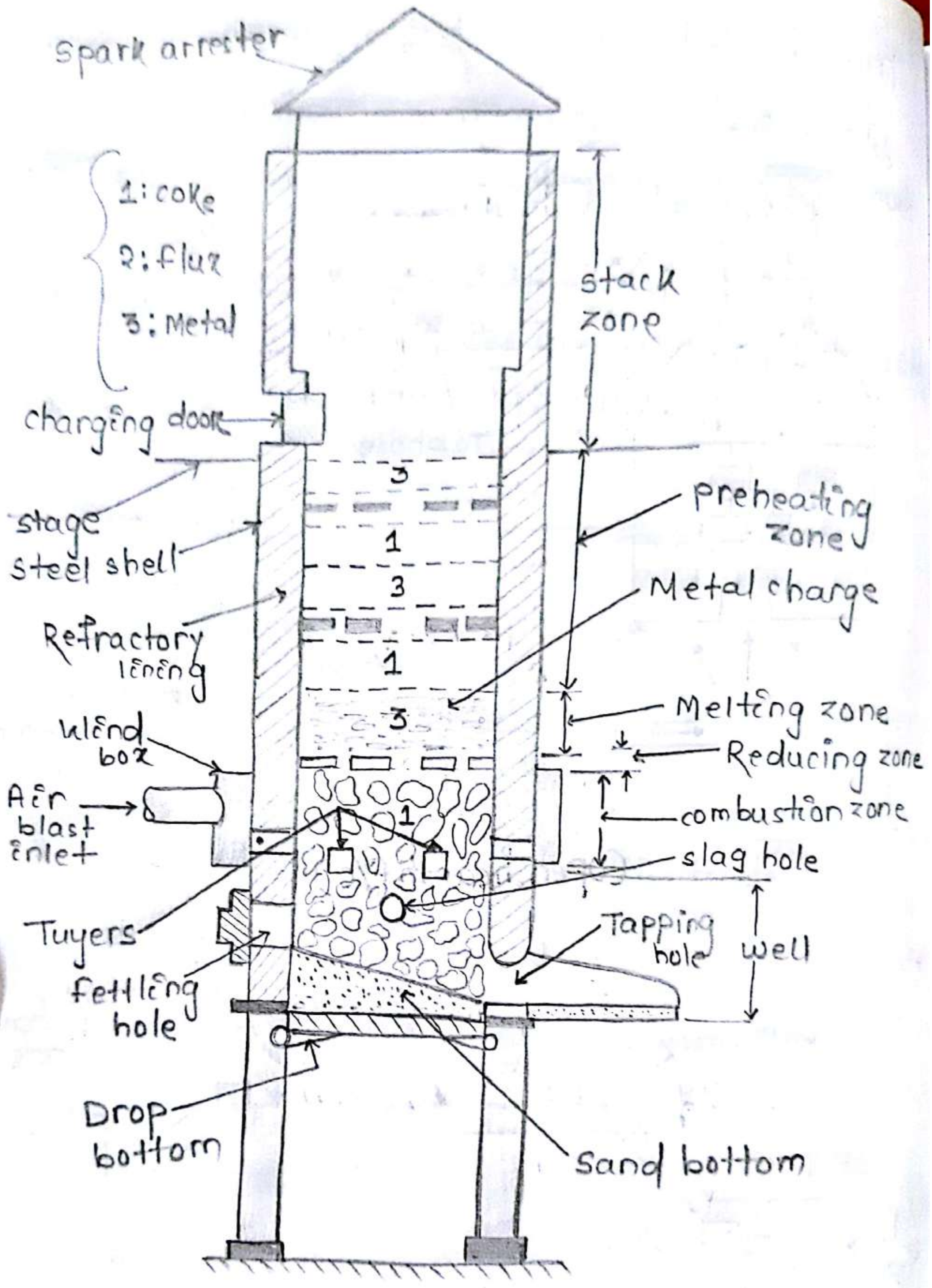
(Resistance heating f/c)



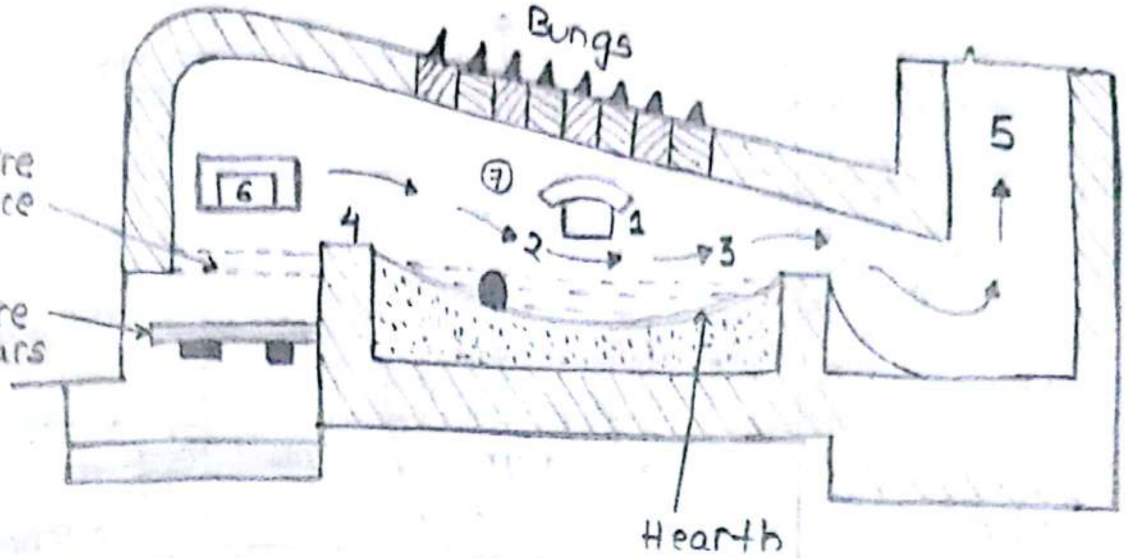
(open hearth f/c)



(Rotary f/c)

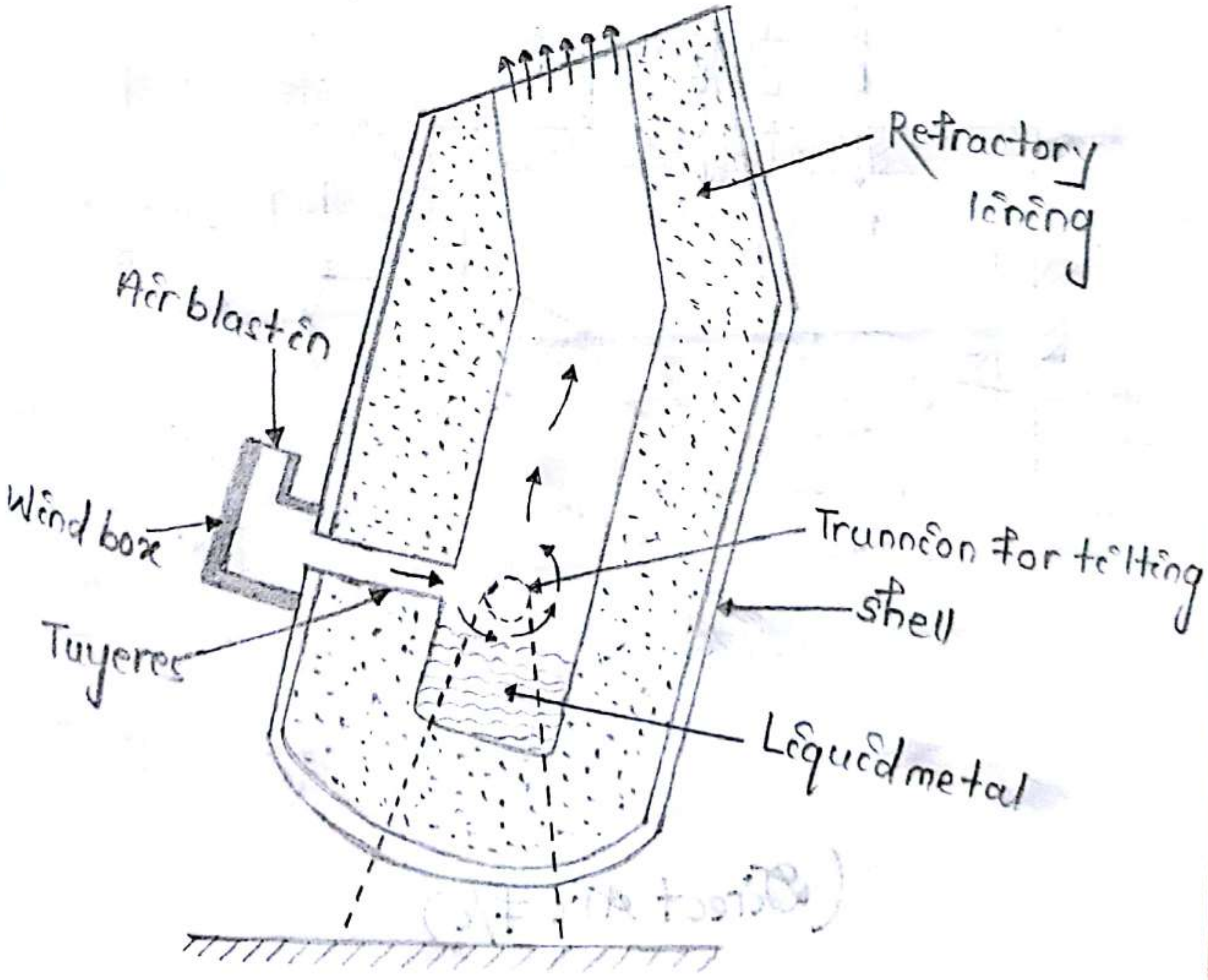

spark arrester
1: coke
2: flux
3: Metal
stack zone
charging door
stage
steel shell
Refractory lining
wind box
Air blast inlet
Tuyers
fettling hole
Drop bottom
preheating zone
Metal charge
Melting zone
Reducing zone
combustion zone
slag hole
Tapping hole
well
Sand bottom
3
1
3
1
3
1

