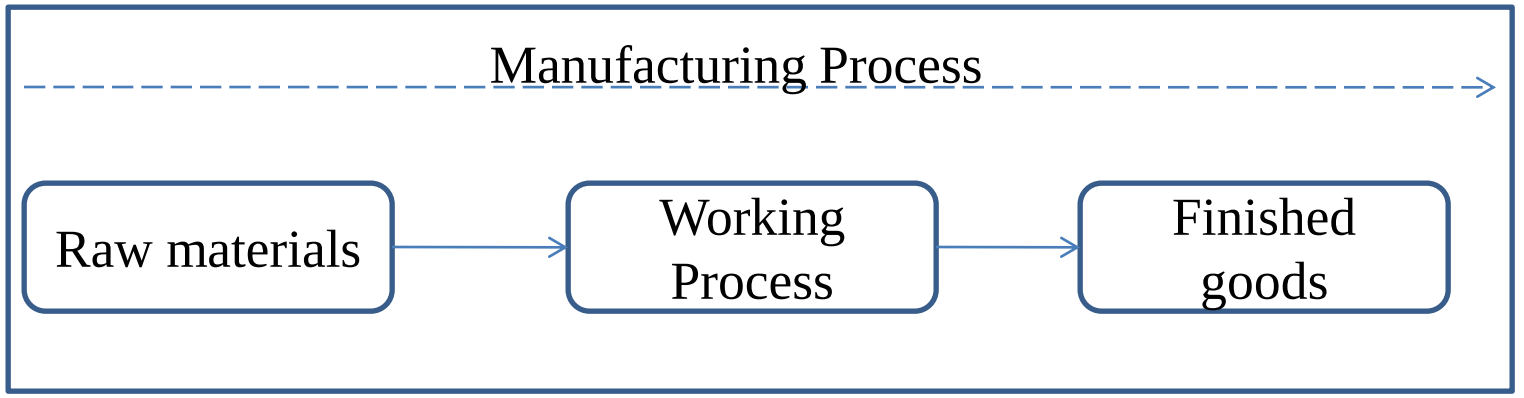
UNIT-IV

Body Components

Manufacturing Process

Manufacturing process is science and technology by which a material is converted into a useful shape, with a structure and properties.



Types of Manufacturing Process

The manufacturing process can be classified into four major types.

They are

(i) Casting

(ii) Material removal

(iii) Deformation processes

(iv) Consolidation processes

(i) Casting

- Expendeble mould
  - Sand casting
  - Shell casting
  - Investment casting
  - Lost wax casing
- Multiple – use mould
  - Die casting
  - Permanent mould casting

(ii) Material removal

- Mechanical machining
  - Turning
  - Milling
  - Drilling
  - Boring
  - Sawing
- Non – traditional machining
  - Etching
  - Electro polishing
  - Electro discharge machining
  - Water jet machining
  - Abrasive jet machining
  - Laser beam machining

(iii) Deformation process

- Hot bulk forming
  - Forging
  - Rolling
  - Extrusion
- Cold forming
  - Wire drawing
  - Swaging
  - Roll forming
  - Deep drawing

(iv) Consolidation processes

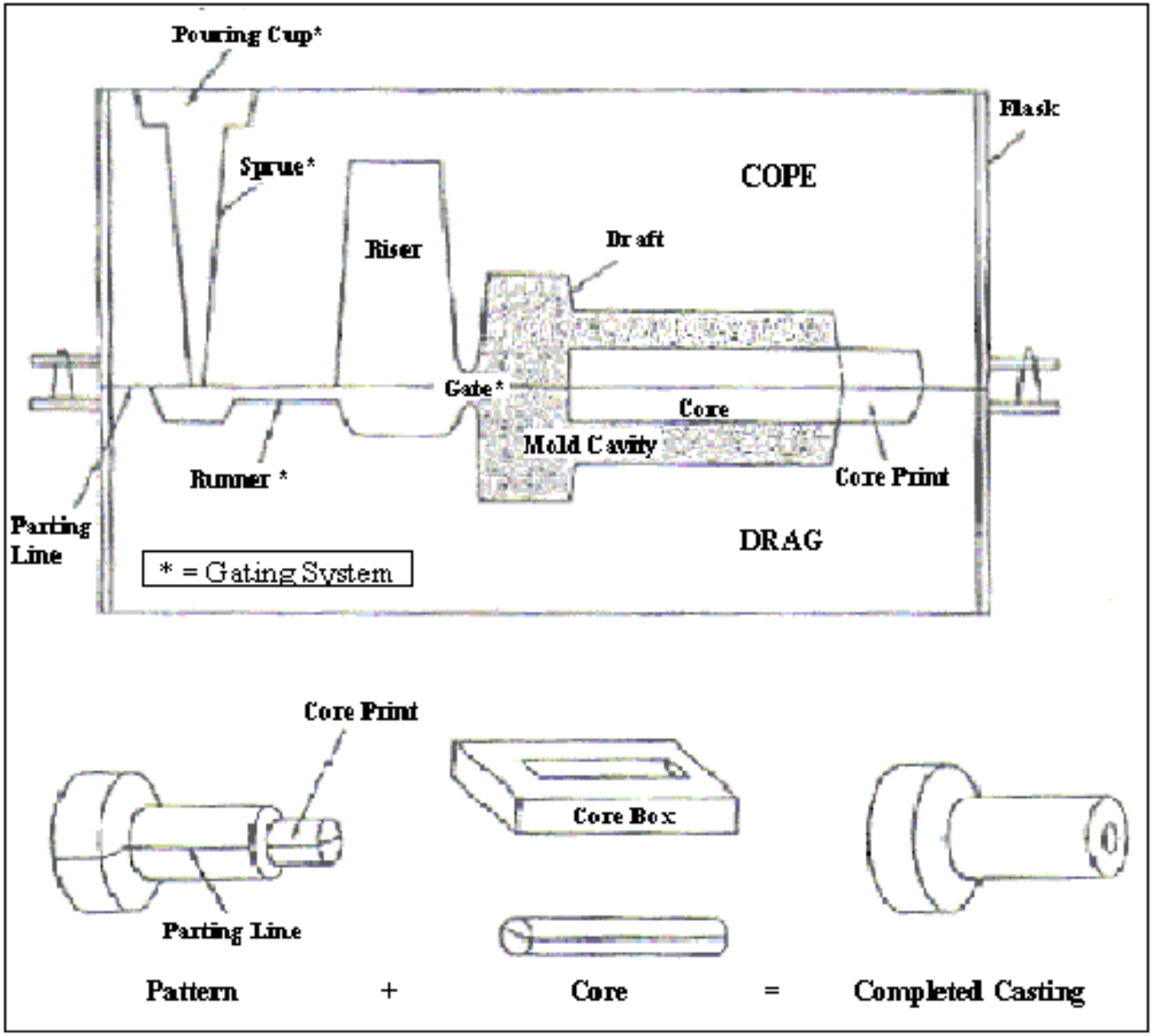
- Welding
  - Oxyfuel
  - Arc
  - Plasma
  - Resistance
  - Laser
- Brazing
- Soldering

(iv) Consolidation processes

- Adhesive bonding
- Mechanical joining
  - Discrete fasteners
  - Integral fasteners
  - Press fit
  - Shrink fit

1. Metal casting processes

- A casting may be defined as a **“metal object obtained by allowing molten metal to solidify in a mould”** , the shape of the object being determined by the shape of the mould cavity.
- Casting (or) foundry is a process of forming metallic products by melting the metal, pouring in to a cavity known as the mould, and allowing it to solidify.


