



SNS College of Technology

Department of Mechanical Engineering



MANUFACTURING TECHNOLOGY

Unit - I

**Topic : Types of Melting furnaces, Solidification and Cooling,
Special casting processes**



Source : inductothermgroup.com

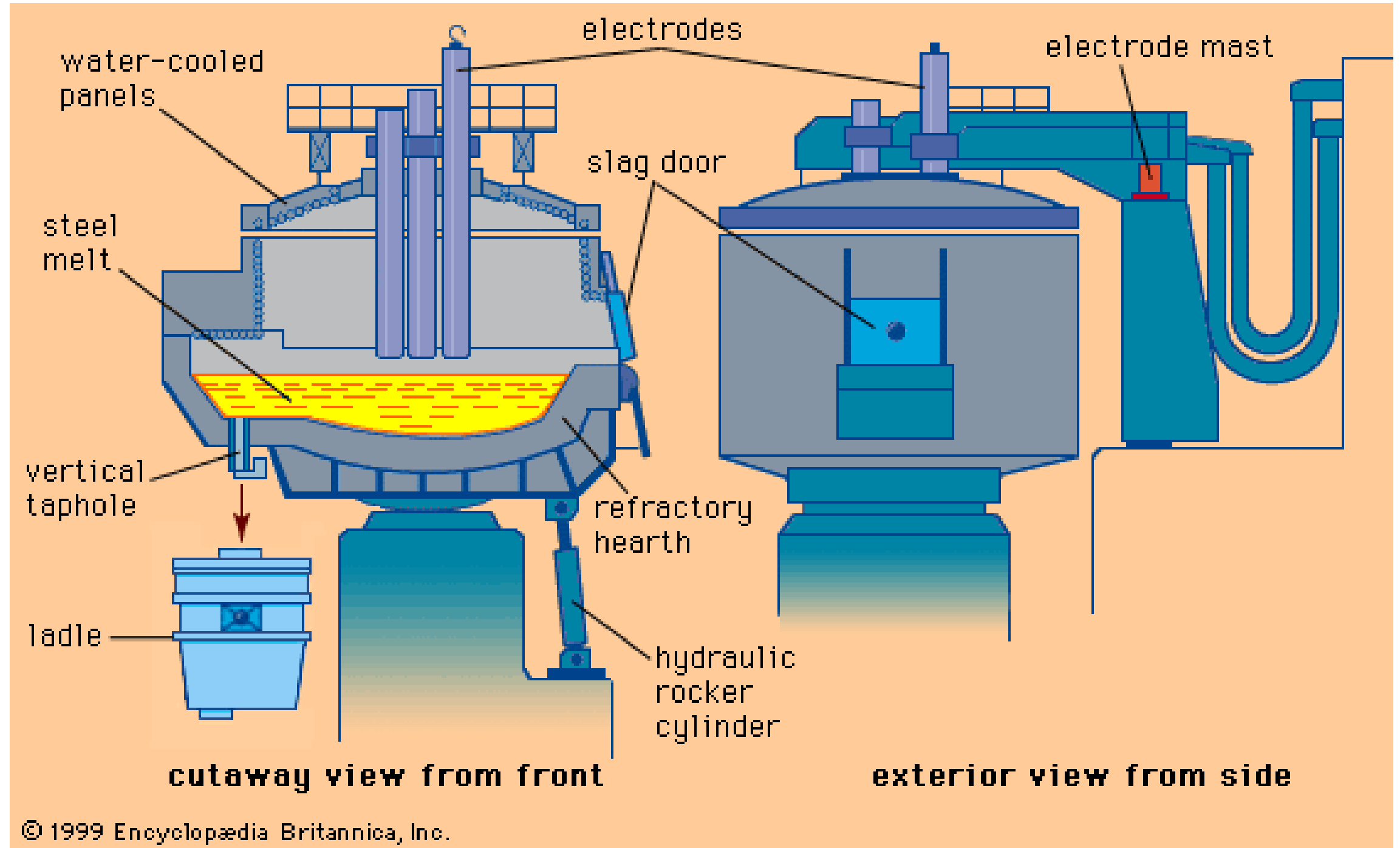
**Mr Gowtham M
AP/Mech**



Types of Melting furnaces



- **Cupola Furnace**
- **Induction Furnace**
- **Electric Furnaces**
- **Hearth Furnace**
- **Blast Furnace**



