UNIT I

What is pattern in casting ?? What are it's types ?? ||Engineer's Academy|| - YouTube

UNIT II

ULTRASONIC WELDING | How Ultrasonic Welding process works - YouTube

UNIT III

Heat Treatment - Types (Including Annealing), Process and Structures (Principles of Metallurgy) - YouTube

UNIT IV

powder metallurgy explained - Process, atomization, compaction, sintering ,applications,products - YouTube

UNIT V

Construction Details and Operation of Different Parts of a Lathe Machine. - YouTube

MANUFACTURING TECHNOLOGY-I

MECHANICAL ENGINEERING

- ‘Manufacturing’ is derived from the Latin,

  manus = hand and factus = made,

that is, the literal meaning is “made by hand”.

- ‘Manufacturing’ means the making of goods and articles by hand and/or by machinery.

- ‘Manufacturing Technology’ or “Production Technology” can be defined as the study of the various processes required to produce parts and to assemble them into machines and mechanisms.

CLASSIFICATION OF MANUFACTURING PROCESSES

- (Metal) Casting Processes
- Joining Processes
- (Metal) Forming Processes
- Sheet metal Processes
- Plastic materials (Polymers) processes
- Machining processes
- Powder Metallurgy
- Heat treatment & Surface treatment processes
- Assembly processes

U-I METAL CASTING PROCESSES

- **SAND CASTING**
- *Sand moulds*
- *Type of patterns*
  - Pattern materials
  - Pattern allowances
- *Moulding sand*
  - Types
  - Properties
  - Testing
- *Core making*
  - Types
  - Applications
- *Moulding machines*
  - Types
  - Application
- **MELTING FURNACES**
  - Blast
  - Cupola
- **SPECIAL CASTING PROCESSES**
  - Shell
  - investment casting
  - Ceramic mould
  - Lost Wax process
  - Pressure die casting
  - Centrifugal casting
  - CO2 process
  - Stir Casting

(Working principle)

- **DEFECTS IN SAND CASTING**

INTRODUCTION

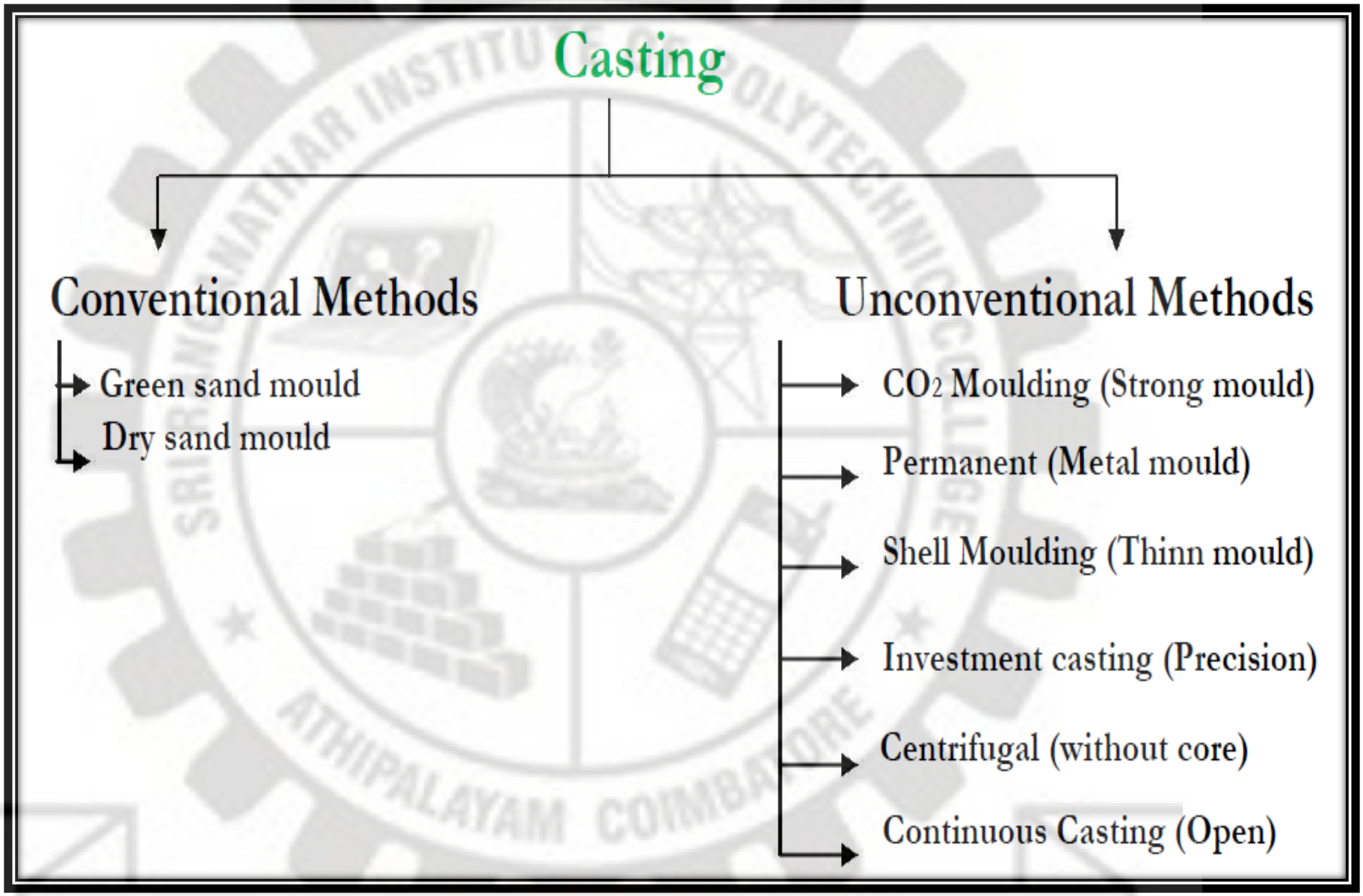
- Ferrous metals
  - Iron

- Non-Ferrous metals
  - Aluminium

Some of the *complicated shapes* may not be produced on the components with *conventional* machining processes.

(SAND) **CASTING**

- ✓ *Casting* is one of the processes used for making components of *complicated shapes* in *larger quantity*.
- ✓ Producing metal parts by pouring *molten metal* into the *mould or mold* cavity of the required shape and allowing the metal to solidify.
- ✓ The solidified metal piece is called as "*casting*"
- ✓ A plant where the castings are made is called a "*Foundry*"


Casting
Conventional Methods
Green sand mould
Dry sand mould
Unconventional Methods
CO_2 Moulding (Strong mould)
Permanent (Metal mould)
Shell Moulding (Thinn mould)
Investment casting (Precision)
Centrifugal (without core)
Continuous Casting (Open)

SAND MOULDS

- Mould is the cavity of the required shape made in *moulding sand* or other material.

- Pattern is the model of required casting made in wood, metal or plastics.

- Foundry processes

1. Pattern making
2. Mould making
3. Casting

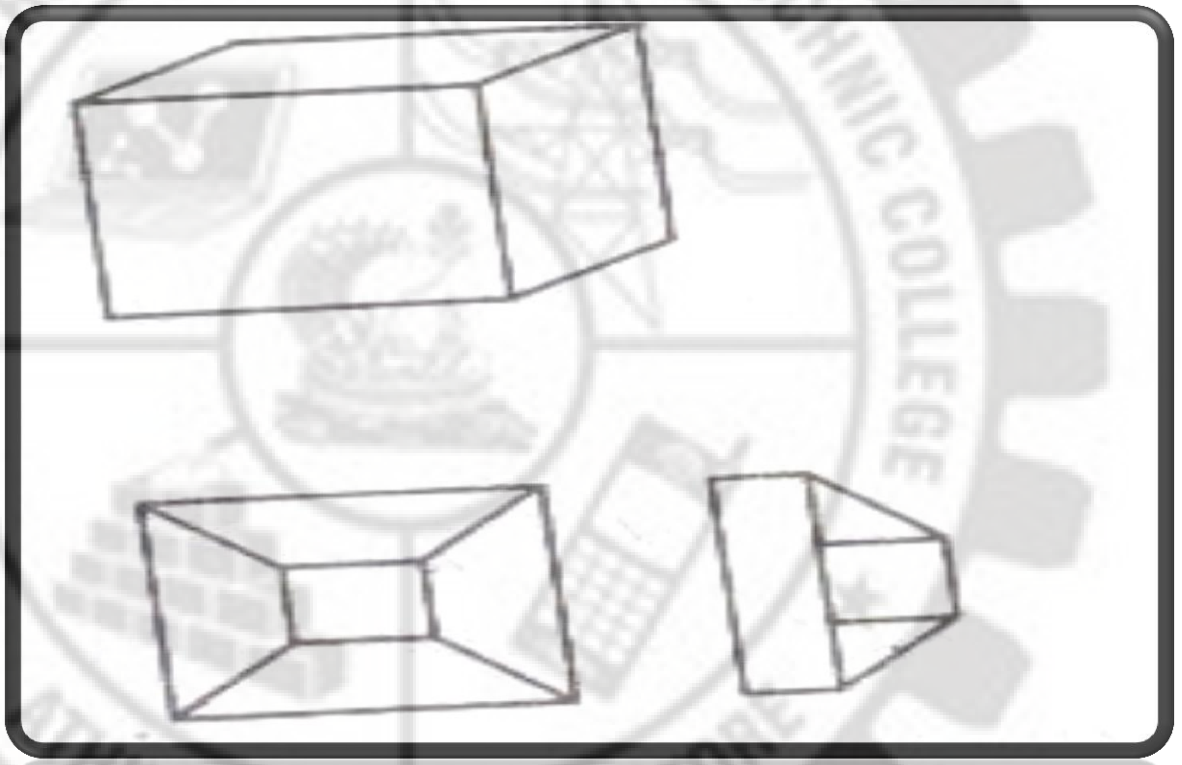
Pattern

- Primarily used to produce the mould cavity in sand.
- It is slightly larger than the desired casting, due to various allowances.

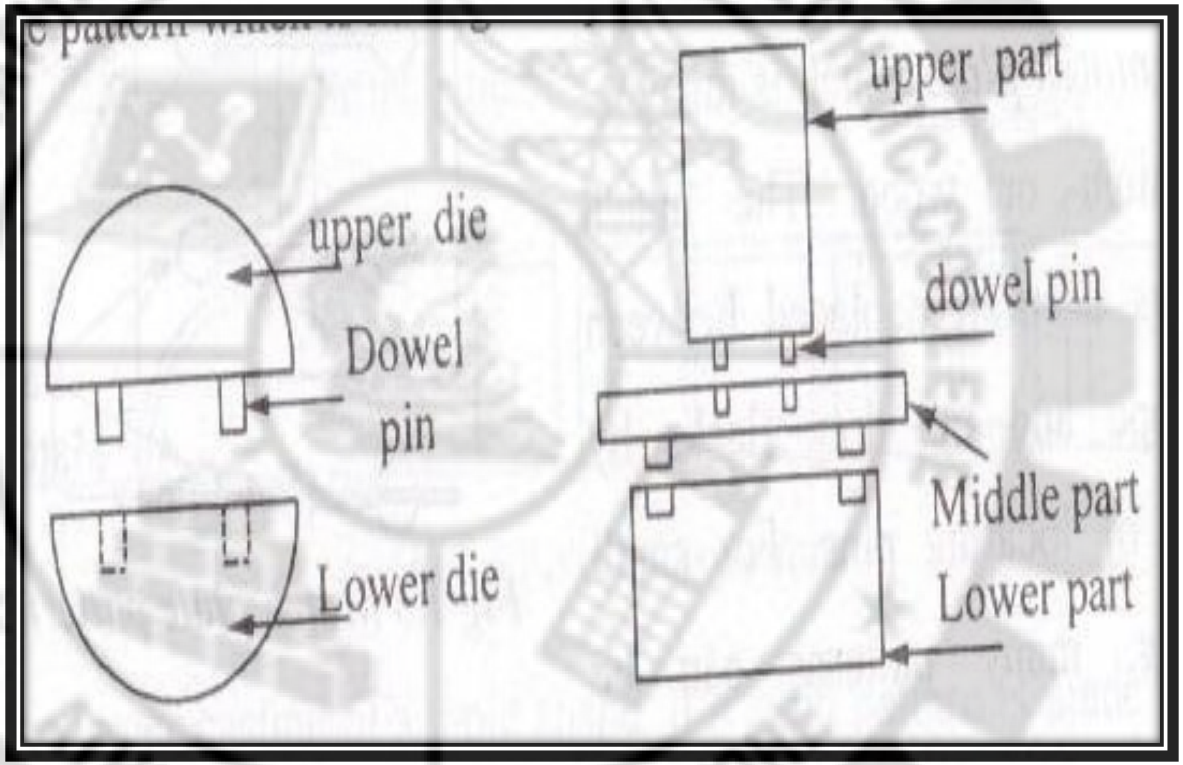
TYPES OF PATTERN

1. Solid or Single piece pattern
2. Split pattern
3. Loose piece pattern
4. Match plate pattern
5. Sweep pattern
6. Skeleton pattern
7. Segmental pattern
8. Shell pattern