Pouring Cup*
Flask
Sprue*
COPE
Riser
Draft
Gate*
Core
Mold Cavity
Runner *
Core Print
Parting Line
DRAG
* = Gating System
Core Print
Core Box
Parting Line
Pattern
+
Core
=
Completed Casting

- When it is removed from the mould, it will be same shapes as the mould.

- Many parts and components are made by casting, including cameras, carburetors, engine blocks, crankshafts, automotive components, agricultural equipments, road equipment, and pipes.

According to the usage

Types of Molding Sand

- Green sand
- Dry sand
- Loam sand
- Facing sand
- Backing sand
- Parting sand
- Core sand

Pattern Materials

The most used pattern materials has good characteristics. There are

(i) Wood and wood materials

(ii) Metals and Alloys

(iii) Plasters

(iv) Plastic and Rubbers

(v) Waxes

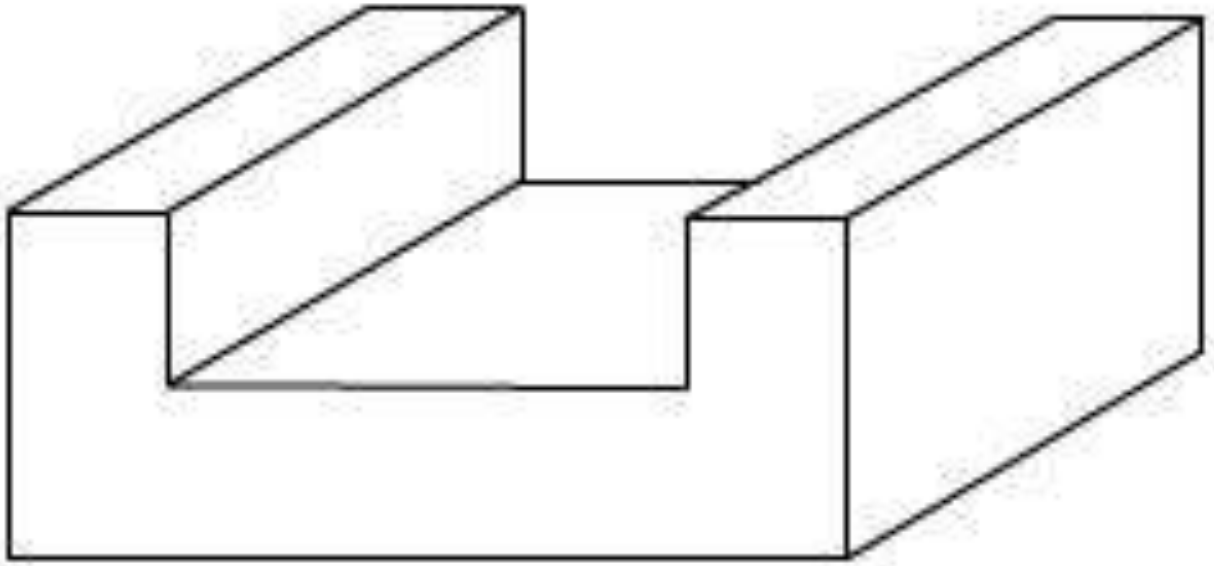
Types of Patterns

(i) Single piece pattern (or) Solid pattern.
(ii) Split pattern
(iii) Match plate pattern
(iv) Cope and Drag pattern
(v) Gated pattern
(vi) Loose – piece pattern
(vii) Sweep pattern
(viii) Skeleton pattern
(ix) Segmental pattern
(x) Shell pattern

(i) Single piece pattern (or) Solid pattern.

- ❖ It is are generally **used for simpler shapes** and low quality production.
- ❖ These type of patterns are **made with out joints**, partings (or) any loose pieces in its.
- ❖ **Soil temper, staffing – box and gland of a steam engine** are few examples of casting which are made by making solid patterns.