<https://tinyurl.com/y6donc6s>

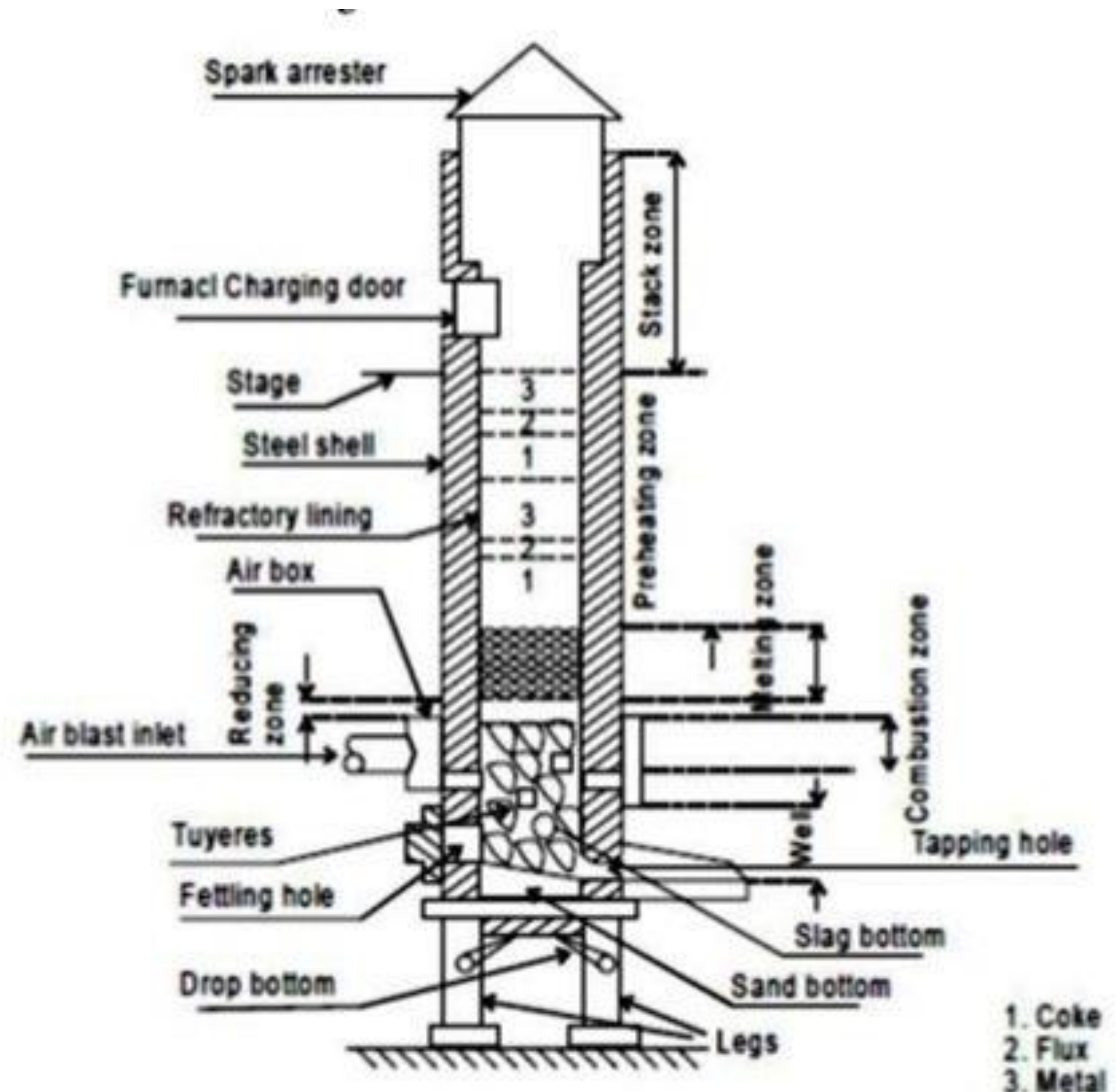


Types of Melting furnaces



➤ Cupola Furnace

One of the oldest style of melting furnaces, the cupola furnace, has a tall, cylindrical shape. The insides of these furnaces are lined with clay, blocks or bricks which protect the furnace's interior from heat, abrasion and oxidation. To melt the metal in the furnace, workers add layers of metal such as ferro alloys, limestone and coke. The limestone reacts with the metal, making the impurities float up to the surface of the melting metal.



<https://tinyurl.com/y42o96y2>

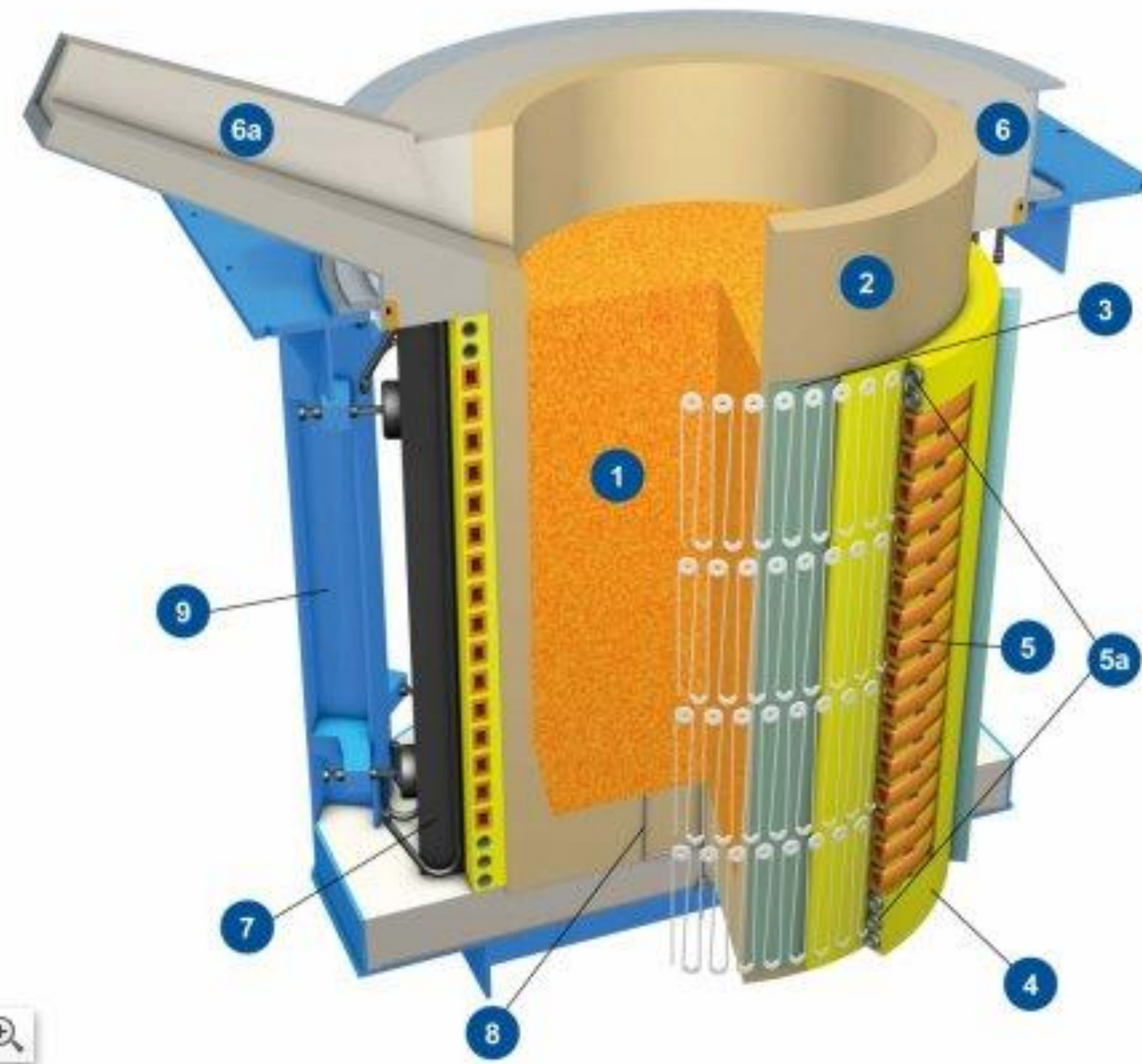


Types of Melting furnaces



➤ Induction Furnace

Induction furnaces use alternating currents to create the necessary heat with which to melt the metal. The refractories, or the lining, of these are made from materials such as alumina, silica and magnesia. These furnaces work well for melting metal such as iron as well as metals that are nonferrous. Inside the induction furnaces are copper coils which are cooled with water.



- 1 molten metal bath
- 2 refractory crucible
- 3 heat insulation layer
- 4 permanent lining with embedded OCP sensor cable*
- 5 power coil
- 5a cooling coil
- 6 furnace top
- 6a pouring spout
- 7 yoke
- 8 earth rod for earth leakage monitoring
- 9 coil cage

* embedded OCP sensor cable (heavy duty jacketed glass fibre)

<https://tinyurl.com/y4mxpr2x>



Solidification and cooling



- Solidification mechanism is essential for preventing defects due to shrinkage.
- As soon as the molten metal is poured in a sand mold, the process of solidification starts.
- During solidification, cast forms develops cohesion and acquires structural characteristics.
- The mode of solidification affects the properties of the casting acquires a metallographic structure which is determined during solidification.

The metallographic structure consists of:

- Grain size, shape and orientation*
- Distribution of alloying elements*
- Underlying crystal structure and its imperfections*



Solidification and cooling



Volume shrinkage/volume contraction occurs during three stages:

- Liquid contraction (shrinkage): liquid contraction occurs when the metal is in liquid state.
- Solidification contraction (shrinkage): solidification contraction occurs during the change from liquid to solid
- Solid contraction (shrinkage): solid contraction occurs when the metal is solid; solid contraction occurs after solidification; solid contraction does not influence shrinkage defects.



Concept of Solidification on Casting



- A metal in molten condition possesses high energy
- As the molten metal cools, it loses energy to form crystals
- Since heat loss is more rapid near the mold walls than any other place, the first metal crystallites called 'nuclei' form here.
- Nuclei formed as above tend to grow at the second stage of solidification.

