

METAL CASTING



Foundry:

" Foundry or casting is the process of producing metal/alloy component parts of desired shapes by pouring the molten metal/alloy into a prepared mould (of that shape) and then allowing the metal/alloy to cool and solidify. The solidified piece of metal/alloy is known as a *CASTING*".

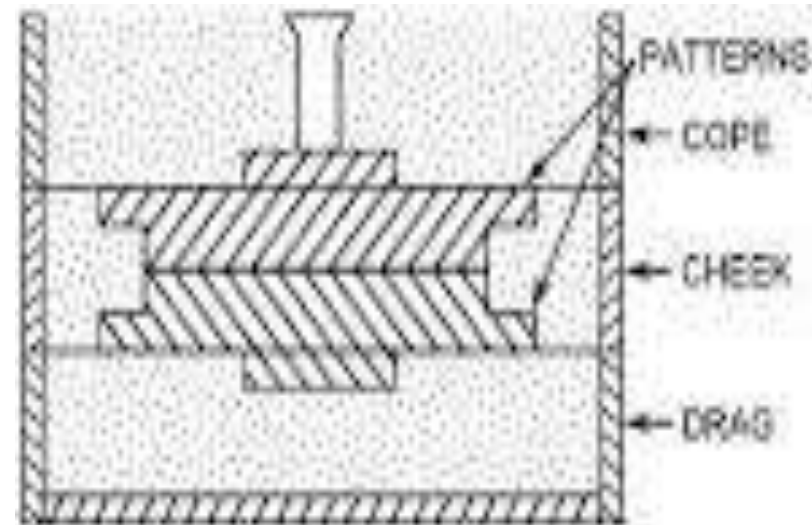
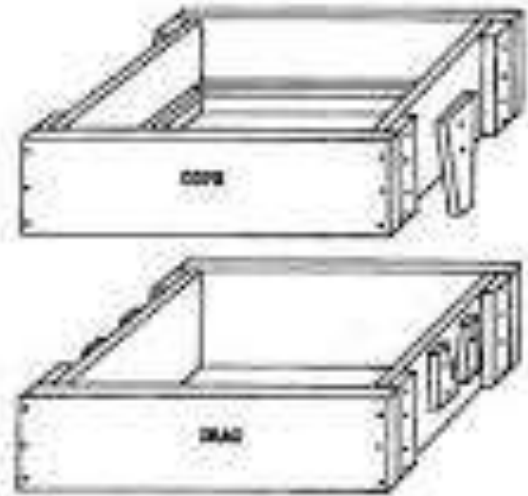
Casting Terms:

1. **Flask**: A metal or wood frame, without fixed top or bottom, in which the mold is formed.

drag - lower molding flask,

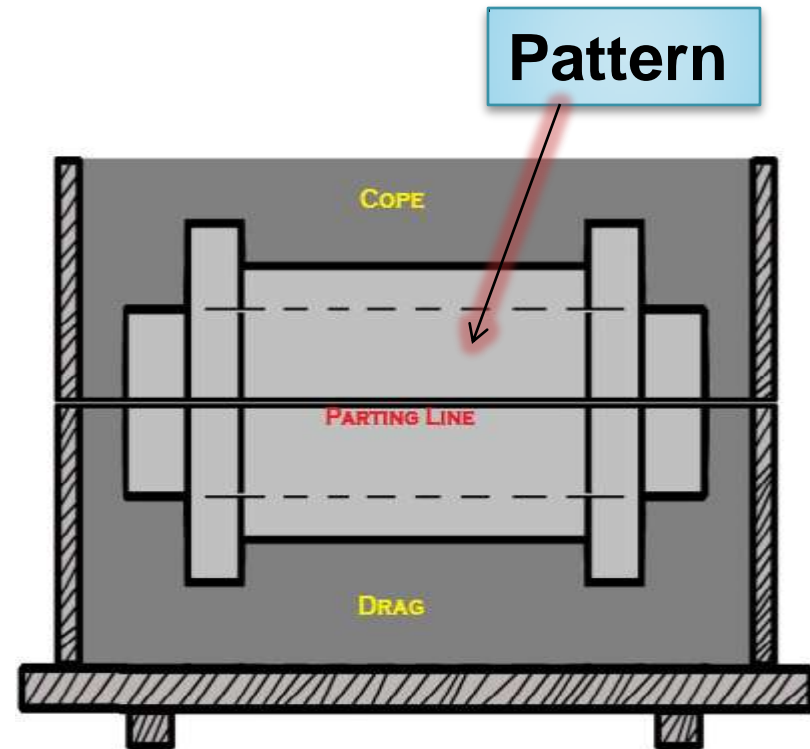
cope - upper molding flask,

cheek - intermediate molding flask used in three piece molding.

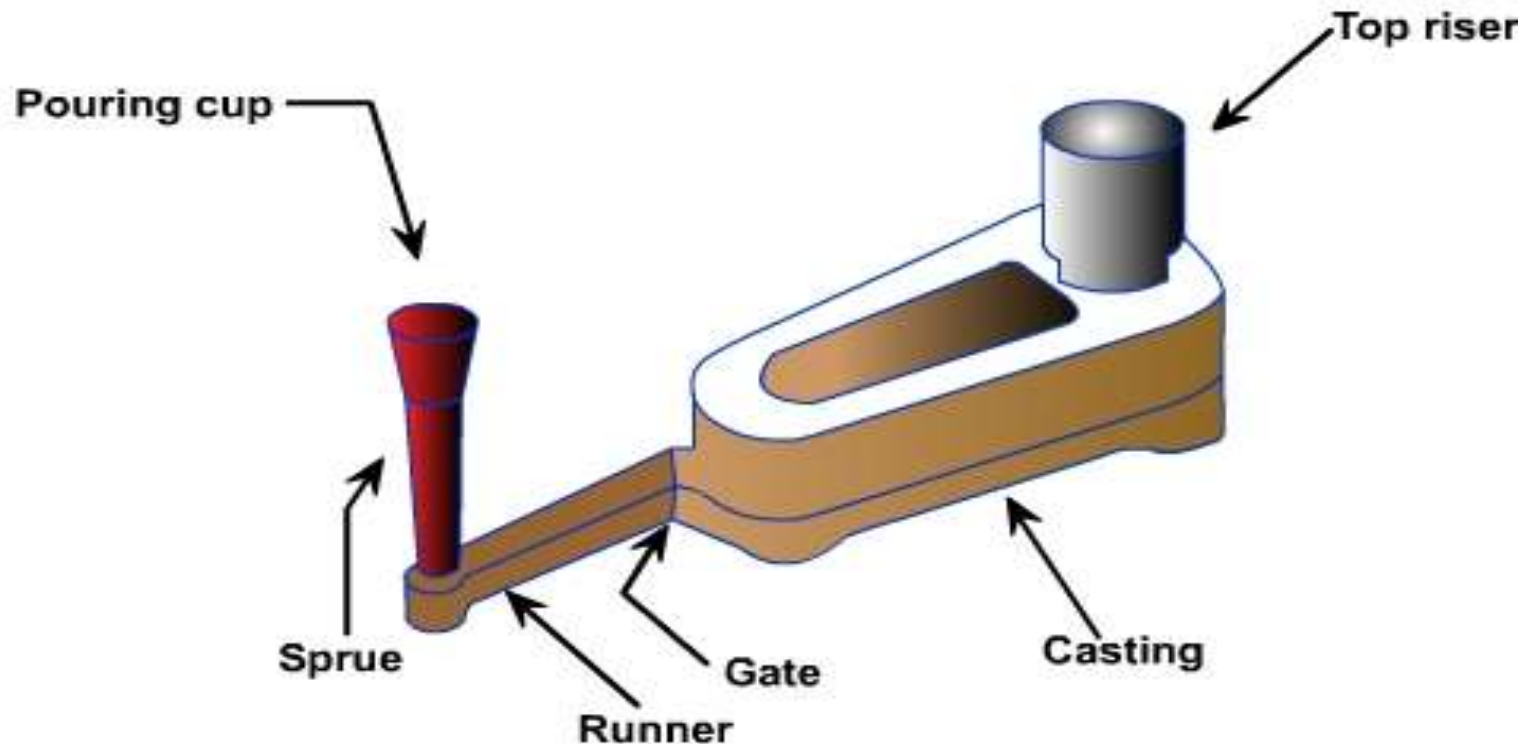


Casting Terms:

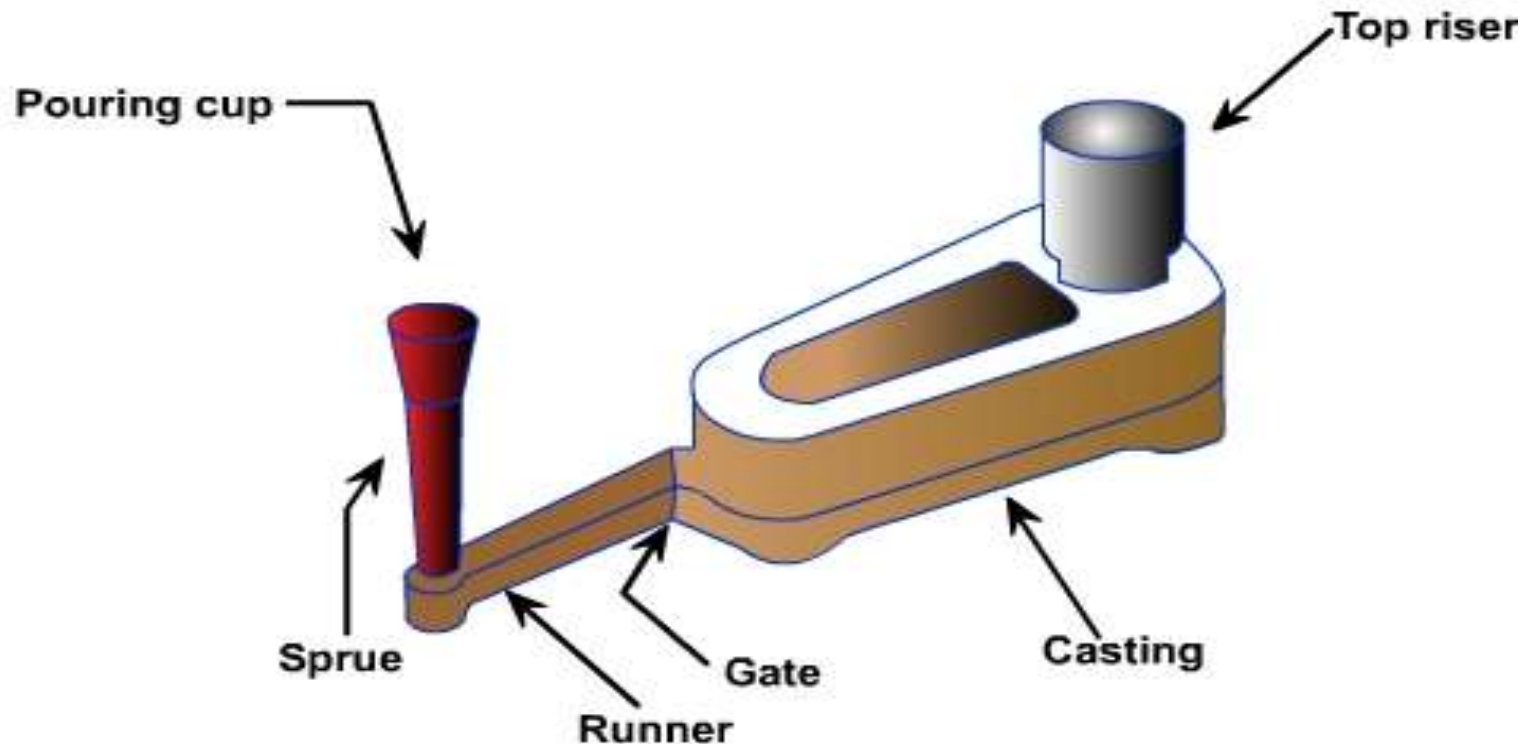
2. **Pattern**: It is the replica of the final object to be made. The mold cavity is made with the help of pattern.
3. **Parting line**: This is the dividing line between the two molding flasks that makes up the mold.



4. **Pouring basin**: A small funnel shaped cavity at the top of the mold into which the molten metal is poured.
5. **Sprue**: The passage through which the molten metal, from the pouring basin, reaches the mold cavity. In many cases it controls the flow of metal into the mold.



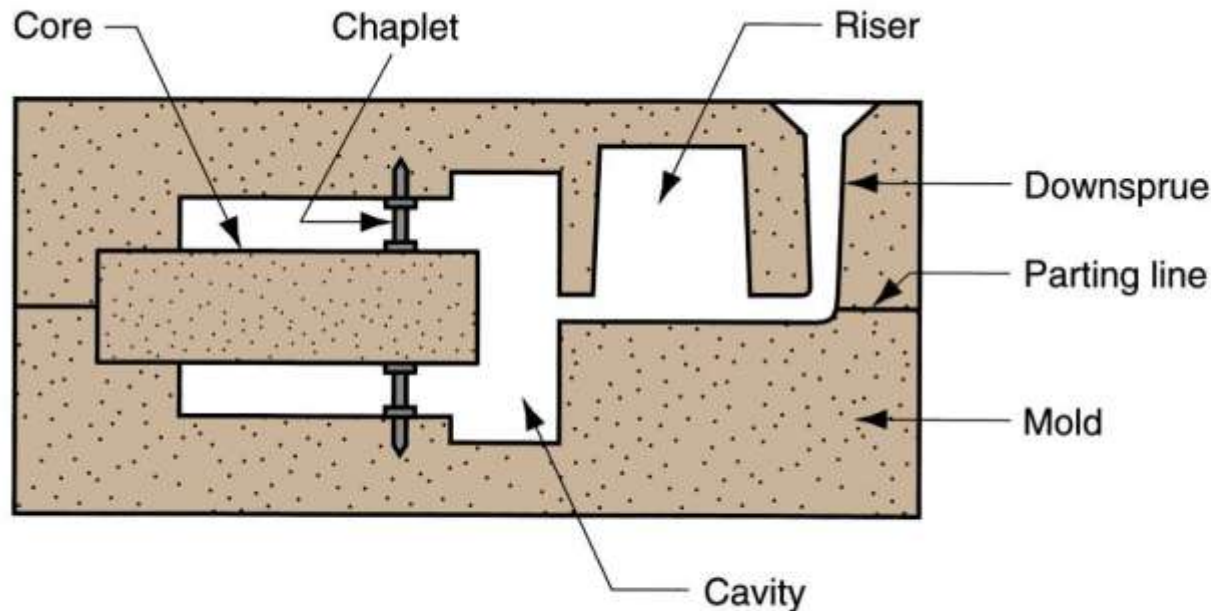
6. **Runner**: The channel through which the molten metal is carried from the sprue to the gate.
7. **Riser**: A column of molten metal placed in the mold to feed the castings as it shrinks and solidifies. Also known as feed head.
8. **Gate**: A channel through which the molten metal enters the mold cavity.