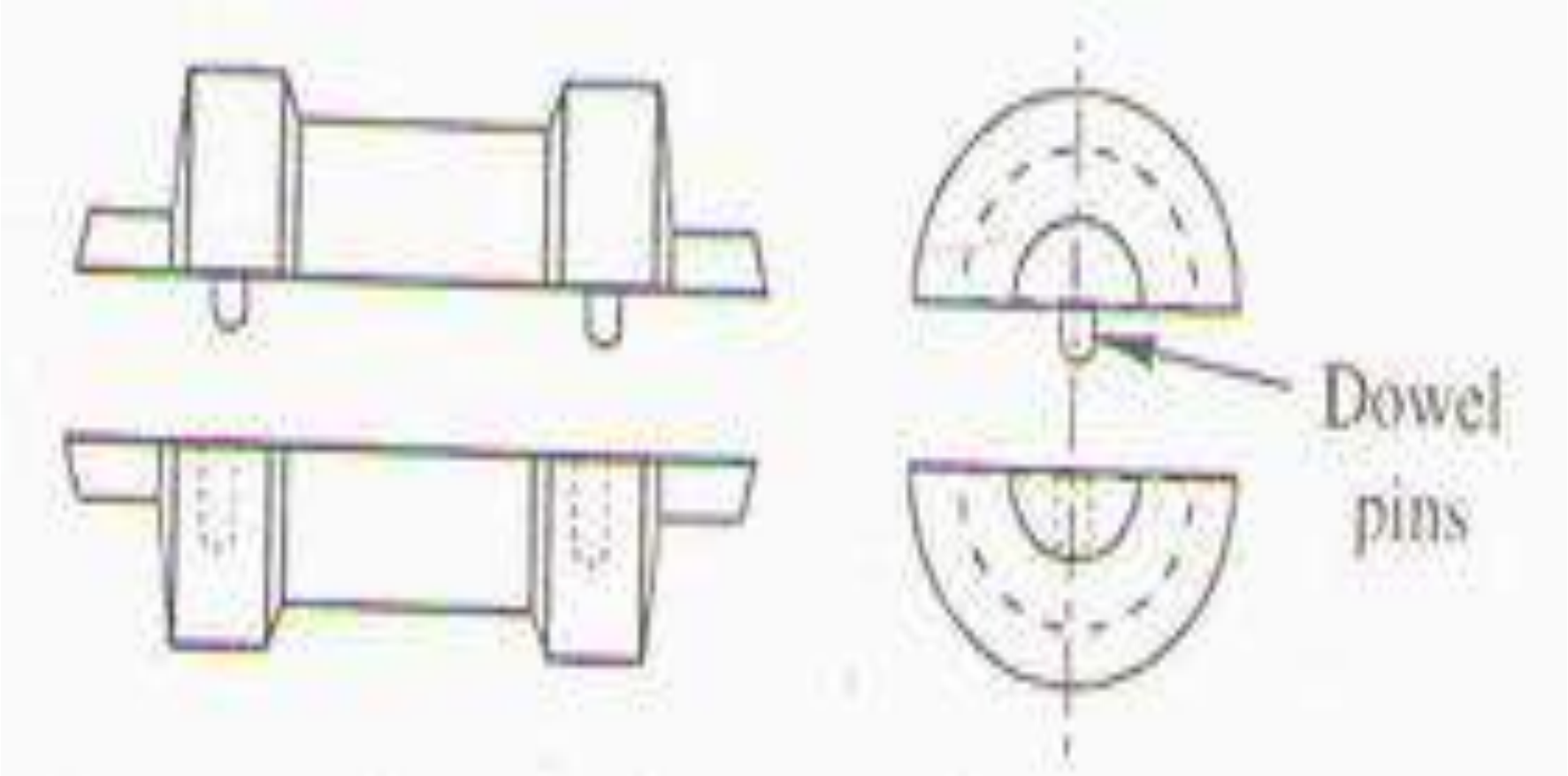
Single piece pattern



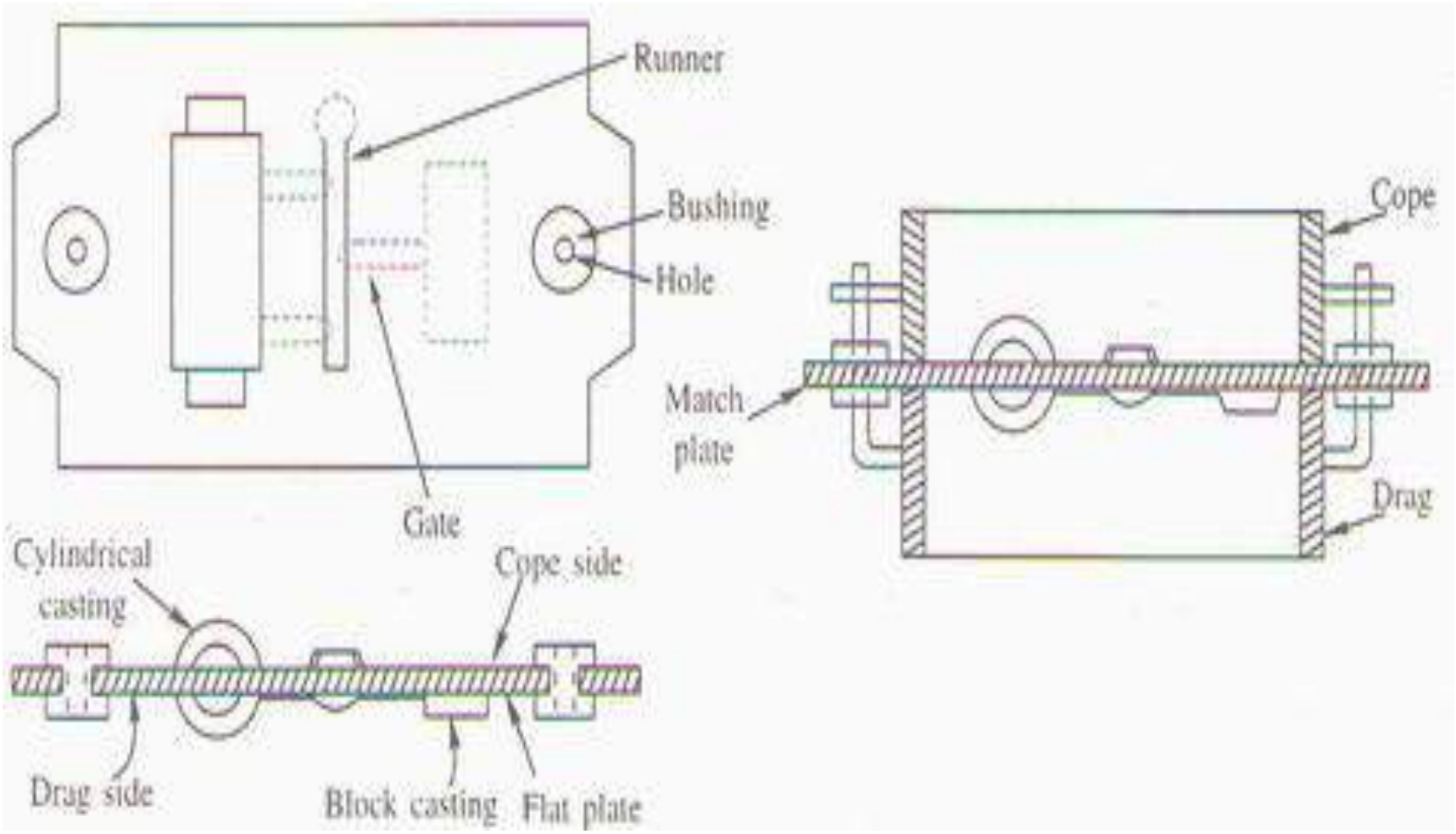
(ii) Split pattern

- Split patterns are **two – piece patterns** made such that each part forms a portion of the cavity for the casting.
- The upper and the lower parts of the split pattern are accommodated in the **cope and drag portions of the mould**.
- The surface formed at the **center line** of the pattern, is called the **parting surface** (or) parting line.
- Making of **more parts instead two** to make completed pattern for a complicated this type of pattern is called **multi- piece pattern**.