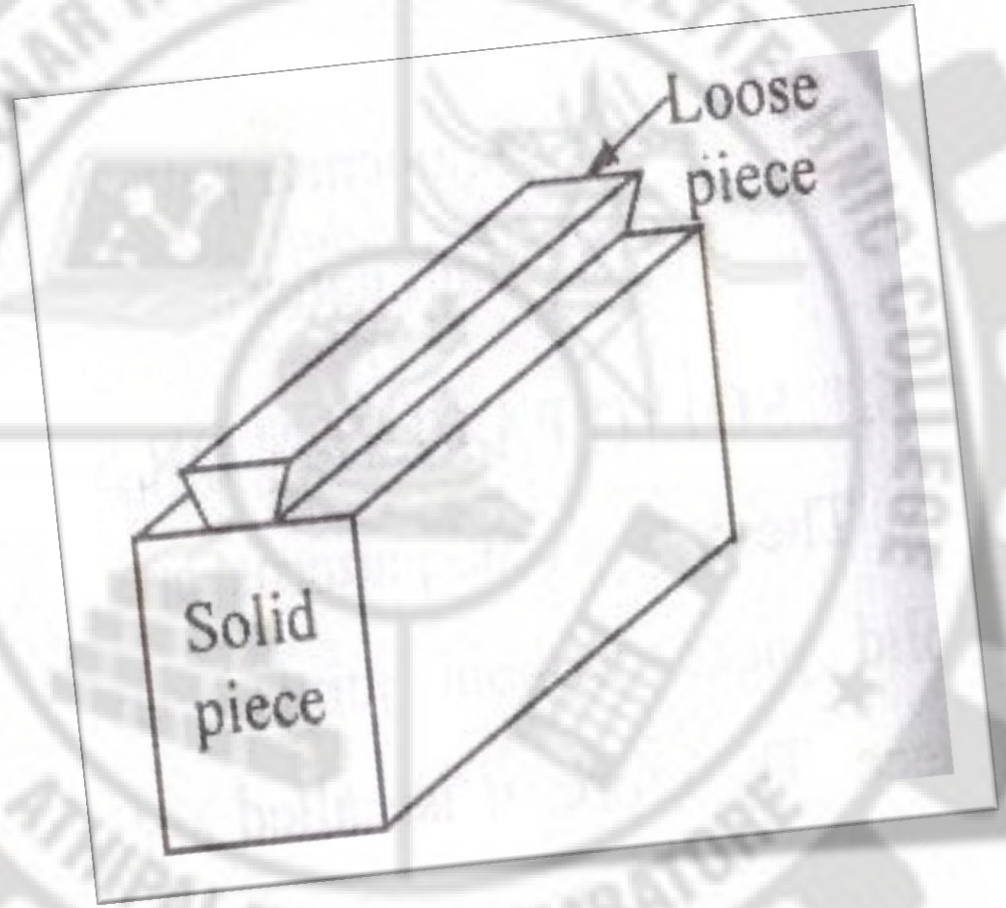
SOLID *or* SINGLE PIECE Pattern



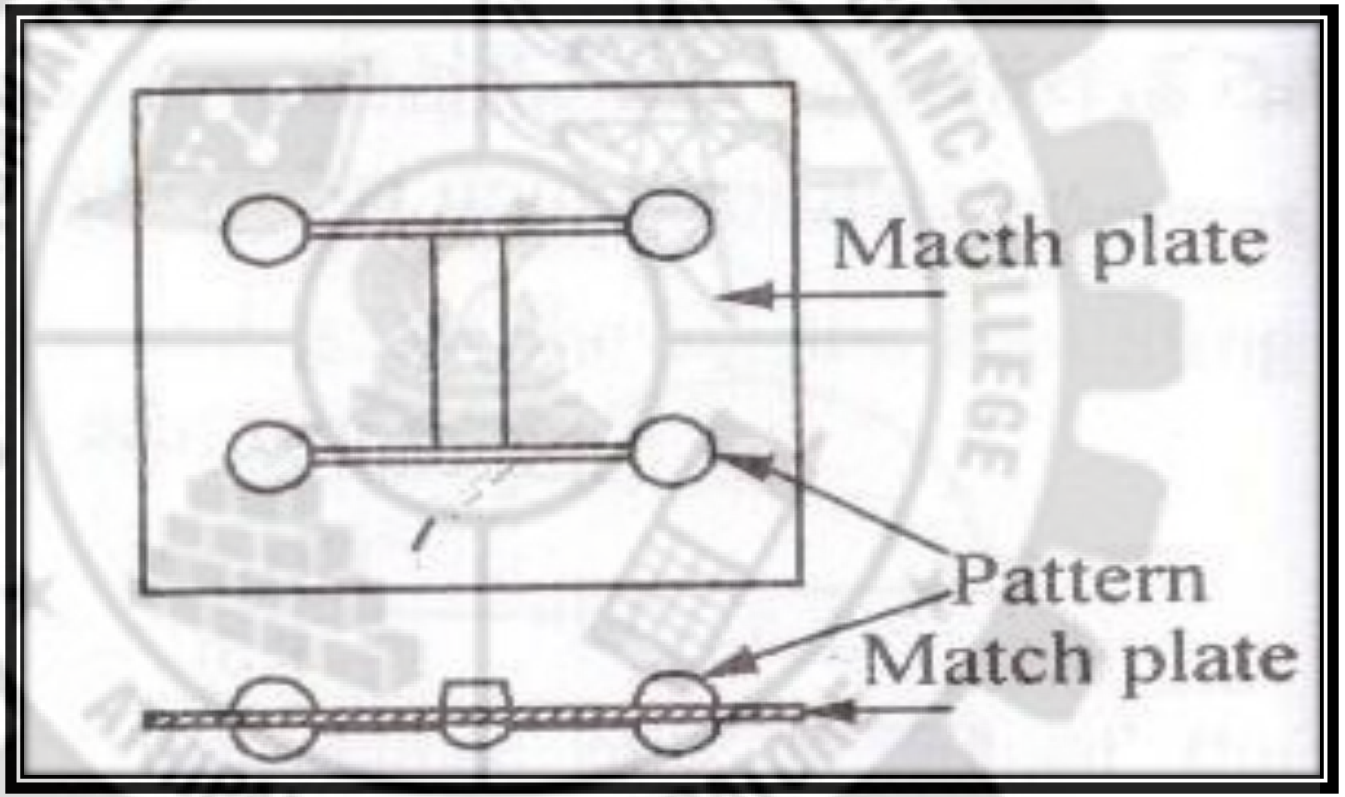
SPLIT Pattern



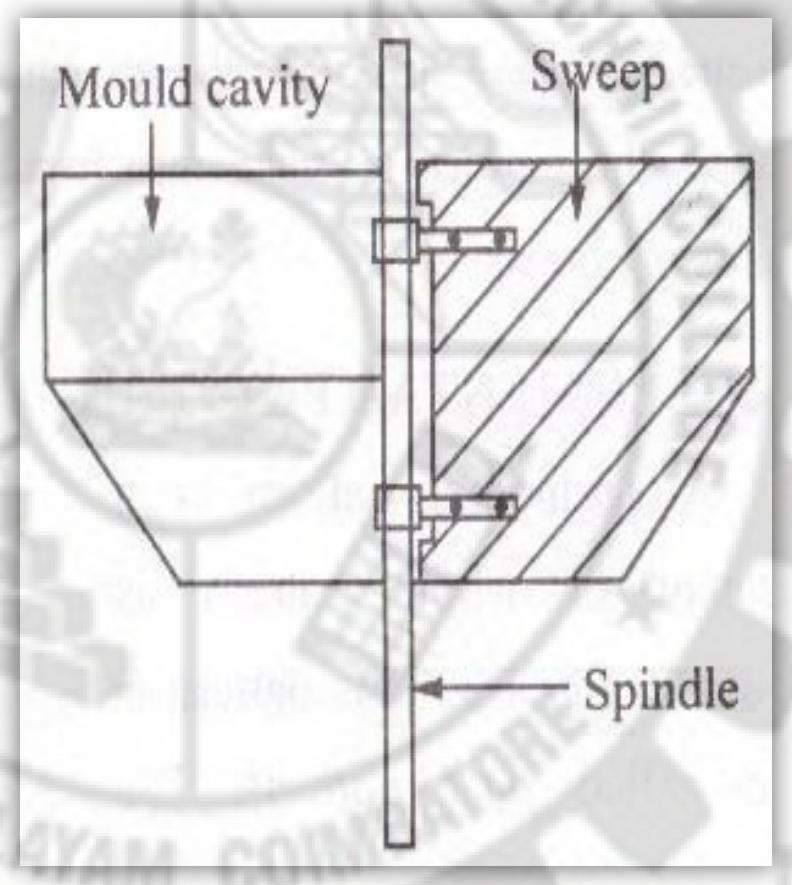
LOOSE PIECE Pattern



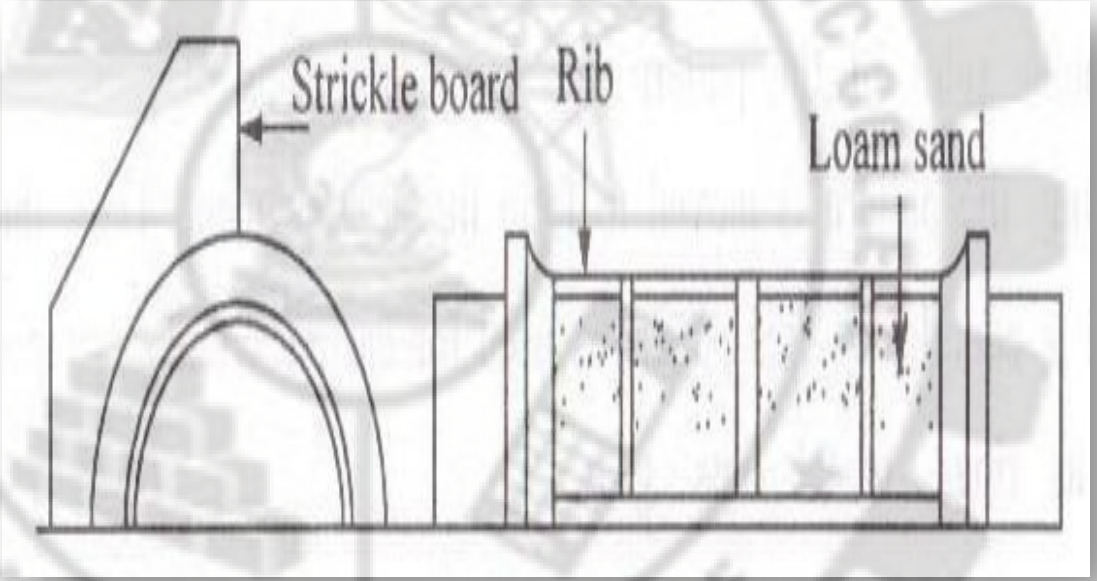
MATCH PLATE Pattern



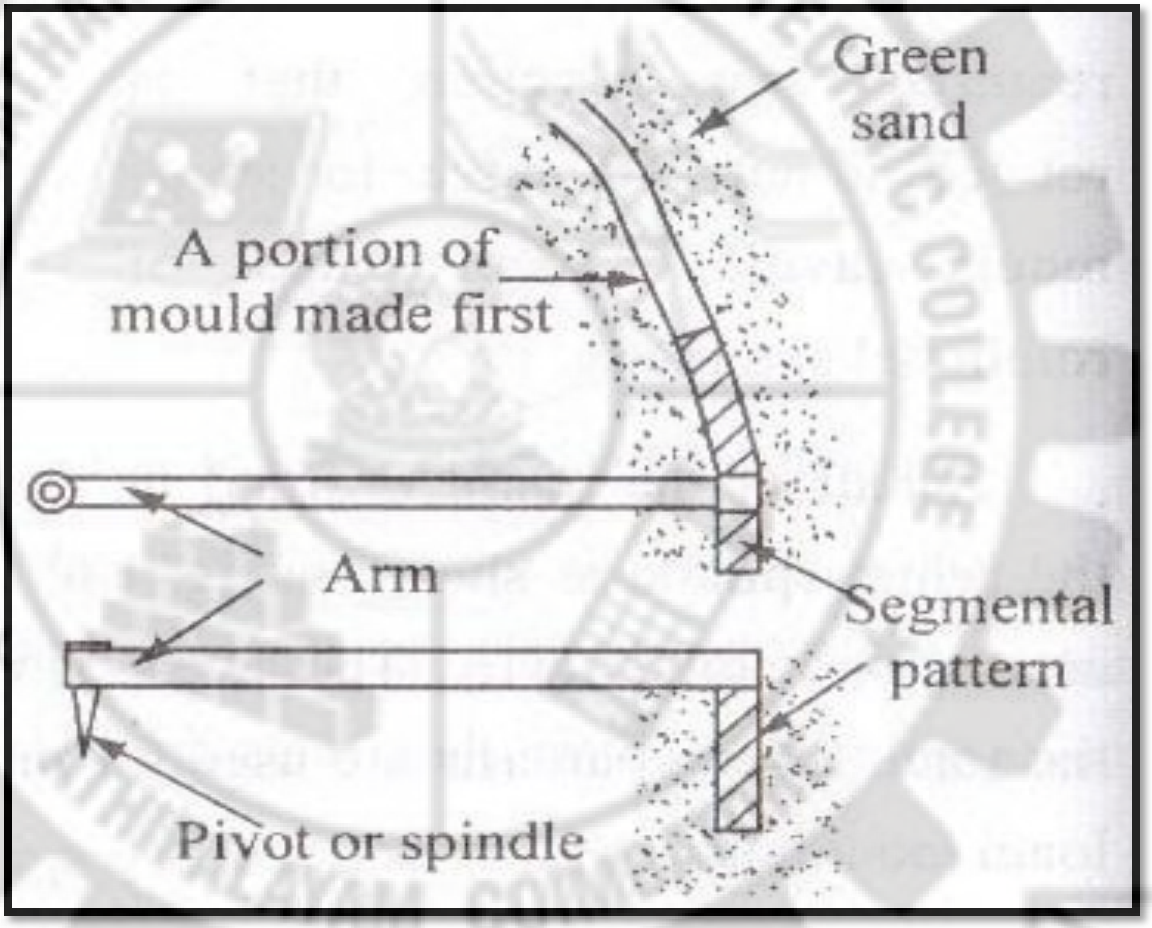
SWEEP Pattern



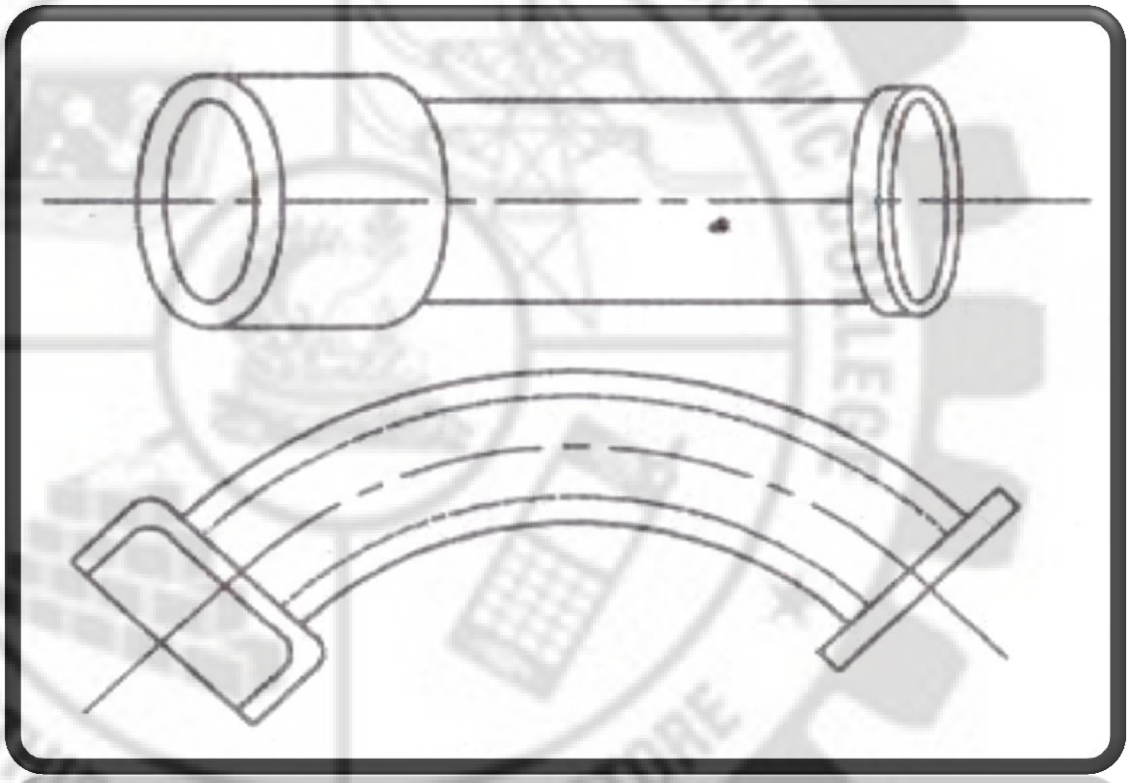
SKELETON Pattern

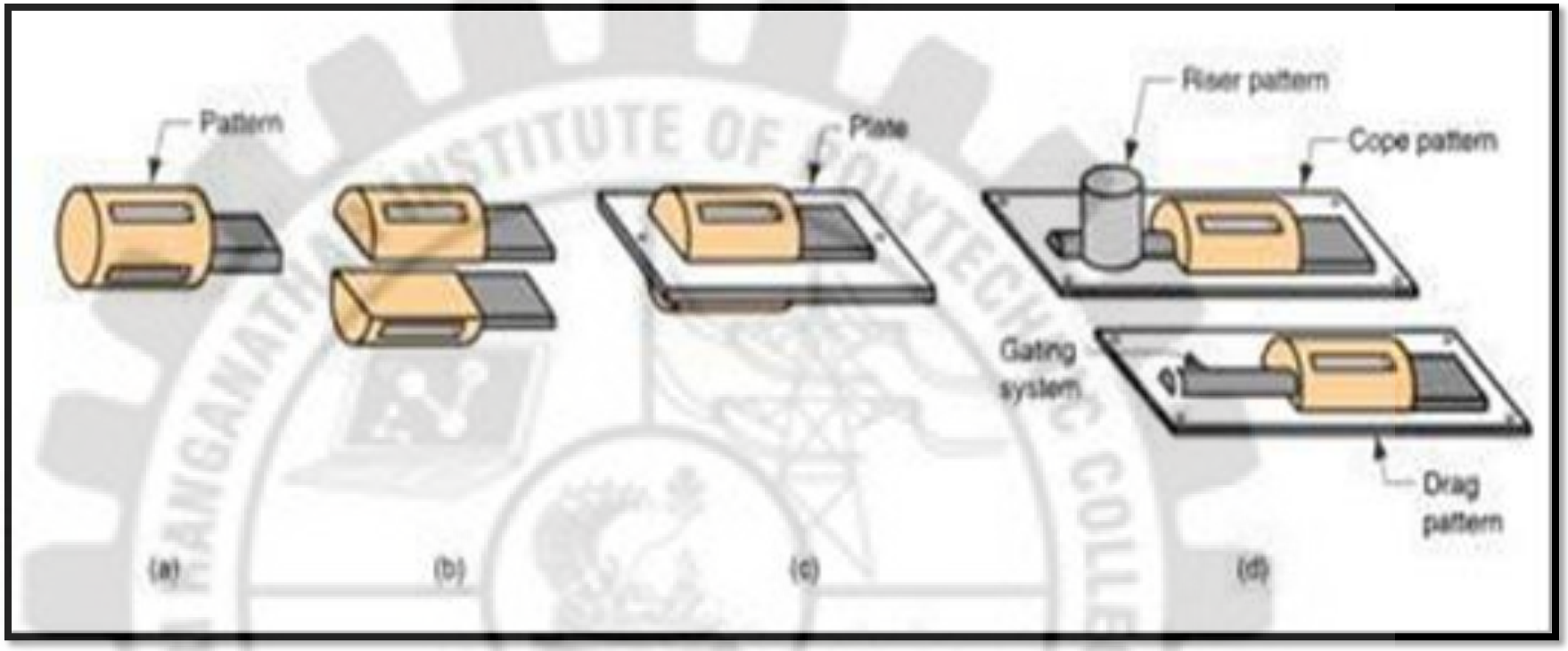


SEGMENTAL Pattern



SHELL Pattern





(a) solid pattern
(b) split pattern
(c) match-plate pattern
(d) cope and drag pattern