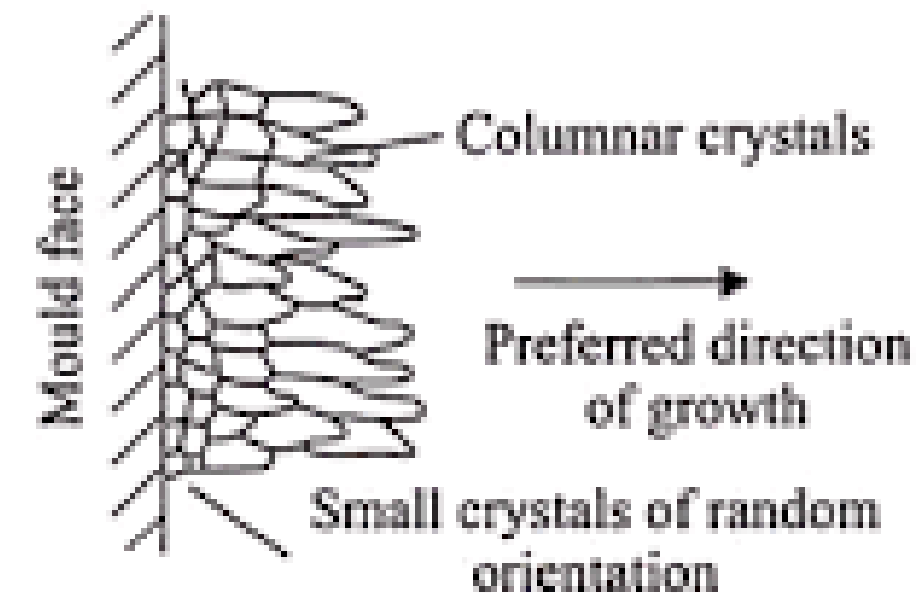
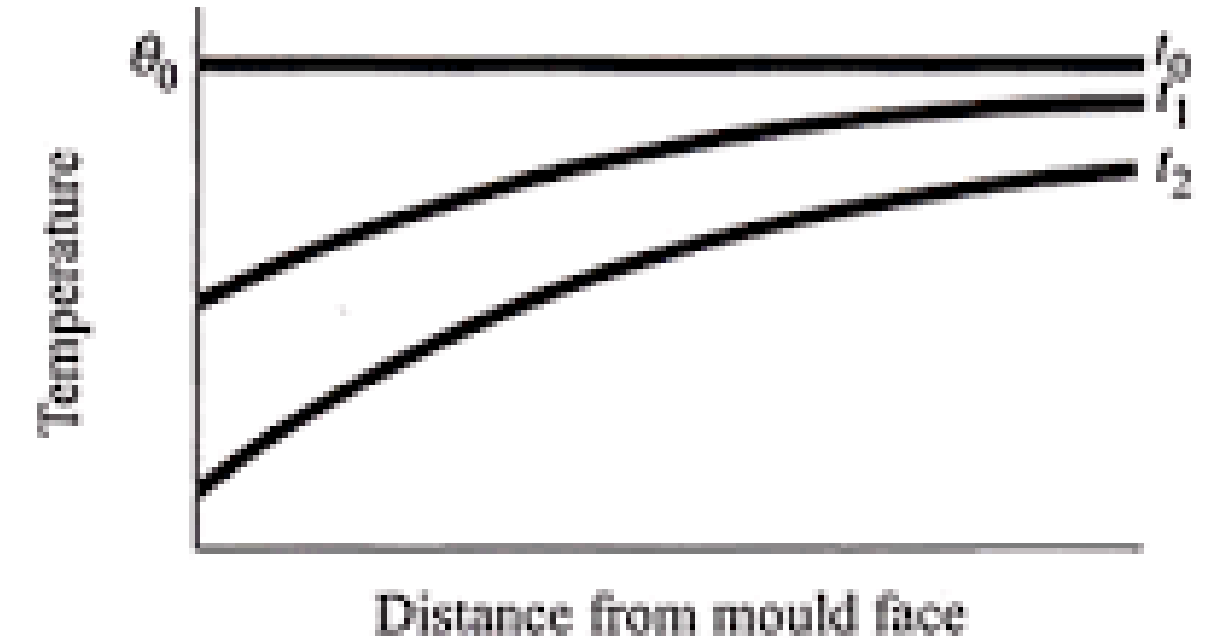


Fig. 2.14 Development of columnar crystals.

<https://tinyurl.com/yyuvl73j>

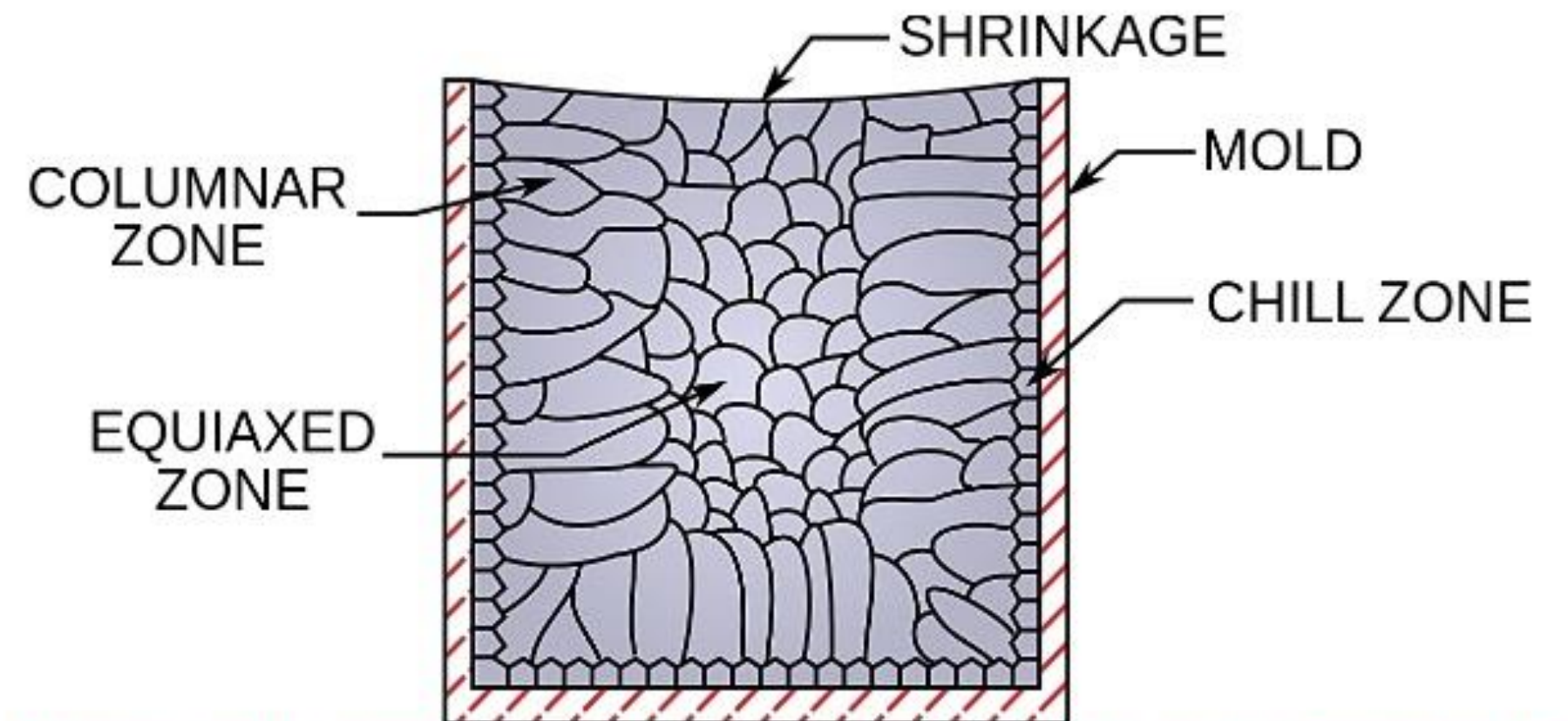


Concept of Solidification on Casting



- The crystal growth occurs in a dendrite manner.
- Dendrite growth takes place by the evolution of small arms on the original branches of individual dendrites:
- Slow cooling makes the dendrites to grow long whereas fast cooling causes short dendrite growth.
- Since eventually dendrites become grains, slow cooling results in large grain structure and fast cooling in small grain structure in the solidified metal.