Two piece pattern



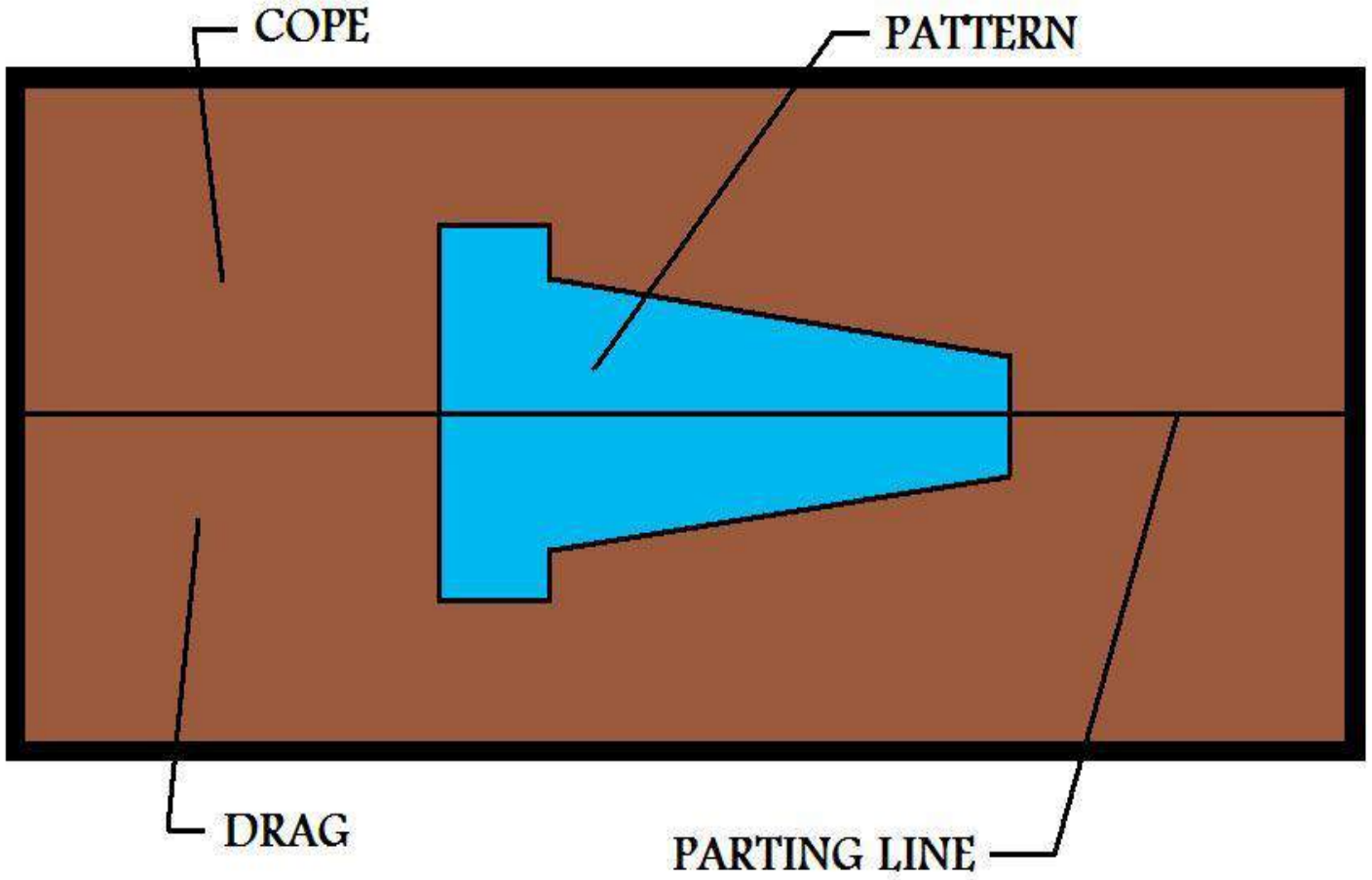
Match plate pattern



(iv) Cope and Drag pattern

- The cope and drag pattern enables the **cope section** of the mould and the **drag section** of the mould to be **created separately** and **latter assembled** before the pouring of the casting.
- It is used to **produce the big castings**.

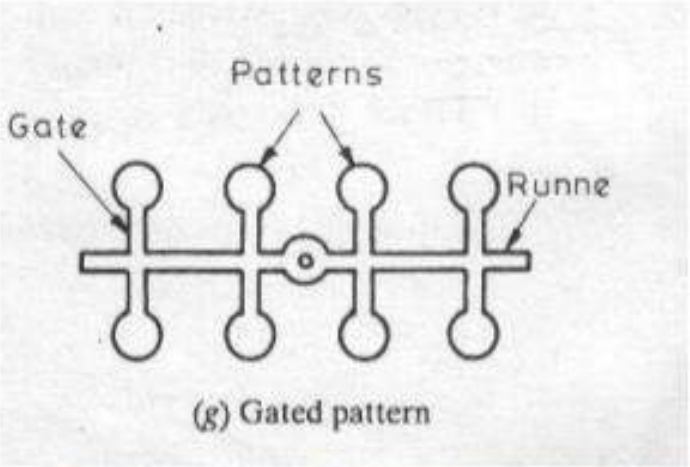
Cope and Drag pattern

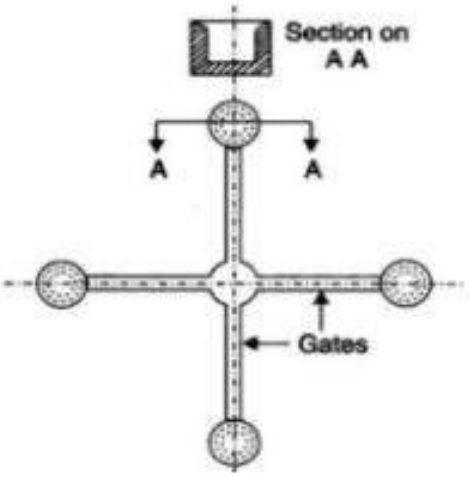


(v) Gated pattern

- In these patterns the sections are connecting **different patterns serve as runner and gates**.
- That is **used for mass production** systems.
- Gated patterns are **usually made of Metal** which increases their **strength** and **reduces** the tendency to **wrap**.

Gated Pattern





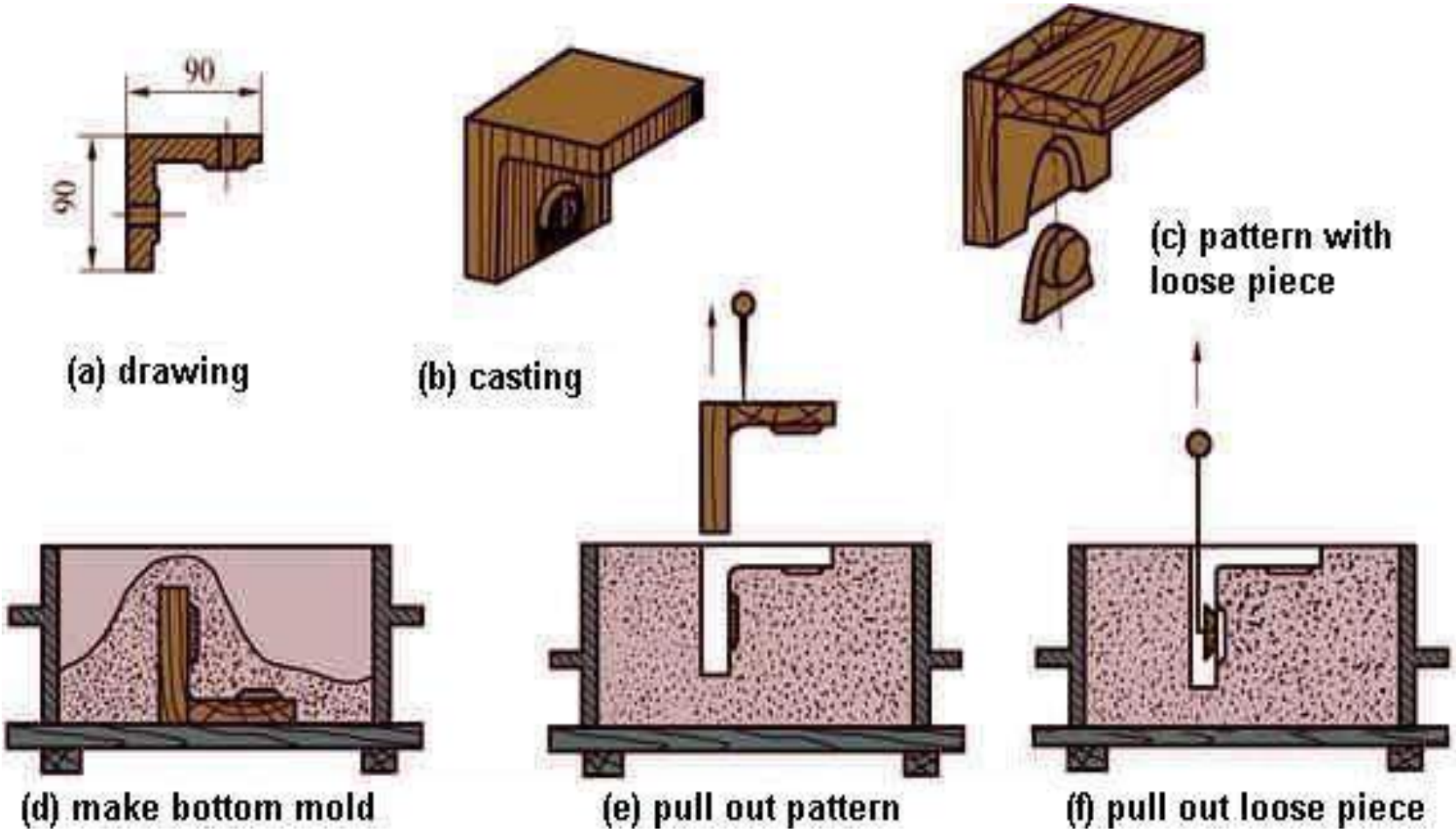
castings

Gating system

(vi) Loose – piece pattern

These loose – piece patterns are needed, when the part is such that the **pattern cannot be removed as one piece**, even though it is split and the line is made on more than one plane.