(cupola)

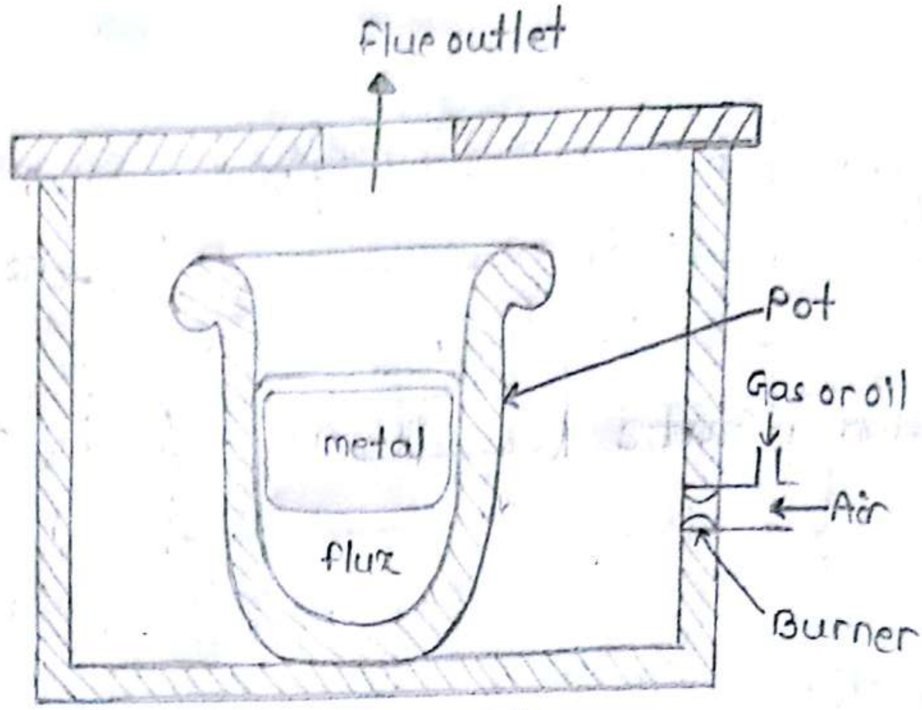


(1) Skimming door (2) Tap hole (3) Molten iron
(4) Fire bridge (5) stack (6) Firing door (7) sight hole

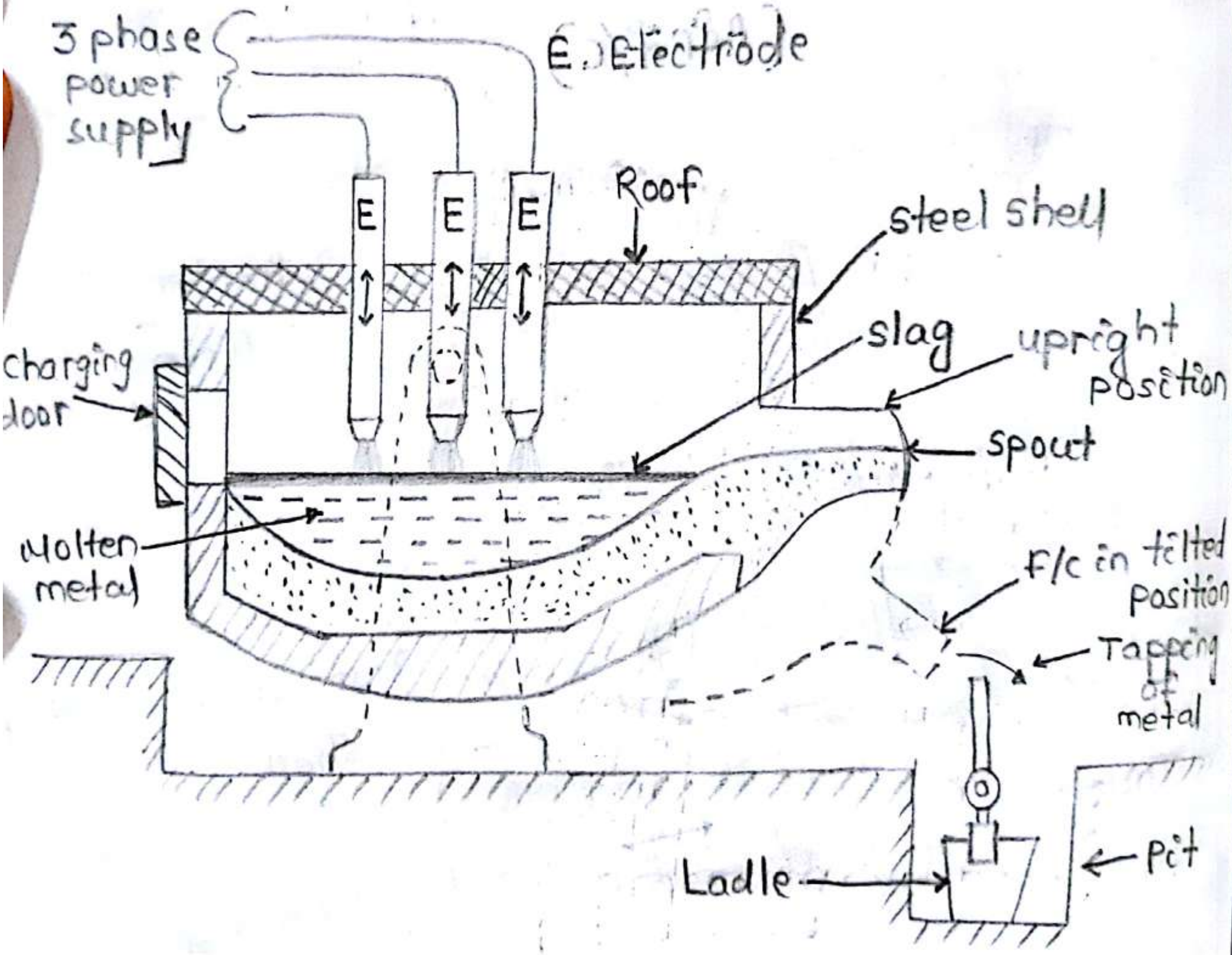
(Air F/C)



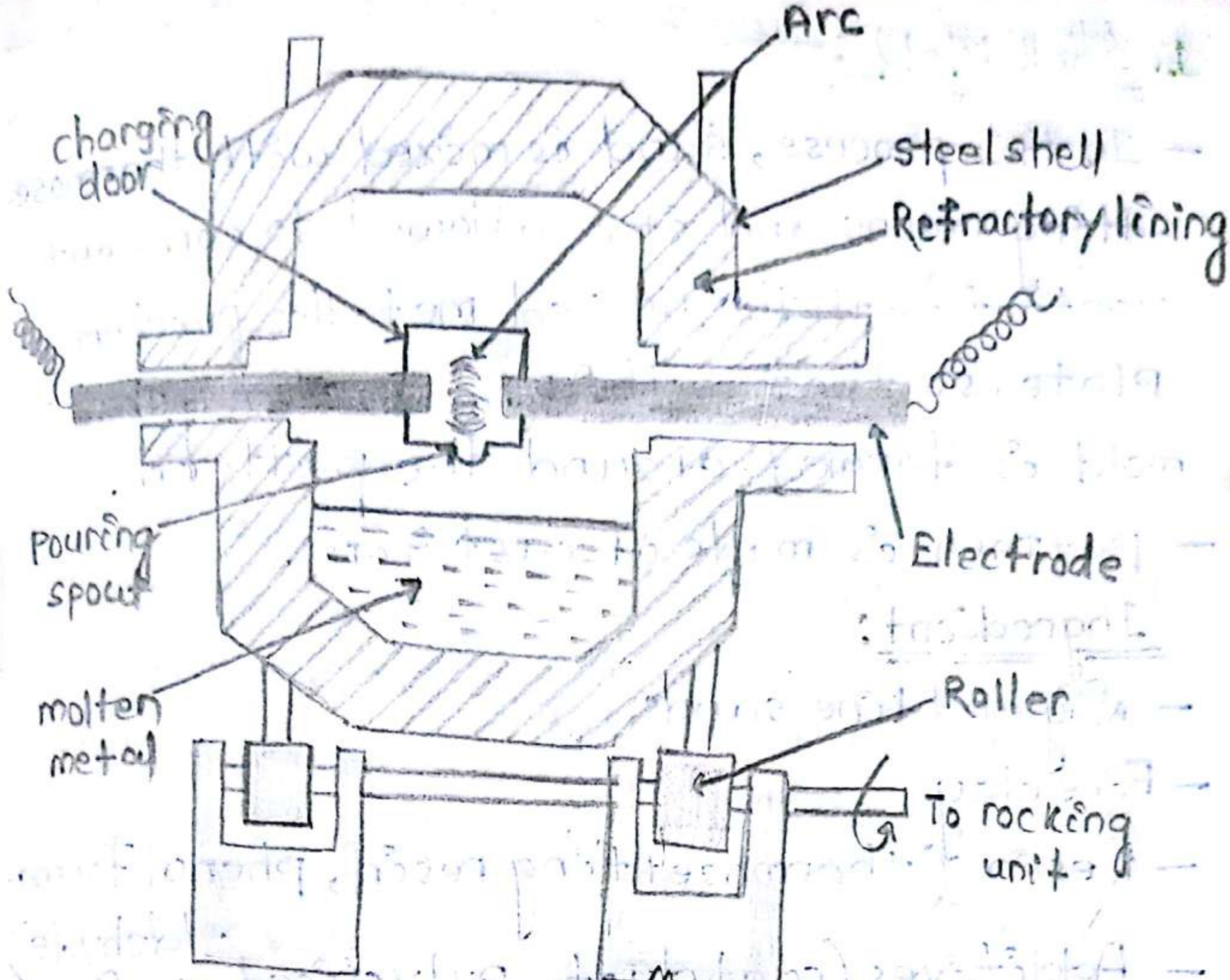
(Side-blown converter)