PATTERN MATERIALS

1. Wood – Teak, Mahogany, White pine….
2. Metal – Cast Iron, Brass, Aluminium, White metal……
3. Plaster
4. Plastics
5. Wax

COLOUR SCHEME FOR PATTERNS

1. Surface as cast : **BLACK**
2. Machined surface : **RED**
3. Core prints an seats : **YELLOW**
4. Loose pieces : **YELLOW** / **RED** (diagonal stripes)
5. Stop-off : **YELLOW** / **BLACK** (diagonal stripes)

SELECTION OF PATTERN MATERIALS

(Requirements of a good pattern)

- ✓ Secure the desired shape and size of the casting.
- ✓ Cheap and readily repairable.
- ✓ Simple in design for ease of manufacture.
- ✓ Light in mass and convenient to handle.
- ✓ Have high strength and long life in order to make as many moulds as required.
- ✓ Retain its dimensions and rigidity during the definite service life.

PATTERN ALLOWANCE

The difference in the dimensions of the casting and the pattern is due to the various allowances considered while designing a pattern for a casting.

The various types of allowances are,

1. Shrinkage allowance
2. Machining or finish allowance
3. Draft or taper allowance
4. Distortion or camber allowance
5. Rapping or shake allowance

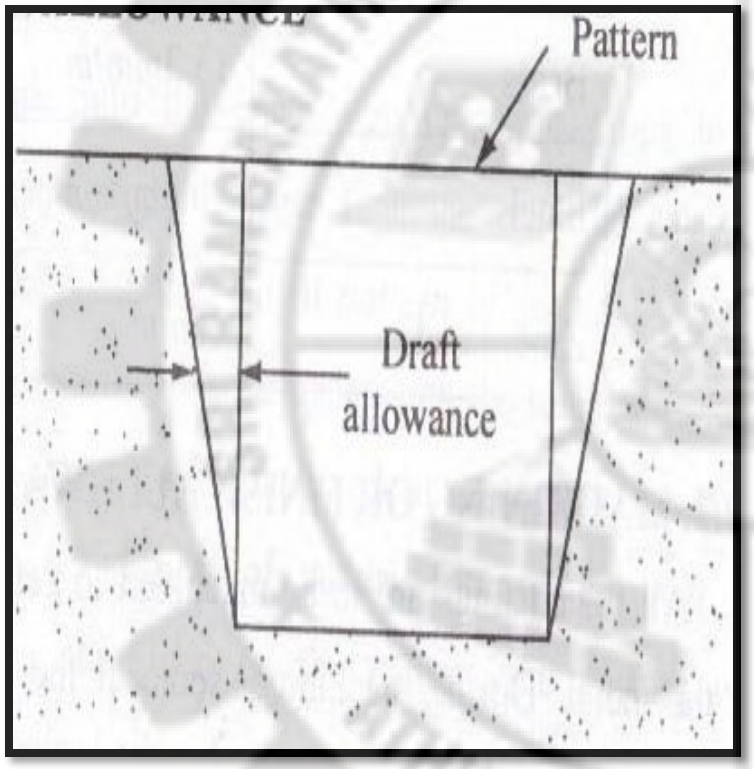
SHRINKAGE ALLOWANCE

Materials	Shrinkage Allowance
C.I	10.4mm/m
Aluminium	17 mm/m
Brass	15.3mm/m
Steel	20.8mm/m
Zinc, Lead	25mm/m

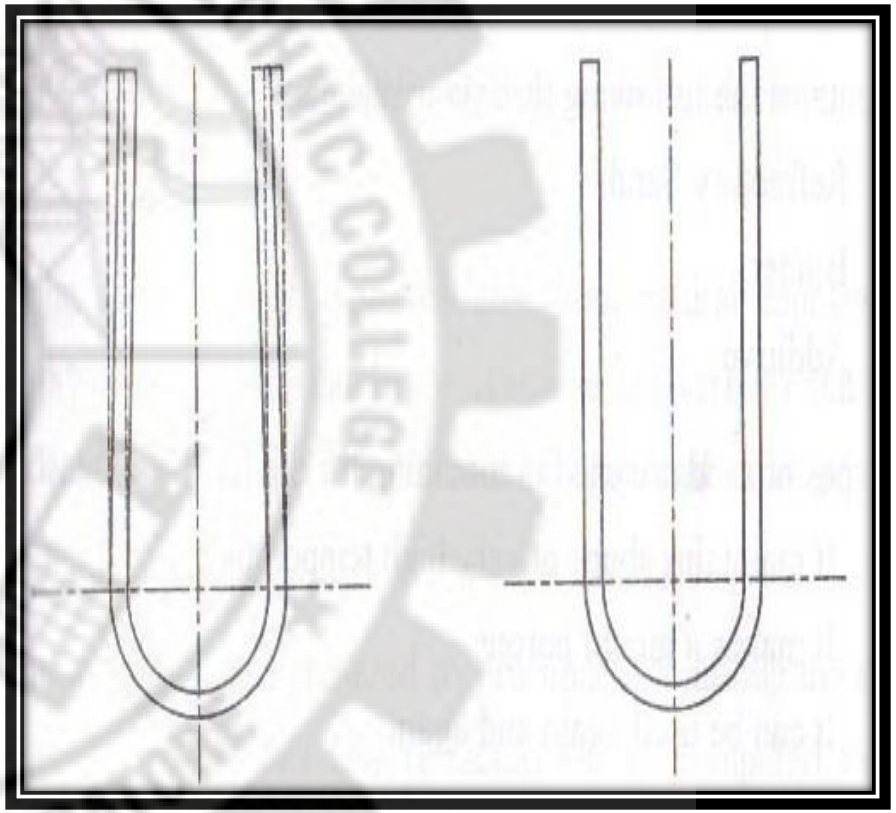
MACHINING or FINISH ALLOWANCE

Materials	Machining allowance	
	0-300mm	0-600mm
Cast iron	2.5mm	4.0mm
Aluminium	1.6mm	3.2mm
Bronze	1.6mm	3.2mm
Brass	1.6mm	3.2mm
Cast steel	3mm	4.5mm

DRAFT or TAPER ALLOWANCE



DISTORTION or CAMBER ALLOWANCE



RAPPING or SHAKE ALLOWANCE

- To remove the pattern out of mould cavity, it is slightly rapped or shaked to detach it from the mould cavity.

- Negative Allowance – subtracted from pattern dimensions.

MOULDING SAND

*Special type of sand is used for making **mould**.*

- 3 Essential constituents
  1. Refractory sand
  2. Binder
  3. Additive

- ✓ Silica is widely used as moulding sand.
- ✓ It has 80 to 90 % - Silica Dioxide
- ✓ It gives ***refractoriness*** to the sand.

TYPES OF SAND

1. Natural Sand
   - ➔ Available from natural deposits
   - ➔ Needs only 5-8% water
   - ➔ Used for light castings in Ferrous & Non-Ferrous

2. Synthetic Sand
   - ➔ Prepared (with desired properties, as we like) artificially by mixing clay free sand
   - ➔ Used in mechanized production machine moulding & High pressure moulding.

3. Special Sand
   a) Zircon sand
   b) Chromite sand

TYPES OF MOULDING SAND

1. **GREEN SAND**
   - in moist state
   - 5 to 8 % of water & 16 to 30 % of clay
   - Having good damping capacity
   - Small and medium size castings

2. **DRY SAND**
   - in dry stage
   - called as ‘dry sand mould’ or ‘skin dry mould’
   - large castings

3. Facing Sand

4. Loam Sand

- Consists of fine silica sand, fine refractories, clay (arround 50 %), graphite, fibre and water.
- Melting large castings – Bell, Roller, Pulleys etc.,

5. Backing Sand

- Used to backup the facing sand and to fill the whole volume of the mould box.
- Old sand may used repeatedly

6. Parting Sand

PROPERTIES OF MOULDING SAND

1. Porosity *or* Permeability
2. Plasticity *or* Flowability
3. Strength *or* Cohesiveness
4. Refractoriness
5. Adhesiveness
6. Collapsibility

MOULDING SAND

According to the *amount of clayey matter* they contain, the moulding sands are classified as:

1. Silica Sand : Upto 2% clay
2. Lean or Weak sand : 2 to 10% clay
3. Moderately strong sand : 10 to 20% clay
4. Strong sand : Upto 30% clay
5. Extra strong sand : Upto 50% clay

Types of sand :

1. Natural 2. Synthetic 3. Chemically coated

Desirable Mold sand Properties and Characteristics

- ✓ **Strength** - *to maintain shape and resist erosion*
- ✓ **Permeability** - *to allow hot air and gases to pass through voids in sand*
- ✓ **Thermal stability** - *to resist cracking on contact with molten metal*
- ✓ **Collapsibility** - *ability to give way and allow casting to shrink without cracking the casting*
- ✓ **Reusability** - *can sand from broken mold be reused to make other molds.*

BINDERS

- Organic - Cereal, resins, pitch, drying oil, molasses etc.,
- In-Organic - Fire clay, **KAOLINITE**, **BENTONITE** and ILLITE

High Thermo Chemical stability

TYPICAL GREEN MOULDING SAND for gray iron

Silica sand	= 68 to 86%
Clay	= 10 to 20%
Water	= 3 to 6%
Additives	= 1 to 6%

ADDITIVES

Additives are added to the molding sand to improve the properties like strength, refractoriness and permeability.

Necessary of Additives:

1. *To give a good surface finish to the casting*
2. *To eliminate casting defects*

(Expansion of moulding sand or Contraction of he casting)

1) Sea Coal – fine bituminous coal powder
2) Saw dust
3) Pitch – distilled from soft coal
4) Cereals – ground corn flour *or* corn starch
5) Silica flour – very fine powdered silica
6) Special additives
    - Fuel oil
    - Dextrin
    - Molasses
    - Iron oxide

MOULDING SAND PREPARATION

- ✓ Mixing of sand
- ✓ Tempering of sand
- ✓ Conditioning of sand

MOULDING TOOLS

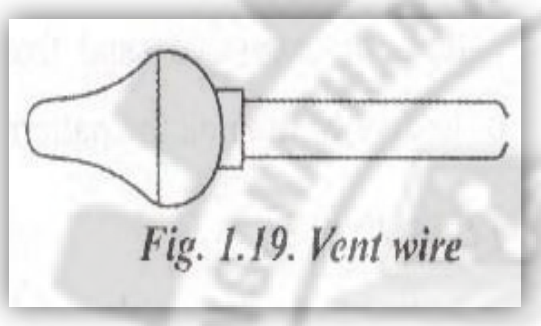
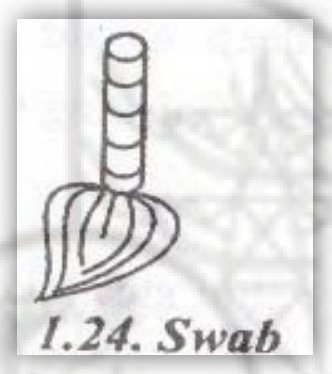