9. **Core**: A separate part of the mold, made of sand and generally baked, which is used to create openings and various shaped cavities in the castings.

10. **Chaplets**: Chaplets are used to support the cores inside the mold cavity to take care of its own weight

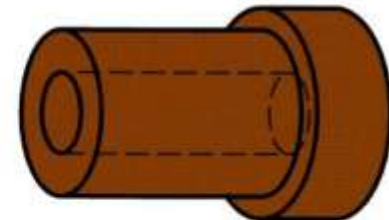
11. **Vent**: Small opening in the mold to facilitate escape of air and gases.



(a)



(b)



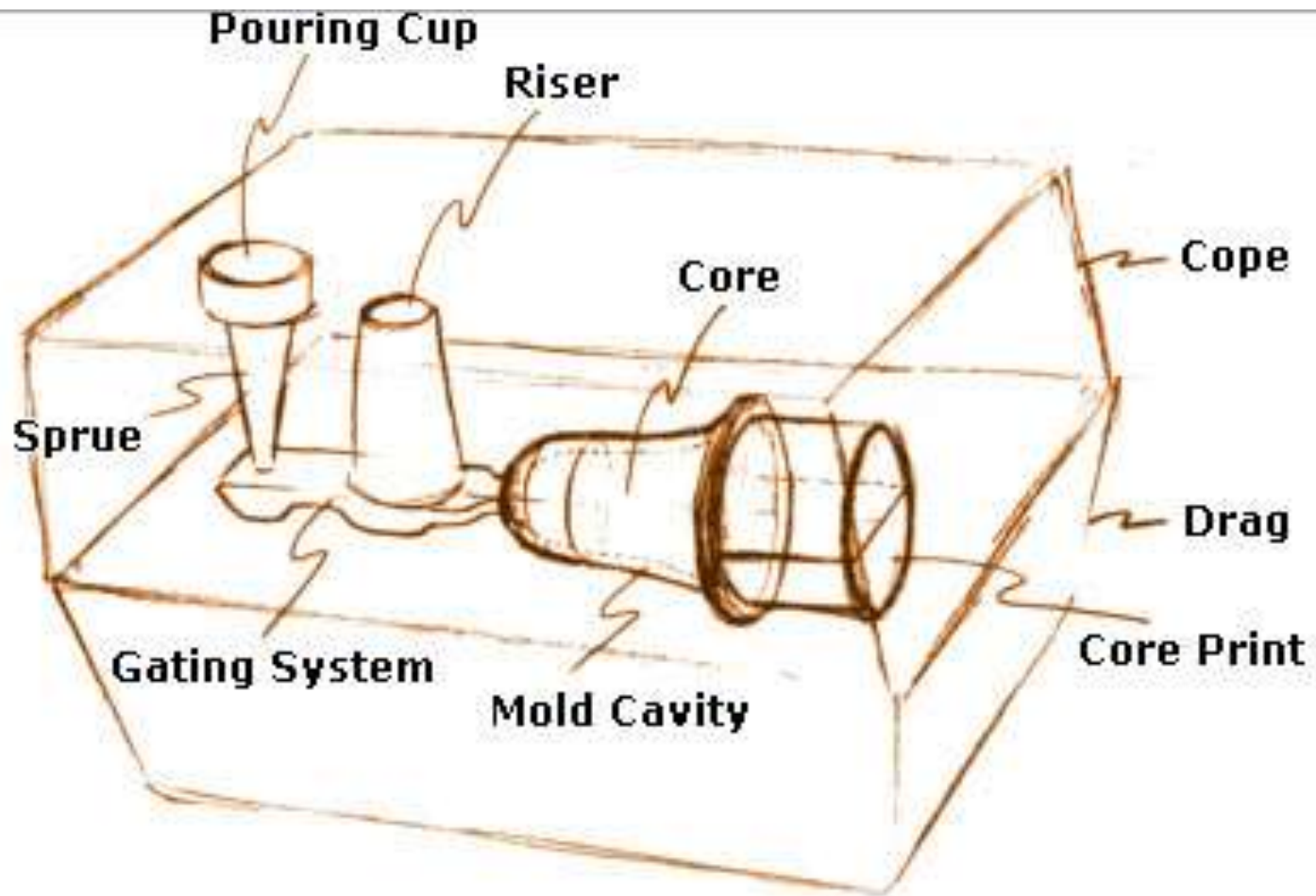
(c)

Basic Features:

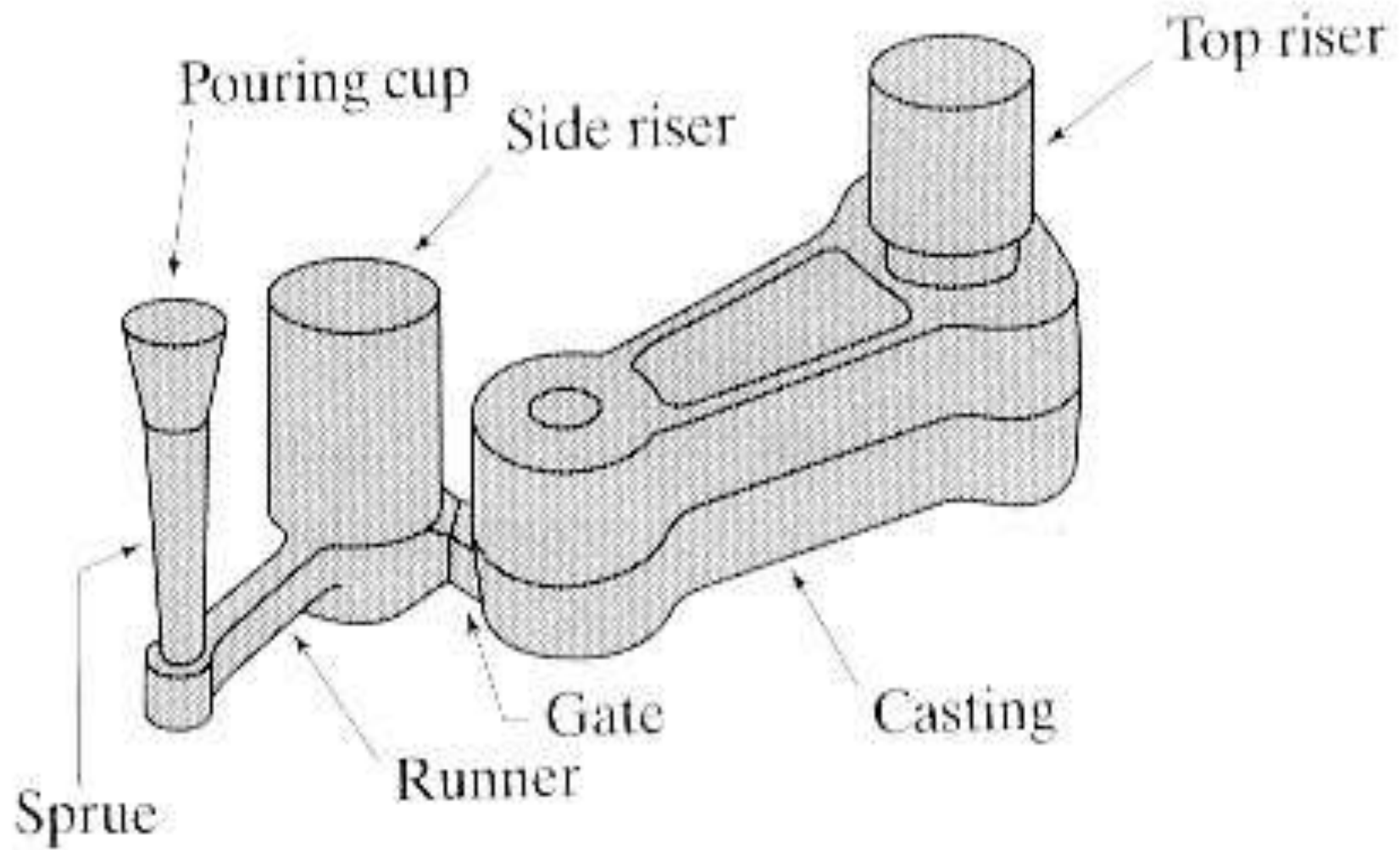
Pattern and Mould

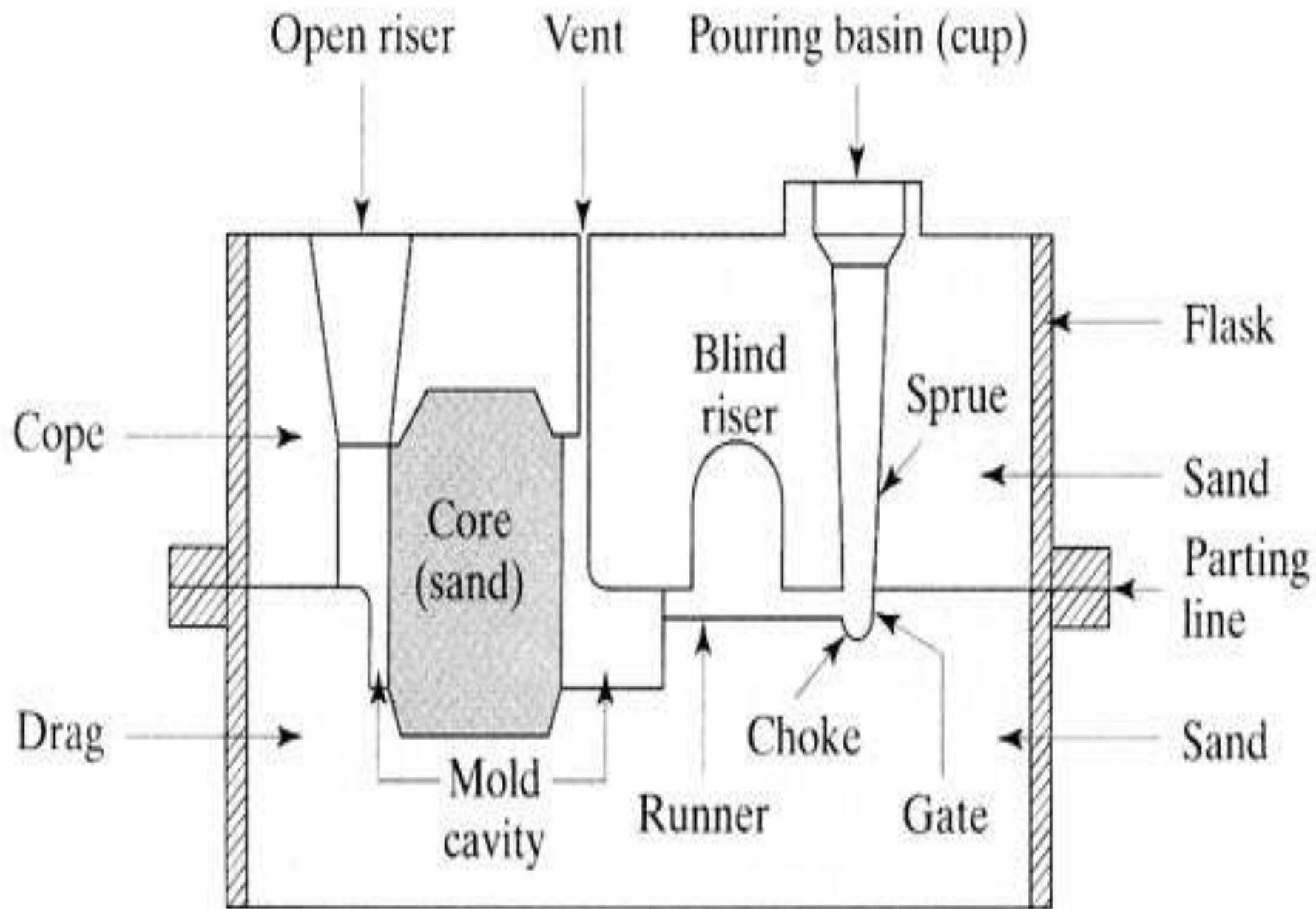
- A pattern is made of wood or metal, is a replica of the final product and is used for preparing mould cavity.
- Mould material should possess refractory characteristics and withstand the pouring temperature.

Schematic diagram of casting mould:

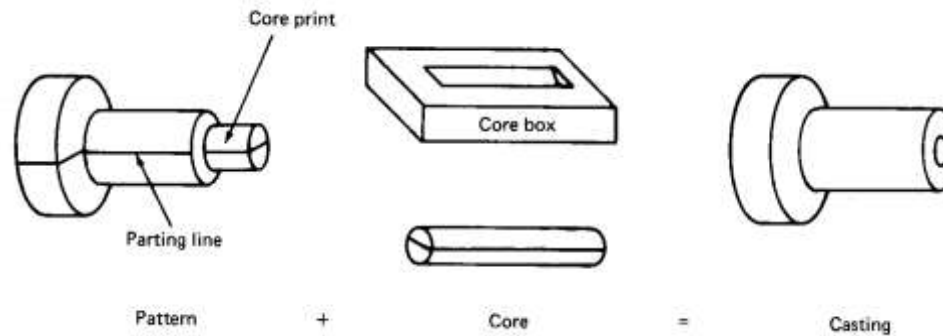
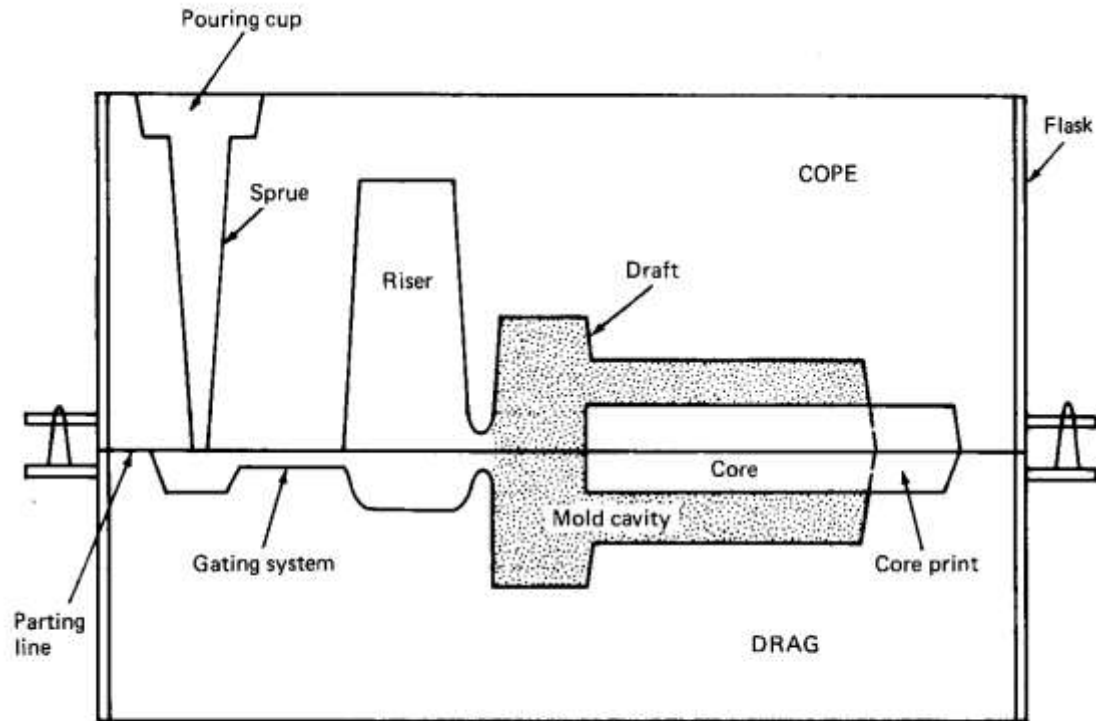


Typical Components of a Two-part Sand Casting Mold.