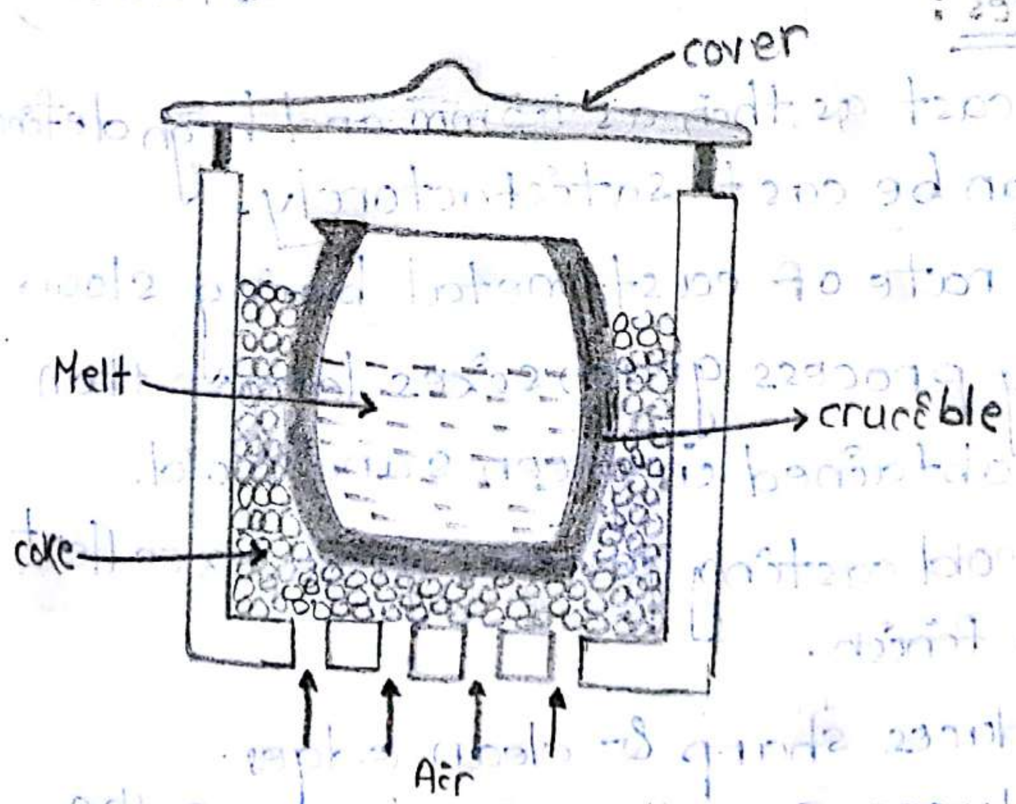
(Pot F/c)



(Direct Arc F/c)



(An indirect Arc f/c)



(crucible f/c)

Types of Mold :—

1. Shell Mold :—

- In this process, sand is mixed with thermosetting resins and it is allowed to come into contact with the heated metallic pattern plate, so that a thick and strong shell of mold is formed around the pattern.
- Pattern is made of cast iron.

Ingredient:

- Dry and fine sands
- Fire clay
- Resin (thermosetting resin, phenol formaldehyde)
- Additives (coal dust, pulverised slag).
- Lubricants (calcium stearate, lime stearate)

Advantages:

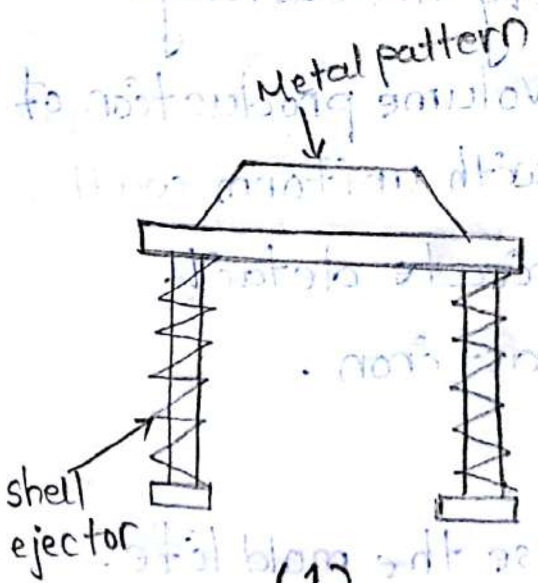
- We can cast as thin as 1.5mm and high definition can be cast satisfactorily.
- cooling rate of cast metal being slow, casting process grain sizes larger than those obtained in green sand mold.
- Shell mold casting process give excellent surface finish.
- It produces sharp & clean edges.
- It produces smoother surface of the castings.

Disadvantages :=

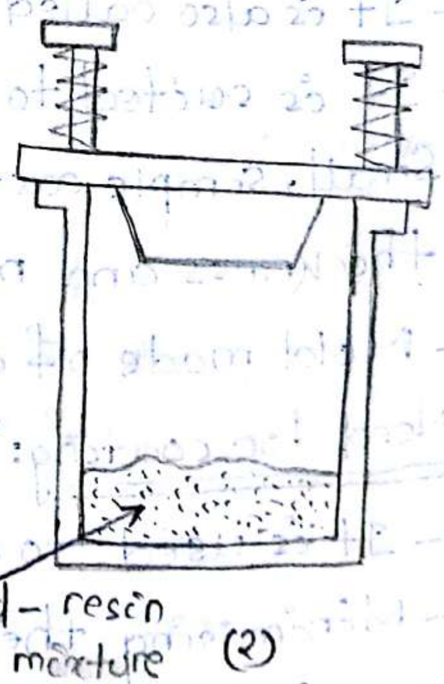
- It is economical on small scale production
- Resin cost are comparatively high.
- Low carbon steel castings made by shell moulding may show depression on their upper surface.

Application :=

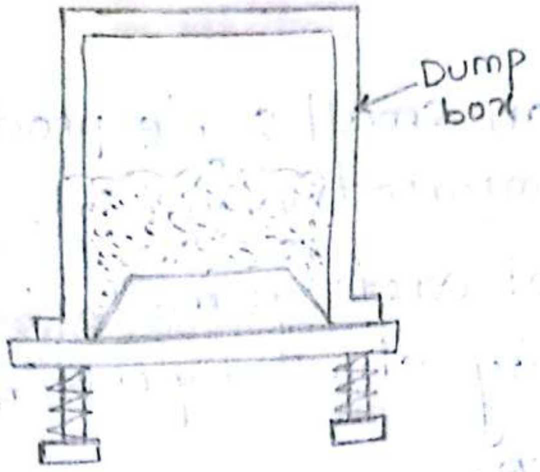
- It is ideal for mass production of small casting.
- It is suited to ferrous & non-ferrous alloy castings in the range 0.1-10Kg.
- A number of small hydraulic castings in stainless steel & copper alloys are produced.
- Small pipes, brackets, spacers, valve a bodies, shafts & gears.



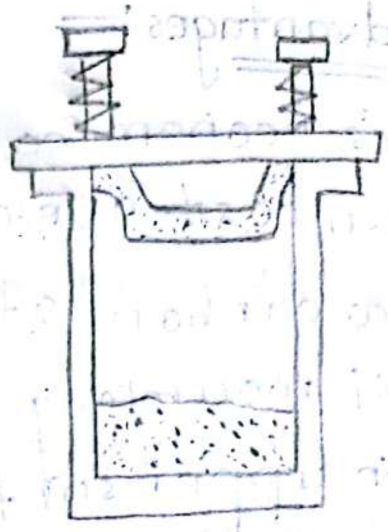
(1)



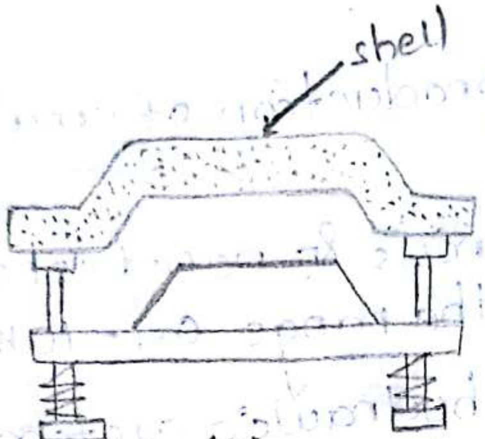
(2)



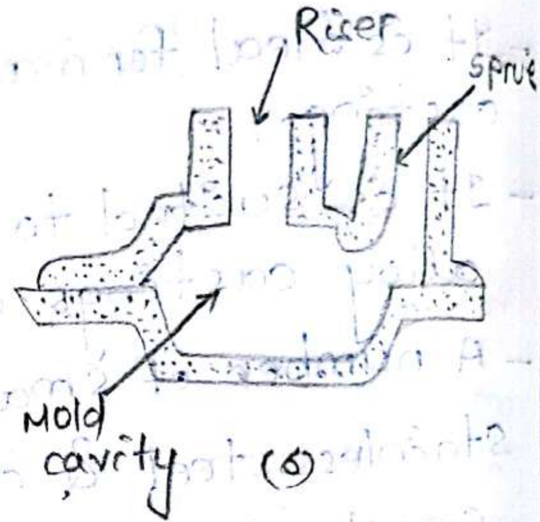
(3)



(4)



(5)



(6)

2. Permanent Mold :—

- It is also called gravity die casting.
- It is suited to high volume production of small, simple castings with uniform wall thickness and no intricate detail.
- Mold made of grey cast iron.

Need for coating:

- It is used to increase the mold life.
- Minimising thermal soak to the mold material
- controlling the rate & direction of the casting solidification.

Advantages:

- Good and fine casting.
- It is very economical.
- close dimensional tolerance.
- Good surface finish

Disadvantages:

- All materials are not suitable for this process.
- complicated shapes are not possible.
- Dies cost is high.