Fig. 1.19. Vent wire



1.24. Swab

Fig. 1.25. Bellows

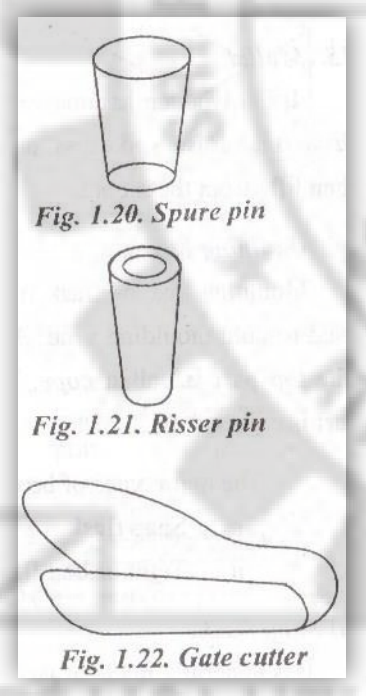


Fig. 1.20. Spure pin

Fig. 1.21. Risser pin

Fig. 1.22. Gate cutter

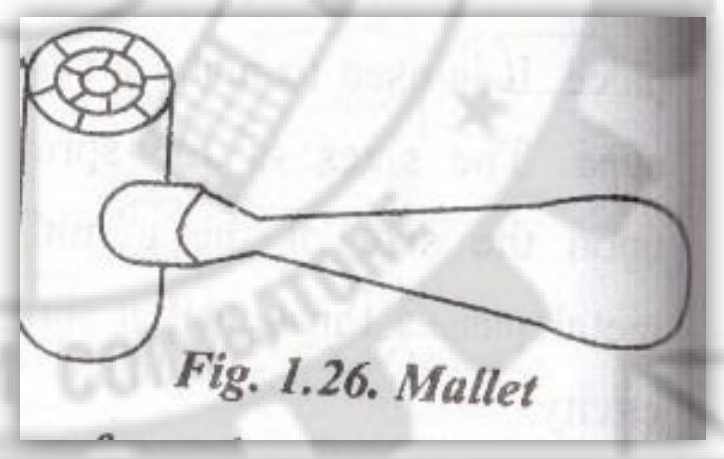


Fig. 1.26. Mallet

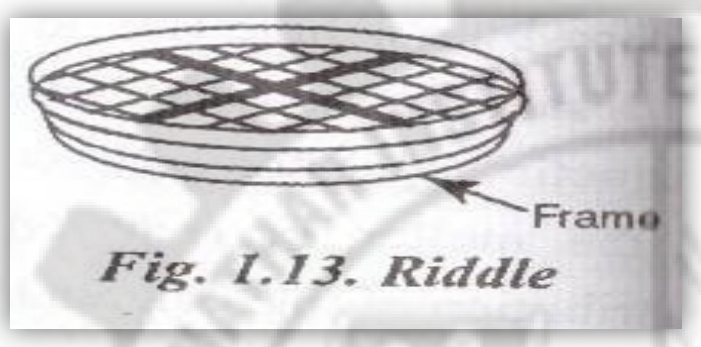


Fig. 1.13. Riddle

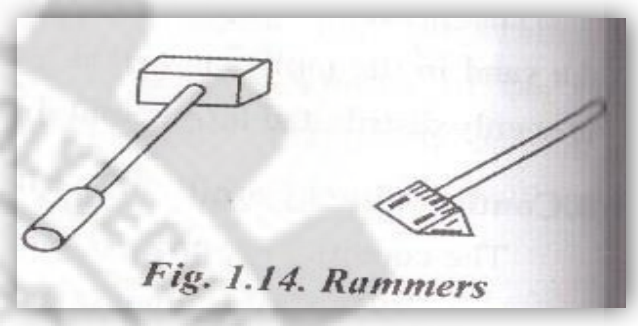


Fig. 1.14. Rammers

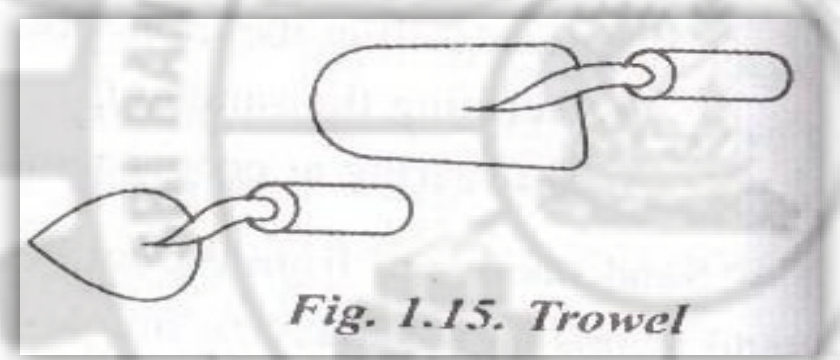


Fig. 1.15. Trowel

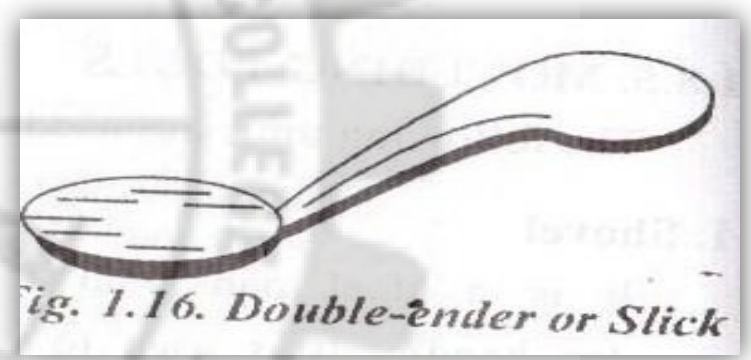


Fig. 1.16. Double-ender or Slick

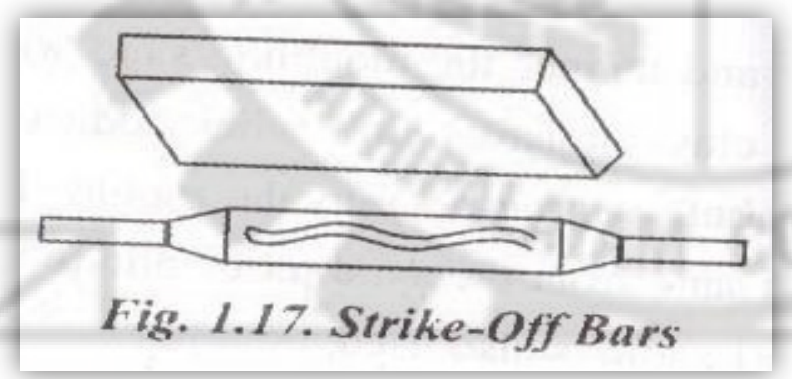


Fig. 1.17. Strike-Off Bars

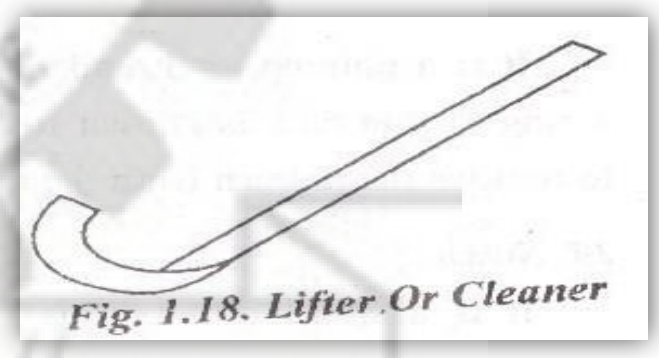


Fig. 1.18. Lifter Or Cleaner

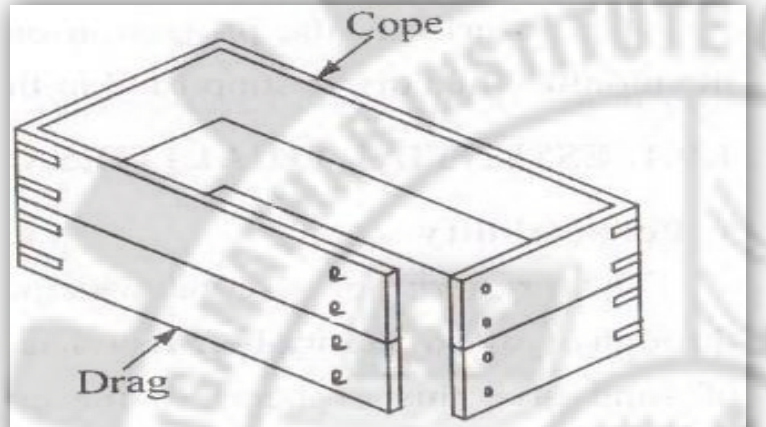


Fig 1.27 Snap flask

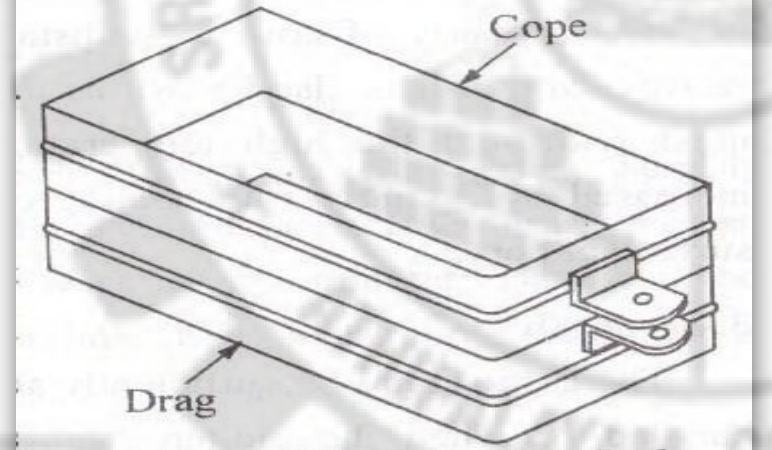


Fig 1.28 Tight or box flask

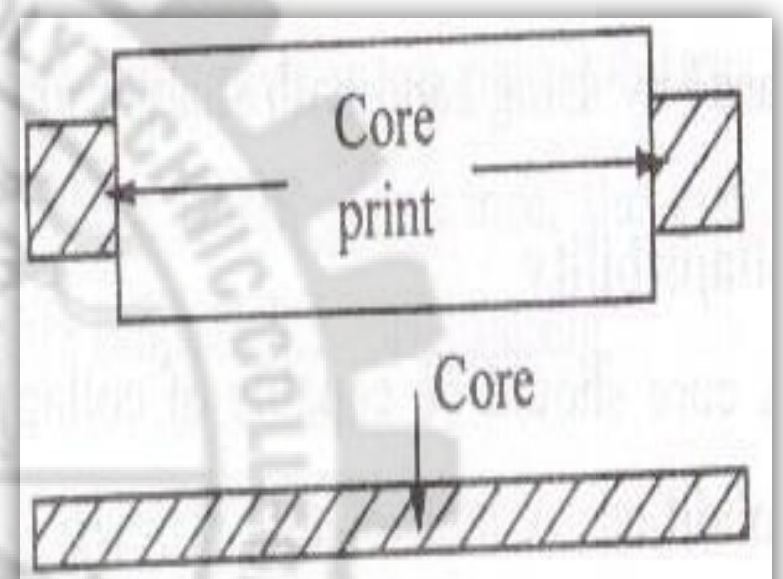


Fig 1.29 Core and core print

CORE

*A **Core** is a body made of sand which is used to make a cavity or a hole in a casting.*

- ***Core Print** is the projection on a pattern.*
- *It forms a seat in the mould.*
- ***Core** is supported in the seat formed by the **Core Print**.*

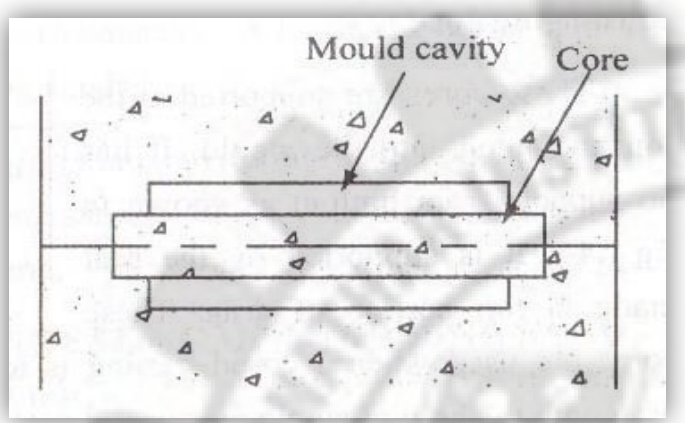
TYPES OF CORE

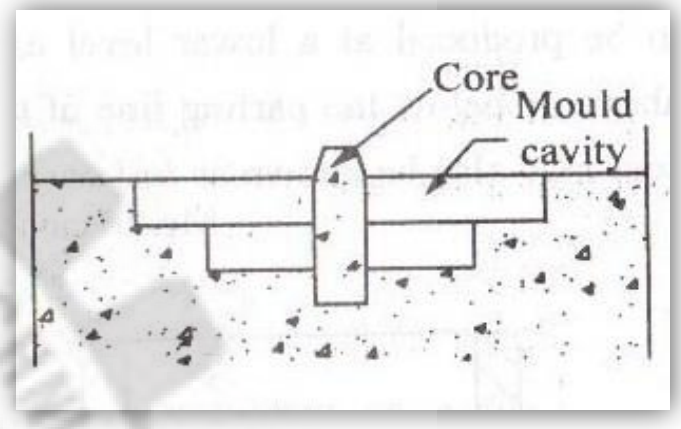
a) *According to the state of core*

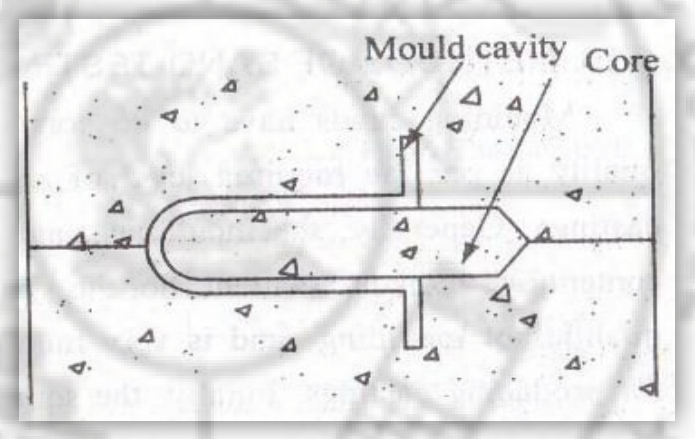
   i. *Green sand core*
   ii. *Dry sand core*

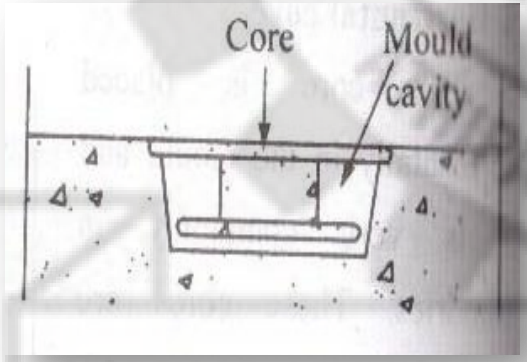
b) *According to the position of the core in the mould*

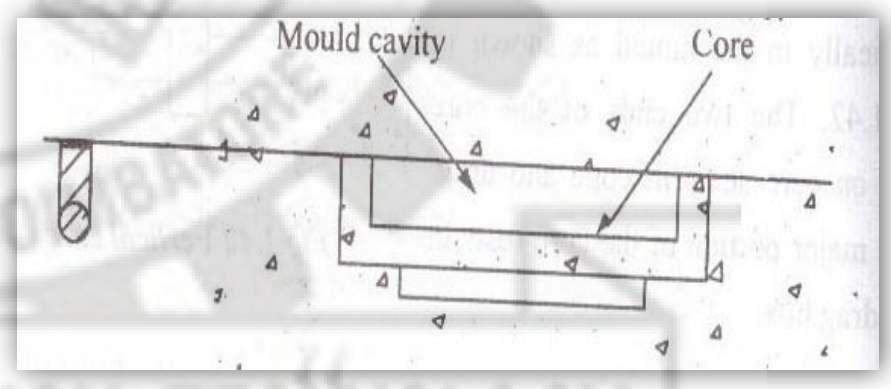
   i. *Horizontal core*
   ii. *Vertical core*
   iii. *Balanced core*
   iv. *Hanging core*
   v. *Drop core*


Mould cavity
Core


Core
Mould
cavity


Mould cavity
Core


Core
Mould
cavity


Mould cavity
Core

ESSENTIAL QUALITIES OF A CORE:

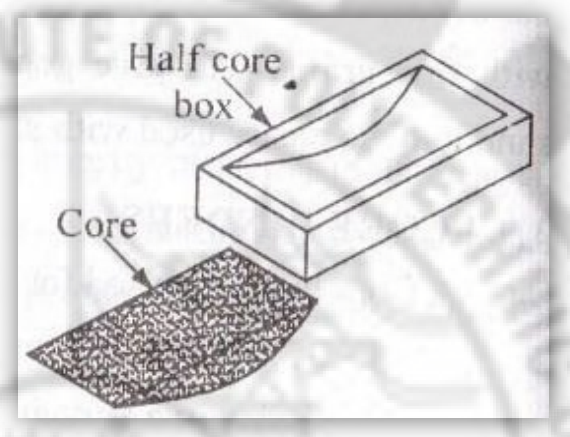
1. Permeability
2. Refractoriness
3. Strength
4. Collapsibility
5. Stability

MATERIALS:

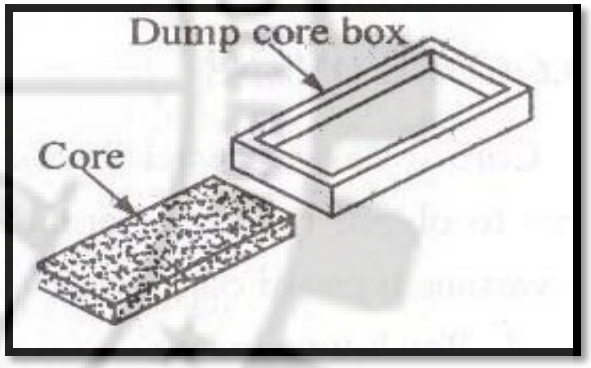
- Core Sand (Refractories) – Silica sand, Zircon, Olivin etc.,
- Binders – Vegetable *or* Mineral oil, Corn flour, Resins water, Fire clay, Bentonite, Urea
- Additives – Wood flour, Coal powder, Seal coal, Graphite, Cow dung, Straw etc.,