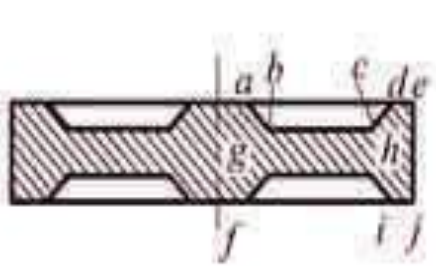
Loose piece pattern



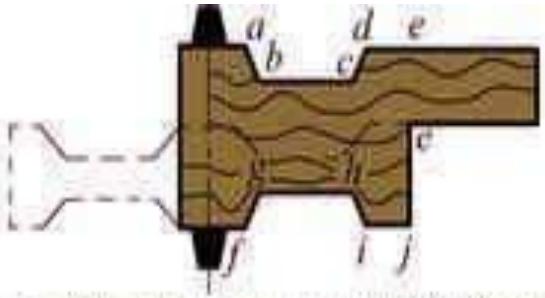
(vii) Sweep pattern

- A sweep pattern is just a form, made on a wooden board with **sweeps the shape of the casting into the sand** all around the **circumference**.
- The sweep patterns are rotating about the post. It is used for **producing large casting of circular sections**.

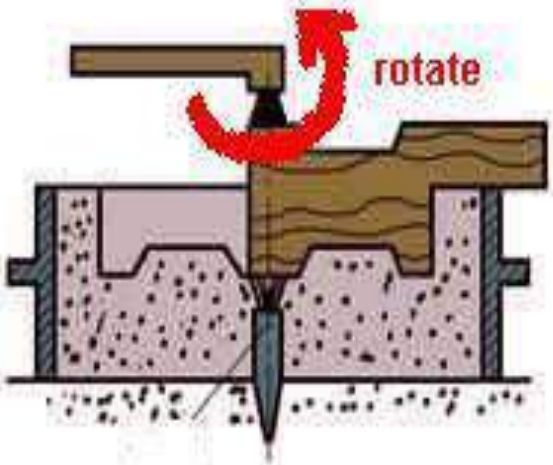
Sweep pattern



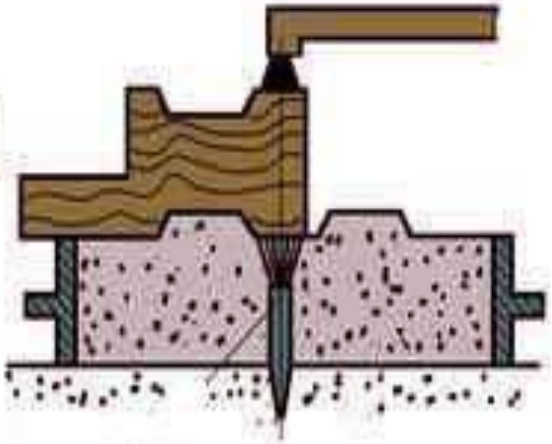
(a) belt pully casting



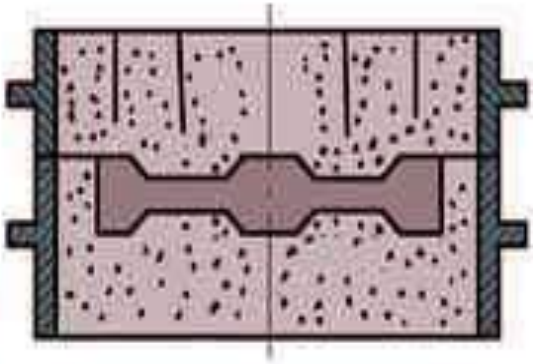
(b) scraper blade pattern



(c) make top mold



(d) make bottom mold



(e) assembly sand boxes

PATTERN ALLOWANCES

A pattern is always made somewhat larger than the final job to be produced. This excess in dimensions is referred to as the **Pattern allowance.**

Types

1. Shrinkage or Contraction allowance
2. Draft or Taper allowance
3. Machining or Finish allowance
4. Rapping or Shaking Allowance
5. Distortion or Camber Allowance

Rapping or Shaking Allowance

- When the **pattern is shaken for easy withdrawal**, the mould cavity, hence the **casting** is slightly **increased in size**. In order to compensate for this increase, the pattern should be initially made slightly smaller.
- For small and **medium sized castings**, this allowance can be **ignored**.
- Large sized and precision castings, however, shaking allowance is to be considered.
- The amount of this allowance is given based on previous experience.

Distortion or Camber Allowance

- Sometimes castings, because of their size, shape and type of metal, tend to **warp or distort during the cooling period** depending on the cooling speed.
- Expecting the amount of warpage, a pattern may be made with allowance of warpage. It is called camber.
- For example, a U-shaped casting will be distorted during cooling with the legs diverging, instead of parallel as shown in fig. For compensating this warpage, the pattern is made with the legs converged but,as the casting cools, the legs straighten and remain parallel.