Application:

- Automobile, pistons, stator, gear plank, connecting rod, aircraft fittings.

3. Investment mold :-

- It is also called lost wax process or precision casting.
- In this process, there is greater freedom of design.
- It is used for gas turbine blades.
- Mold is prepared around an expandable pattern (wax, mercury, plastic)

Steps:

- Producing a die for making wax pattern.
- Making of expandable pattern and getting system.

- Investing the wax pattern for the production of mold.
- Removing wax pattern from the investment mold.
- Pouring metal into the mold.
- After solidified, the castings are removed from the mold.
- cleaning, finishing and inspection.

Advantages:

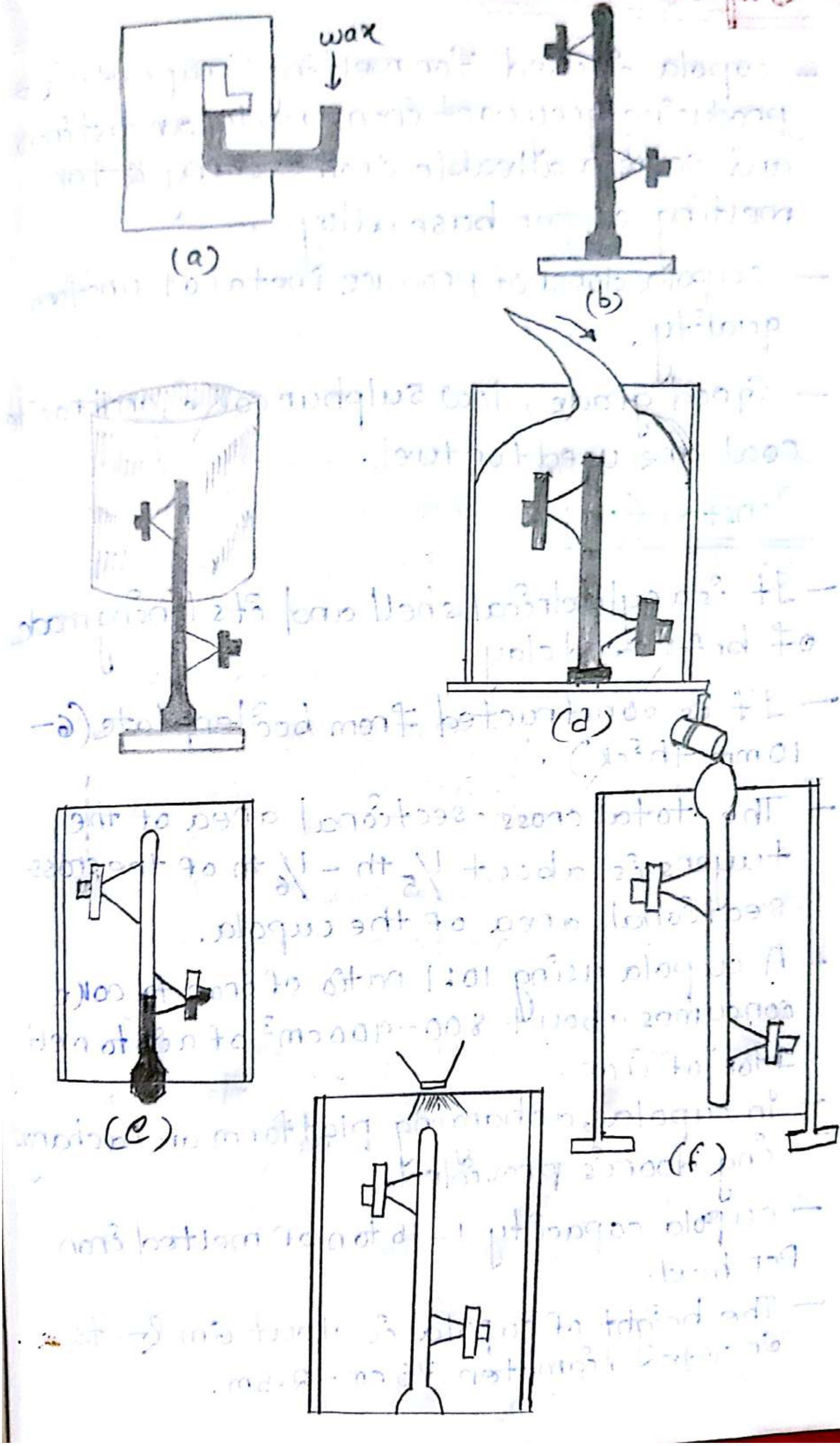
- close dimensional tolerance.
- Good surface finish.
- Complex shapes can be produced.

Disadvantages:

- More expensive process.

Applications:

- Gas turbine blade.
- Jewellary.
- Surgical instrument.
- Triggers for fire alrams.


wax
(a)
(b)
(d)
(e)
(f)

Cupola Furnace :—

- cupola is used for melting Scrap metal & producing grey cast iron, nodular cast iron and some malleable iron casting & for melting copper base alloys.
- cupola doesnot produce metal of uniform quality.
- Good grade, low sulphur coke, anthracite coal are used for fuel.

Construction :—

- It is a cylindrical shell and its lining made of brick and clay.
- It is constructed from boiler plate (6-10 mm thick).
- The total cross-sectional area of the tuyers is about $1/5$ th - $1/6$ th of the cross-sectional area of the cupola.
- A cupola using 10:1 ratio of iron to coke consumes about 800-900 cm^3 of air to melt 1 ton of iron.
- In cupola, a charging platform and a charging door is provided.
- cupola capacity 1-15 ton of melted iron per heat.
- The height of cupola is about 6m & its inside diameter 75 cm - 2.5m.

Cupola Operation :-

(a) preparation of cupola :-

- slag, coke and iron sticking into the side walls of the f/c are removed and clean.
- Damaged fire bricks are replaced by new one.
- The f/c lining is reconditioned.

(b) Lightning the fire :-

- cupola is started about 3hrs before the molten metal is needed.
- soft and dry pieces of wood are placed on the sand.
- coke is placed over the wooden pieces and the wooden pieces are ignited.
- air necessary for combustion of coke enter from the tuyers.
- When the initial coke is burning well, an additional amount of the same is added to the desire height.
- coke bed height is around 75cm above the tuyers levels.

(c) Charging of cupola :-

- Input material are coke, flux, metal (pig iron, cast iron scrap, steel scrap).
- Fluxes are basic and therefore should not be added in large amount otherwise they will attack the acid refractory lining of cupola.

- The quantity of limestone varies from 2 to 4% by weight of the metal charge.
- Fuel used are a good grade of low sulphur coke, anthracite coal, carbon briquette.
- The ratio of metal to fuel by weight ranges 4:1 to 2:1.

(d) Melting :=

- After the cupola is fully charged a soaking period of about 30 min – 1 hour is given for pre-heat.
- Blowers are not started during the soaking period. At the end of the soaking period the blast is turned on.
- After air blast has been on for about 10 min, molten iron starts accumulating in the hearth.

(e) Slagging & metal tapping :=

- After enough metal iron has collected, the slag hole is open and the slag comes out.
- In the same way, the molten metal also come out through the tapping hole.

(f) Dropping down the bottom :=

- Near the end of the cupola, charging of cupola is stopped.
- All the contains in the cupola are allowed to melt till 1 to 2 charges are left above the coke bed.

- The bottom door is knocked down & the remains in the cupola are either dropped onto the floor or into a bucket.

Zones of a Cupola :-

(a) **Well** :-

- It is a well of molten iron which is collected in this zone before tapping.

(b) **Superheating, combustion or oxidising zone** :-

- It is situated 15cm to 30cm above the top of the tuyers.
- In this zone, combustion reaction takes place. so, alot of heat is liberated.
- chemical reaction which occur in this zone are:

$$C + O_2 = CO_2 + heat$$

$$2Mn + O_2 = MnO_2 + heat$$

$$Si + O_2 = SiO_2 + heat$$

(c) **Reducing zone or protective zone** :-

- It extends from the top of combustion zone to the top of coke bed.
- It has reducing atmosphere, so it protects from oxidation.
- An endothermic reaction takes place in this zone in which some of hot CO_2 moving upward through hot coke get reduced.

$$CO_2 + C = 2CO$$

- Temperature = 1200°c.

(d) Melting zone :—

- Temperature = 1600°c
- As per the following reaction, the molten iron picks up carbon

$$3Fe + 2CO = Fe_3C + CO_2$$

(e) preheating zone :=

- In this zone, the cupola charge lies as alternate layers of coke, limestone & metal.
- Gases like CO_2, CO & N_2 rising upwards from combustion and reducing zones preheat the cupola charge to about 1100°c.
- So, the preheated charge gradually moves down in the melting zone

(f) Stack zone :=

- Hot gases from cupola pass through the stack zone and escape to atmosphere.
- composition of gases is equal amount of CO_2 and CO which is 12% each and the rest is 76% nitrogen.

Advantages of cupola :=

- Simple design and easier construction.
- Low initial cost as compared to other f/c.
- Simple to operate and maintain in good condition.
- Economy in operation & maintanance.
- It can be continously operated for many hours

Limitation of cupola :-

- Since molten iron and coke come in contact with each other, certain elements (silicon & manganese) are lost while others like sulphur is come from coke.
- close tempr control is difficult to maintain.

Modern Trends in Cupola :-

1. The most recent development in cupola is plasma assisted shaft f/c, where electrical energy is used to heat hot blast air.
2. pilot plant work has demonstrated usefulness of the technique to produce hot blast tempr in the range of 2000 - 3000 °F.
3. Today environment dictates require that cupola top gas CO to be burned before going to atmosphere.
4. Investigations are underway to determine the feasibility of using excess cupola top gas energy to produce oxygen rich air for blast purpose.
5. The gas fired or coke less cupola is creating interest, particularly as a low sulphur melter for ductile iron production.
6. The main trend in cupola design is to achieve high thermal efficiency, uniform

chemistry & tempr level in the tapping metal.