Sand Casting Terminology



Steps involved in making a casting:

1. Make the pattern out of Wood , Metal or Plastic.
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 and remove the casting from the mould after the metal solidifies.
6. Clean and finish the casting.
7. Test and inspect the casting.
8. Remove the defects, if any.
9. Relieve the casting stresses by Heat Treatment.
10. Again inspect the casting.
11. The casting is ready for shipping.

Applications of Casting:

- Transportation vehicles
- Turbine vanes
- Power generators
- Railway crossings
- Agricultural parts
- Aircraft jet engine parts
- Sanitary fittings
- Communication, Construction and Atomic Energy applications, etc..

Raw Materials for Foundry:

Metals and alloys

Fuels (For melting metals)

Fluxes



Metals and alloys commonly used in Foundries:

1. Ferrous
2. Non-Ferrous

FERROUS:

- a. Cast irons
- b. Steels

NON-FERROUS:

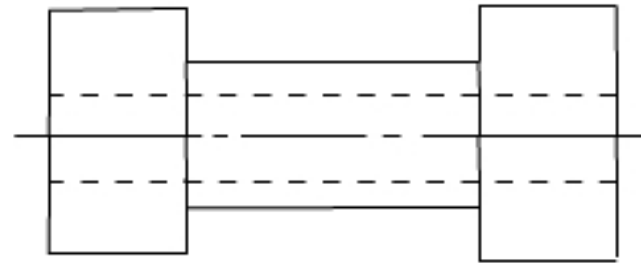
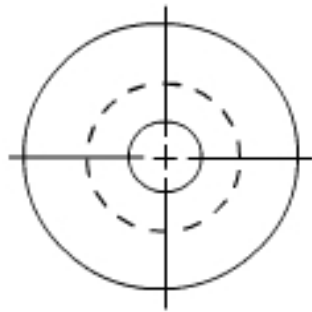
- a. Copper alloys
- b. Aluminium alloys
- c. Magnesium alloys
- d. Zinc alloys
- e. Nickel alloys

Pattern Making:

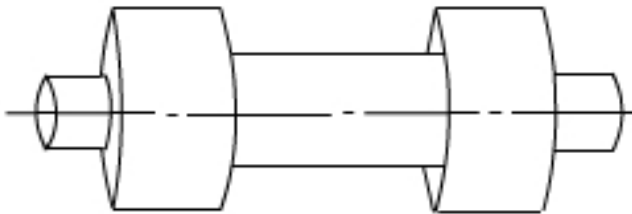
- ❖ A Pattern is a model or the replica of the object to be cast.
- ❖ Except for the various allowances a pattern exactly resembles the casting to be made.
- ❖ A pattern is required even if one object has to be cast.

Functions of Patterns:

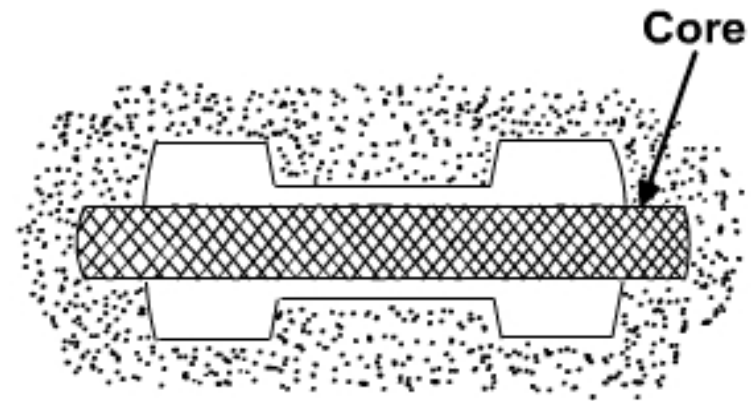
- A Pattern prepares a mould cavity for the purpose of making a casting.
- A Pattern may contain projections known as core prints if the casting requires a core and need to be made hollow.
- Patterns properly made and having finished and smooth surfaces reduce casting defects.
- Properly constructed patterns minimize overall cost of the casting.



JOB



Pattern



Mould

Pattern having core prints

Selection of Pattern Materials:

The following factors assist in selecting proper pattern material:

- No. of castings to be produced.
- Dimensional accuracy & surface finish.
- Shape, complexity and size of casting.
- Casting design parameters.
- Type of molding materials.
- The chance of repeat orders.
- Nature of molding process.



The pattern material should be:

1. Easily worked, shaped and joined.
2. Light in weight.
3. Strong, hard and durable.
4. Resistant to wear and abrasion .
5. Resistant to corrosion, and to chemical reactions.
6. Dimensionally stable and unaffected by variations in temperature and humidity.
7. Available at low cost.

Materials for making patterns:



WOOD



METAL



PLASTIC



PLASTER



WAX

Types of Patterns:



Single piece pattern.



Split pattern



Loose piece pattern



Match plate pattern



Sweep pattern



Gated pattern



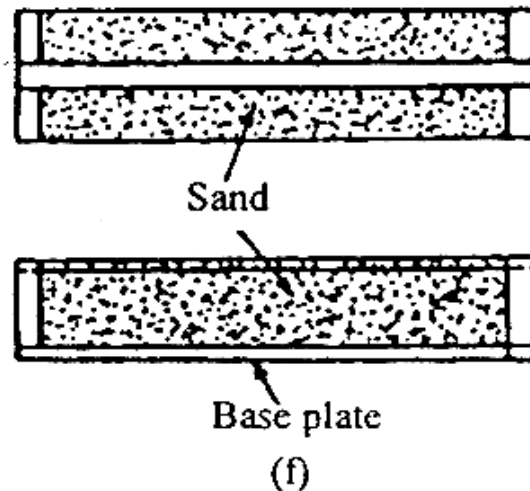
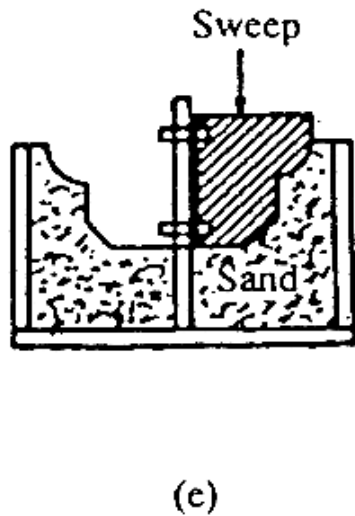
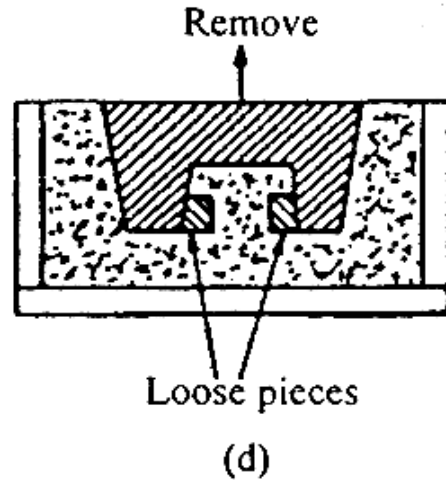
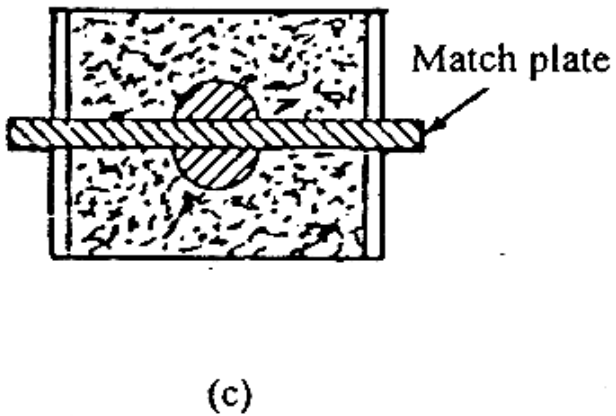
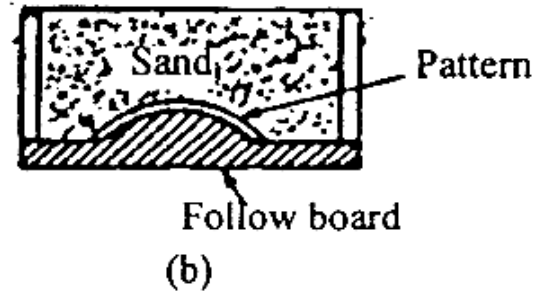
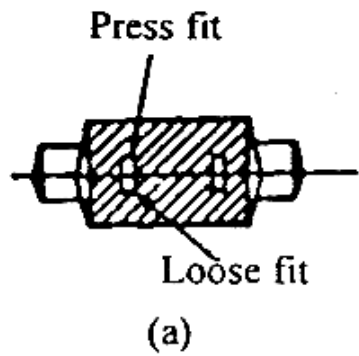
Skeleton pattern



Follow board pattern



Cope and Drag pattern



(a) Split pattern

(b) Follow-board

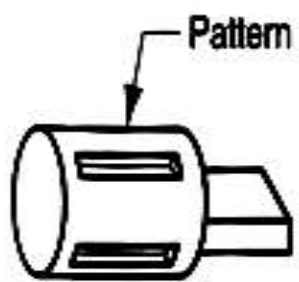
(c) Match Plate

(d) Loose-piece

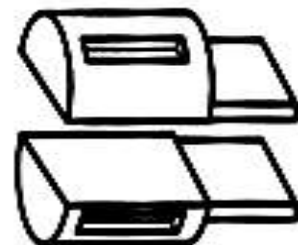
(e) Sweep

(f) Skeleton pattern

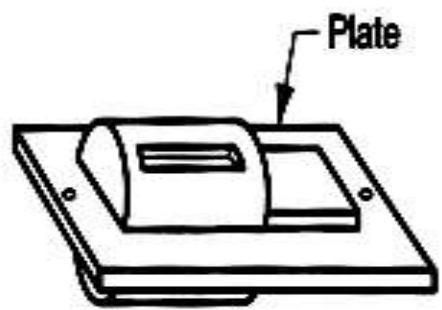
Types of patterns used in sand casting: (a) solid pattern, (b) split pattern, (c) match-plate pattern, and (d) cope-and-drag pattern.



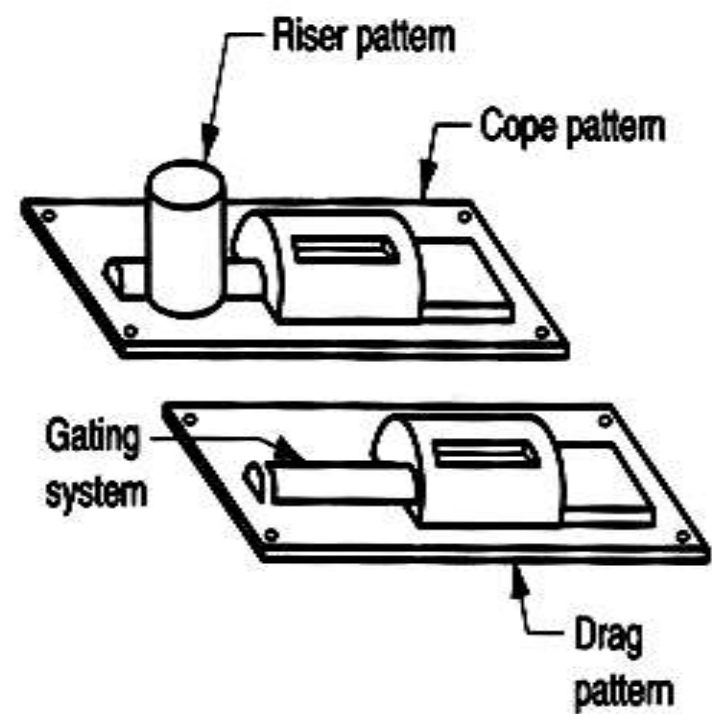
(a)