CORE BOXES

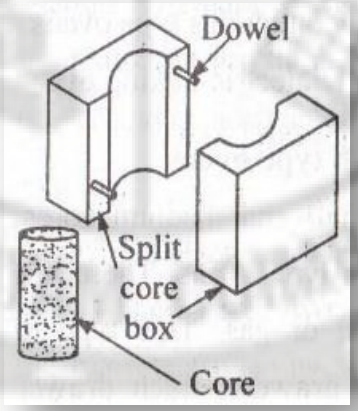
1. Half core box



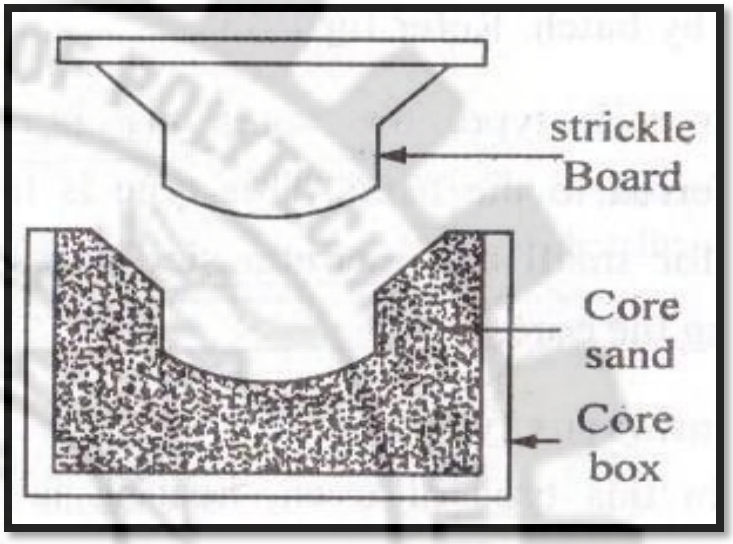
2. Dump *or* slap core box



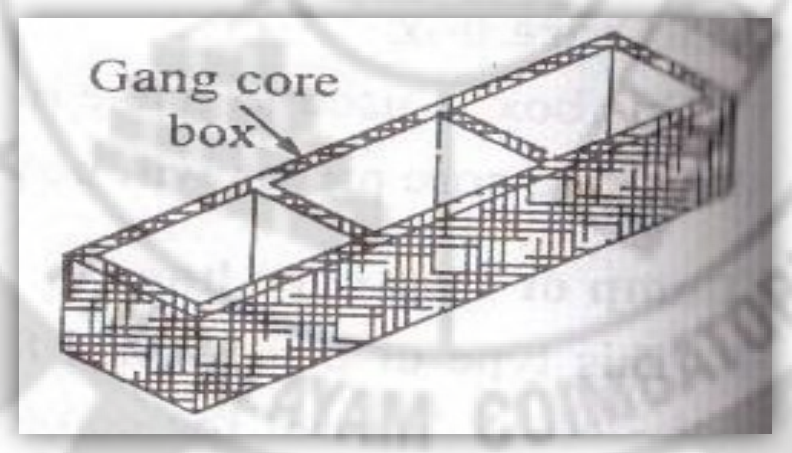
3. Split core box



4. Strickle core box

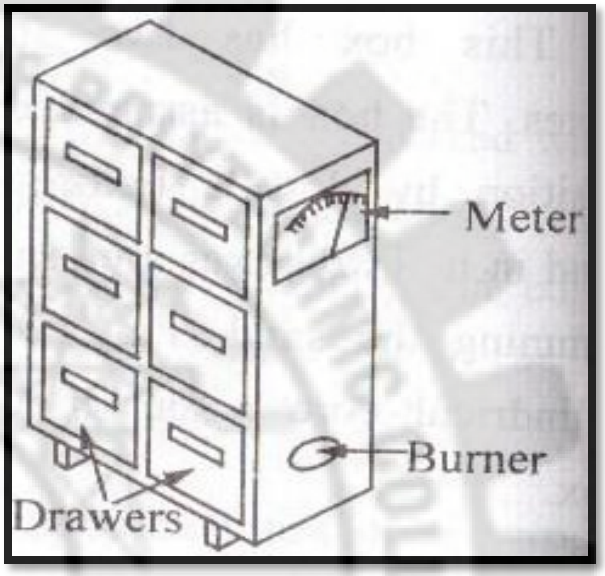


5. Gang core box

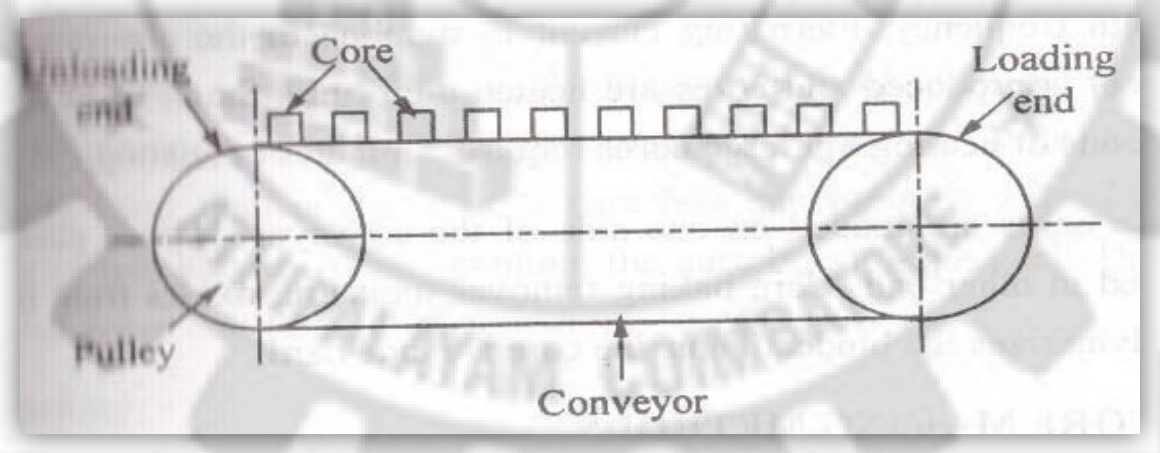


CORE OVENS

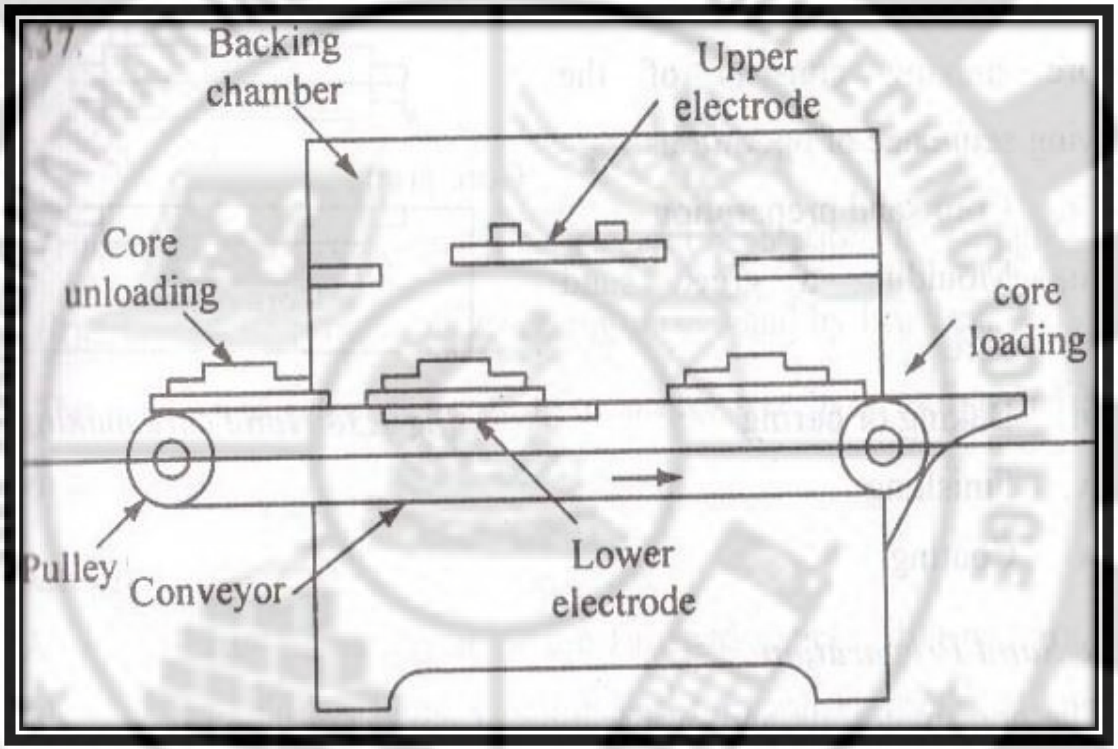
1. Batch type ovens



2. Continuous type ovens



3. Dielectric baking ovens



CORE MAKING METHOD

1. Hand core making
   i. Core sand preparation

   ii. Moulding a green sand core

   iii. Baking - 200^{o}C to 350^{o}C

   iv. Finishing
      a. Trimming – *removing fins and sand projections by* **filing**
      b. Brushing – *process of removing loose sand by* **brushes**
      c. Sizing – *making a core to a correct size by* **grinding** *or* **filing**

   v. Coating
      - Coating material – powdered graphite *or* Silica *or* Mica
      - Coating is applied either by dipping or spraying. This is also called as **Dressing**

2. **Hot core box method**

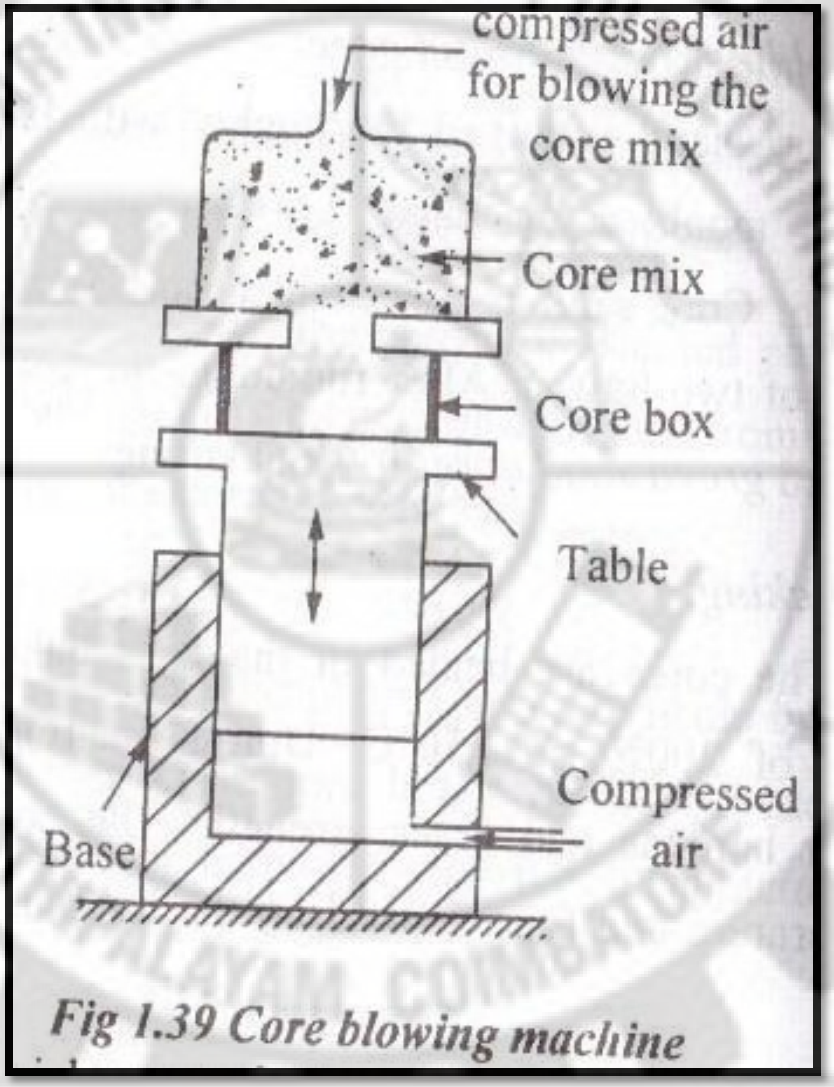


Fig 1.39 Core blowing machine

- **Baking or Curing** *will be lengthens the production process and lowers the operating efficiency of the foundry.*

- *This can be eliminated by using quickset synthetic resins-bonded core sands.*

- *Binders – Phenol formaldehyde, Urea formaldehyde, Phenolic alcohols and Furan-base binders.*
  - ✓ *These binders are capable of hardening at 230-250^{o}C in a short time (2 to 3 minutes)*

- *Catalysts – Benzene sulfonic and Nitric acids (to speed up the process of curing)*

3. **Synthetic resin-based cold curing Method**

- These sands do not require heat treatment after obtaining from ovens.
- In this method core is allowed to stand in the air for 30 to 120 min. (having strength of about 800 to 1200 kPa.

  - Strength is lesser than HOT BOX METHOD.
  - Only used for moderately complex and simple configuration.

MANUFACTURING TECHNOLOGY-I

MECHANICAL ENGINEERING

- ‘Manufacturing’ is derived from the Latin,

  manus = hand and factus = made,

  that is, the literal meaning is “made by hand”.

- ‘Manufacturing’ means the making of goods and articles by hand and/or by machinery.

- ‘Manufacturing Technology’ or “Production Technology” can be defined as the study of the various processes required to produce parts and to assemble them into machines and mechanisms.

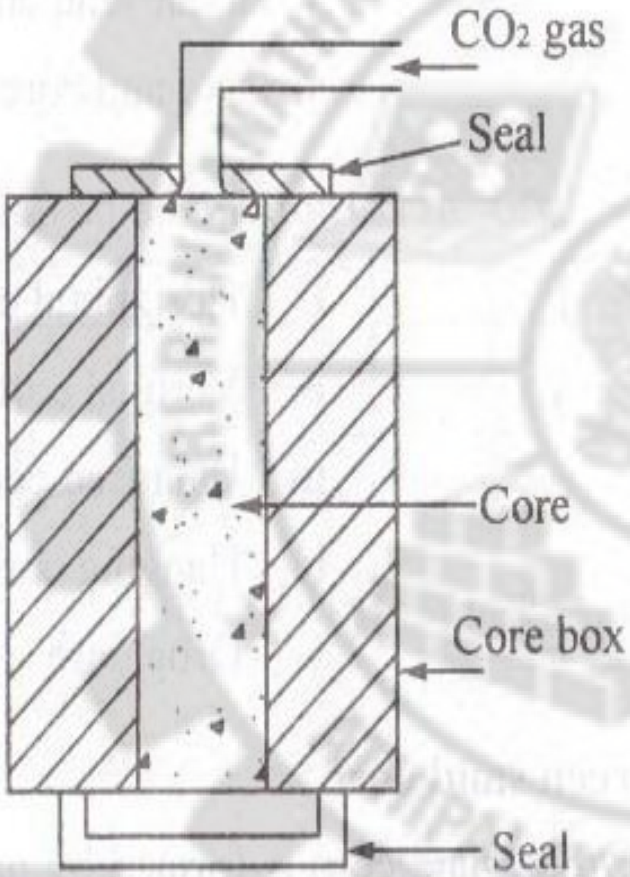
- **SAND CASTING**
- Sand moulds
- Type of patterns
  - Pattern materials
  - Pattern allowances
- Moulding sand
  - Types
  - Properties
  - Testing
- Core making
  - Types
  - Applications
- Moulding machines
  - Types
  - Application

- **MELTING FURNACES**
  - Blast
  - Cupola
- **SPECIAL CASTING PROCESSES**
  - Shell
  - investment casting
  - Ceramic mould
  - Lost Wax process
  - Pressure die casting
  - Centrifugal casting
  - CO_2 process
  - Stir Casting

(Working principle)

- **DEFECTS IN SAND CASTING**

Cold curing CO_2 Process



- To make good Quality castings in large numbers.
- Binder – Pure dry silica sand + Sodium silicate liquid
- Moisture content – Should not exceed 3 %
- Additives – Sawdust about 1.5%, Asbestos powder – up to 5%, Graphite powder – deformable & collapsible

- CO_2 gas is passed through the core for 30 sec at 140 KN/m^2.