Casting without camber | Actual casting | Pattern with camber allowance

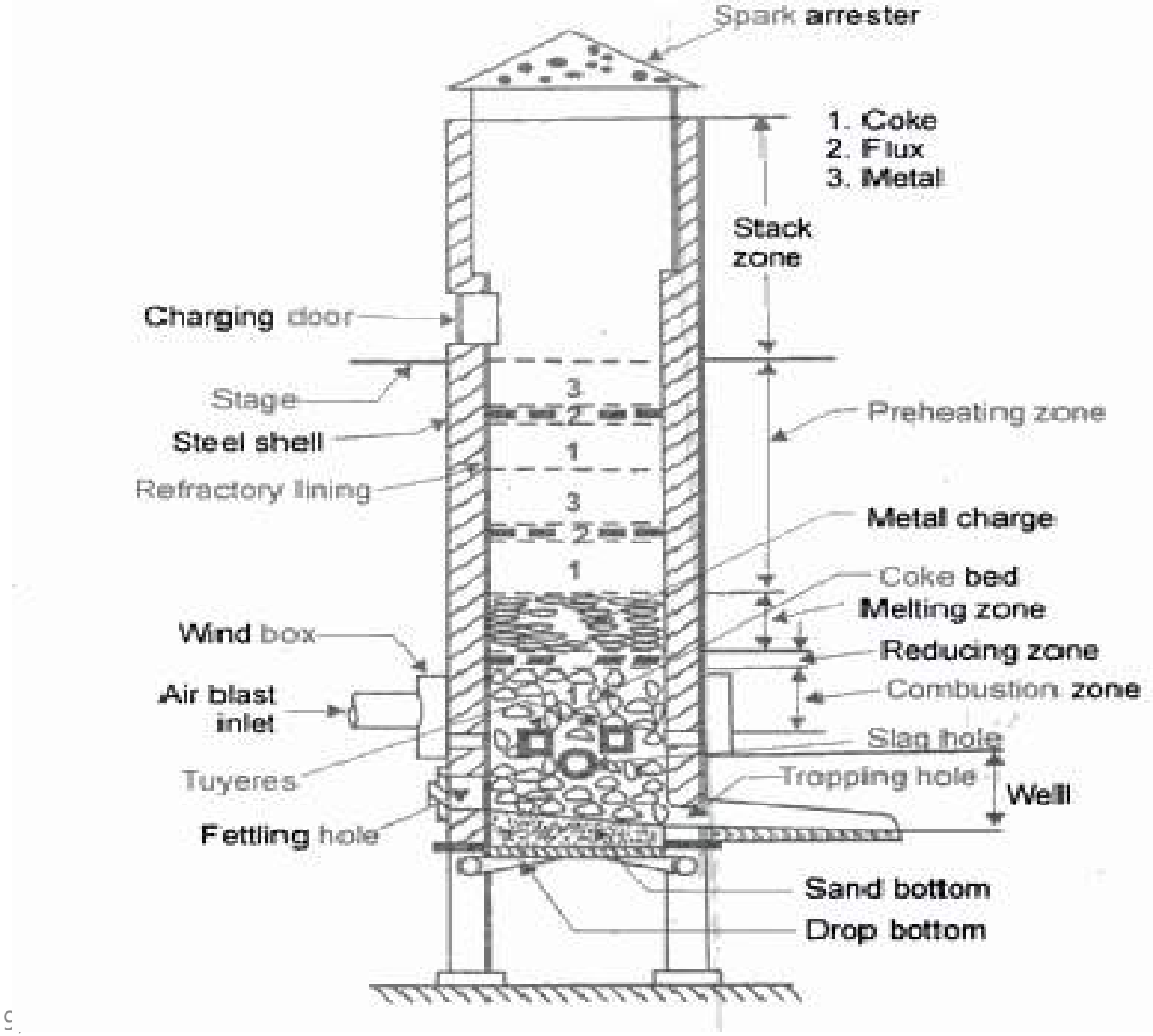
CORES

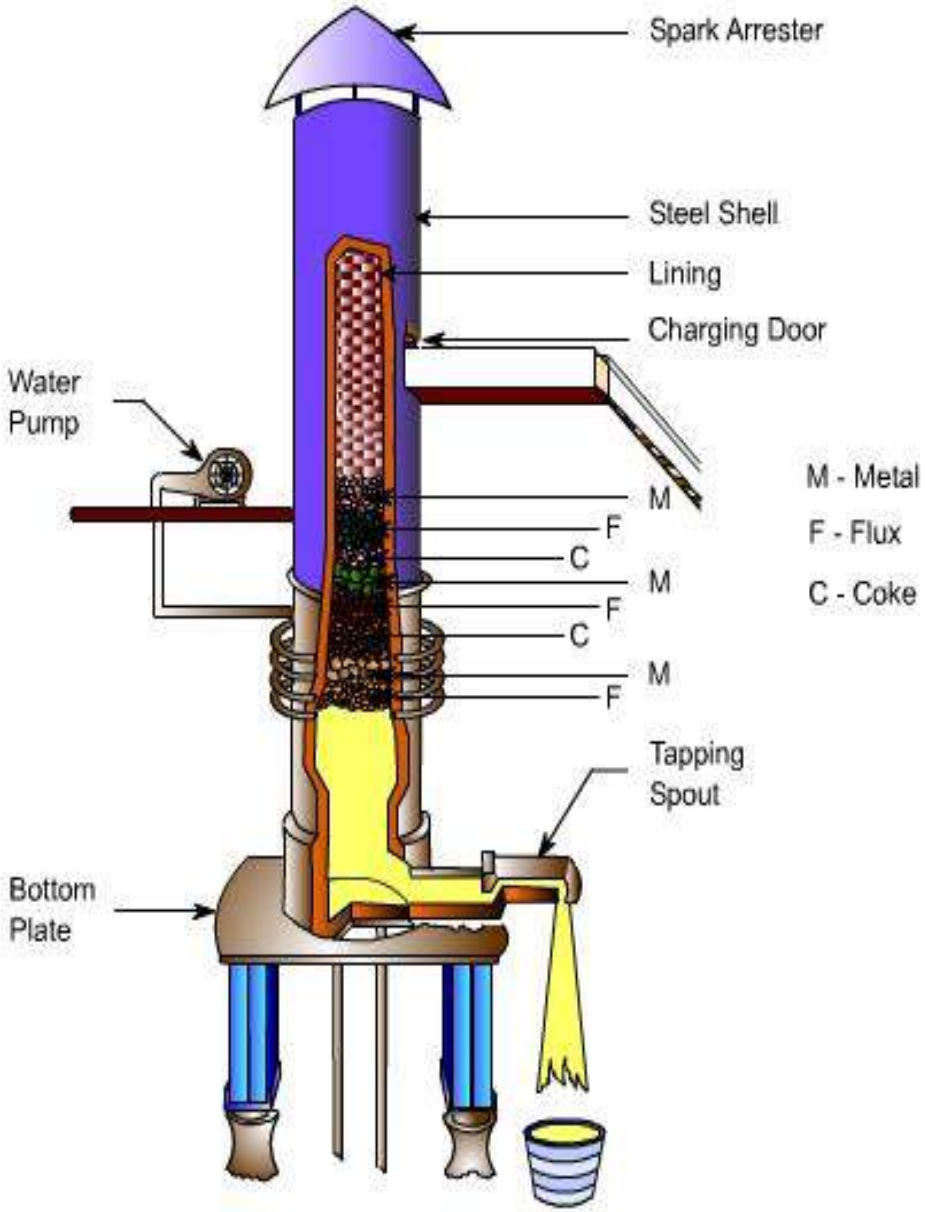
What is core in Casting?

- A core is a body made of **sand which is used to make a cavity or a hole** in a casting.
- Also used to make **recesses, projections, undercuts and internal cavities.**

Melting furnaces

Cupola furnaces:




Spark Arrester
Steel Shell
Lining
Charging Door
Water Pump
M
F
C
M
F
C
M
F
Tapping Spout
Bottom Plate
M - Metal
F - Flux
C - Coke

Construction:

- Cylindrical shell made of **10 mm thick** steel plate.
- Lined with **refractory bricks** inside.
- Two bottom **doors**.
- **Sand bed** laid over the bottom doors.
- **Slag hole** provided above the tap hole.
- Opening called **tuyeres** one meter above bottom
- Wind box and blower
- Charging door.