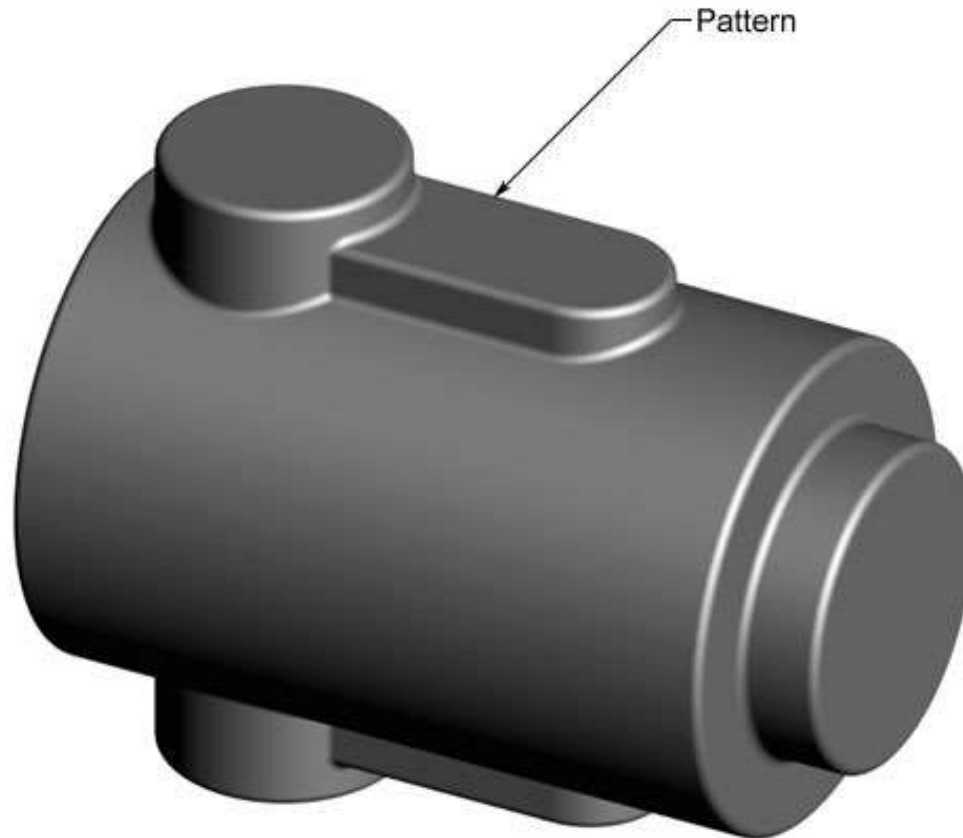
(b)



(c)



(d)



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Fig: Single piece pattern

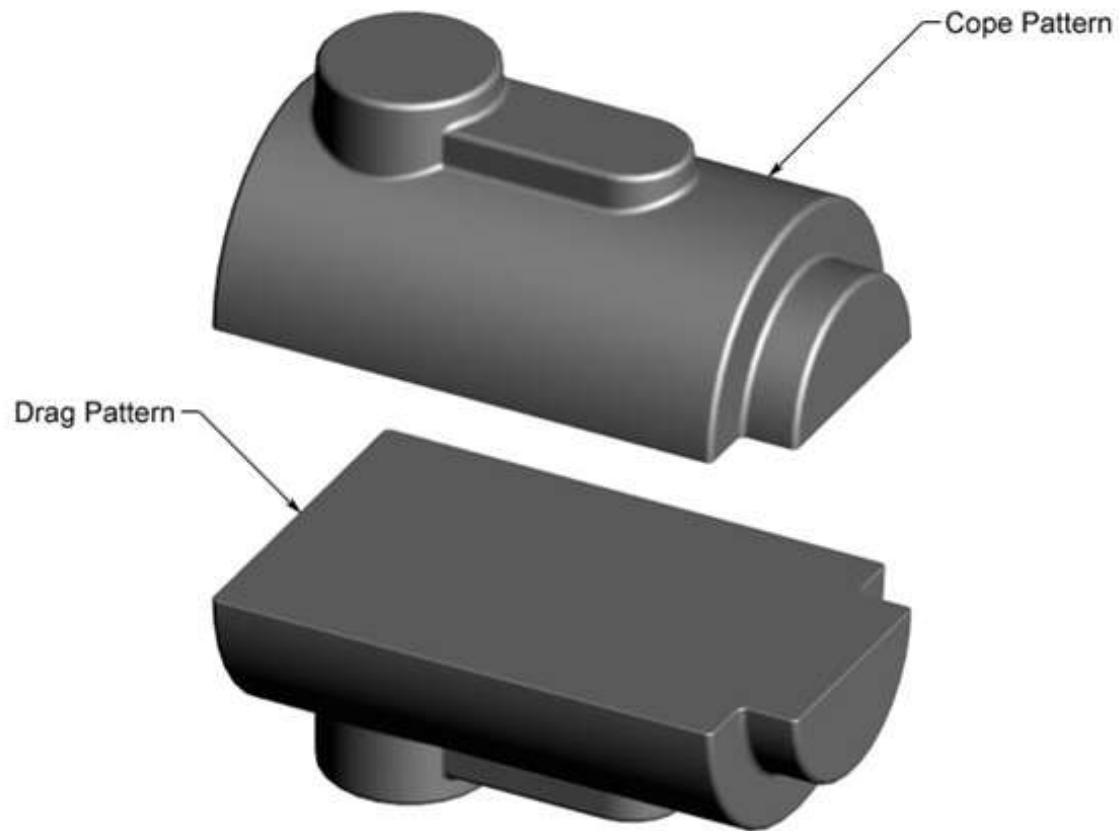


Fig: split piece pattern

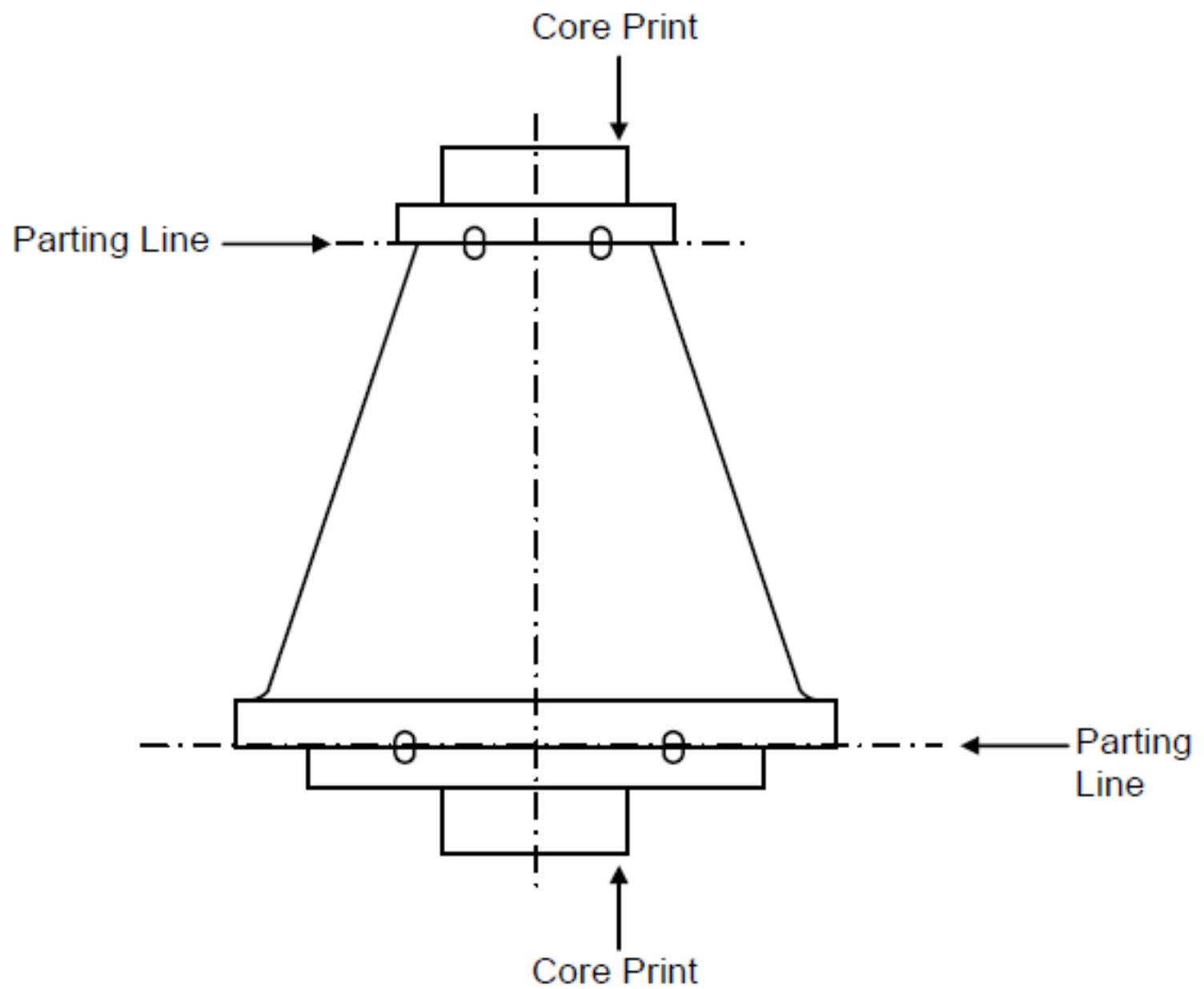
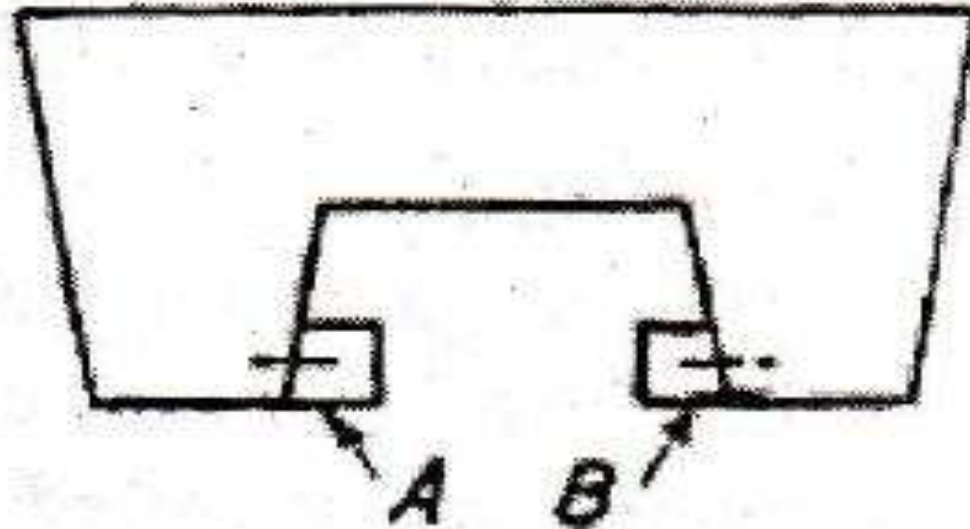


Figure 2.7 : Multipiece Pattern

3. Loose piece pattern:



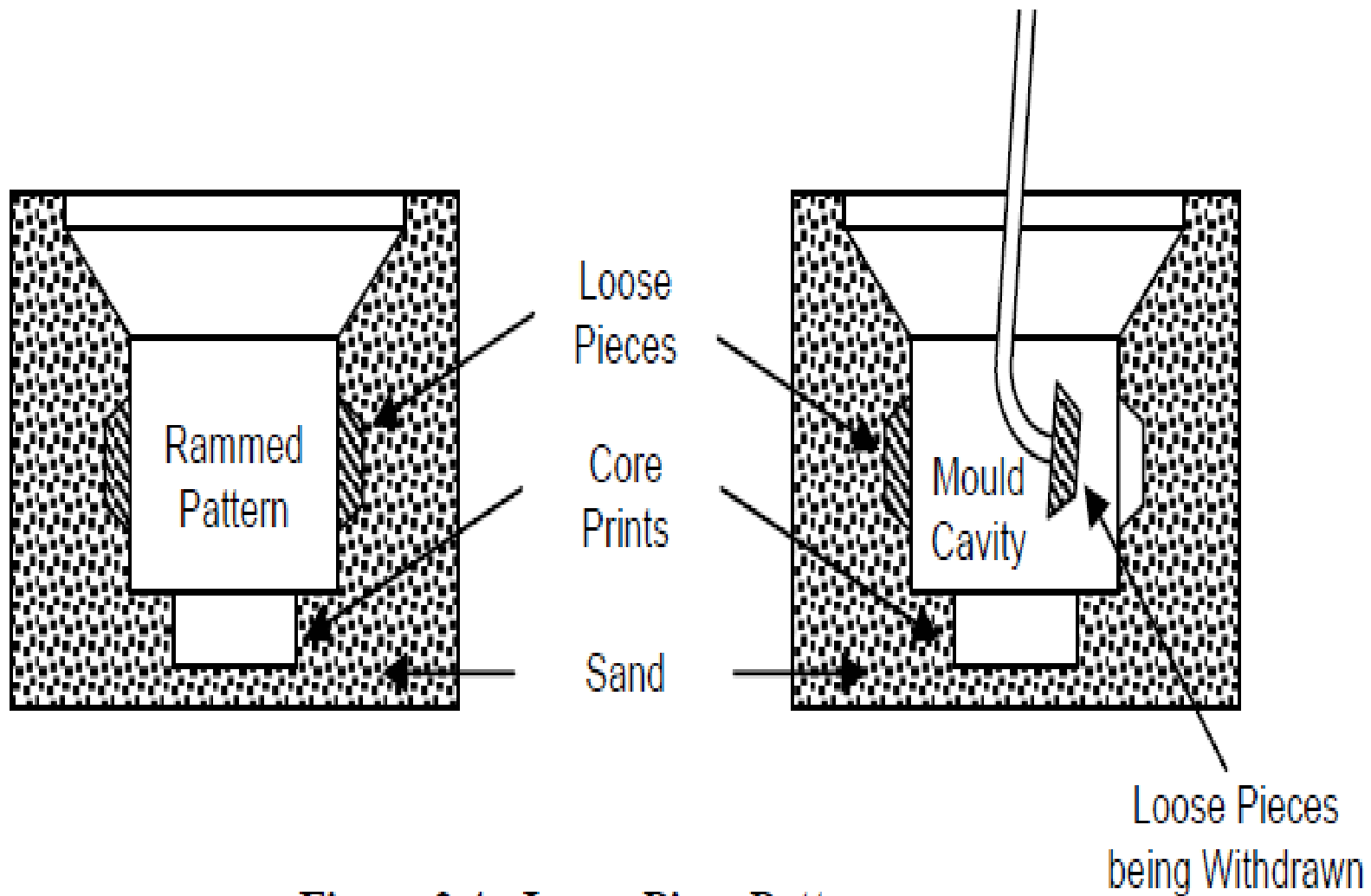
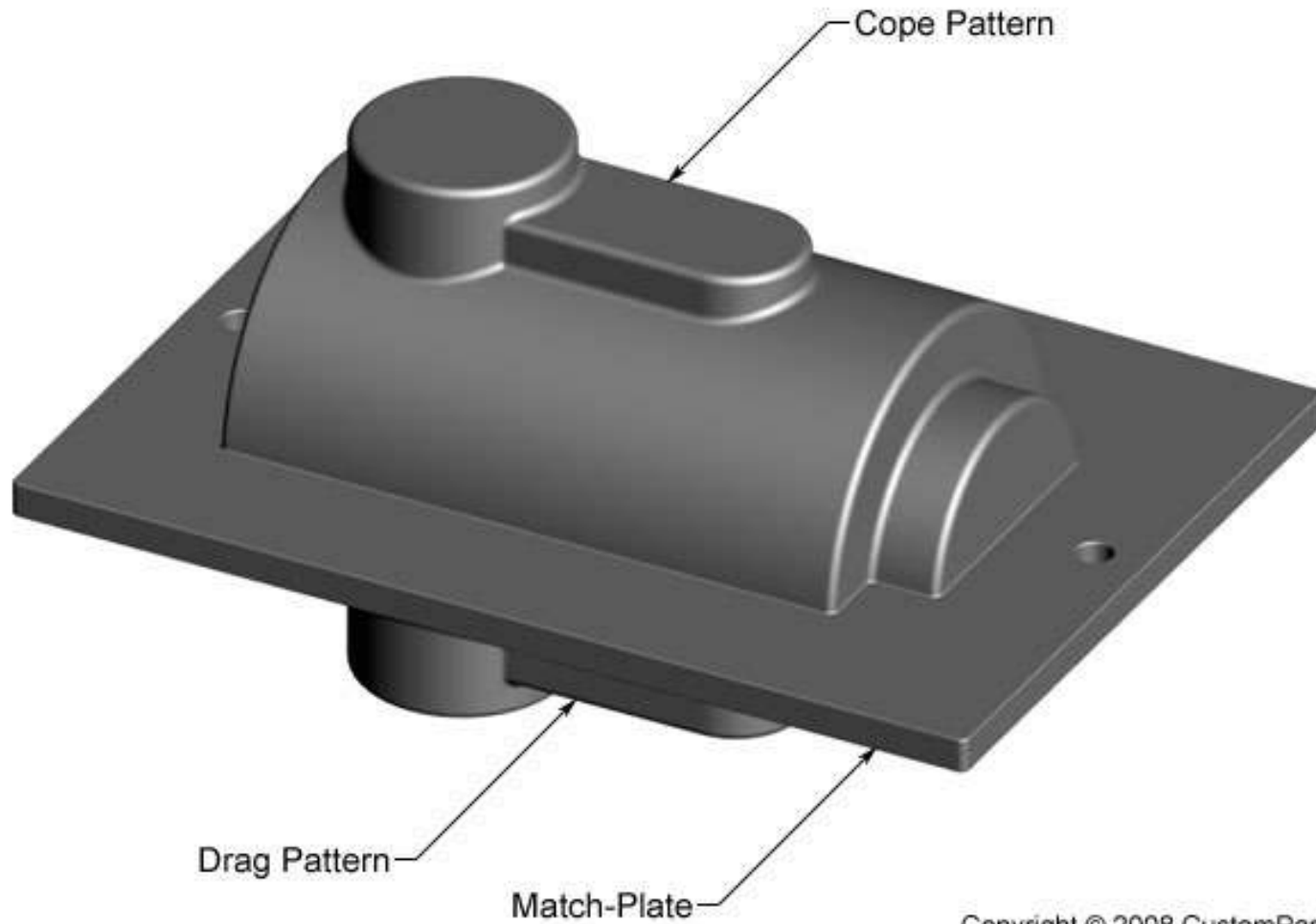