These goals are achieved through the use of combination refractory lined, watercooled, side wall design, to minimise heat loss to cooling water, proper combination of effective stack height & vertical shaft velocity, to minimise heat transfer in the preheat zone & reduce top gas sensible heat loss.

Electric Arc F/C :-

Electric arc f/c are used for the production of high quality castings.

→ Used for melting steel.

→ capacity - 250 kg - 10 tons.

Direct Electric Arc F/C :-

→ It is most widely used remelting unit in steel foundries.

→ It re-melts steel of widely differing composition.

→ Its diameter is upto 6 metre and capacity of about 125 ton.

Operation :-

- The interior of the f/c is preheated before placing the metal charge in the f/c.
- After preheating, the electrode pieces placed on the hearth are removed.
- The f/c is charged through the charging door. Once the cold charge has been placed on the hearth of the f/c, electric arc is drawn between the electrodes and the surface of the metal charge by lowering the electrodes down till the current jumps the gap between the electrode & the charge surface.
- Before pouring the liquid metal into the laddle, the f/c is tilted backward and the slag is poured off from the charging door.
- The f/c is then tilted forward and the molten metal is emptied into laddles.

Advantages :-

- Closed temperature and heat control.
- Analysis of melt can be kept to accurate limits.
- It is not difficult to control the f/c atmosphere above the molten metal.
- It can make steel directly from pig iron and steel scraps.

- Arc f/c are longer and its electrical equipments is cheaper to install.

Limitation :-

- Heating costs are higher than for other f/c.

Uses :-

- In general, high quality carbon steel & alloy steels are made in electric direct arc f/c.

Indirect Electric Arc f/c (Rocking f/c)

- It is used for producing smaller melts as compared to direct electric arc f/c.
- Unlike direct electric Arc f/c, an electric arc is placed between two graphite electrodes.
- An indirect electric Arc f/c is of rocking type.
- Metal charge melts because of the heat radiation from the arc and the hot refractory walls of the f/c.
- It is used for the melting cast iron, steel, copper & its alloy.
- It obtains lower temp^r and has less efficiency as compared to direct electric arc f/c.

Operations :-

- Initially, pig iron is charged in the f/c above pig iron, scrap is placed.
- With electric power ON, graphite electrodes are brought nearer till the current jump and an electric arc is setup between them.
- The heat generated in the arc is responsible for melting the charge.
- As soon as some metal has melted, the f/c is set to rock to and fro.
- Rocking helps better heat exchange betn refractory lining, molten metal & solid metal.
- When the melting is complete, the f/c is tilted mechanically to permit liquid metal to flow out through the tap hole into the laddle.

Advantages :-

- Rocking of f/c avoids overheating & therefore decreases the chances of damaging refractory linning.
- Its speeds of melting and stirs the bath and provides a melt of uniform composition.

- Low cost Scrap metals can be used in an indirect arc f/c.
- Operation & control of the f/c are simple.

Core-less type high frequency induction furnace

A high frequency induction f/c consist of a refractory crucible placed centrally inside water cooled copper coil and packed into position by ramming dry refractory tightly between the crucible and the copper coil.

Principle of operation :-

- Steel Scrap is placed in the f/c as metal charge.
- A high frequency current is passed through the water cooled copper coils.
- Therefore heavy alternating currents induced in the metal charge by electro-magnetic induction which create heat. This heat develop in the skin of metal charge reaches inside by conduction & melts the charge.
- A magnetic stirring action on the molten metal speeds up the melting

process and mixes up the metal charge unifo-
-rmly.

- Frequency ranging from 500 - 10,000 cycles per second.

Advantages :-

- It can melt relatively small quantities (from 1.5 kg to 12 tons) of a wide variety of metals & alloys quickly.
- Magnetic stirring of the melts produces excellent uniformity of the composition.
- Rate of energy input can be easily controll-
-ed.
- f/c atmosphere can be easily controlled.
- It doesnot need a warming up time.
- A number of alloys one after the other can be easily melted.
- Addition of elements like nickel, Co, Cr, W, Mo, V can be made easily.

Limitation :-

- The initial cost of f/c is high.
- Due to the speed with which the process of melting is completed, there is little time available for analysis melt composit-
-ion.

Applications :—

- It is very useful for melting general, special, alloy & high quality steels in small quantities.

Principle of Riser :—

- A riser is a passage of sand made in the mold during ramming the cope.
- The molten metal rises in the riser after the mold cavity is filled up.
- This metal in the riser (feeder head) compansates the shrinkage as the casting solidifies.

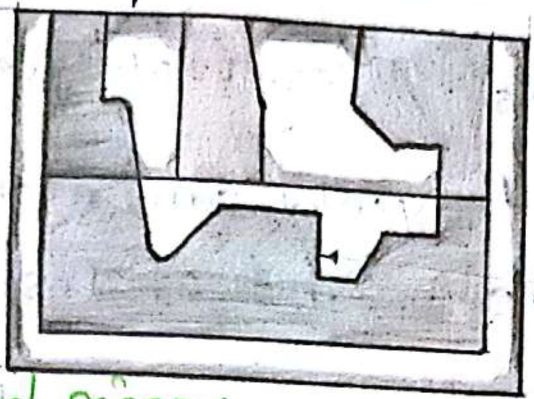
Function of riser :—

- The primary function of riser is to feed metal to the casting so that shrinkage cavities can be filled up.
- A riser permits the escape of air and mould gases as the mold cavity is filled with molten metal.
- A riser full up molten metal indicates that the mold cavity has already been completely filled up.
- Risers promote directional solidification

Two types of Riser :—

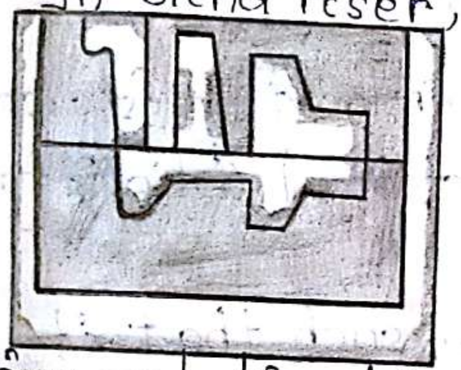
↳ Open riser :

- The top of the open riser is open.
- It is exposed to atmosphere:



↳ Blind riser :

In blind riser, top is closed.



Riser and directional Solidification :—

- Riser and directional solidification are inter-related because when solidification proceed directionally from the casting towards the riser, the result is a sound casting.
- A riser is very necessary for all casting to avoid shrinkage defects.

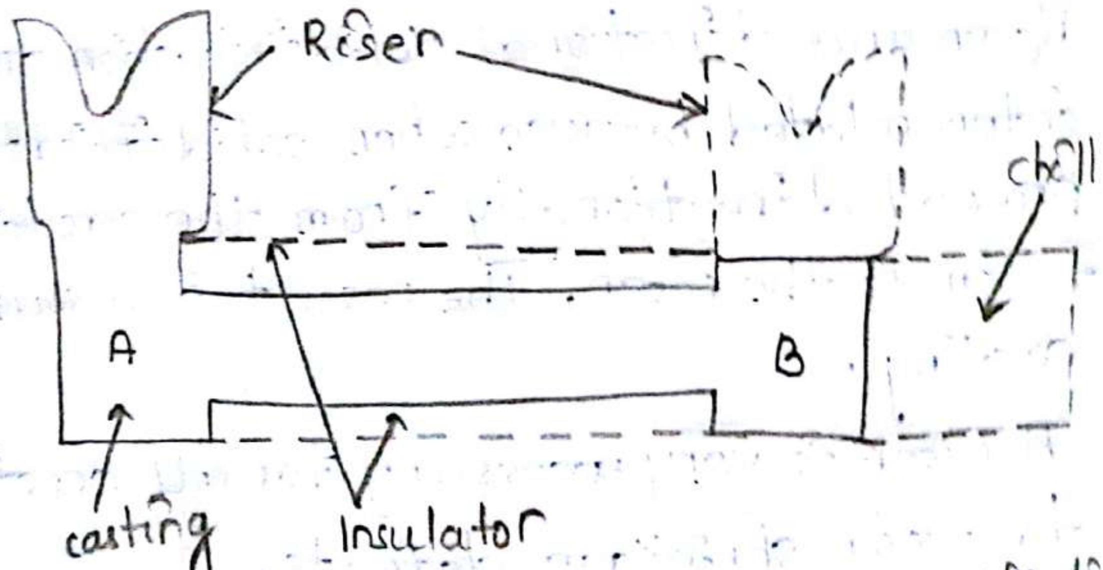
$$\text{yield} = \frac{W_c}{W_c + W_{RS}} \times 100$$

- The yield for the casting should be high

Here, W_c = Weight of the casting.

W_{RS} = Weight of riser, sprue etc.

- This indicates the yield can be increased by reducing the weight of riser, sprue
- Weight of the riser can be reduced by making its size small.
- Besides riser size, riser location is also important as for directional solidification.
- Riser location should be such that it promotes directional solidification.



(Riser location and directional Solidification)

- This figure shows a single riser to feed the casting.
- The result is a shrinkage defect in the casting.
- There way to hotspot at two portion 'A' and 'B' of the casting & the solidification occurs directionally towards them (i.e. from thin to thick section).
- Hotspot at 'A' could be fed by riser whereas hotspot at 'B' was unfed. And this was the reason for shrinkage to occur.
- However, the shrinkage at 'B' can be avoided by providing a second riser at 'B' (dotted part).

Riser efficiency :—

$$\text{Efficiency} = \frac{I - F}{I} \times 100$$

where, I = Initial volume in the riser

F = Final " " " "

I - F = Amount of metal supplied to the casting by riser.

- Solidification in the casting as well as in the riser start at same time.