- CO_2 + Sodium silicate = Sodium carbonate + Silica jell

- **Silica jell** binds the sand.

(*MOULDING*) **SAND TESTING METHODS**

1. Moisture content test
2. Clay content test
3. Grain fitness test
4. Permeability test
5. Strength test
6. Deformation *or* Toughness test
7. Hot strength test
8. Refractoriness test
9. Mould hardness test

(*CORE*) **SAND TESTING METHODS**

1. Green strength test
2. Baked strength test
3. Retained strength test
4. Core strength test
5. Moisture content test

MOULDING

Moulding is the process of making a mould cavity by packing prepared moulding sand around the pattern and removing the pattern from the mould to form the mould cavity.

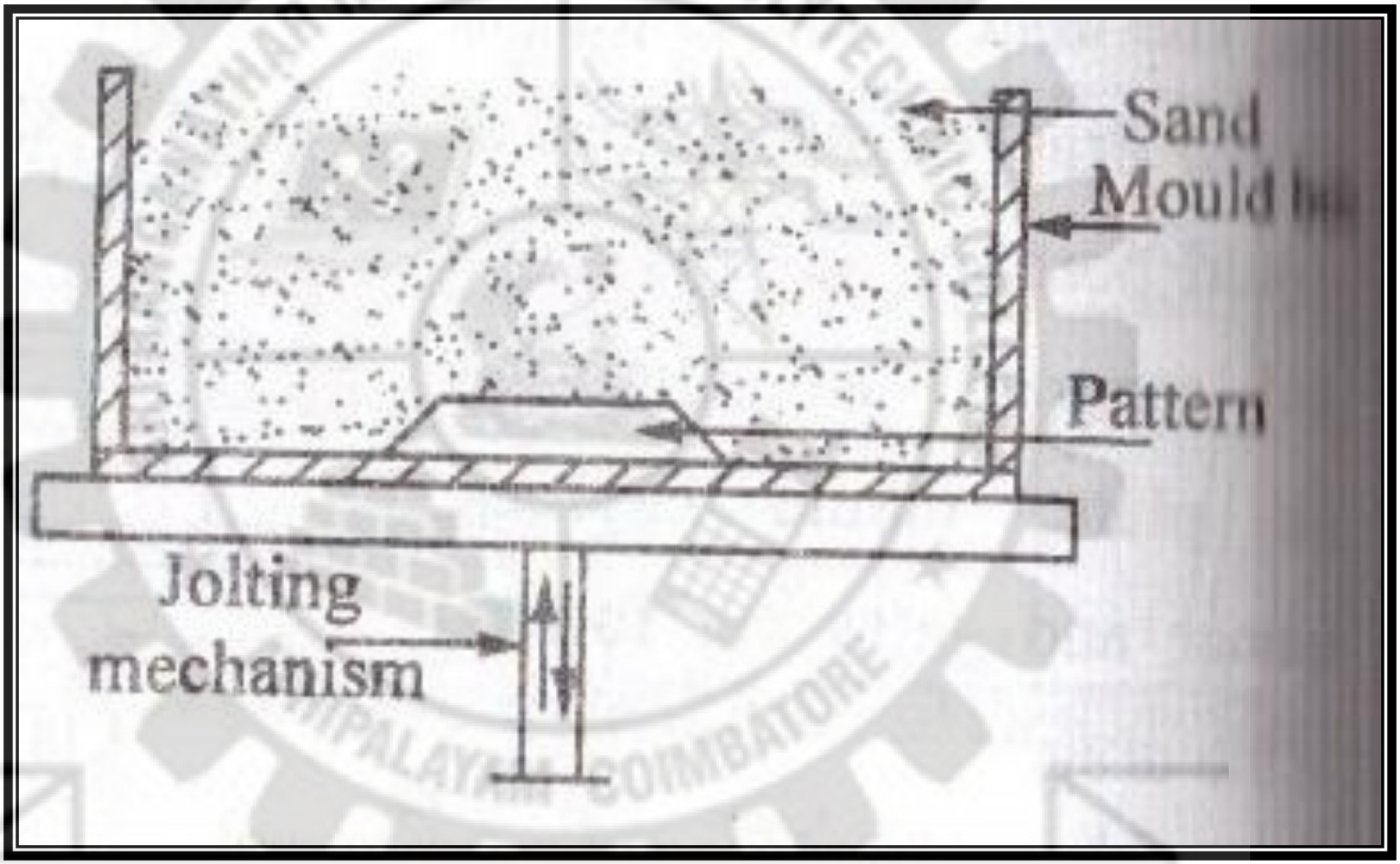
Types:

1. Green sand mould
2. Dry sand mould
3. Loam sand mould

MOULDING METHODS

1. Bench Moulding
2. Floor Moulding
3. Pit Moulding
4. Sweep Moulding
5. Plate Moulding

JOLTING MACHINE



SQUEEZING MACHINE

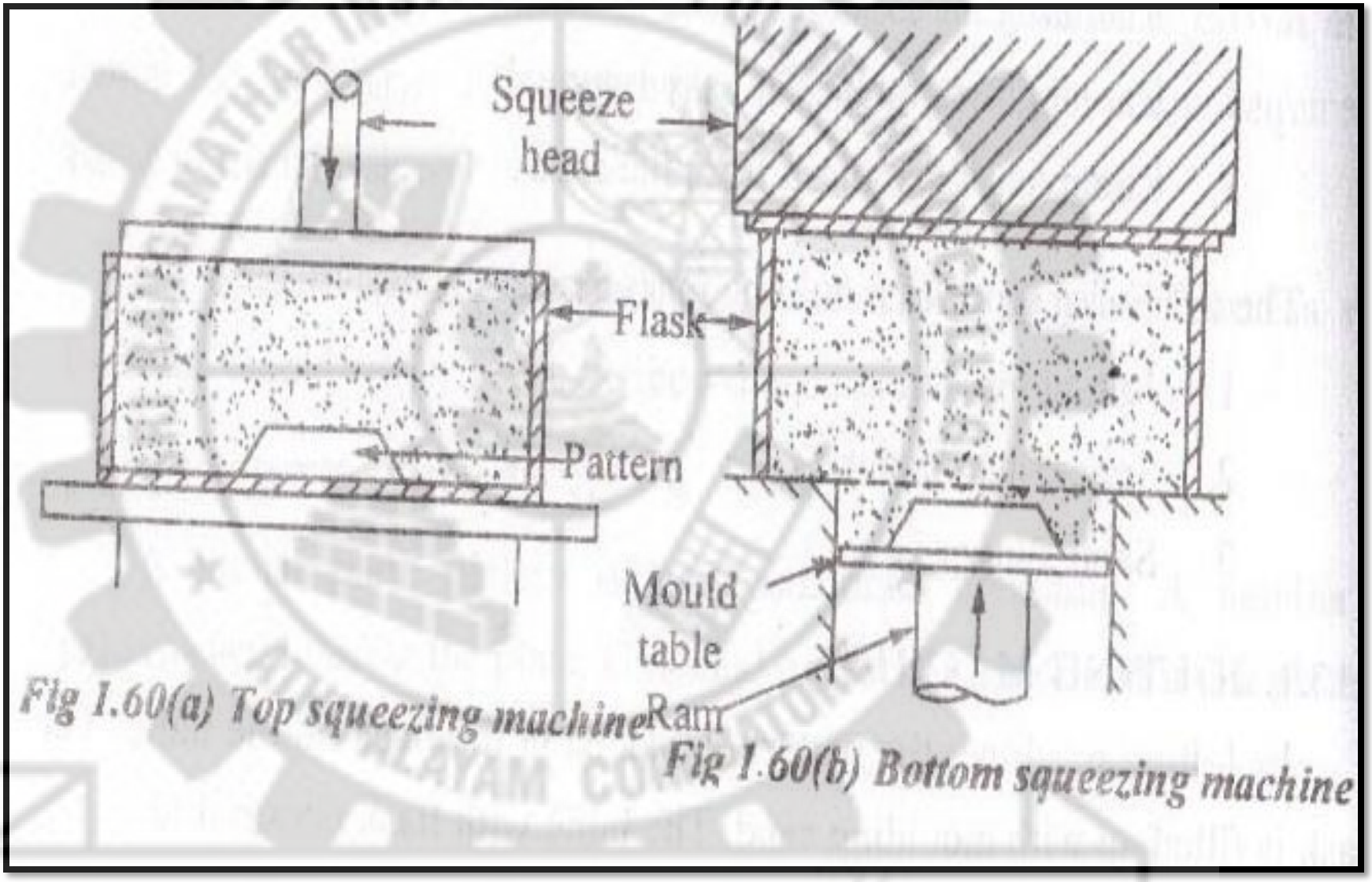
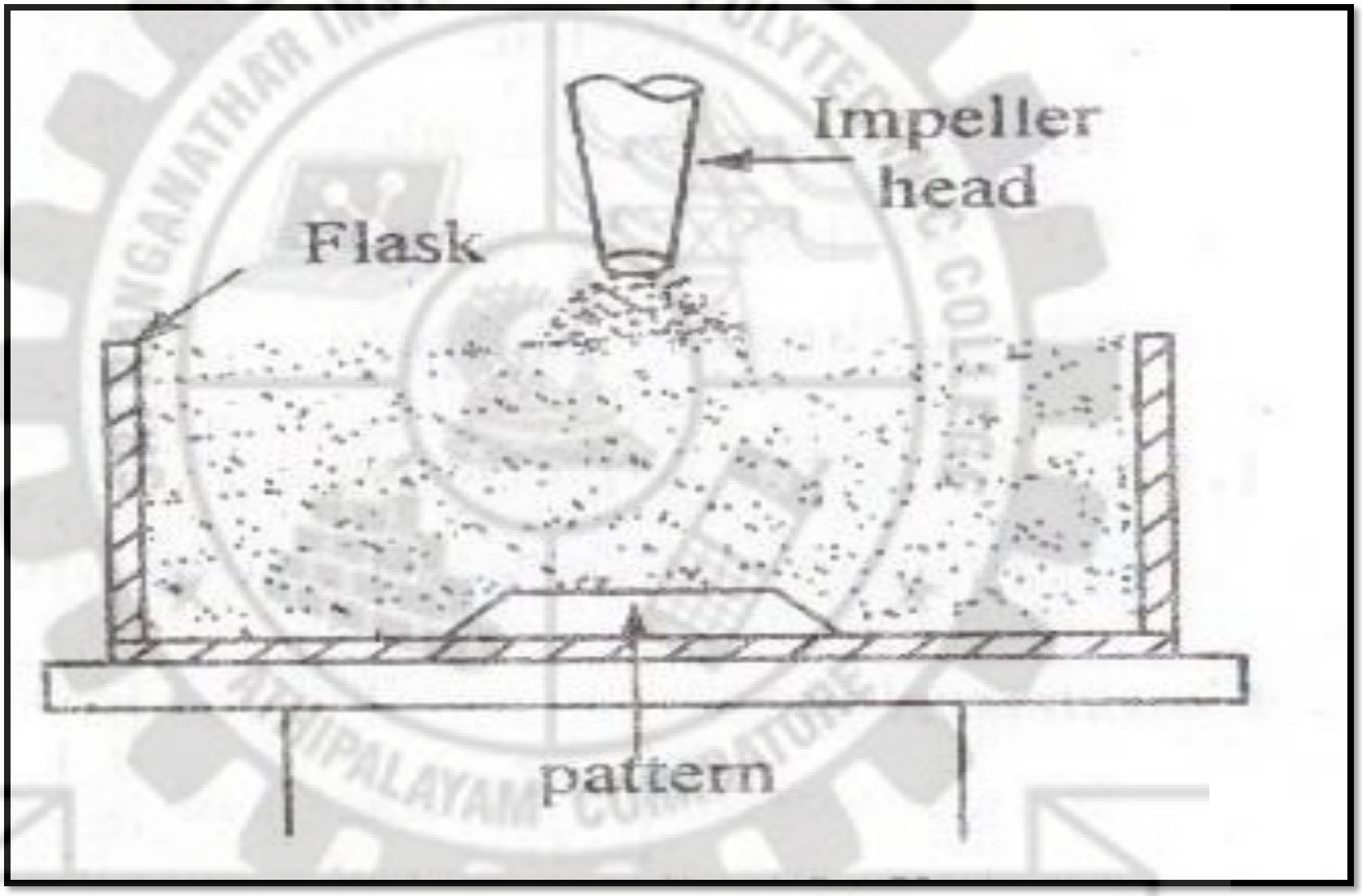