A typical cast metal structure



Coarse grain structure can be converted into fine grain structure by grain refinement. This can be achieved by high cooling rates, low pouring temp, and addition of inoculating agent

Hari Prasad-Assistant Professor

<https://tinyurl.com/y5oxmwgd>

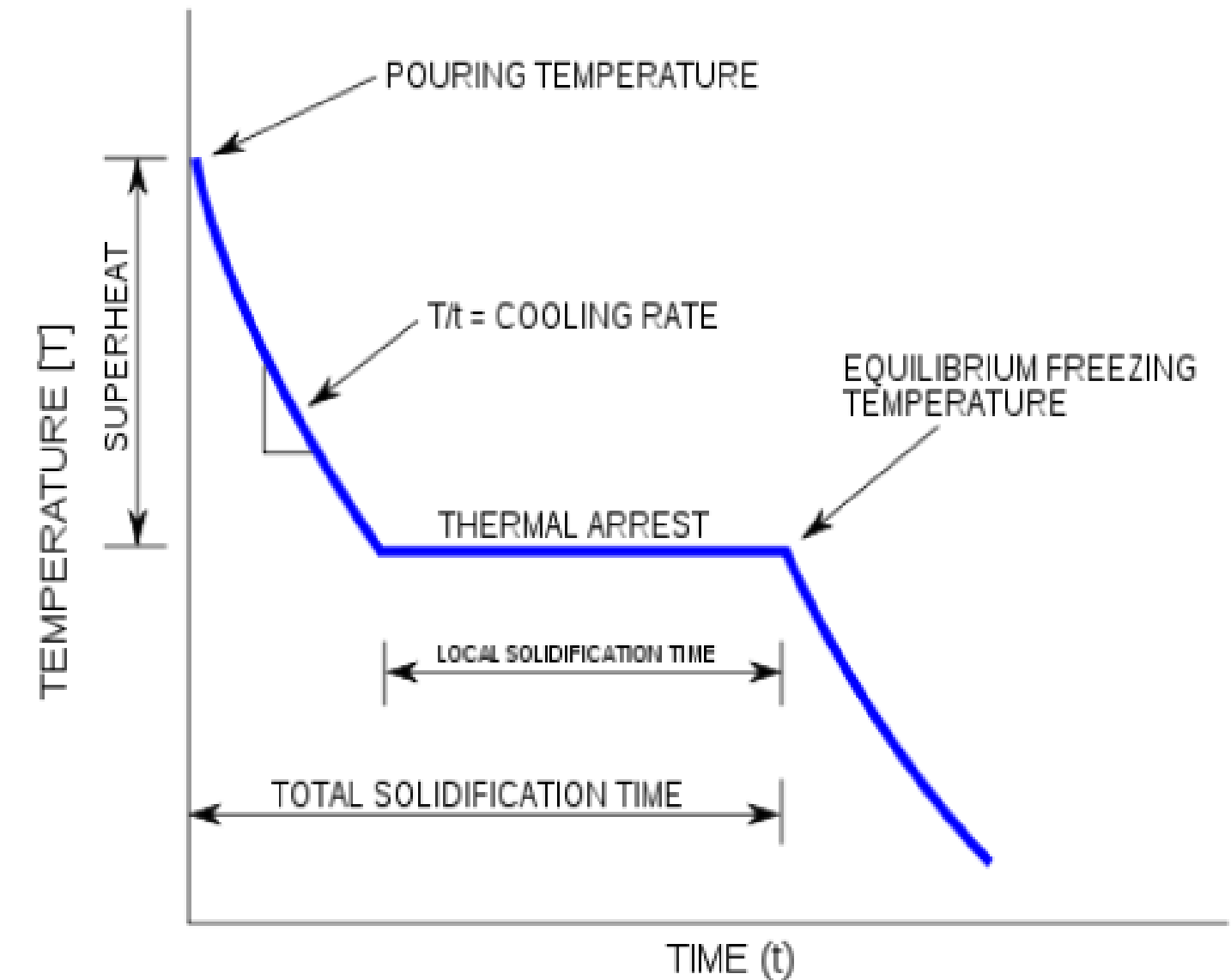


Concept of Solidification on Casting



From the above curve the following observations can be made:

- Liquid metals cools from A to B
- From B to C, the melt liberates latent heat of fusion; temperature remains constant.
- The liquid metal starts solidifying at B and it is partly solid at any point between B and C and at C metal is purely solid.
- From C to D, the solid metal cools and tends to reach room temperature.
- The slopes of AB and CD depend upon the specific heats of liquid and solid metals respectively.



Solidification curve for metals

Source : Book - **Manufacturing Engineering & Technology** by Serope Kalpakjian



Special casting processes



The sand moulds may be used for casting ferrous and non-ferrous metals, but these moulds can be used only once, because the mould is destroyed after the metal has solidified. This will increase the cost of production. The sand moulds also, can not maintain the tolerance and smooth surface finish.

In order to meet these requirements, following casting method may be used:



Types of Special Casting Process

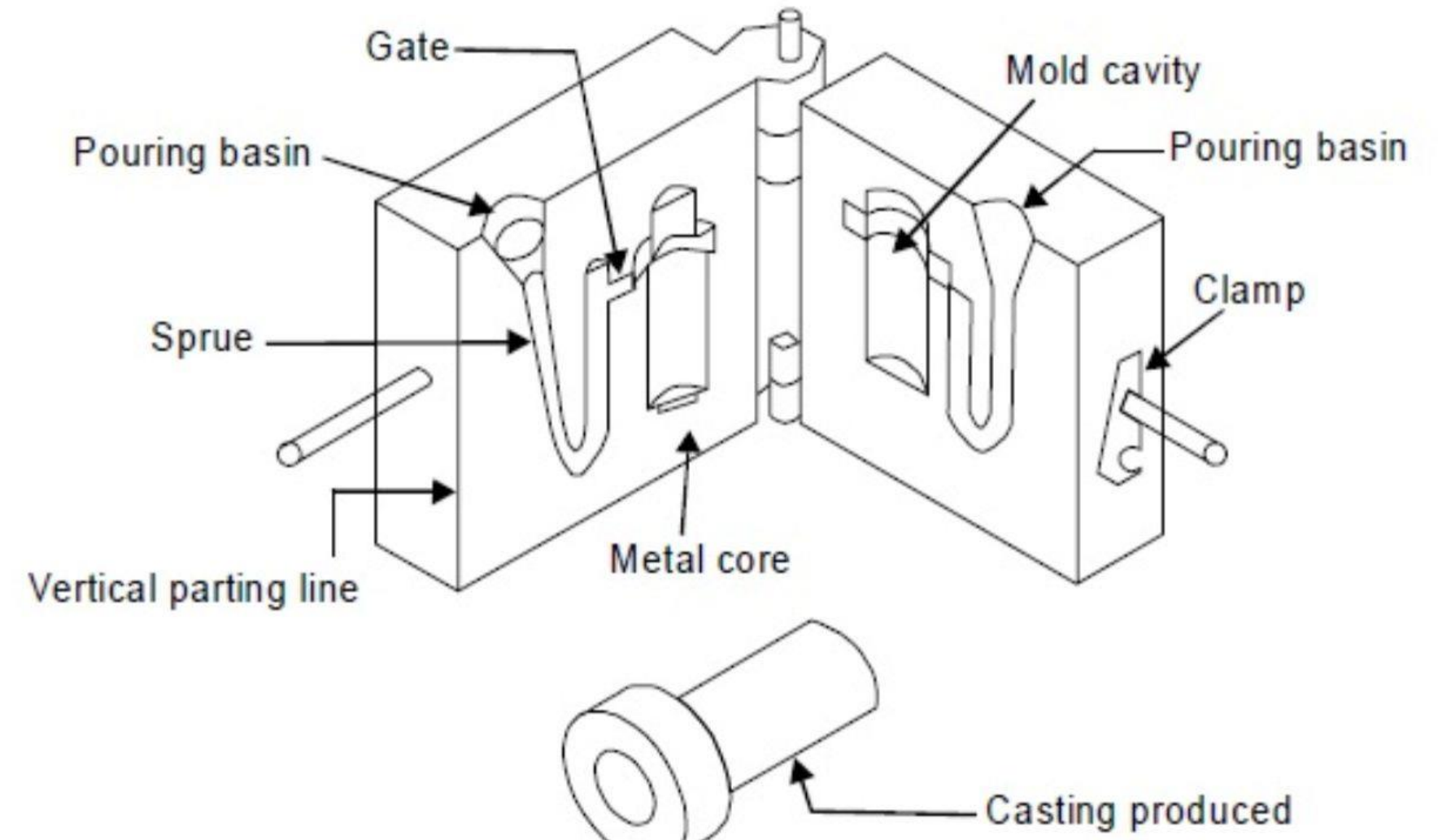


1: Permanent Mould Casting

A casting made by pouring molten metal by gravity into a mould made of some metallic alloy or other material of permanence is known as permanent mould casting.

2: Slush Casting

The slush casting is a special application involving the used of permanent mould. It is used for casting low melting temperature alloys. This method is only adopted for ornaments and toys of non-ferrous alloys.



<https://tinyurl.com/yx9vptpp>

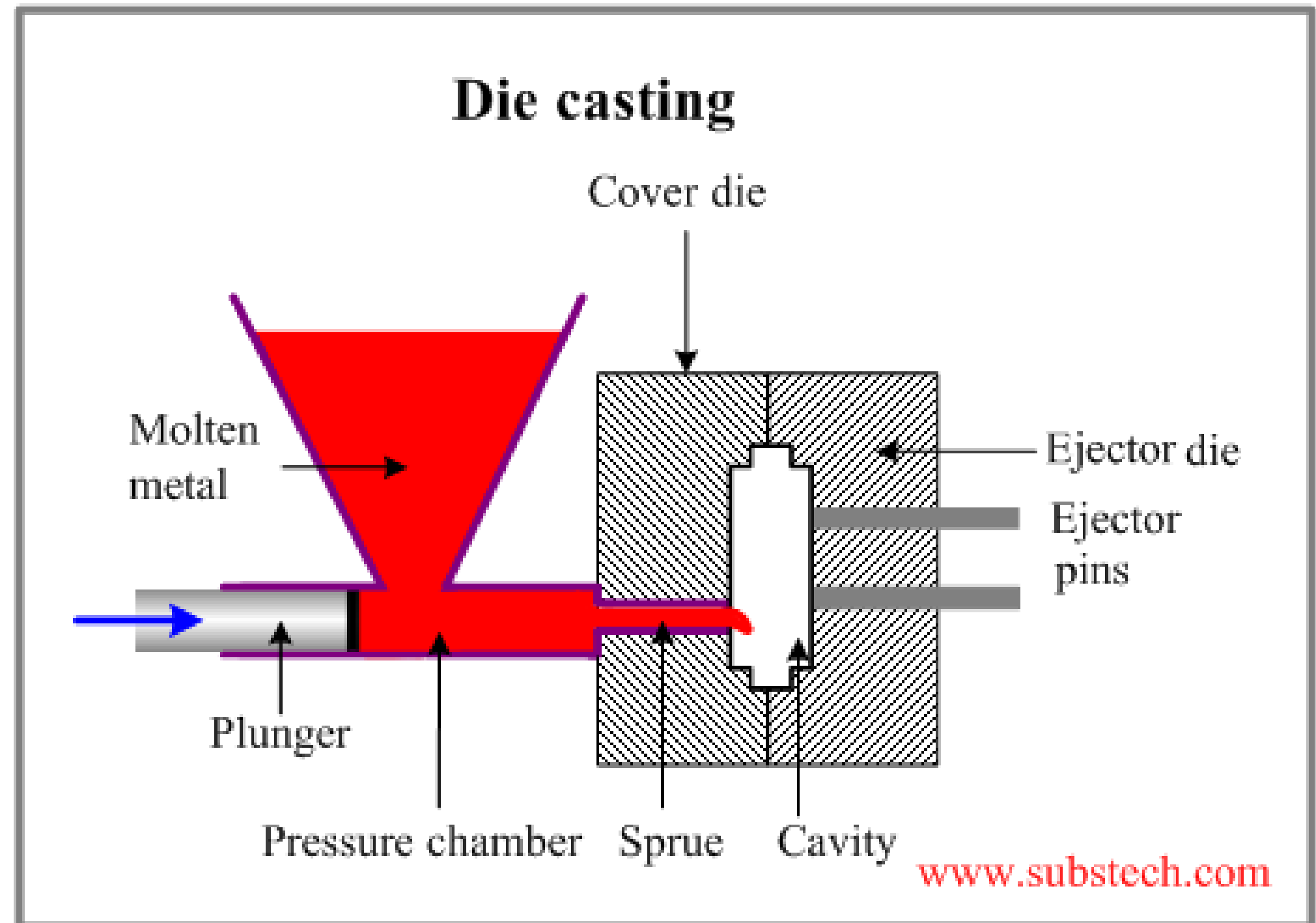


Types of Special Casting Process



3: Die Casting

The die casting (also known as pressure die casting) may be defined as that casting which uses the permanent mould (called die) and the molten metal is introduced into it by means of pressure, following are two type of die casting machines commonly used for die casting:



<https://tinyurl.com/vbl3exe>

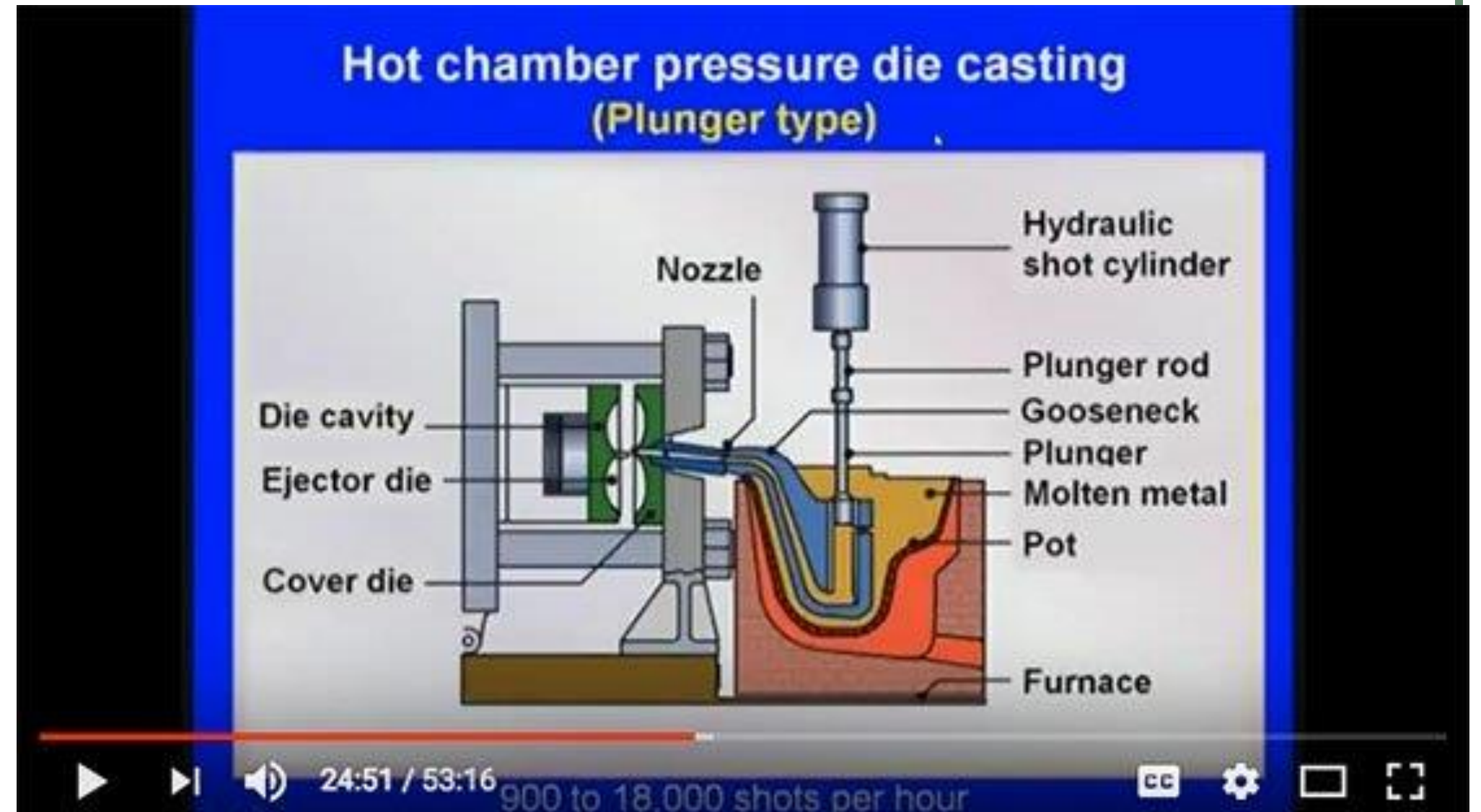


Types of Special Casting Process



(a) Hot chamber die casting machine

In a hot chamber die casting machine, the melting pot is an integral part of the machine. The molten metal is forced in the die cavity at pressure from 7 to 14 MPa. The pressure may be obtained by compressed air or by hydraulically operated plunger. The hot chamber die casting machine is used for casting zinc, tin, lead and other low casting melting alloys.



<https://tinyurl.com/y2aub82h>

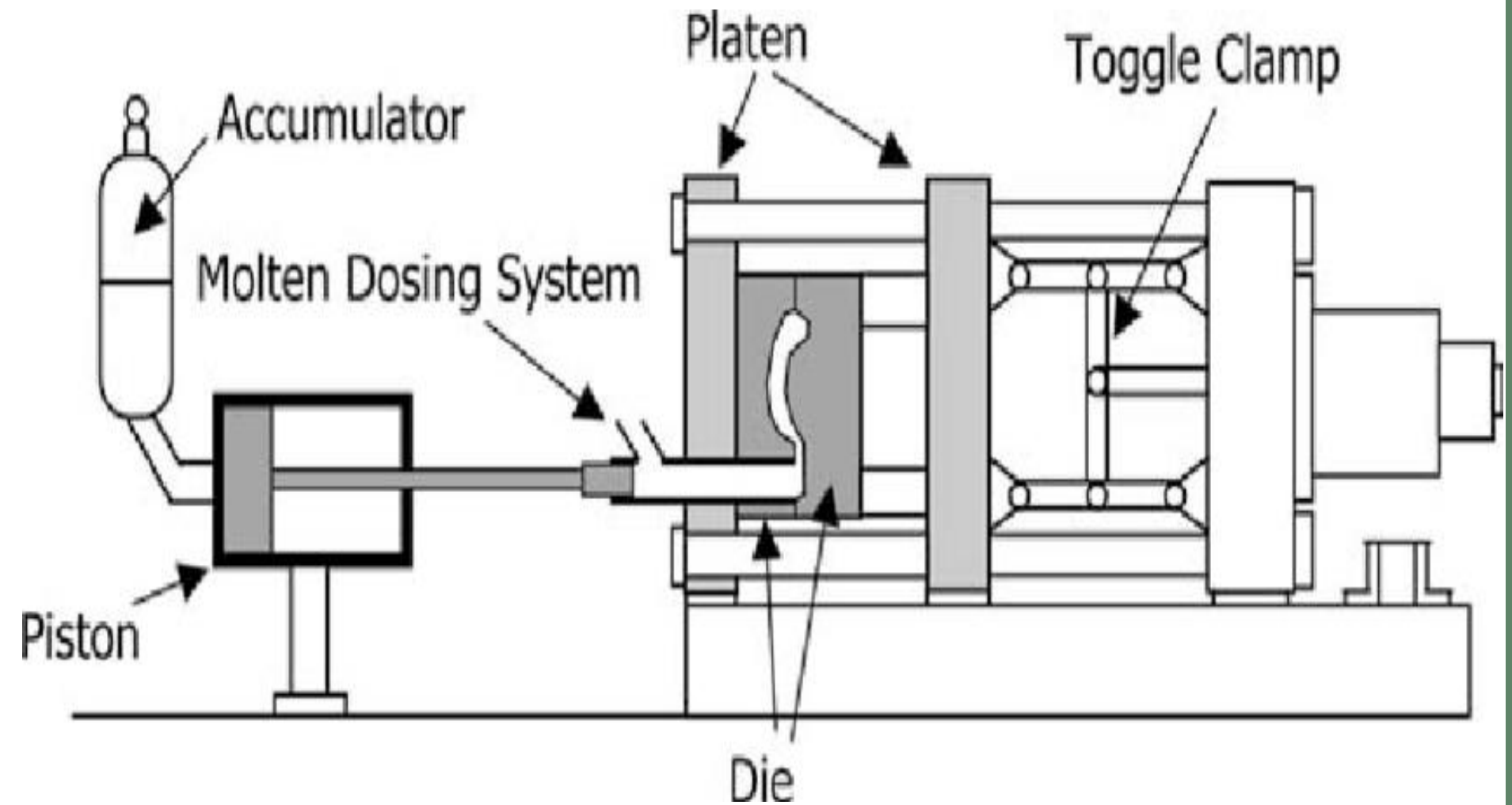


Types of Special Casting Process



(b) Cold chamber die casting machine

In a cold chamber die casting machine, the melting pot is usually separate from the machine and the molten metal is not transferred to injection mechanism by ladle. The pressure on the casting metal may vary from 21 to 210 MPa and in some cases may reach 700 MPa. This process is used for casting aluminum, magnesium, copper, brass alloys and other high melting alloys.