- Efficiency of riser may be increased by employing or providing the following methods :=

(a) Insulating material.
(b) Exothermic material.
(c) Use of chills.
(d) Use of padding.
(e). Use of chaplets..
(f) Use of molding materials of different chill capacity.
(g) Use of Topping up :

Insulating Material :=

- Solidification in riser or thin section of mold may be delead by simple insulation.
- Insulation can be done by using insulating powder, Insulating sleeve, insulating pad.
- We can achieve by adding powder graphite or charcoal & refractory powders.

Exothermic Materials :—

- These materials create considerable amount of heat by exothermic reaction.
- The use of exothermic compounds improve efficiency about 70%.

chills :—

- chills are metal shapes inserted in mold to speed of the solidification of a particular portion of the castings.
- chills equalised the cooling rate of thin & thick section and prevent hot tears.
- chills promote progressive & directional solidification.

Padding :—

- When others methods of achieving directional solidification cann't be used at that time we can go for padding, which developes tempr gradient for directional solidification.
- It involves a modification in the fundamental design of the casting.
- Where by thin sections are thickened or a tapper is introduced to achieve directional solidification.

Mold materials of different chill capacities

- Mold materials with different heat conductivity (those having different chill capacities) may be used to control the directional solidification

- Varies mold materials with increasing chilling ability are :-

(i) chamottee.

(ii) Zircon.

(iii) chrome ore.

(iv) alumina.

(v) Magnesite.

(vi) Silicon carbide.

Topping up :-

- It is useful with very heavy casting having long solidification time.

- Topping up extend the feeding period.

- It involves addition of Super heated molten metal into the riser at suitable intervals after the mold is filled.

Scanned by CamScanner

Riser shape :-

- Riser shape is decided considering the following factors.

(i) permissible area :

- The permissible area of junction between riser and casting these should be optimum, minimum in order to reduce fettling cost.

(ii) freezing time :

chvorinov's rule :-

$$t = K\left(\frac{V}{A}\right)^2$$

$$K = 13.7 \ \text{min}/(\text{inch})^2$$

- freezing time is proportional to $(V/A)^2$

$$t \propto \left(\frac{V}{A}\right)^2$$

- Sphere shape riser will contain its metal in the liquid form for the longest period of the time.

Riser size :-

- Riser size is determine by considering freezing time & feed volume factors.

- A riser must be large enough to freeze after casting.

$$\left(\frac{V}{A}\right)_{Riser} > \left(\frac{V}{A}\right)_{casting}$$

- Since higher $\frac{V}{A}$ associates with it increased time to freeze.

Gating System :-

- Gating system refers to all passage ways through which the molten metal passes to enter the mold cavity.

The gatting system is composed of

(a) pouring cup & basin.
(b) Sprue
(c) Runner
(d) Gates
(e) Risers

Function of the gating System :-

1. fill the mold cavity completely before freezing.
2. Introduced the liquid metal into the mold cavity with low velocity and little turbulance.
3. Help to promote tempr gradient favourable for proper directional Solidification

4. Regulate the rate of which liquid melt enter into the mold.

Characteristics :—

1. A gate is a channel which connects runner with the mold cavity & through which molten metal flows to the mold cavity.

2. A gate should feed liquid metal to the casting at a rate consistent with the rate of solidification.

3. The size of the gate depends upon the rate of solidification.

4. A small gate is used for casting which solidify slowly and vice versa.

5. More than one gates maybe used to feed a first freezing casting.

6. A gate should not have sharp ages because they may break during pouring.

7. A gate basine preferable provided to act as a reserver or store for molten metal.

8. A gate basine prevent turbulent liquid metal from entering the gate.

Three major types of gate :=

1. Top gate
2. Bottom gate
3. parting line side gate.

Casting defects :=

1. **Shift :=**

Mis match of top & bottom part.

2. **Smell :=**

Enlargement of the mold cavity by metal pressure.

3. **Sand wash :=**

It occured near the ingates.

4. **fin :=**

It is a thin projection of metal not intended as part of casting.

5. **Blowhole :=**

It occured due to inadequate venting.

6. **cold short :=**

It occured when to stream of weld that are unable to fuse together properly & produce discontinuity.

7. Mis runs :-

When a section of casting is incompletely filled with metal, it is known as mis runs.

8. sand inclusion :-

When a portion of the mold breaks away or erroded by the metal stream a sand inclusion occurs.

9. Hot tear :-

→ Hot tears are solidification cracks at vari-
-ous point in a casting brought about by internal stresses resulting from restric-
-ted contraction.

→ It occured due to high residual stress that are generated as a result of the enability to shrink.

10. Scab :-

It is one kind of sand shearing in this case penetration of molten metal into mold sand happens.

Due to very fine sand.

11. Blister :-

It occured due to un-even venting design where air entrapped in metal

12. Rat tail :-

Indentation on casting surface.

13. Pull down :-

It occur in the cope of sand casting.

Cleaning of casting :-

Shake Out :

After the molten metal has been poured into the mold, it is permitted to cool and solidify when the casting was solidified, it is removed from the molding box.

This operation is known as shakeout.

Fettling :

Fettling includes :

(a) removal of cores from the casting.

(b) removal of adhearing scale & oxide scale from the casting surface.

(c) removal of gates, riser, runner etc.

Fettling operation in two stages :-

(a) Removal of cores :-

- Hammering or vibration given to core does loosen & break them.
- sand portions sticking inside the castings are removed by the pocking action using a metal load.

(b) cleaning of casting Surface :=

- The outside and inside surface of casting are cleaned of adhearing refractory particle and oxide scale and surface look smooth and pleasing.
- The extend of surface cleaning required depends upon the metal, alloy of the casting and size of the casting.
- Heavy casting suffer more than light casting.
- Sand may be removed from surface of the casting using hand method and mechanical equipments.

Sand Blasting :=

- If the strip of air carrying sand strike against the surface of casting. The process is known as sand blasting.
- In shot blasting, the stream of air carrage shots of metal..
- In sand blasting, the particles are introduced into the air stream by gravity feed, direct pressure on the abbrasive.
- In sand blasting, the sand particles are introduced into the air stream by direct pressure gravity feed, direct Pressure

on the abbrassive.

- Sand particles fed into the high velocity air jet are responsible for the abbrasion action on the casting surface, which intern get clean.

- shot blasting provides a higher rate of output.

- abbrasives are still shot, while cast iron shot, malleable iron grit.
  White cast iron grit, chilled iron grit, cut wire pillet.

- Size of the shot & grit may range upto 3mm.

- Small size shots are used for cleaning very light castings.

- shot blasting involves inter change of molecules between abbrasive particles & the abbraded casting surface.

- The air pressure used to carry abbrasives is of the order of 7kg/cm² & the velocity of particles ranging from 2050 to 4600 mtr/min.

Chemical cleaning :-

- Chemical cleaning methods utilise baths of molten caustic soda containing other additional reagent to react with & break the surface oxide layer.
- The electrolytic method involves the application of electric current.
- Pickling makes use of dil. acid for removing sand from the surface.
- Hydroflouric acid attack sand on the casting where as sulphuric acid attack casting metal.
- Pickling involves dipping the casting in acid.

Removal of gates & Riser :-

Methods are :

1. chipping hammers
2. Flogging
3. Shearing
4. Sawing
5. Abrassive wheel slotting
6. Machining

7. Flame cutting.
8. plasma cutting.

1. Chipping hammers :-

- It is an air driven hammer having a chisel as the cutting tool.
- It is used for casting of Copper, brass, bronze, ductile cast iron, low and medium carbon steel.

2. Flogging :-

- Flogging employes removing gates & risers from a casting by striking with a hammer.
- It is very suitable for brittle materials such as grey & white cast iron.

3. Shearing :-

- Shearing is carried out on a shear or shearing machine.
- It is used for small job operations.
- Al, Mg, malleable iron are operated on shearing machine.

4. Sawing :-

- Many kinds of saws are used for removing the runner, gates & riser.
- Hacksaw, circularsaw, band saw.

5. Abrassive wheel slitting :-

- It is also used for get removal.
- In this process, we can form hard or difficult to saw alloys as well as commonly foundry alloys such as grey, malleable and ductile cast iron and steel.

6. Machining :-

- Much smoother cuts can be obtained with machine cutting & no further finishing need to be carried out.

7. Flame cutting :-

- Feeder heads has larger in size & of irregular shapes on steel castings are very easily removed by oxyacetylene cutting torch.

8. Plasma cutting :-

- plasma cutting torch can be used for removing feeder heads from castings of stainless steel & non-ferrous metals and alloys.

Grinding :-

- It is generally the rough grinding which is used for cleaning the casting surface.

Trimming & Sizing :-

- castings may be trimmed & sized on shearing punching & straightening process.

Flame gauging & flame scarfing :-

- These process are adoption of flame cutting and are used to remove excess undesired material from the casting.
- This technique can removed riser pads, clean penetrated sand & prepare casting for weldings.

Centrifugal Casting :-

- In centrifugal casting, the liquid metal is introduced into rotating mold.
- Centrifugal force plays a major role in shaping and feeding of casting.