Fig 1.60(a) Top squeezing machine

Fig 1.60(b) Bottom squeezing machine

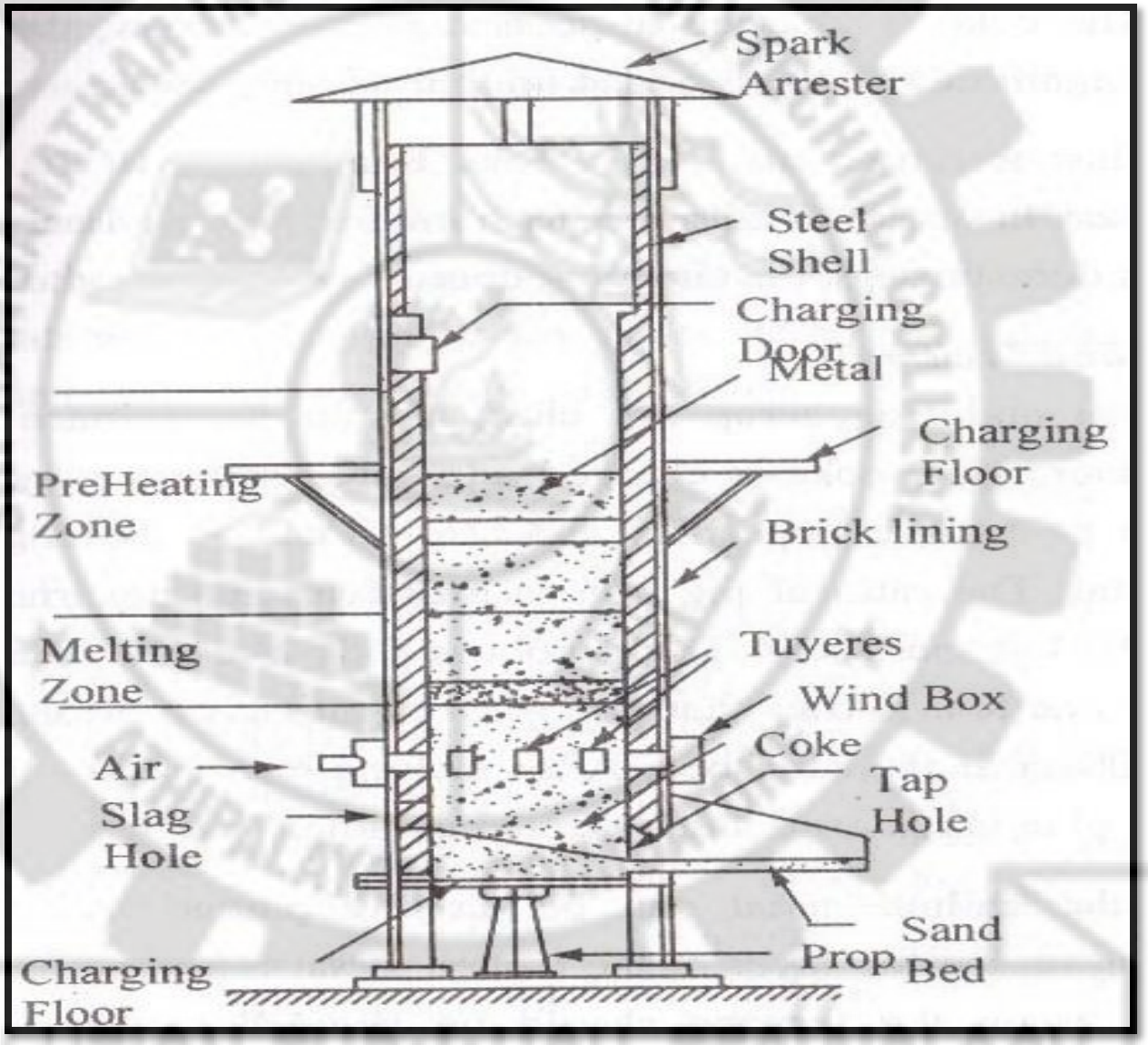
SAND SLINGER



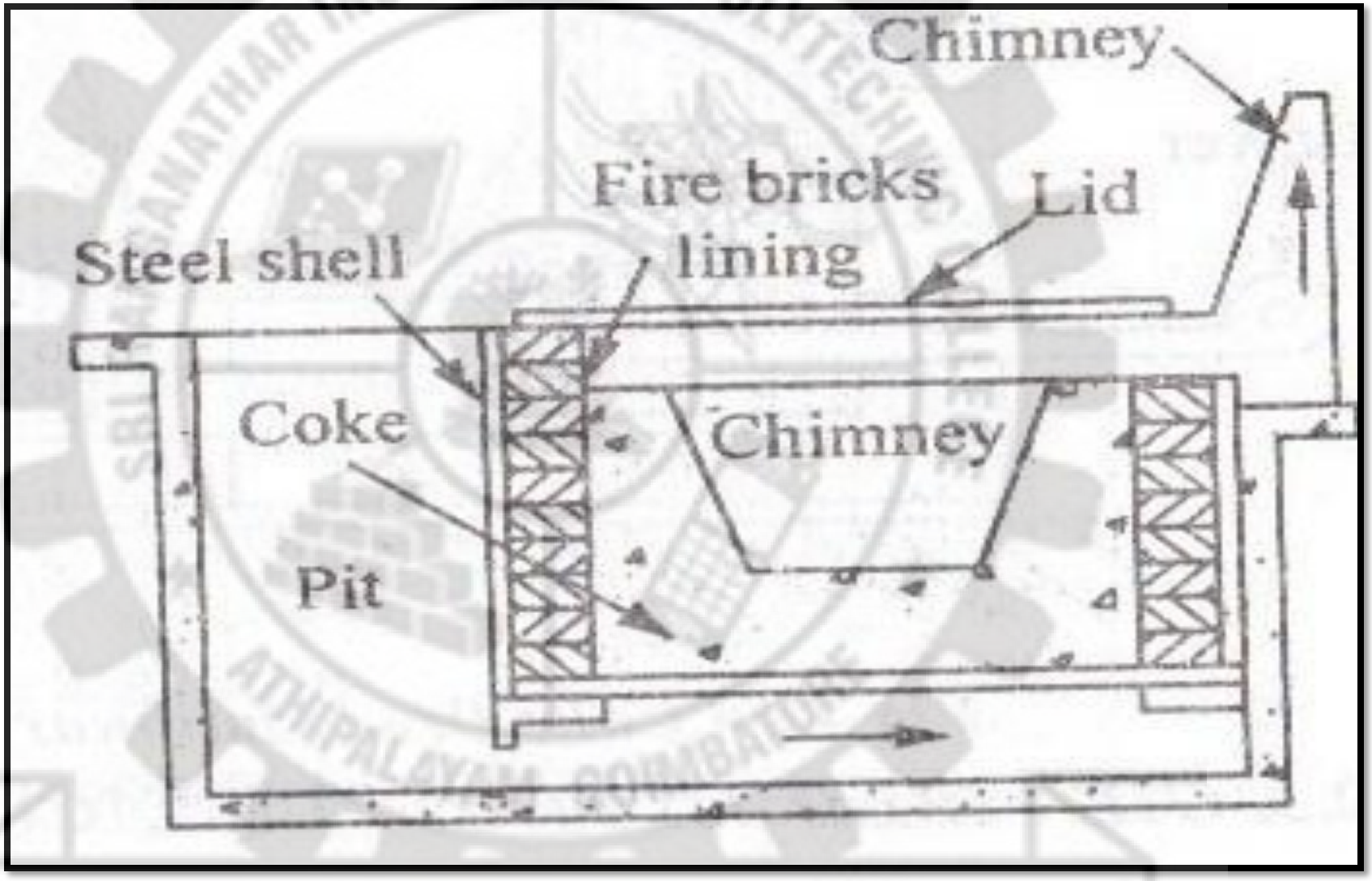
MELTING FURNACE

1. Cupola – CI
2. Open hearth – Steel
3. Crucible – Non-Ferrous
   a) Pit type
   b) Coke fired stationary
   c) Oil fired tilting
4. Pot
5. Electric
   a) Direct arc
   b) Indirect arc
   c) Induction