Preparation:

- Previous melting cleaned
- Broken bricks must be replaced
- Bottom doors are closed
- Sand bed sloping towards tap hole-height 200mm
- Tap hole lined with clay
- Slag hole is prepared
- Cupola dried thoroughly

Firing

- Oil and wooden piece-placed at bottom
- Air- sufficient amount is supplied
- Coke-charged at several portions
- Blast is turned off
- More coke- upto tuyeres level
- Coke-level of bed charge
- Coke-burn for half an hour
- Charging-at the charging door

Charging and Melting

- Pig iron and iron scrap-charged at charging door
- Coke-charged alternatively
- Limestone-remove impurities-thorough mixing
- Pig iron to limestone ratio: 25:1
- Pig iron to coke: 10:1
- Iron soaked for 1 hour
- Blast turned on
- Molten metal-collected at sand bed
- Clay plug-collected in ladles

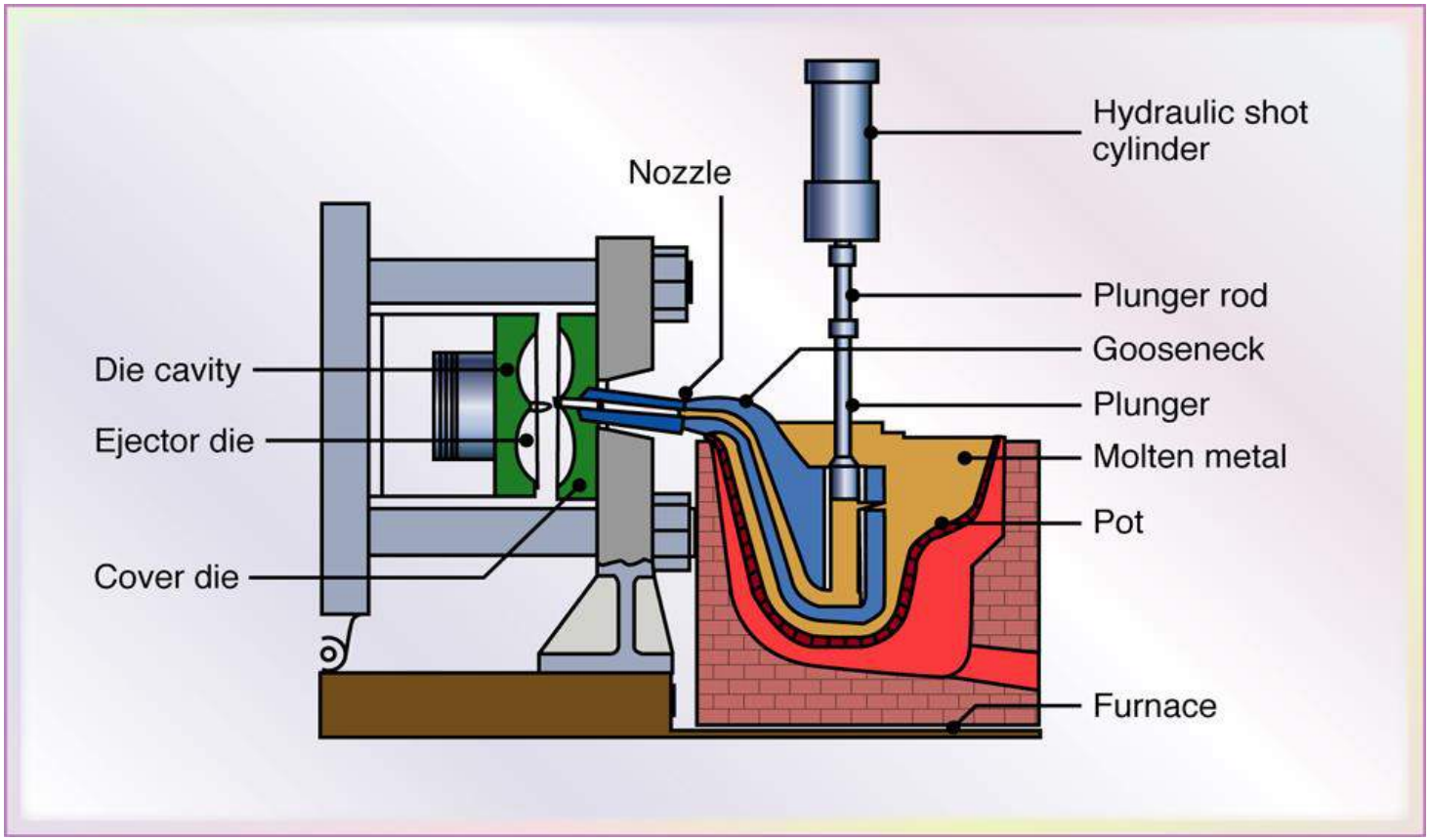
- Molten metal-poured into moulds
- Floating slag-tapped out through slag hole
- Furnace charged full-repeating same procedure
- Cupola shut off-by stopping air blast
- Wastes-dropped down and quenched by water

Application:

Melting Cast iron

Injection Molding process

- Figure shows a 'goose neck' type of injection molding machine.
- In this process, the dies are made in two halves: one half called the fixed die or 'stationary die' while the other half called 'movable die'.
- The dies are aligned in positions by means of ejector pins which also help to eject the solidified casting from the dies.



Cold chamber Die Casting Process

- In hot chamber process, the charging unit (goose neck) rests in the melting chamber, whereas in cold chamber process, the melting chamber is separate and the molten metal is charged into the machine by means of ladles.
- Cold chamber process is employed for casting materials that are not possible by the hot chamber process.
- For example, aluminum alloys react with the steel structure of the hot chamber machine and as a result there is a considerable iron pick-up by aluminum.
- This does not happen in cold chamber process, as the molten metal has a momentary contact with the structure of the machine.
- Figure shows the cold chamber die casting machine

- The machine consists of a die, made in two halves: one half called the 'fixed die' or 'stationary die' while the other half called 'movable die'.
- The dies are aligned in positions by means of ejector pins which also help to eject the solidified casting from the dies.

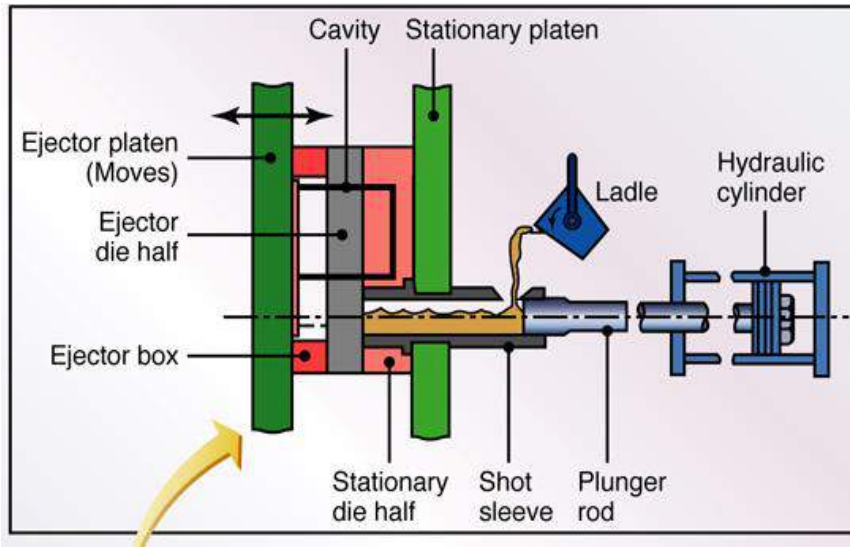
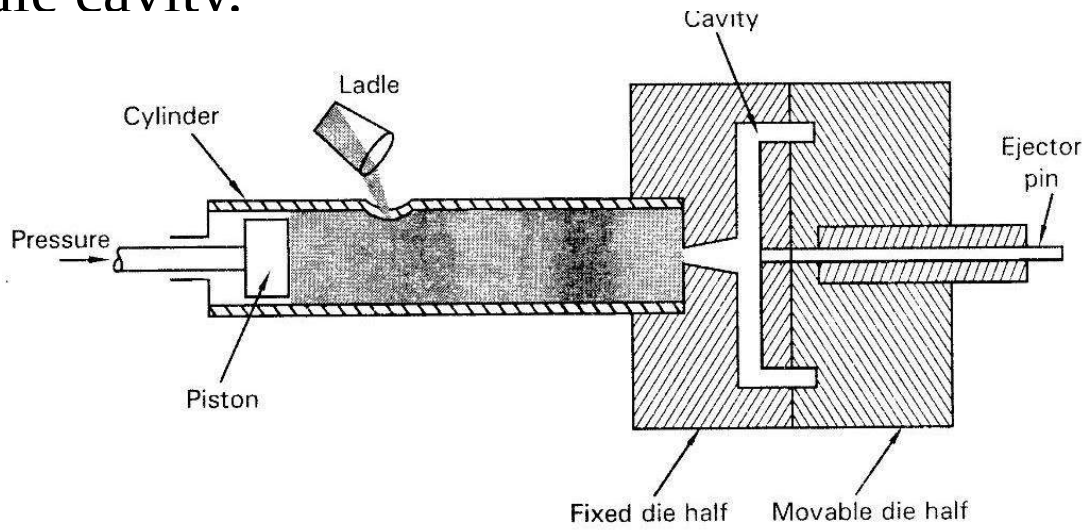