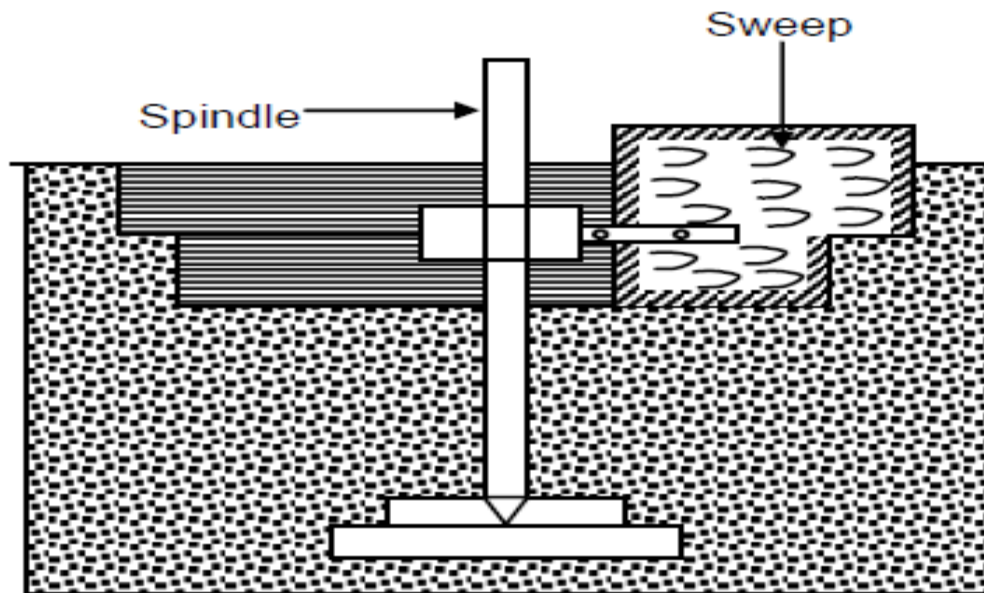
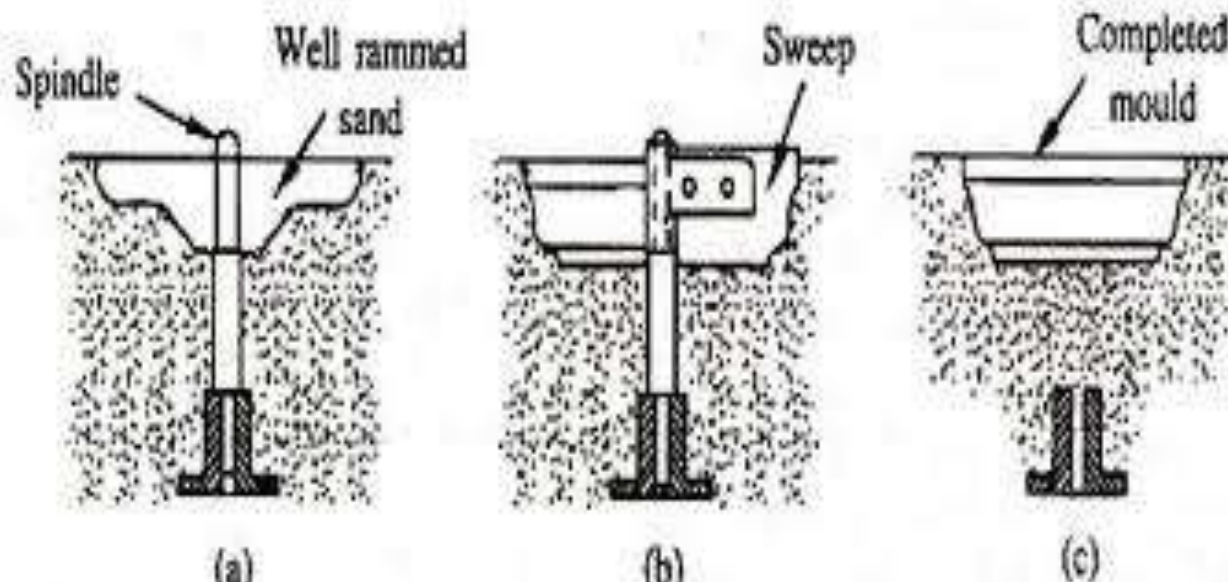
Figure 2.4 : Loose Piece Pattern



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Fig: Match plate pattern

Sweep pattern:

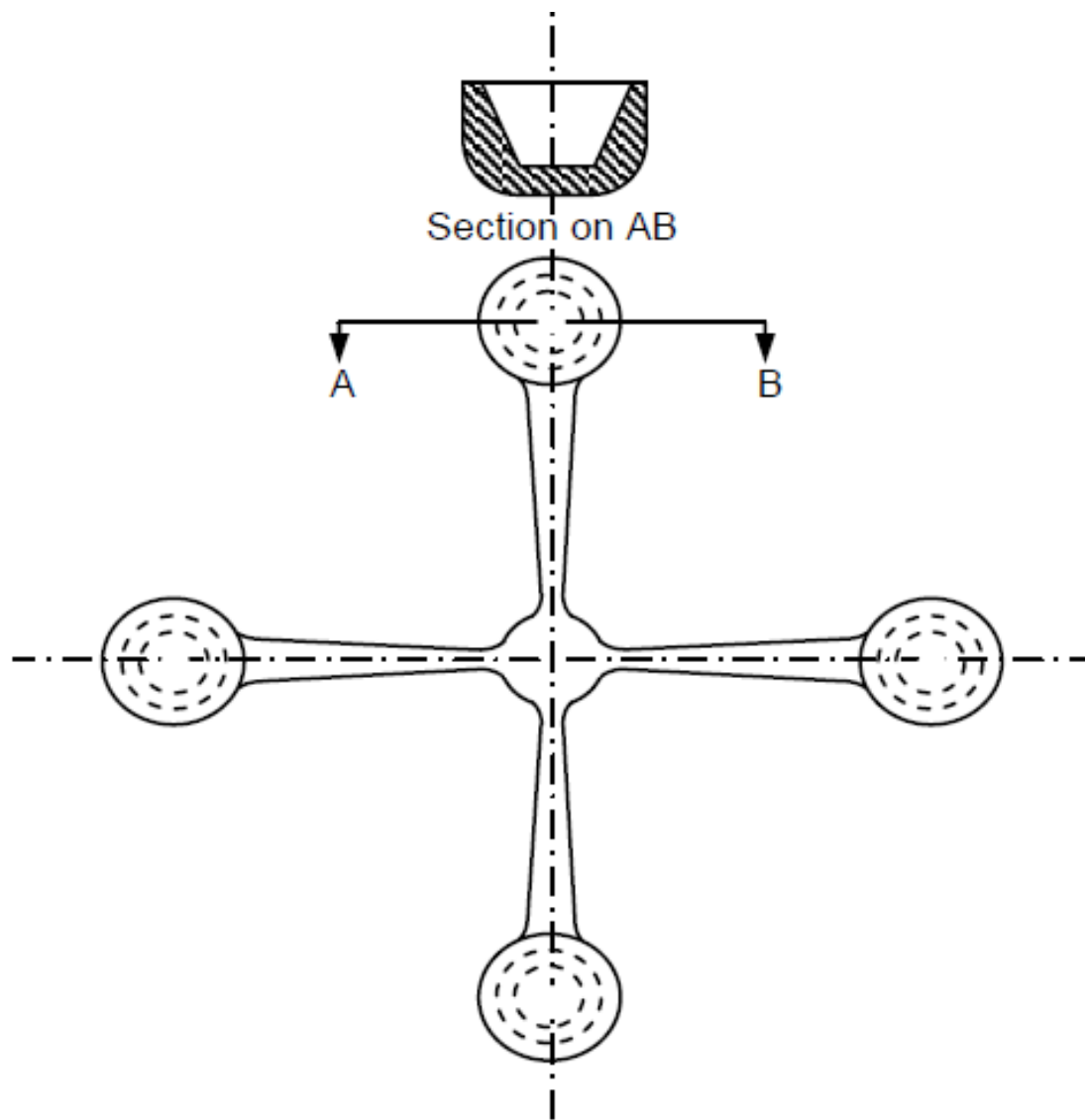




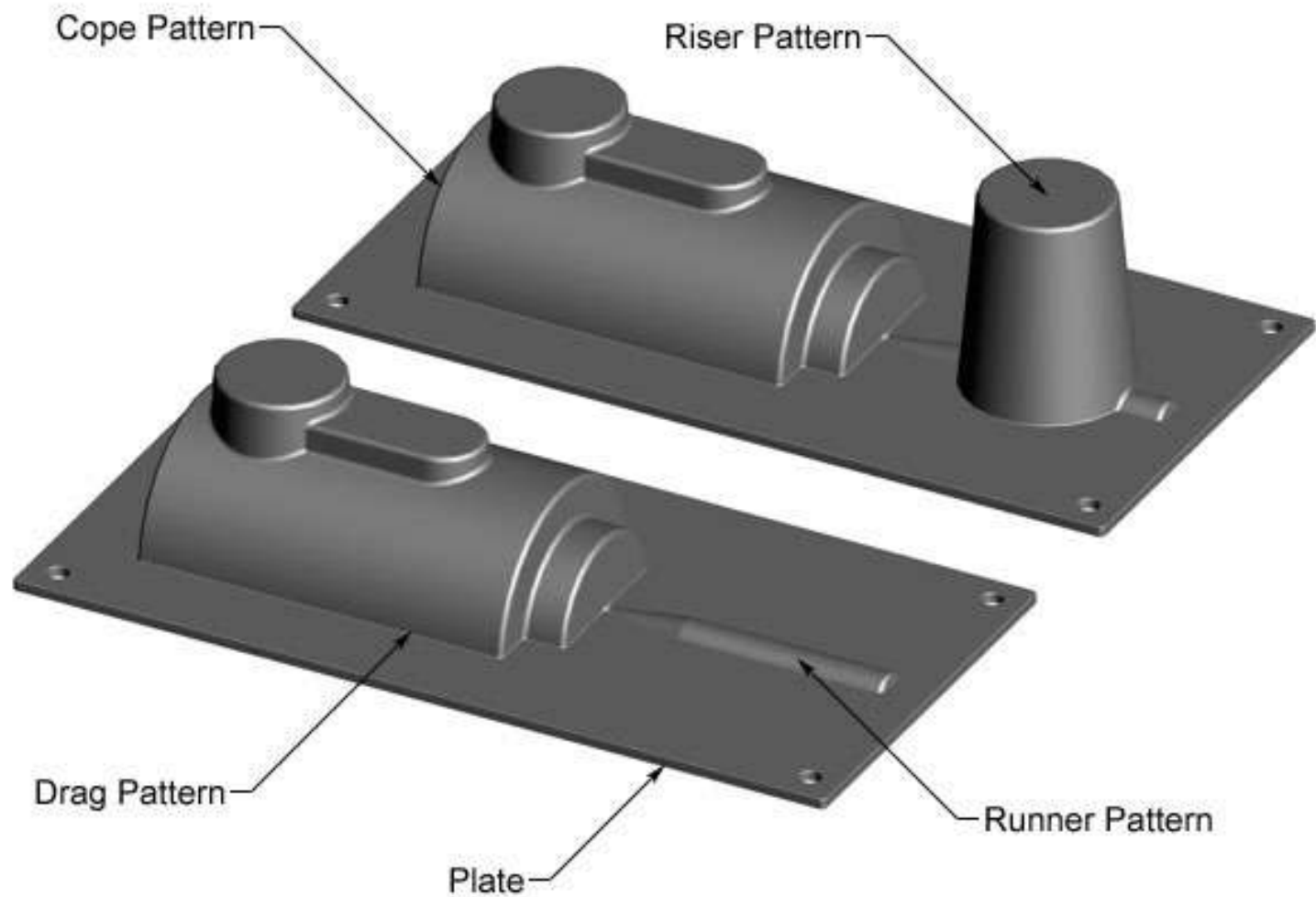
→ castings

→ Gating system

GATED PATTRN



GATED PATTRN



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Fig: Cope and drag pattern

Types of Pattern Allowances:

THE VARIOUS PATTERN ALLOWANCES ARE:

1. Shrinkage or contraction allowance.
2. Machining or finish allowance.
3. Draft of tapper allowances.
4. Distortion or chamber allowance.
5. Shake or rapping allowance.