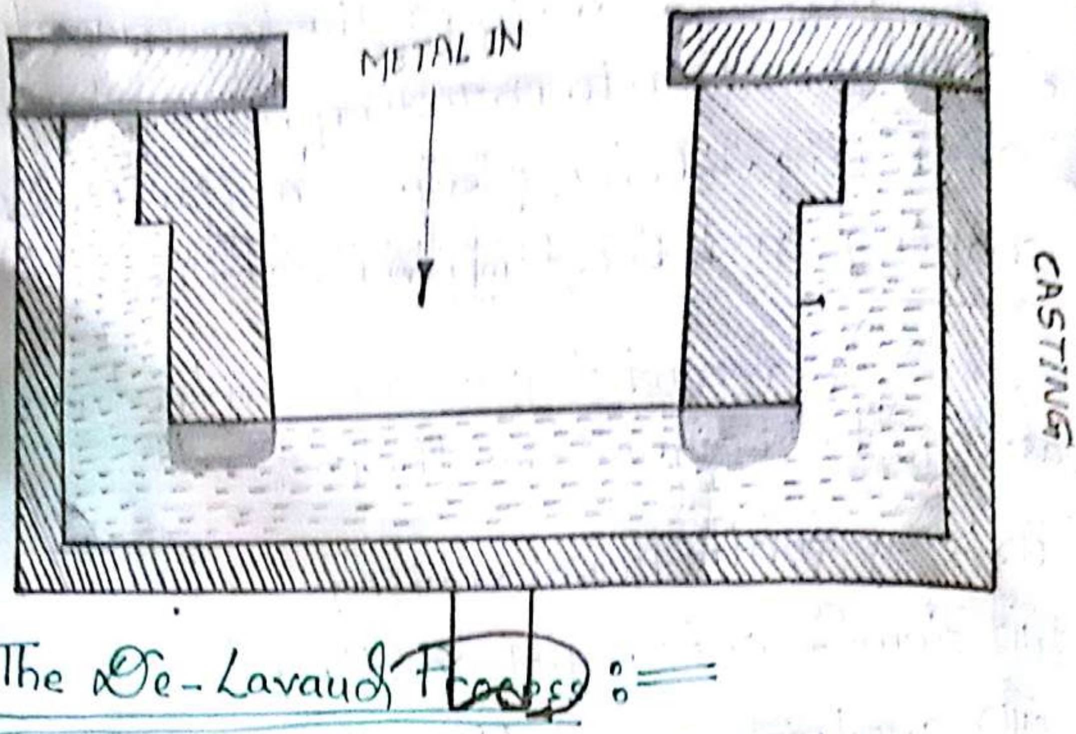
Different types of centrifugal casting techniques are there :-

(i) True centrifugal casting.
(ii) Semi- centrigal casting.
(iii) centrifuge casting.

(i) True centrifugal casting :-

- True centrifugal casting are upstraight uniform inner diameter and are produced by spinning the mold about its own axis either vertically or horizontally.
- They have symmetrical configuration (round, square, hexagonal etc) on their outer contour and donot need any centre core.
- A cylindrical mold is made to rotate on its own axis at a speed such that the metal which is poured is thrown to the outer surface of the mold cavity

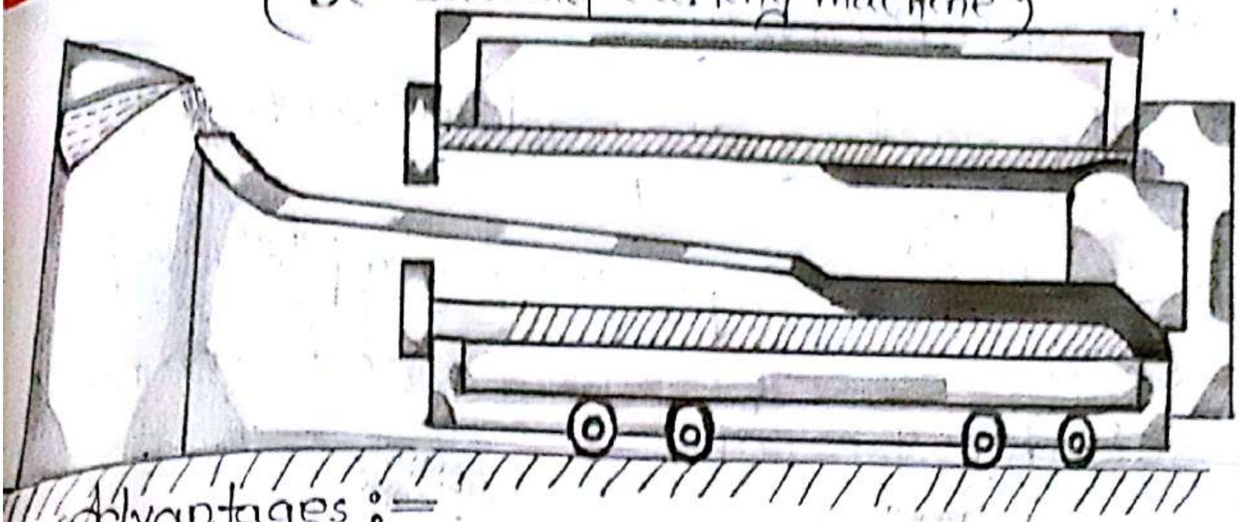
(True centrifugal casting)



The De-Lavaud Process :-

- De-Lavaud process makes use of metal mold.
- In this casting, machine contains an accurately machined metal mold which is entirely surrounded by cooling water.
- The machine is mounted on wheels & it can be moved lengthwise on a slidely inclined track.
- As pouring proceeds, the rotating mold i.e. the casting machine is moved slowly down the track so that the metal is laid progressively along the length of the mold wall.

(De-Lavaud casting machine)



Advantages :-

- It may be adopted for mass production.
- In this casting, gating system is not required.
- Dense & fine grain metal casting are produced by true centrifugal casting technique.

Disadvantages :-

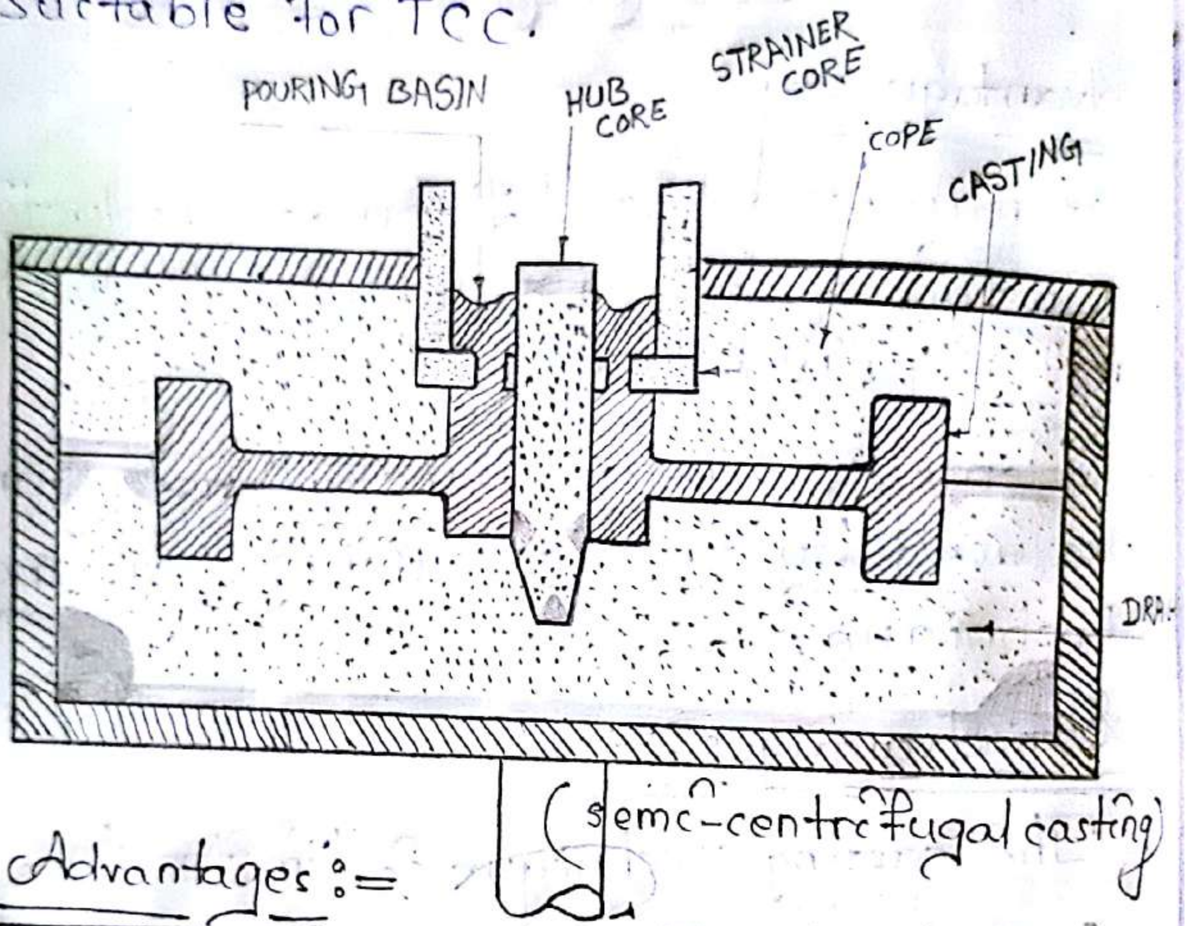
- This casting technique is limited to certain shapes.
- Equipment costs are high.

(ii) Semi-centrifugal casting :-

- Sheaves, gear blank & wheel are produced.
- In this casting, rotation of the mold about its axis happen like T.C.C.
- In this casting, core is used to form

the central cavity.

- This casting are made in vertical machines.
- In this castings, more complicated shapes can be produced which are not suitable for TCC.