Fig: cold chamber die casting machine

Steps involved in the process

- A cylindrical shaped chamber called 'cold chamber' is fitted with a freely moving piston and is operated by means of hydraulic pressure.
- A measured quantity of molten metal is poured into the cold chamber by means of ladles.
- The plunger of the piston is activated and progresses rapidly forcing the molten metal into the die cavity. The pressure is maintained during the solidification process.
- After the metal cools and solidifies, the plunger moves backward and the movable die half opens by means of ejector pins forcing the casting from the die cavitv.



Thermoforming

- **Thermoforming** – Thermoforming is a general term that refers to the process of transforming a plastic sheet into a 3-dimensional shape by using heat, vacuum, and pressure.
- **Thermoplastics** – Thermoplastics refers to a type of plastic made from polymer resins that become homogenized when heated.

Thermoforming.mp4

Thermoforming

- **Thermoforming** – It is a process of heating a thermoplastic sheet to its softening point. The sheet is stretched across a single-sided mold and then manipulated. Then, it cools into the desired shape.
- **Thermoplastics** – Thermoplastics refers to a type of plastic made from polymer resins that become homogenized when heated.

Thermoforming.mp4

Thermoforming Applications

- R**efrigerators and freezer door liners** are thermoformed.
- Some dishwashers and clothes dryers,
- window air conditioners, computers and television cabinets are made by thermoforming

Thermoforming

- Types of Thermoforming

1. Pressure forming
2. Vacuum forming

The optimum temp of 310^0 F is used to heat the plastic for Thermoforming 275^0 F - 310^0 F

Thermoforming.mp4

Pressure forming

- This process adds a pressure box to the tooling package.
- It utilizes both vacuum and positive air pressure.
- This process generates as much as 3 to 4 times the forming pressure as vacuum forming does.
- Therefore, fine details such as surface textures can be formed on the mold without incurring excessive extra costs.

Vaccum forming

- The specific process that involves forming a part by heating and stretching the plastic across a mold using a vacuum.
- Normally the mold is open and the force involved with forming the sheet is limited to about 15 psi.

Pressure & Vaccum forming

- Thermoforming is a process where thermoplastic sheets are heated to a pliable temperature, formed to a specific shape using a mold, and trimmed to create a finished product.
- Vacuum Forming takes it one step further. When the part is formed to the mold, vacuum pressure is added to assist with the molding of the part.

Pressure & Vacuum forming

Difference

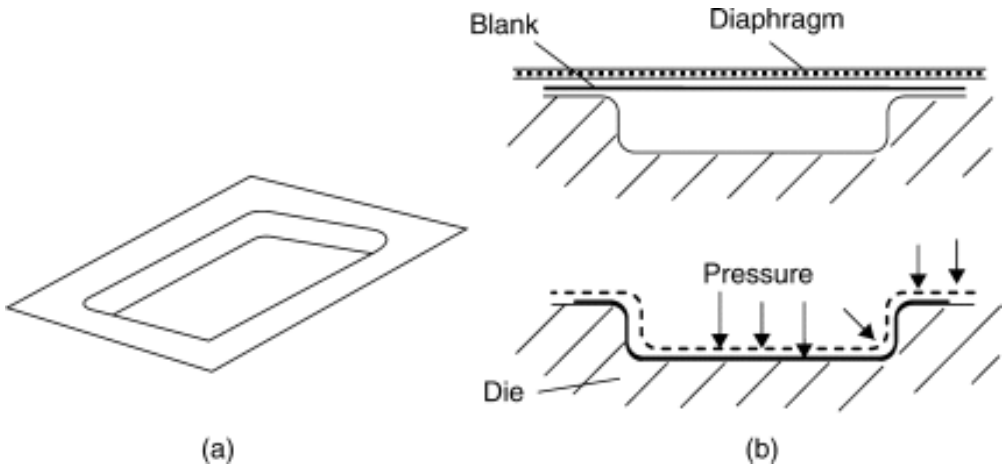
- When Thermoplastic is heated to a certain temperature, the process is vacuum forming.
- If the plastic is produced under extreme pressure and temperature, it is known as thermoforming.

Hydroforming

- Hydroforming is a metal forming technology based on the application of pressurized liquid media to generate defined workpiece shapes from tubular materials or sheet metals.

Hydroforming

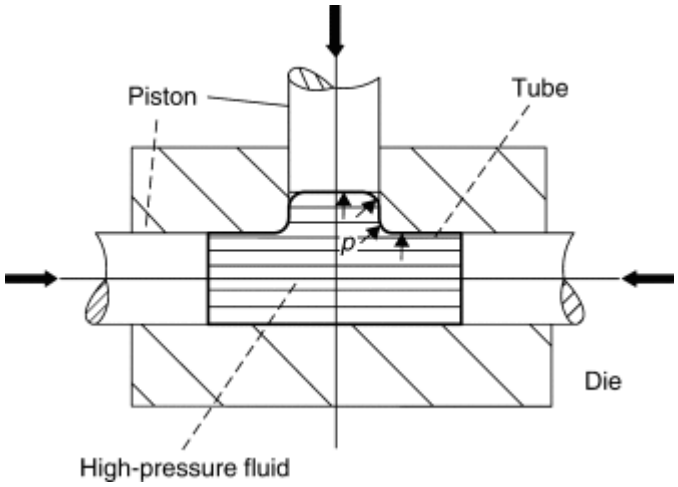
- In hydroforming, or fluid pressure forming, sheet is formed against a die by fluid pressure. In many cases, a flexible diaphragm is placed on the sheet and it is then formed into a female die cavity as shown in Figure



Hydroforming

- Hydroforming is also used to form tubular parts such as brackets for bicycle frames or pipe fittings, as shown. Axial force may be applied to the tube as well as internal pressure; this creates compressive stress in one direction so that elements of the tube deform without thinning and tearing is delayed.


Hydroforming.mp4



Hydroforming

- Hydroforming is the manufacturing of hollow parts with complex geometries by means of fluid pressure.

- Two types of Hydroforming are:

1. Tube hydroforming
2. Sheet hydroforming