<https://tinyurl.com/y4zaoazs>

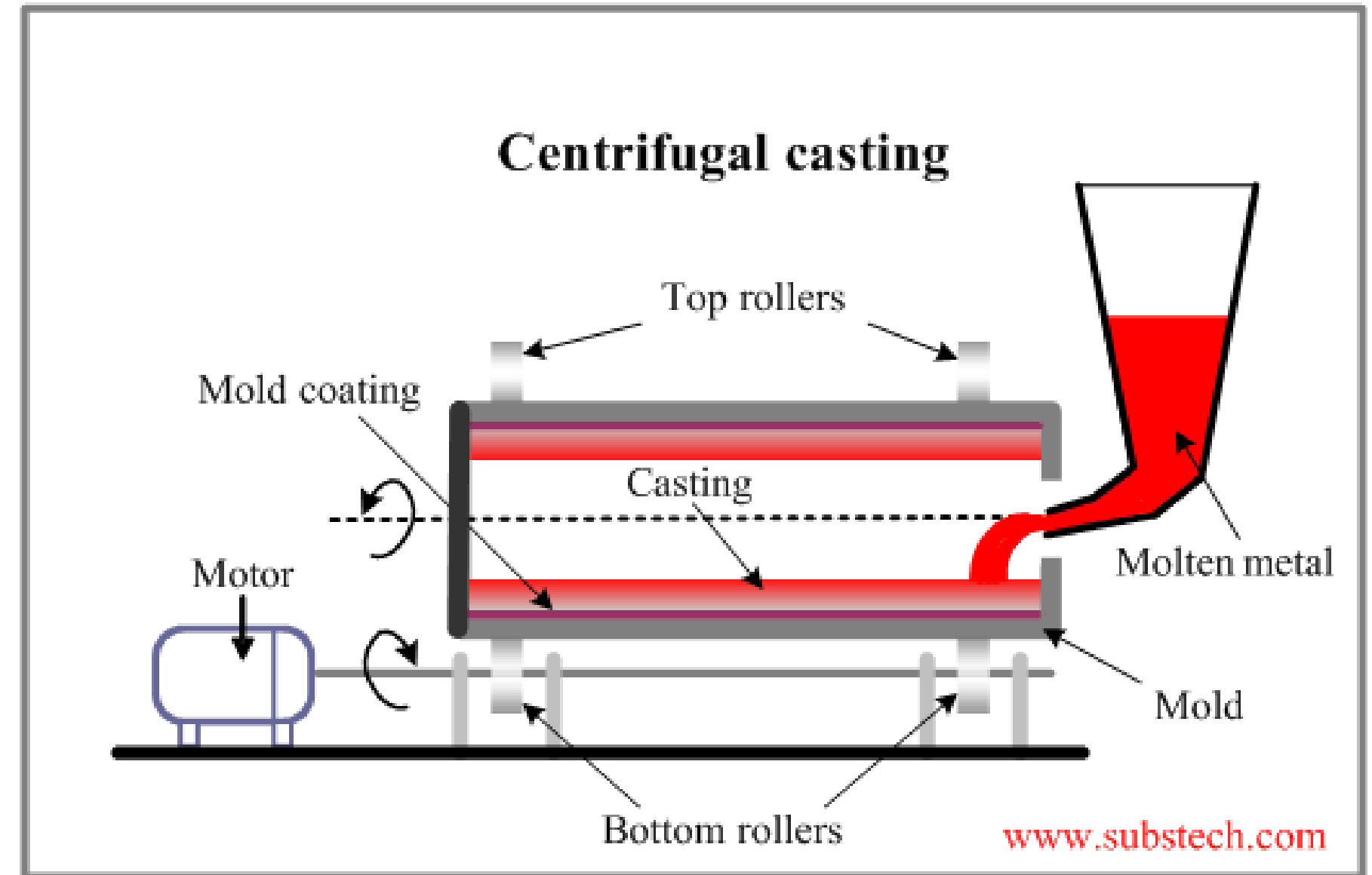


Types of Special Casting Process



4: Centrifugal Casting

A casting process in which the molten metal is poured and allowed to solidify while the mould is revolving, is called centrifugal process. The casting produced under this centrifugal force is called centrifugal casting. This process is especially designed for casting of symmetrical shape. The ferrous and the non-ferrous metals can be obtained by this process. The casting produced by this process have dense and fine grained structure.