1. Shrinkage Allowance:

All most all cast metals shrink or contract volumetrically on cooling.



2. Machining Allowance:

A CASTING IS GIVEN AN ALLOWANCE FOR MACHINING, BECAUSE:

- i. Castings get oxidized in the mold and during heat treatment; scales etc., thus formed need to be removed.
- ii. It is intended to remove surface roughness and other imperfections from the castings.
- iii. It is required to achieve exact casting dimensions.
- iv. Surface finish is required on the casting.

3. 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 the molding material tightly packed around it without damaging the mould cavity.

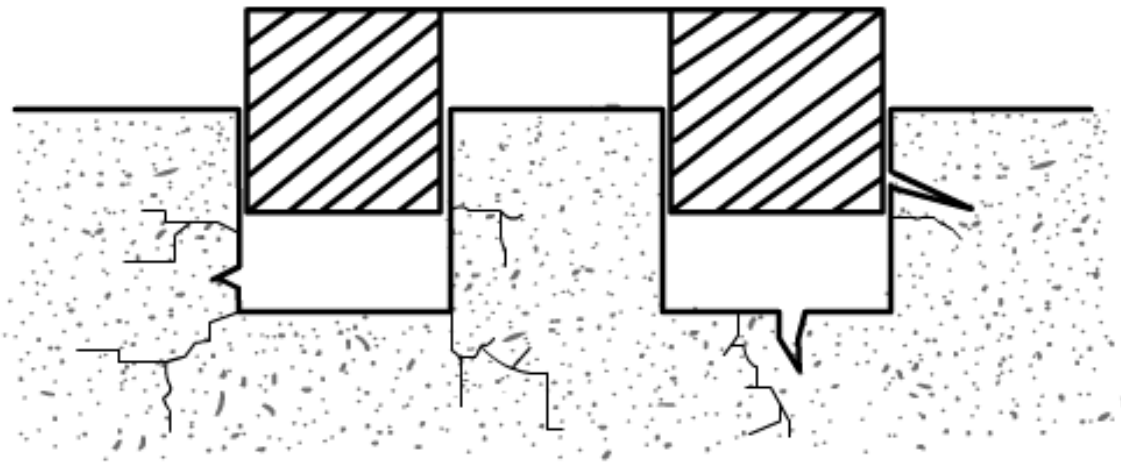


Figure 3 (a) Pattern Having No Draft on Vertical Edges

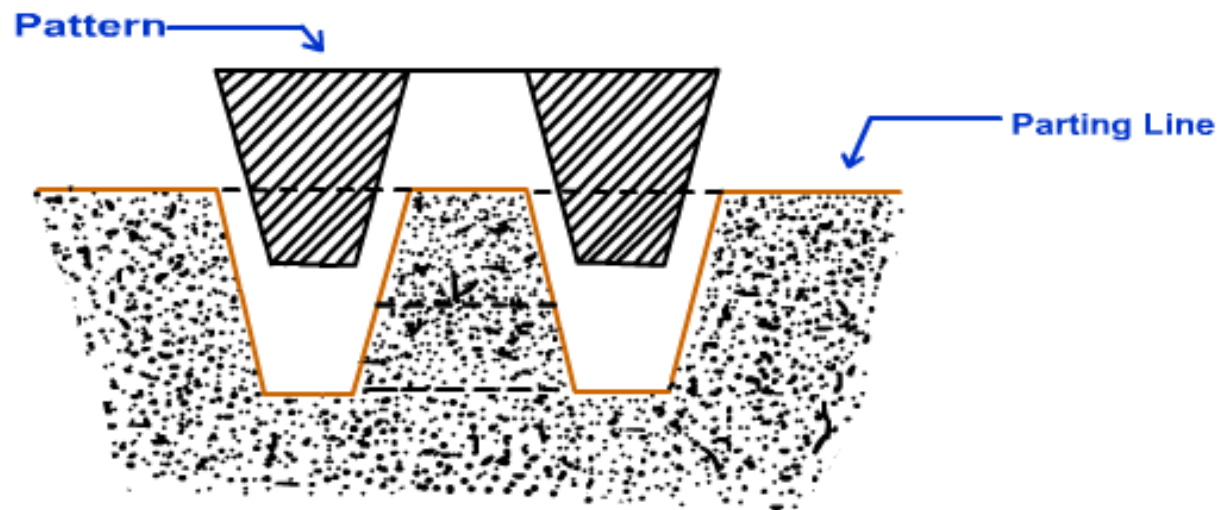


Figure 3 (b) Pattern Having Draft on Vertical Edges

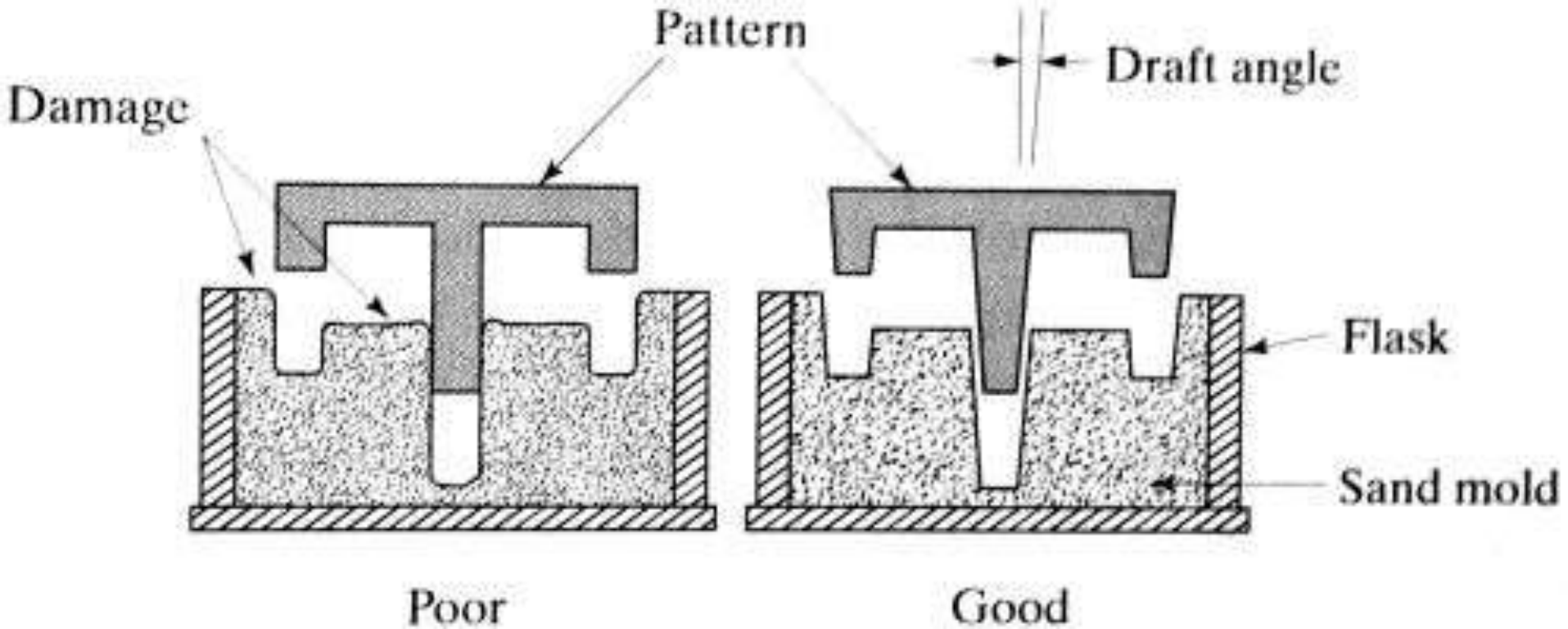


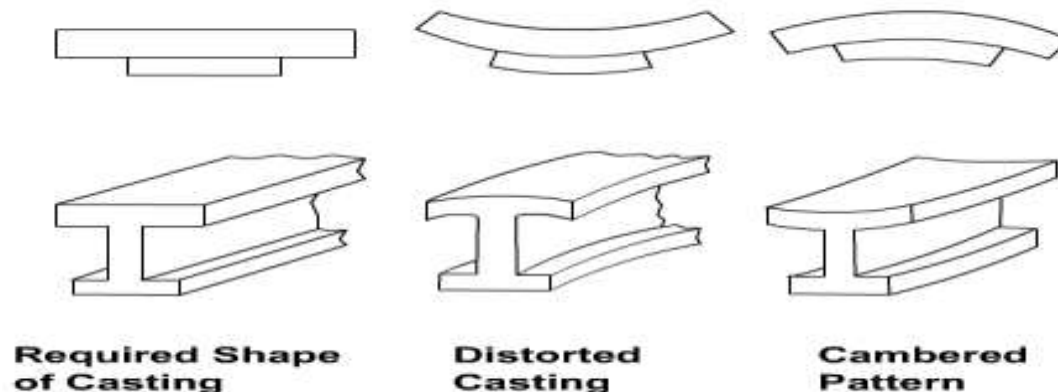
Fig: taper in design



4. Distortion or cambered allowance:

A CASTING WILL DISTORT OR WARP IF :

- i. It is of irregular shape,
- ii. All its parts do not shrink uniformly i.e., some parts shrink while others are restricted from doing so,
- iii. It is u or v-shape



5. Shake allowance:

- ❑ A pattern is shaken or rapped by striking the same with a wooden piece from side to side. This is done so that the pattern a little is loosened in the mold cavity and can be easily removed.
- ❑ In turn, therefore, rapping enlarges the mould cavity which results in a bigger sized casting.
- ❑ Hence, a –ve allowance is provided on the pattern i.e., the pattern dimensions are kept smaller in order to compensate the enlargement of mould cavity due to rapping.

Pattern Layout:

Steps involved:

- Get the working drawing of the part for which the pattern is to be made.
- Make two views of the part drawing on a sheet, using a *shrink rule*. A shrink rule is modified form of an ordinary scale which has already taken care of shrinkage allowance for a particular metal to be cast.
- Add machining allowances as per the requirements.
- Depending upon the method of molding, provide the draft allowance.

Pattern Construction:

- ❑ Study the pattern layout carefully and establish,
 - a. Location of parting surface.
 - b. No. of parts in which the pattern will be made.
- ❑ Using the various hand tools and pattern making machines fabricate the different parts of the pattern.
- ❑ Inspect the pattern as regards the alignment of different portions of the pattern and its dimensional accuracy.
- ❑ Fill wax in all the fillets in order to remove sharp corners.
- ❑ Give a shellac coatings(3 coats) to pattern.
- ❑ impart suitable colors to the pattern for identification purposes and for other informations.

Moulding Materials

Major part of Moulding material in sand casting are

1. 70-85% silica sand (SiO_2)
2. 10-12% bonding material e.g., clay cereal etc.
3. 3-6% water

Properties of molding sand are:

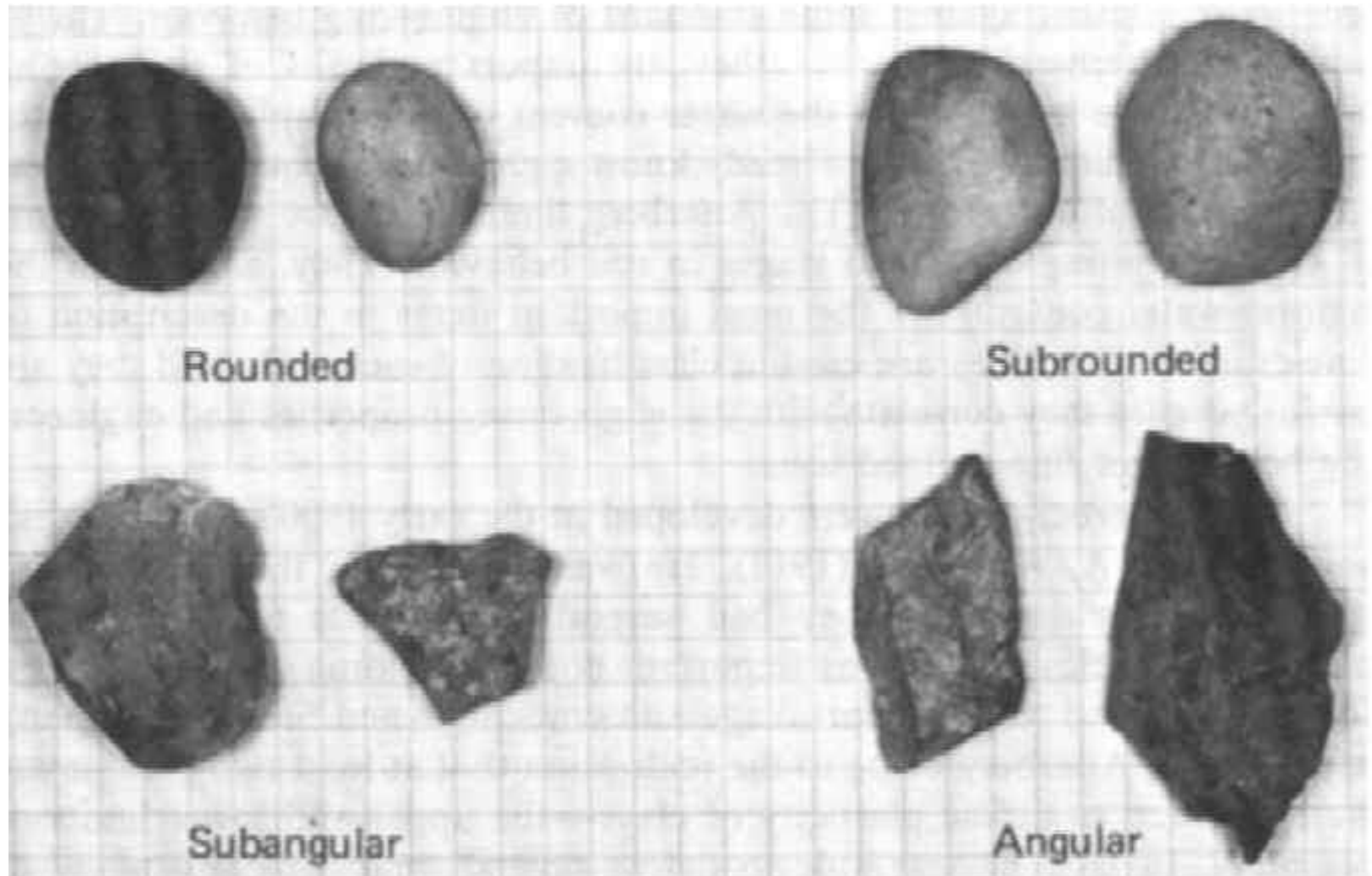
- (a) Refractoriness
- (b) Cohesiveness
- (c) Strength/Adhesiveness
- (d) Permeability
- (e) Collapsibility
- (f) Flowability
- (g) Chemical Inactiveness