(semi-centrifugal casting)

Advantages :=

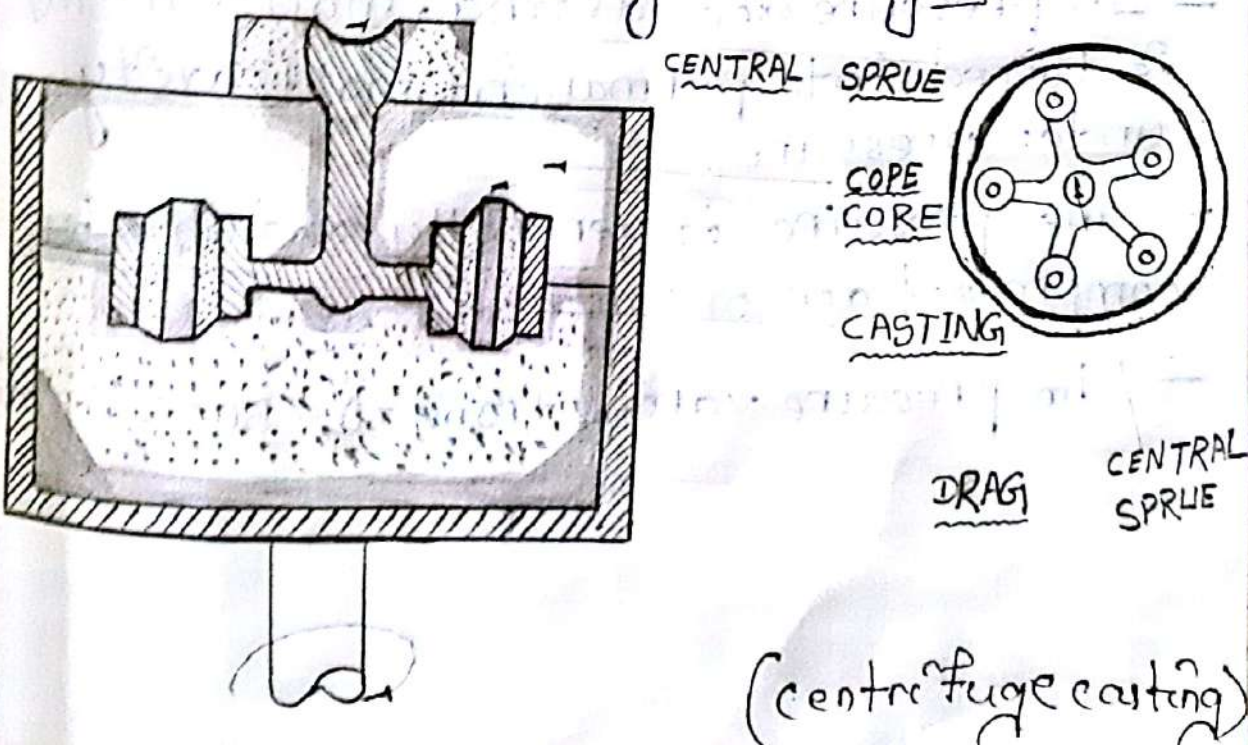
- It ensures purity & density at the extremities such as cast wheel.

iii) Centrifuge casting :=

- parts which are not symmetrical about any axis of rotation may be cast in a group of molds arranged in a circle to balanced each other.

- The axis of mold and axis of rotation do not coincide with each other.
- The setup is revolved around the centre of circle to induce pressure on the metal in the mold.

Advantages :-
- Better quality.
- More economical.
- Fettling & cleaning cost are less.
- The percentage of reject is very low.
- Directional Solidification can be achieved.
- It is simpler to inspect the casting because defect will occur on the surface not inside the casting.
- We can achieve high casting yield.



(centrifuge casting)

Moore sand casting System :-

- Moore sand casting system for small production of large cast iron pipes, use a rammed and dried sand lining in consumption with & pouring.
- The mold rotates & it does not move length wise.
- Its one end can be raised off or lower to facilitate progressive filling of the mold with liquid metal.
- Initially one end of the mold is raised. so, that it becomes inclined.
- As the pouring start & continous, the end is gradually lowered till the mold is horizontal when the pouring stops.

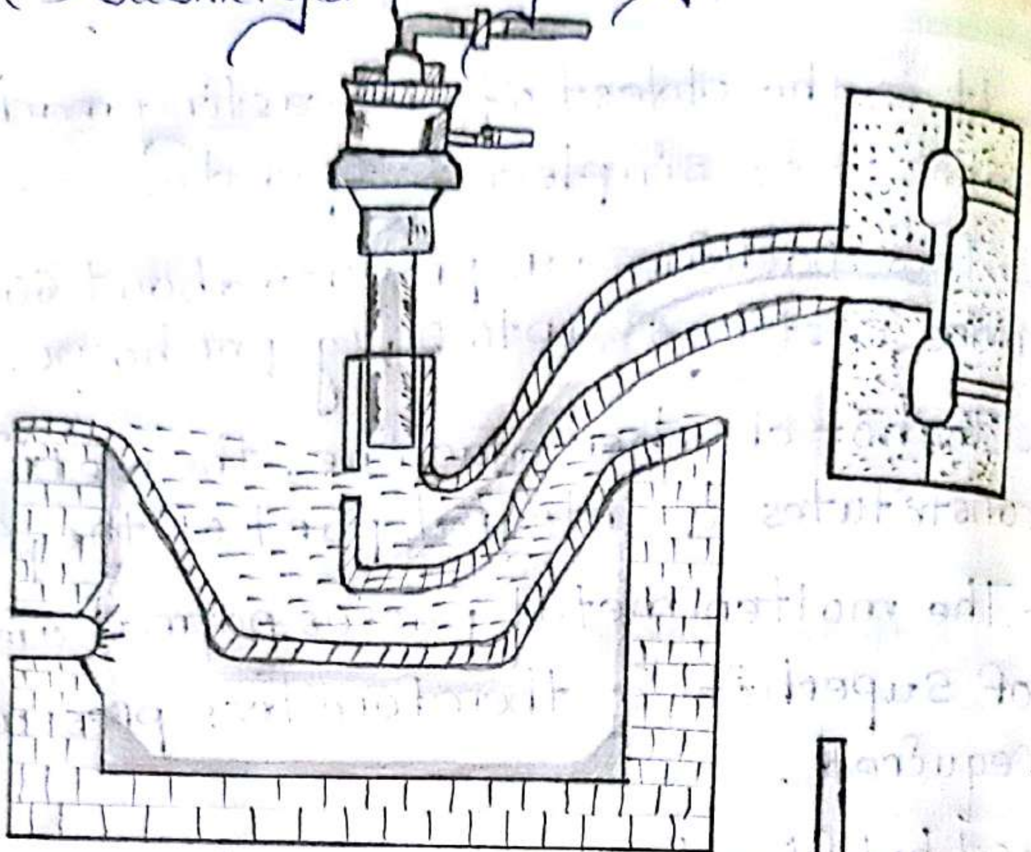
Pressure die-castings :-

- In pressure die casting, molten metal is forced into permanent mold cavity under pressure.
- The pressure is generally obtained by compressed air or hydraulically.
- The pressure varies from 70 - 5000 Kg/cm²

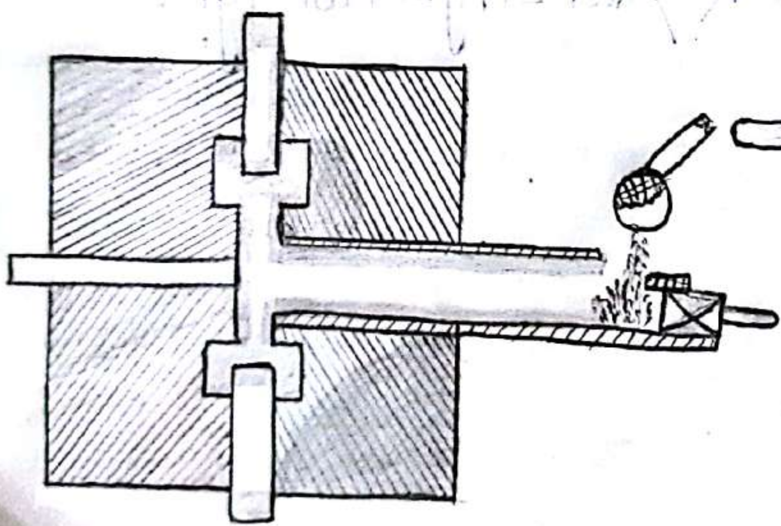
Hot chamber die casting :-

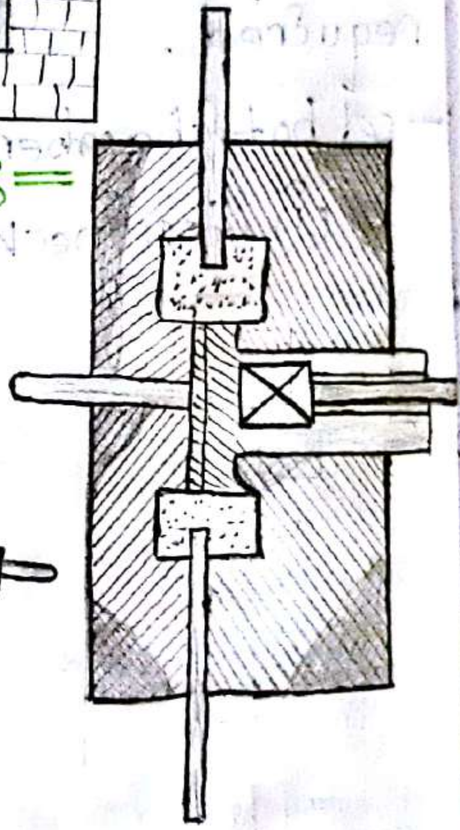
- It is the oldest of die casting machine and it is simplest to operate.
- This machine can produce about 60 or more castings upto 20kg per hour.
- In hot chamber machine, the melting unit constitutes & integral part of the process.
- The molten metal posses normal amount of superheat & therefore less pressure is required.
- A hot chamber process is of :
  (i) Gooseneck / air-injection type

(ii) Submerged plunger type.



cold chamber die casting :–





- Melting unit is not a integral part of the cold chamber die casting machine.
- Molten metal which is poured into the cold chamber die casting machine is at a lower temperature as compare to that of hot chamber die casting machine.

Therefore, it requires much higher pressure if experience less thermal stress due to lower tempr of the molten metal.

Advantages of die casting :—

- High production rate can be achieved.
- We can get close dimensional tolerance.
- Very thin sections can be cast without any difficulty.
- Intrigates shapes can be die cast.
- Machining cost are very small.
- Lower labour cost.
- It is less effective than sand casting.
- A no. of non-ferrous alloys can be die cast
- It requires less floor space than other casting techniques.
- It is very economical, when used for large scale production.

Limitation of die casting :—

- Ferrous alloys are not cast.
- The maximum size of the casting is restricted.
- It is uneconomical for small scale production (less than about 20,000 casting.

- It contain some porousity.
- It requires comparatively a longer period of time for going into production.
- Dies may produce an undesirable chilling effect on the die casting.