<https://tinyurl.com/yypfoz2>

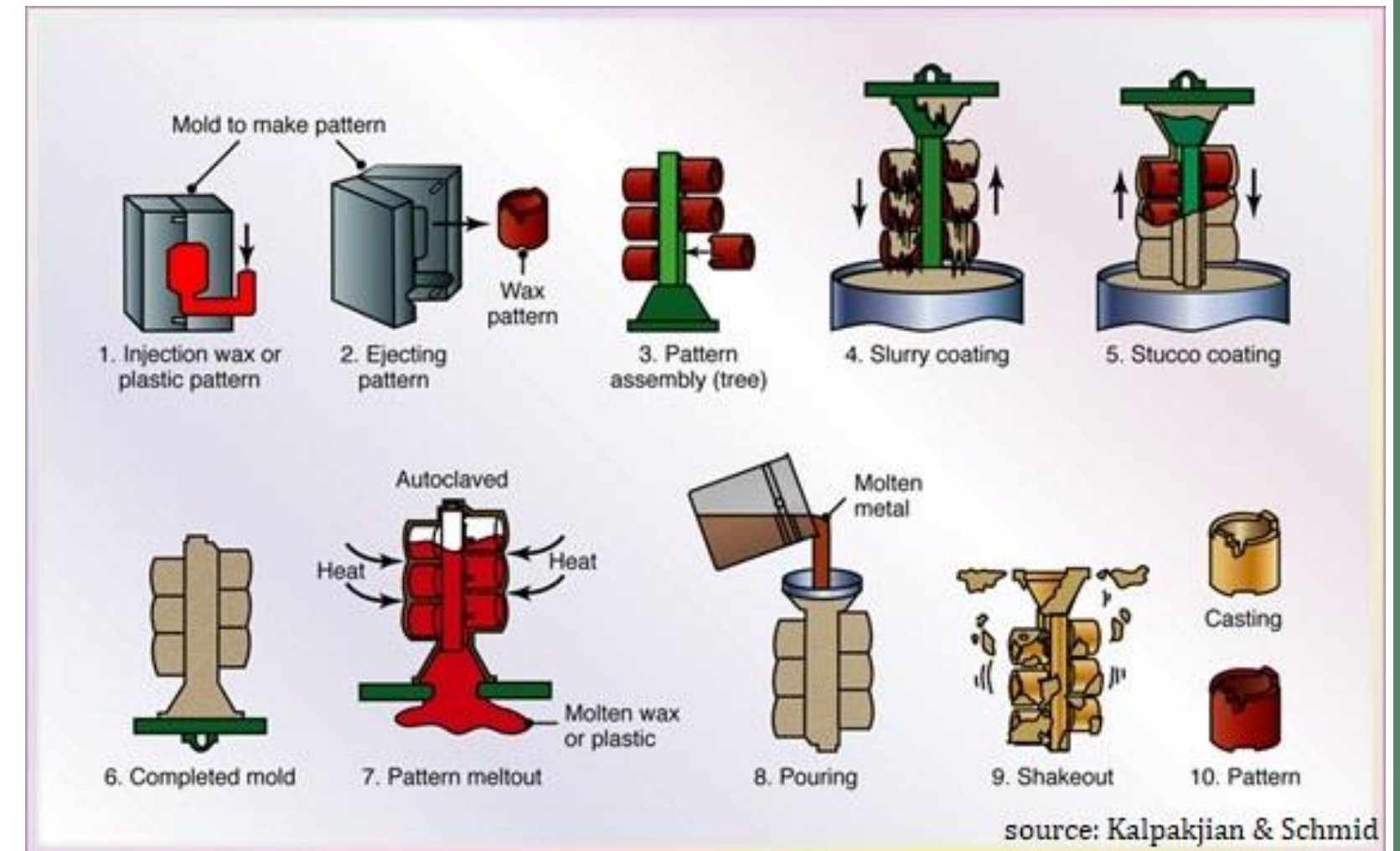


Types of Special Casting Process



5: Investment Casting

In **investment casting**, a wax or suitable polymer pattern is coated by dipping into the refractory material slurry. Once the refractory material coating is hardened then this dipping process is repeated several times to increase the coating thickness and its strength. Once the final coating is hardened the wax is melted out and molten metal is poured into the cavity created by the wax pattern. Once the metal solidifies within the mould, metal casting is removed by breaking the refractory mould.



<https://tinyurl.com/yxj8gwpc>



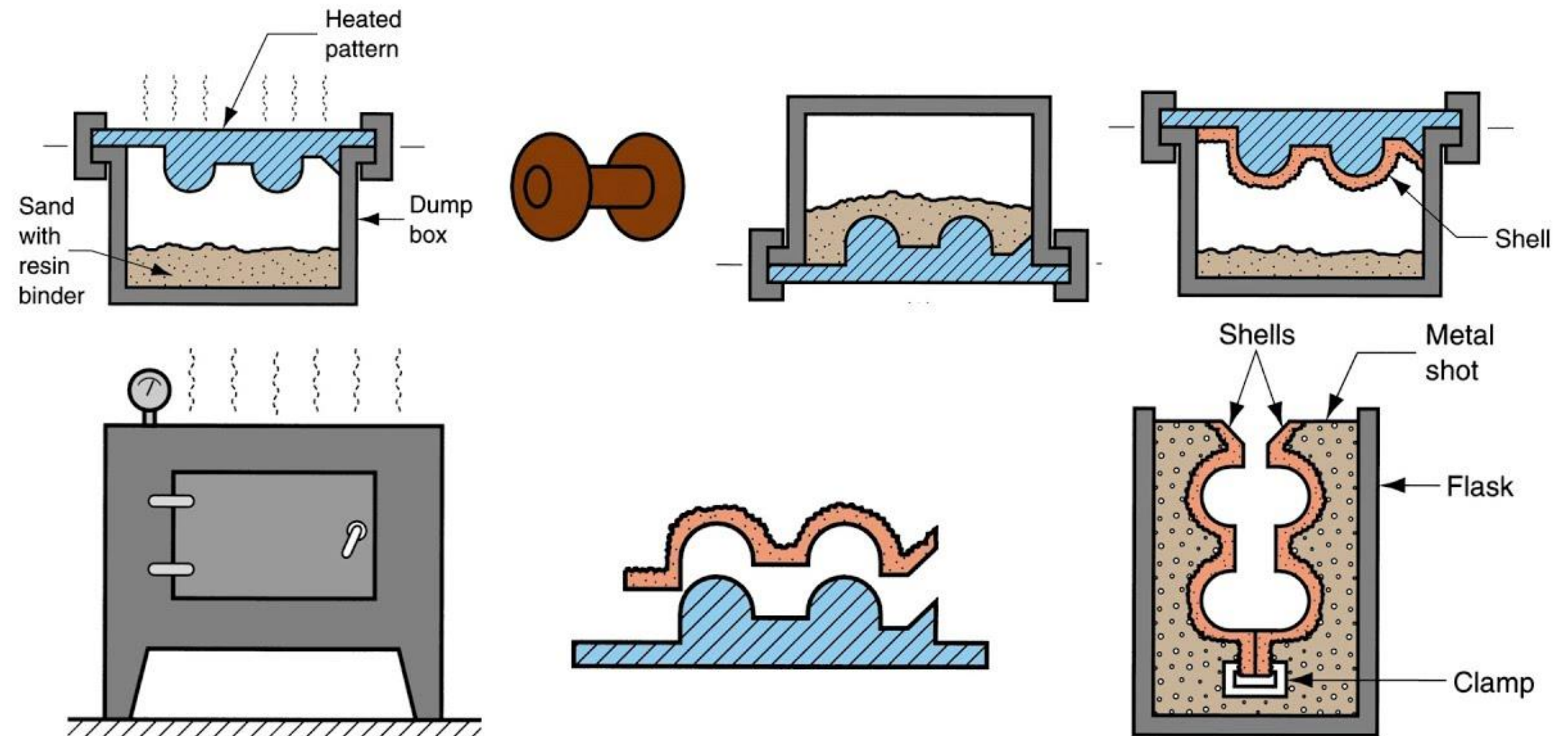
Types of Special Casting Process



6: Shell Moulding Process

in shell mold casting, the mold is a thin-walled shell created from applying a sand-resin mixture around a pattern. The heated pattern partially cures the mixture, which now forms shell around the pattern. The mold is securely clamped together while the molten metal is poured from a ladle into the gating system and fills the mold cavity.

Shell Molding Process



https://www.youtube.com/watch?v=hCiqoFBh_DA



Workbook Questions

1. The induction produces the temperature upto
 - a) 500 deg
 - b) 1000 deg
 - c) 1500 deg
 - d) 2000 deg
2. The operating frequency of the induction furnace is _____
3. Which of the following statement is wrong?
 - a) The hot chamber die casting machine is used for casting zinc, tin, lead and other low melting alloys.
 - b) The cold chamber die casting machine is used for casting aluminium, magnesium, copper base alloys and other high melting alloys.
 - c) The castings produced by centrifugal casting method have open and coarse grained structure.
 - d) All the above



Assessment



4. Match the following

List I

- a) Sand casting
- b) Plaster mould casting
- c) Shell mould casting
- d) Investment casting

List II

- 1) Symmetrical and circular shapes only
- 2) Parts have hardened skins and soft interior
- 3) Minimum post-casting processing
- 4) Parts have a tendency to warp
- 5) Parts have soft skin and hard interior
- 6) Suitable only for non-ferrous metals

5. In _____ casting process wax pattern is used



THANK YOU