Molding Sand Composition:

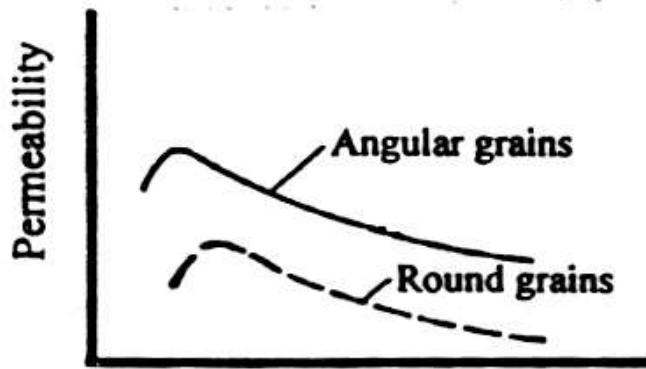
The main ingredients of any molding sand are:

- Base sand,
- Binder, and
- Moisture
- Additives

Shape of the Sand Grains

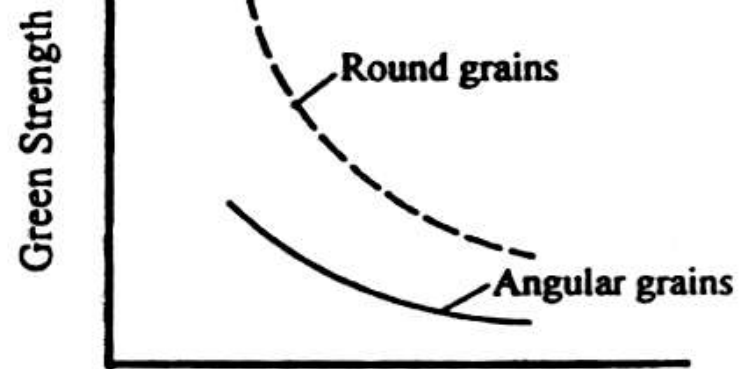


Effect of moisture, grain size and shape on mould quality



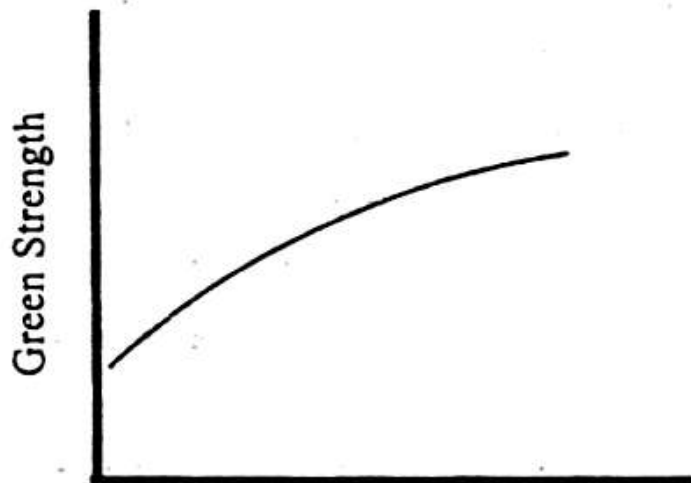
% Moisture

(a)



% Moisture

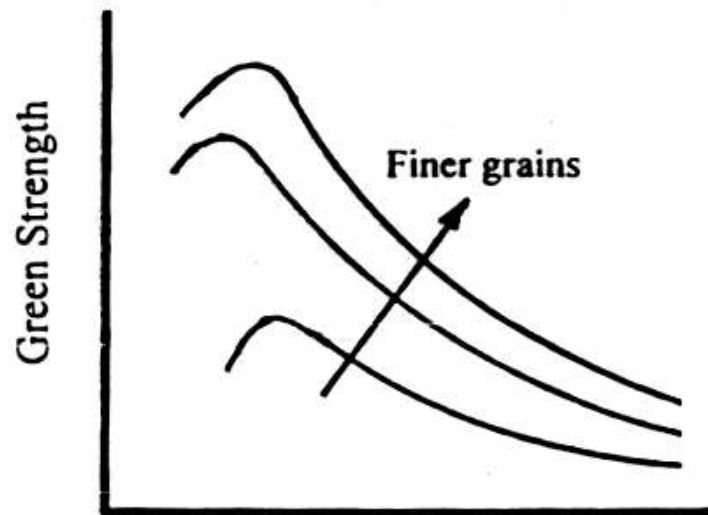
(b)



← Coarse grains Fine grains →

Size of Grain

(c)



% Moisture

(d)

Grain size of sand

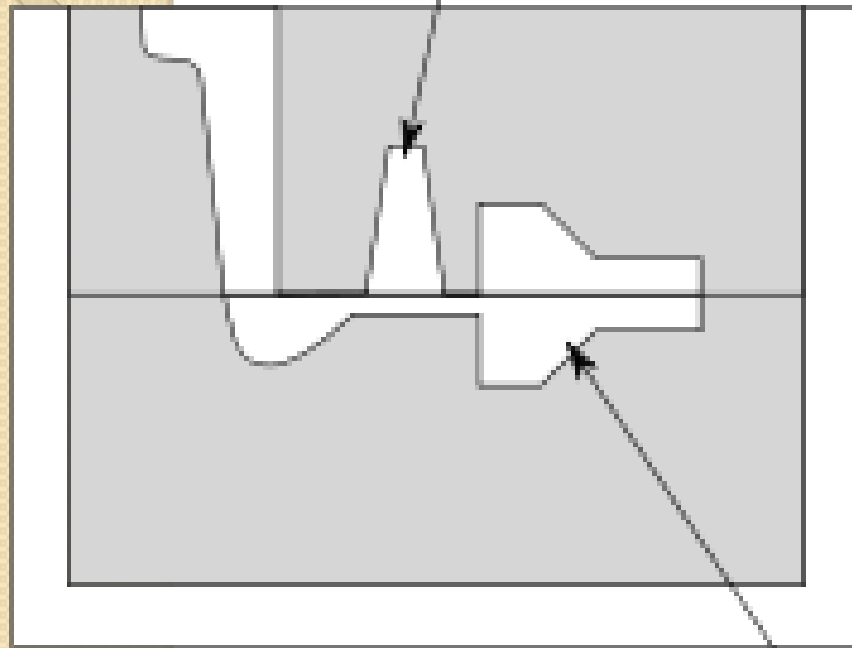
There are three distinct size of sand grains:

1. Fine
2. Medium
3. Coarse

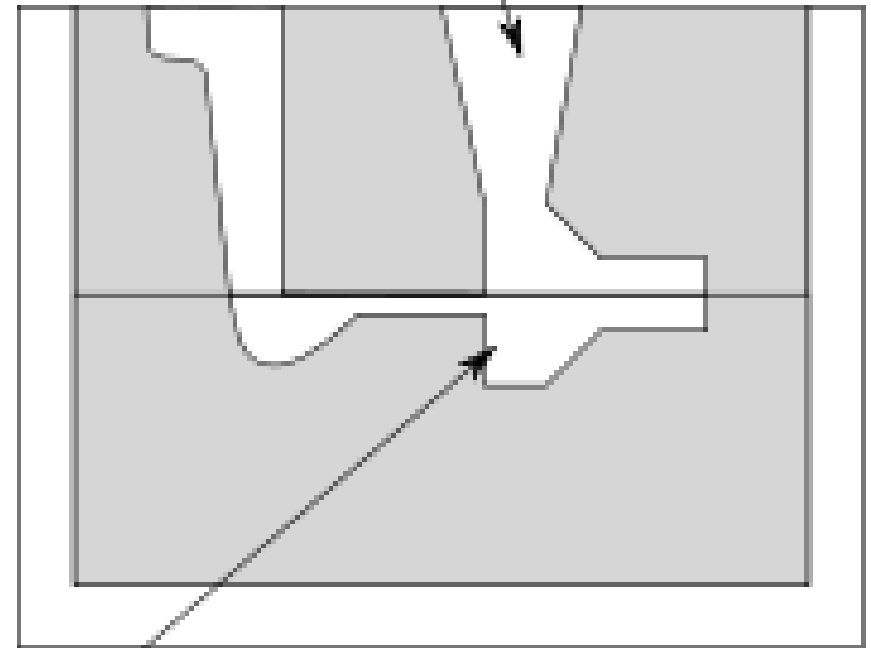
Types of Moulding Sand

1. Green Sand
2. *Dry Sand*
3. Facing Sand
4. *Loam Sand*
5. *Backing Sand*
6. *Parting Sand*
7. *Core Sand*

SIDE RISER (BLIND-TYPE)



TOP RISER (OPEN-TYPE)



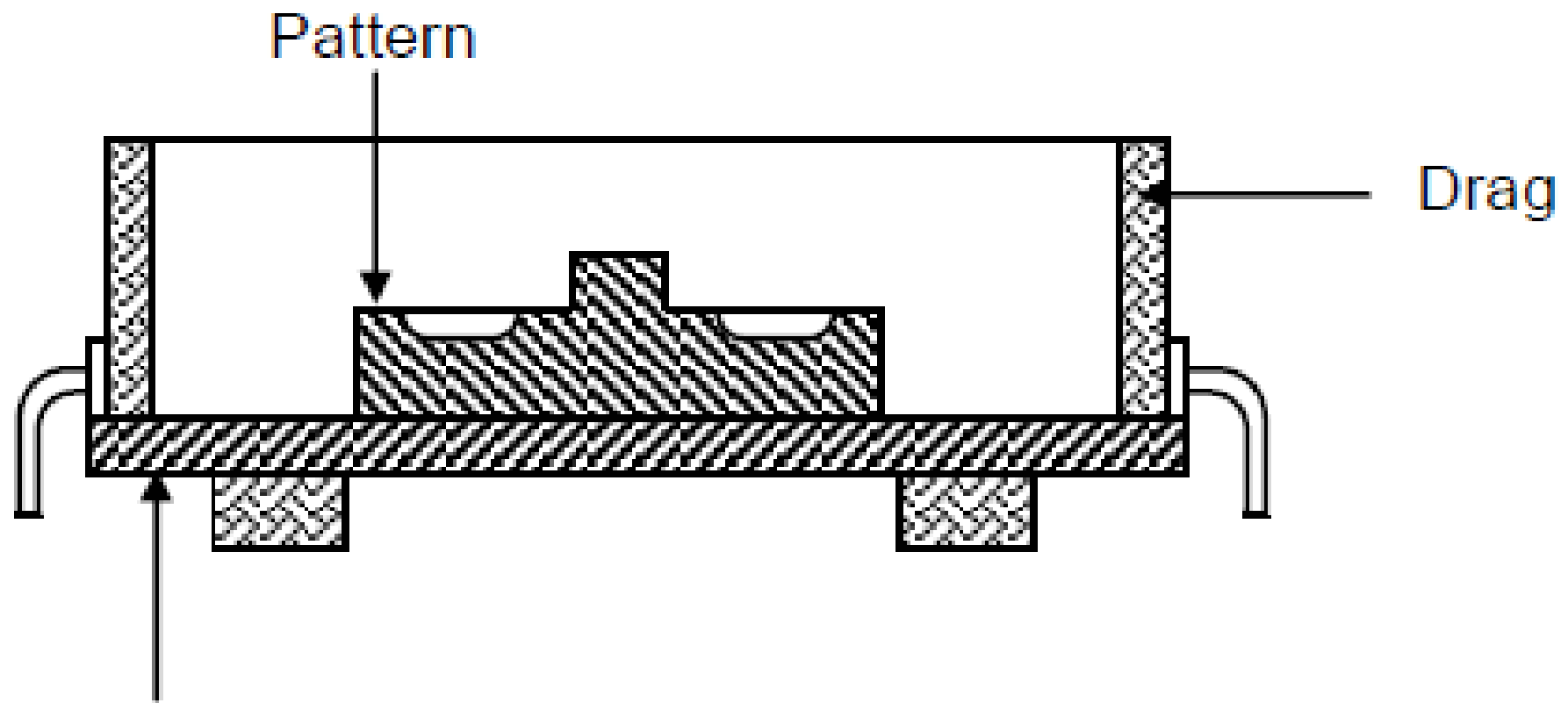
MOLD CAVITY

2 types of moulding flask designs

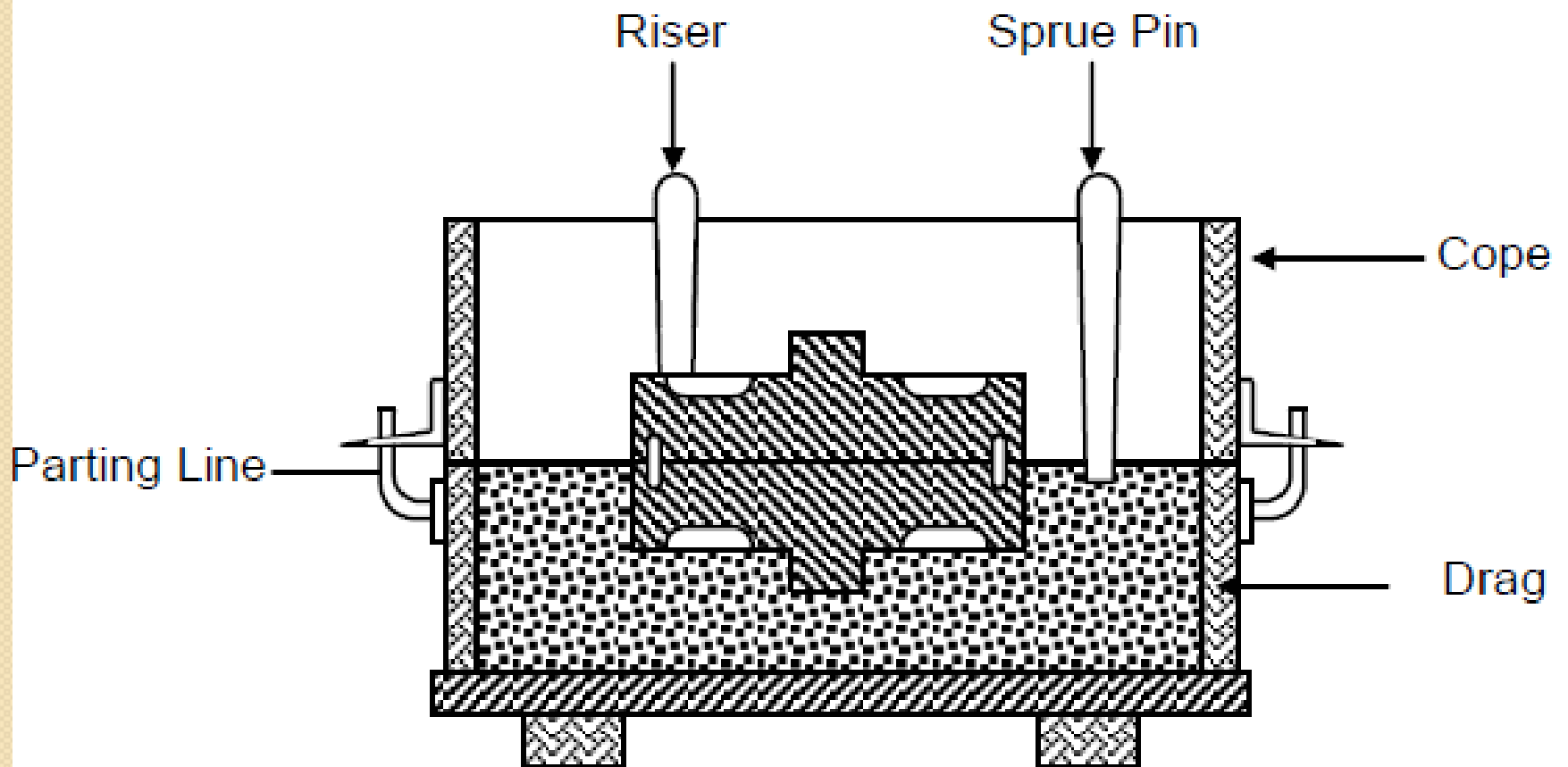


SAND MOULDING

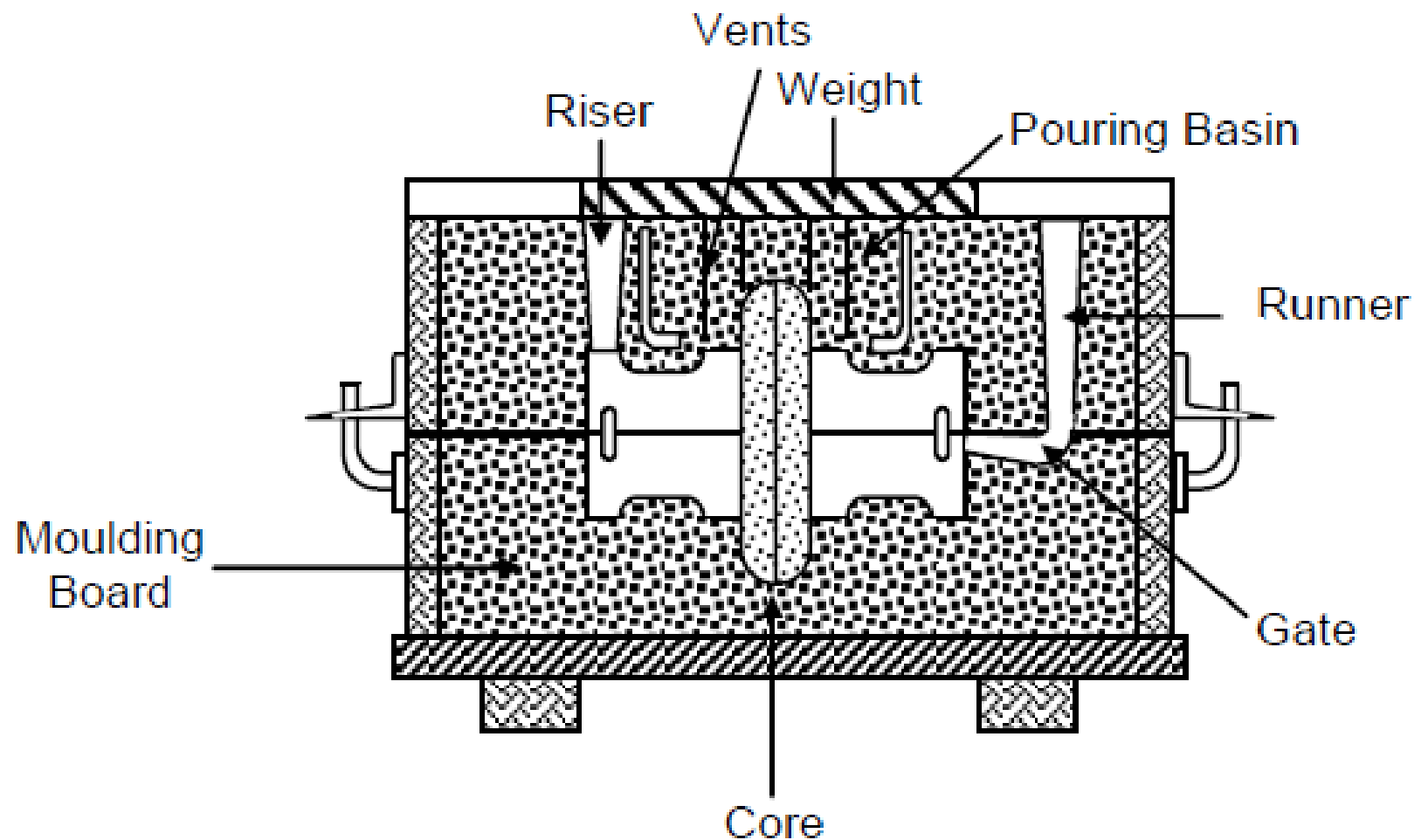
PROCESS



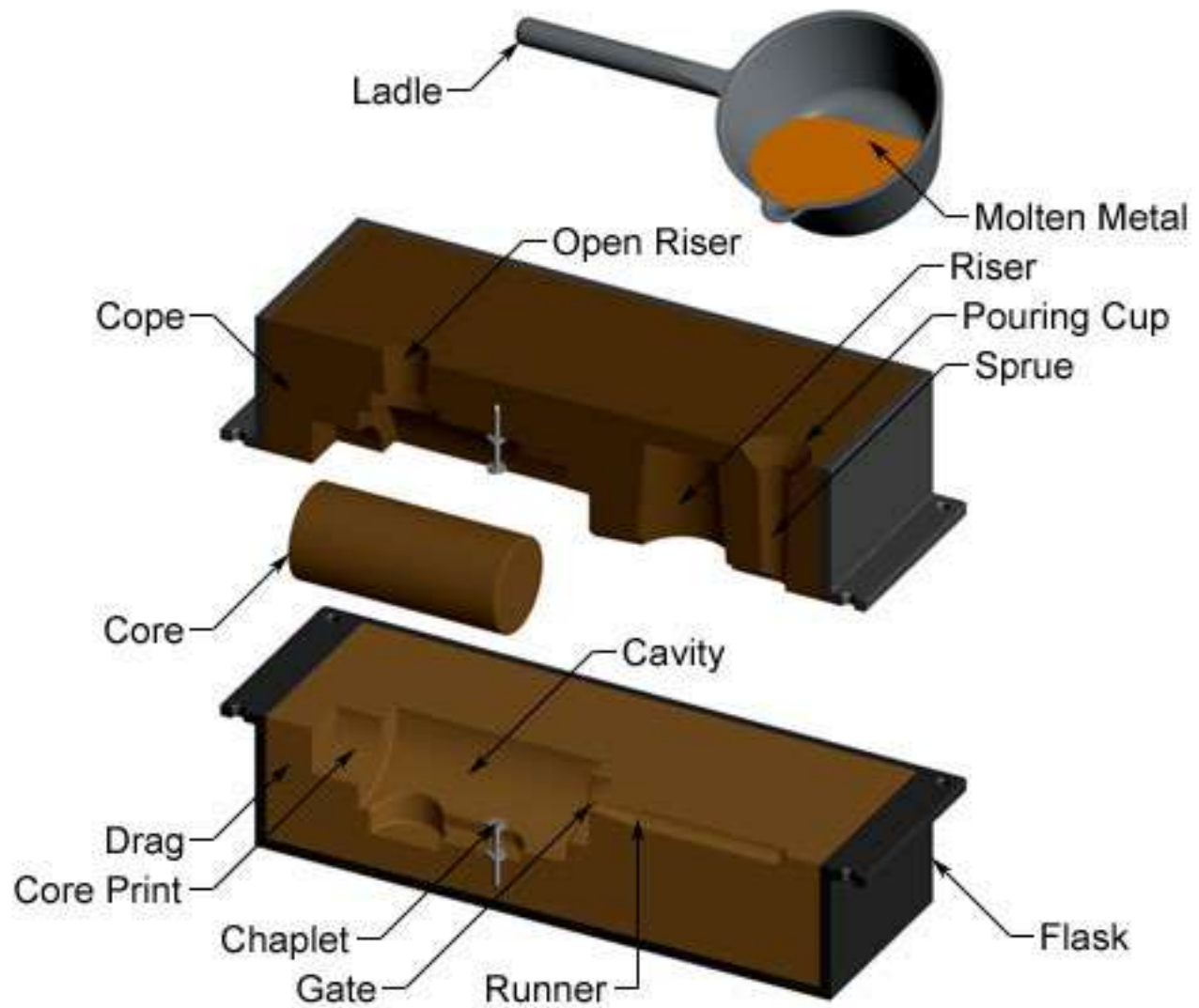
(First Step)



(Second Step)

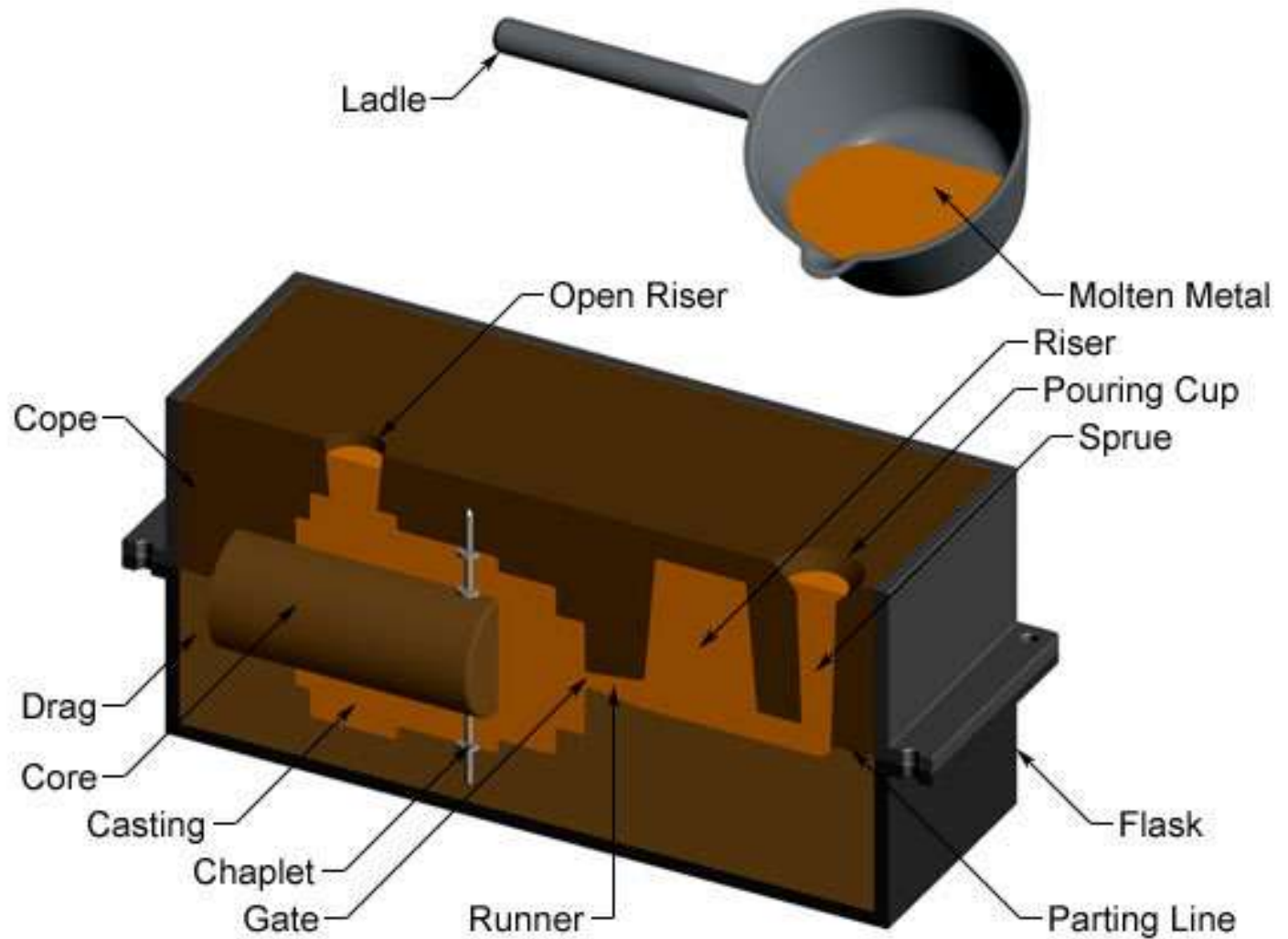


(Third Step)
(Completed-Mould)



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Sand mold - opened



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Sand mold - closed



Mixing moulding sand with binders & adhesives



Filling sand in moulding flasks



Melting furnace



Pouring molten liquid



Knock out



Heat treatment



Machining



final products of casting

Casting Methods



- Sand Casting
High Temperature Alloy,
Complex Geometry,
Rough Surface Finish



- Investment Casting
High Temperature Alloy,
Complex Geometry,
Moderately Smooth Surface
Finish



- Die Casting
High Temperature Alloy,
Moderate Geometry,
Smooth Surface