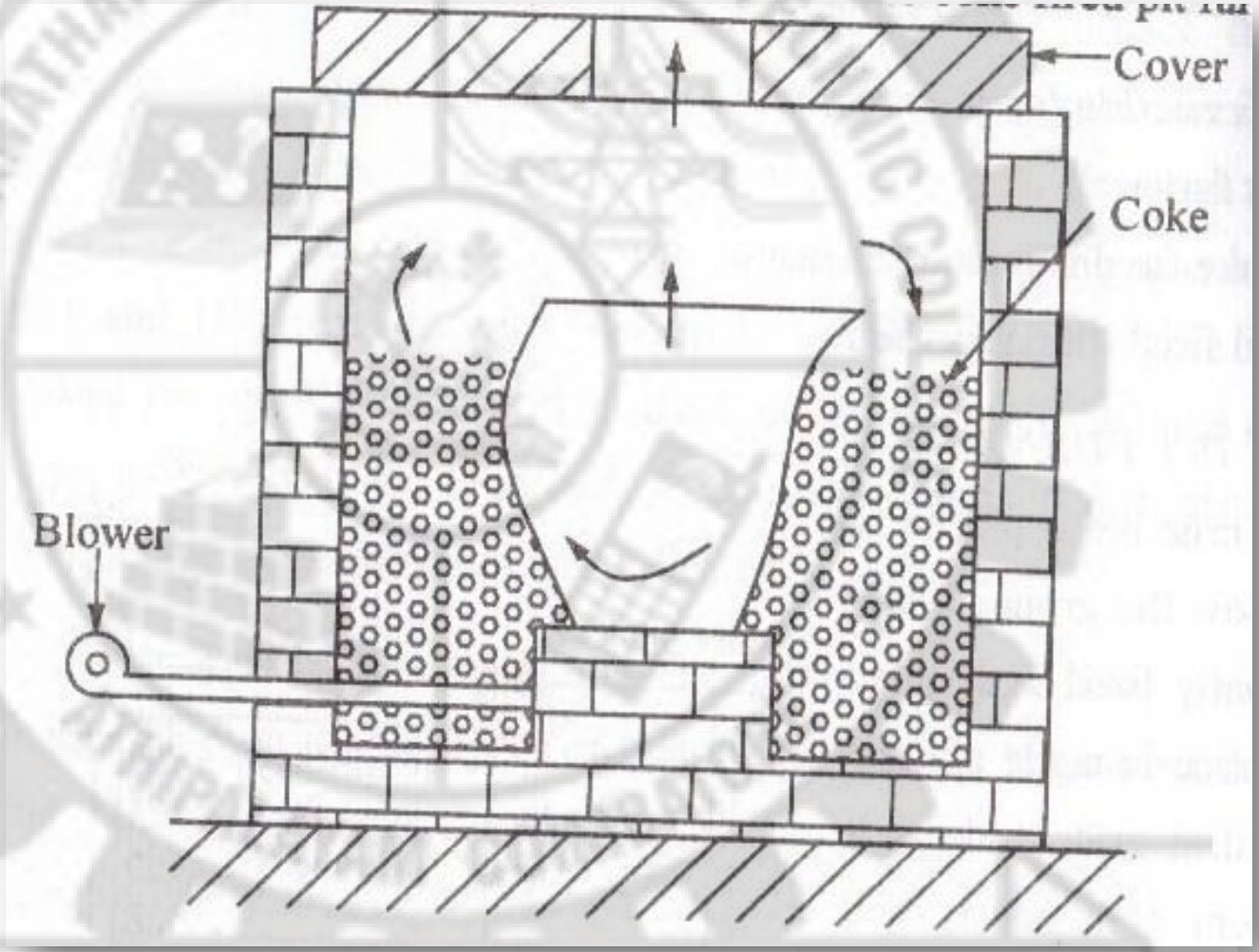
CUPOLA FURNACE



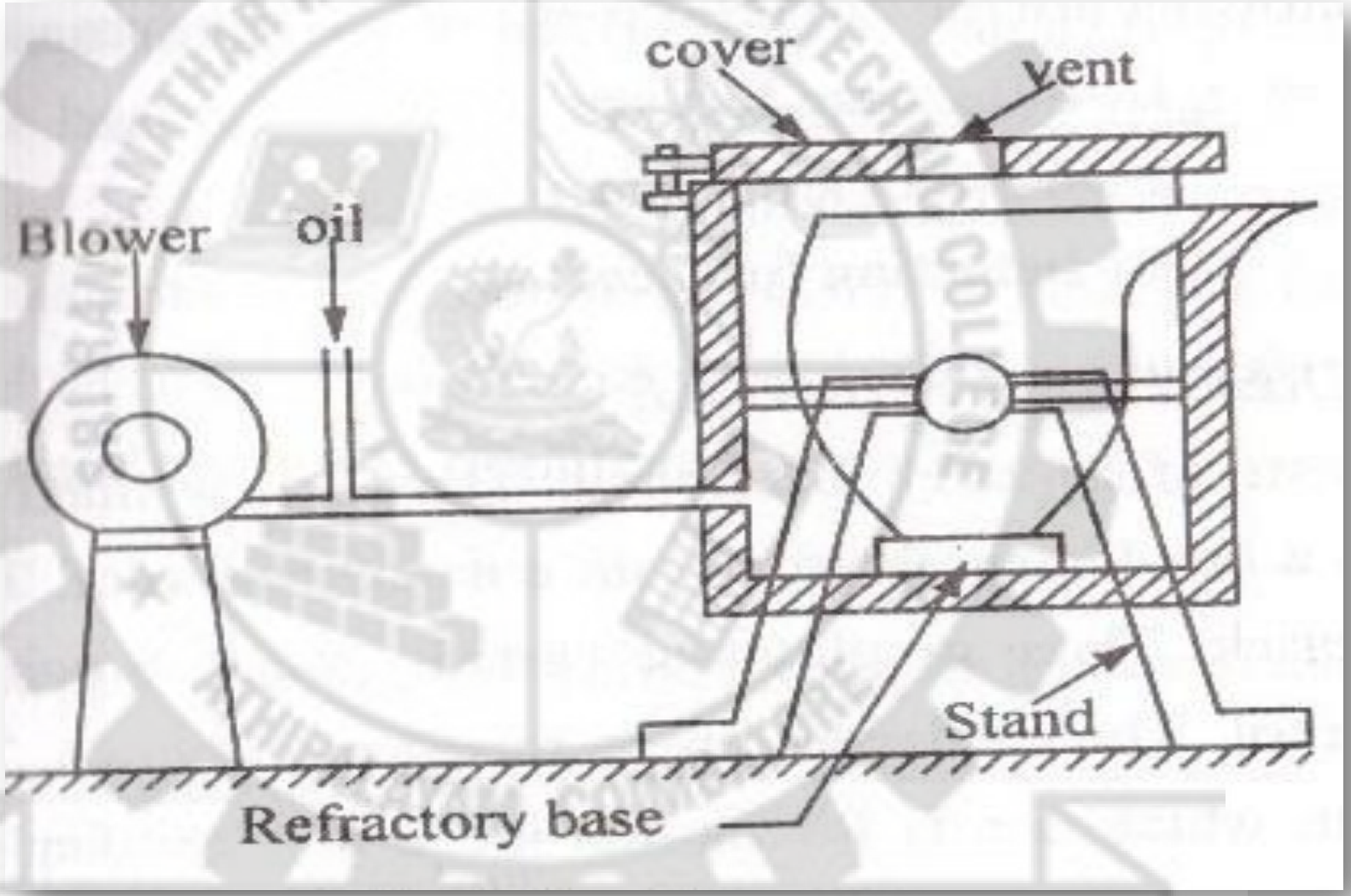
CRUCIBLE - PIT FURNACE



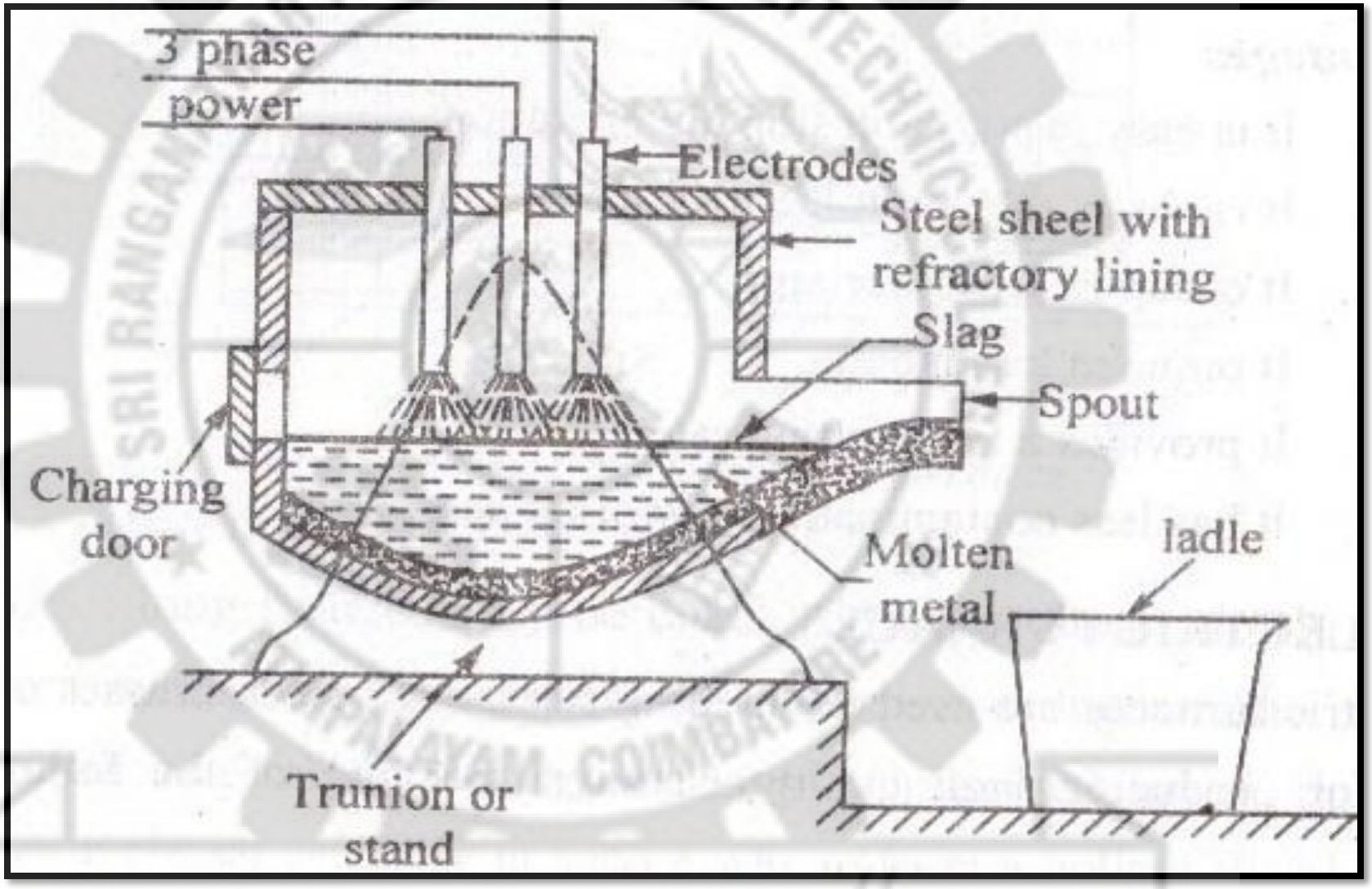
CRUCIBLE - CFS FURNACE



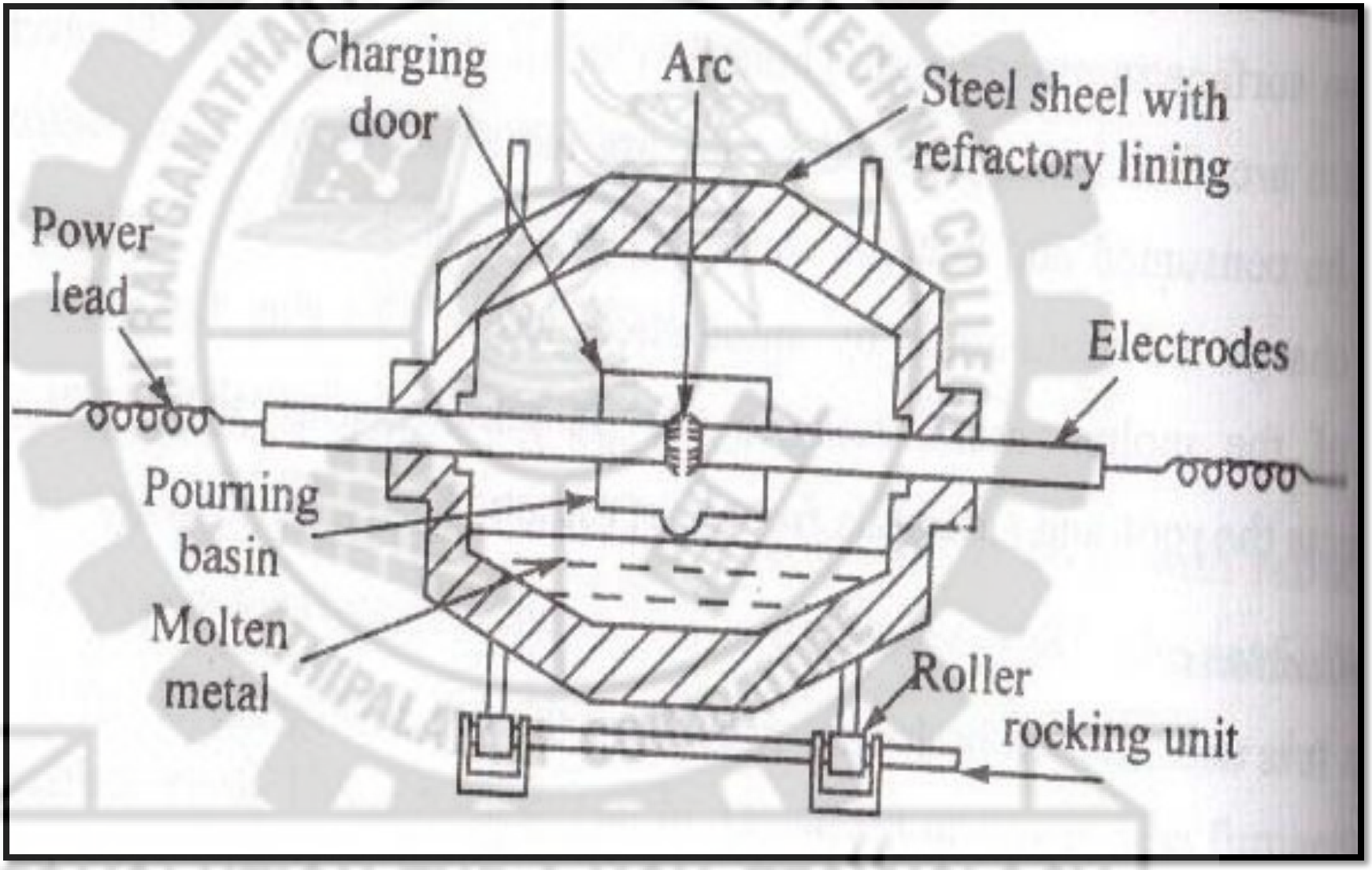
CRUCIBLE - OFT FURNACE



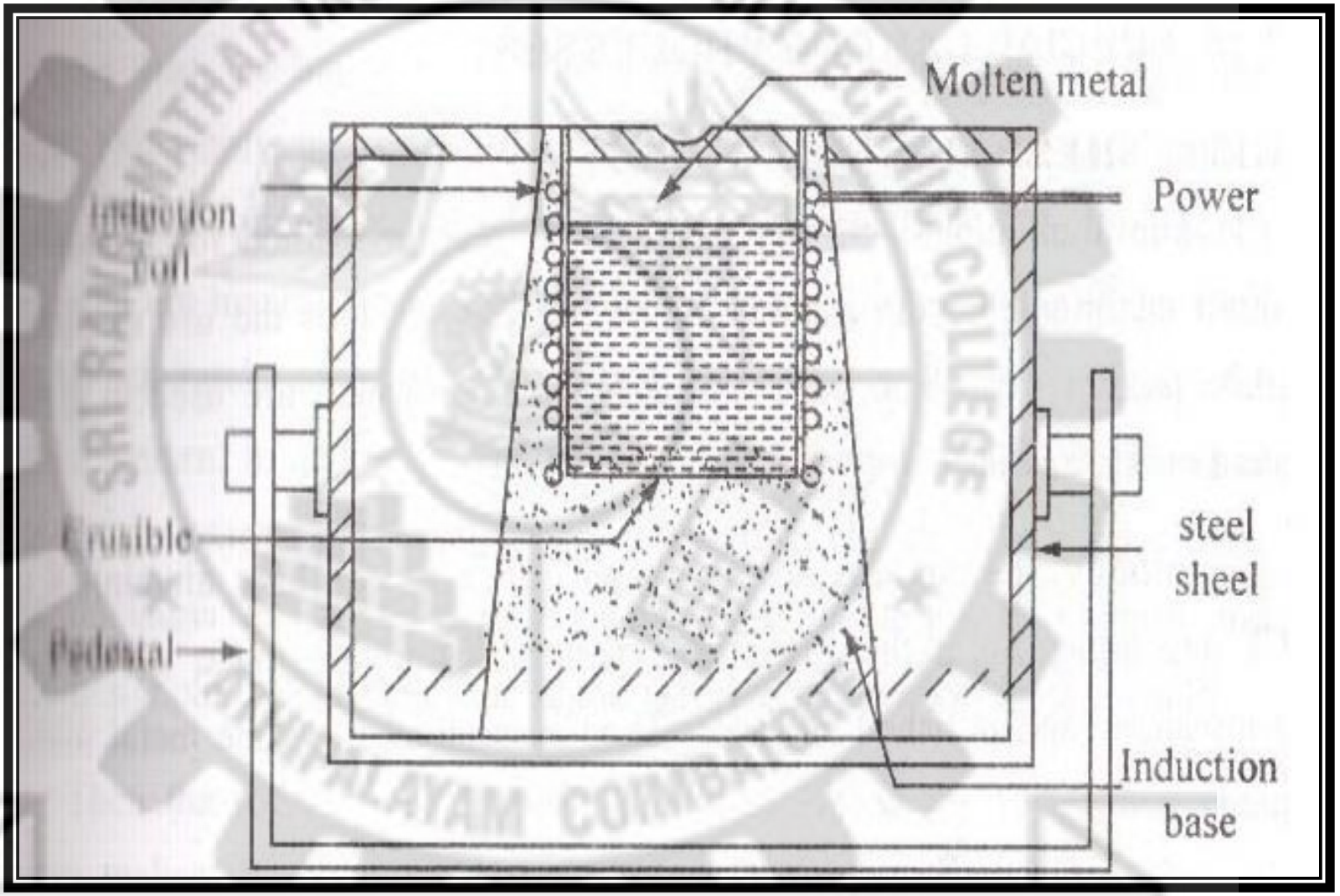
ELECTRIC – DA FURNACE



ELECTRIC – IDA FURNACE



INDUCTION FURNACE



SPECIAL CASTING PROCESSES

1. Shell Mould Casting
2. Investment Casting
3. Ceramic Mould Casting
4. Lost Wax Process

5. Pressure Die Casting

    1) Hot chamber Die Casting

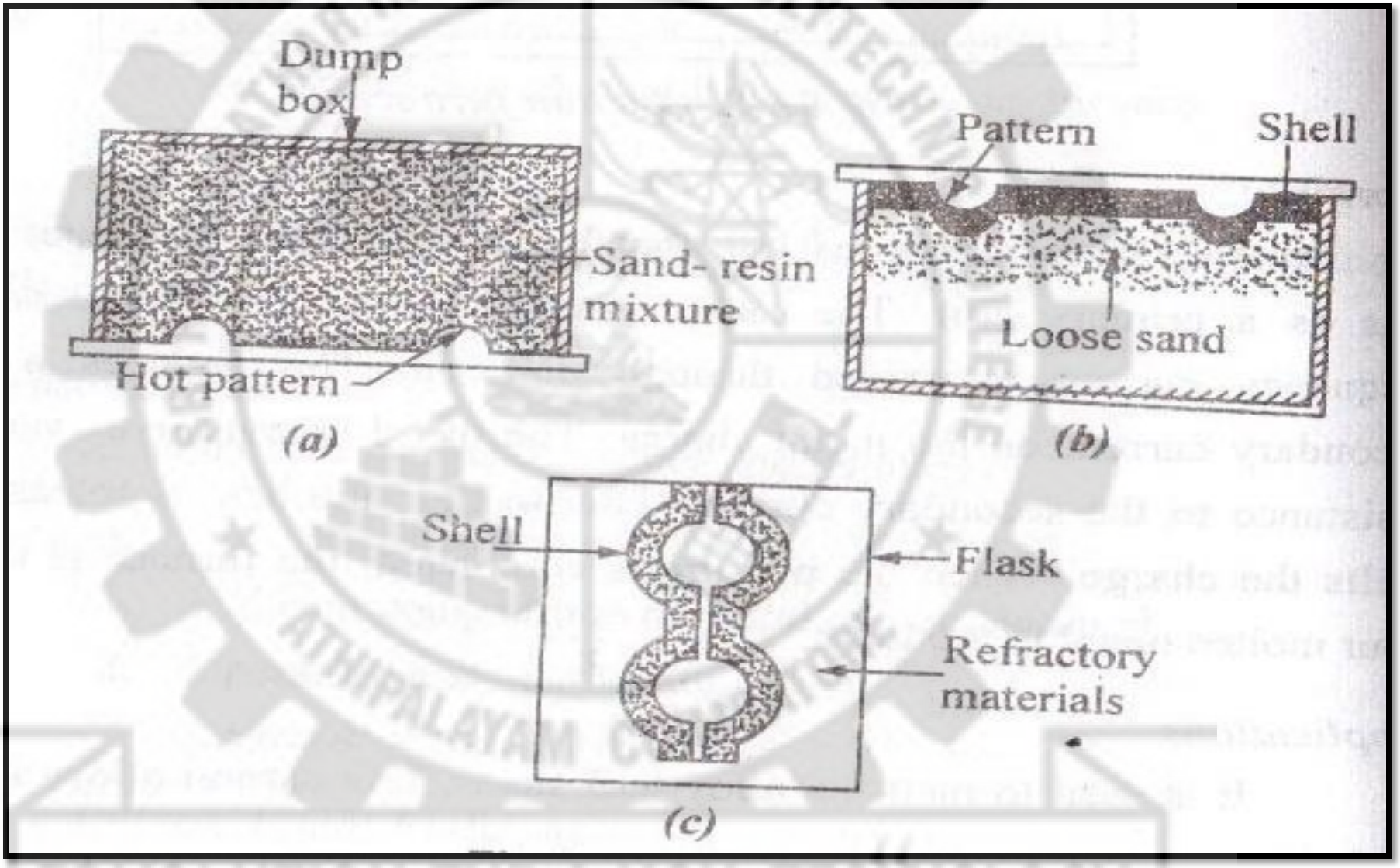
    2) Cold chamber Die Casting

6. Gravity Die Casting

7. Centrifugal Casting

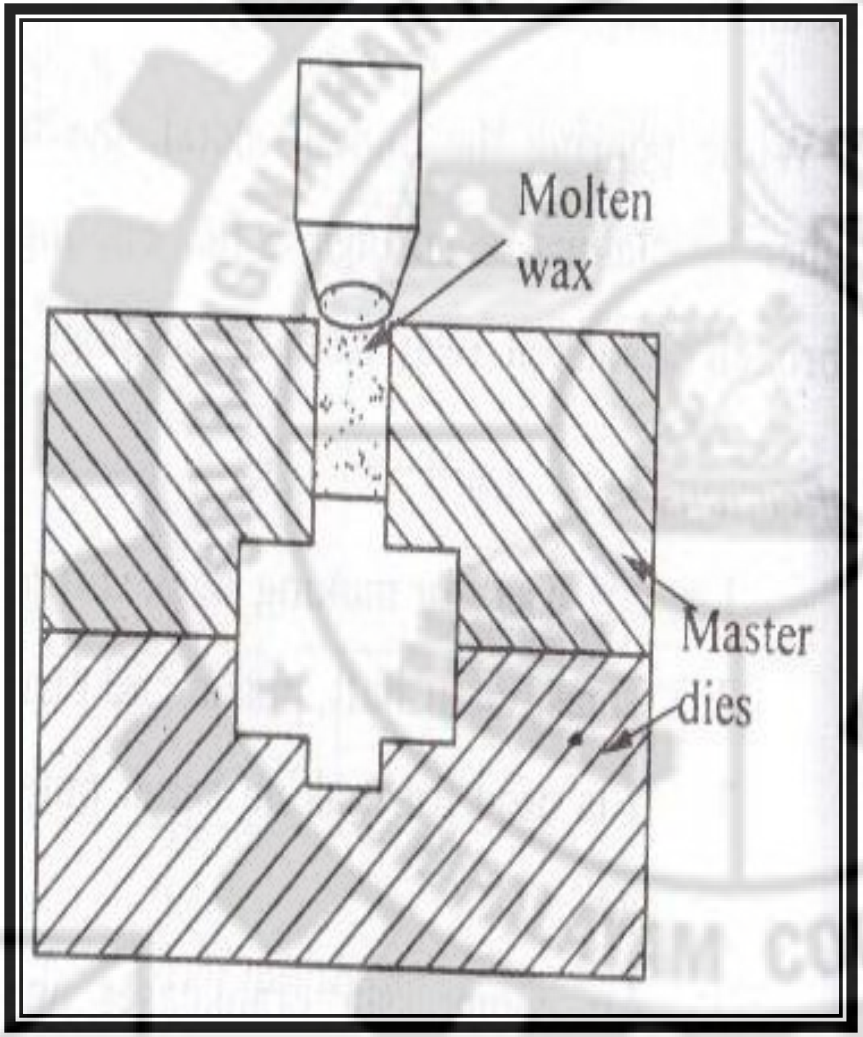
8. Continuous Casting process

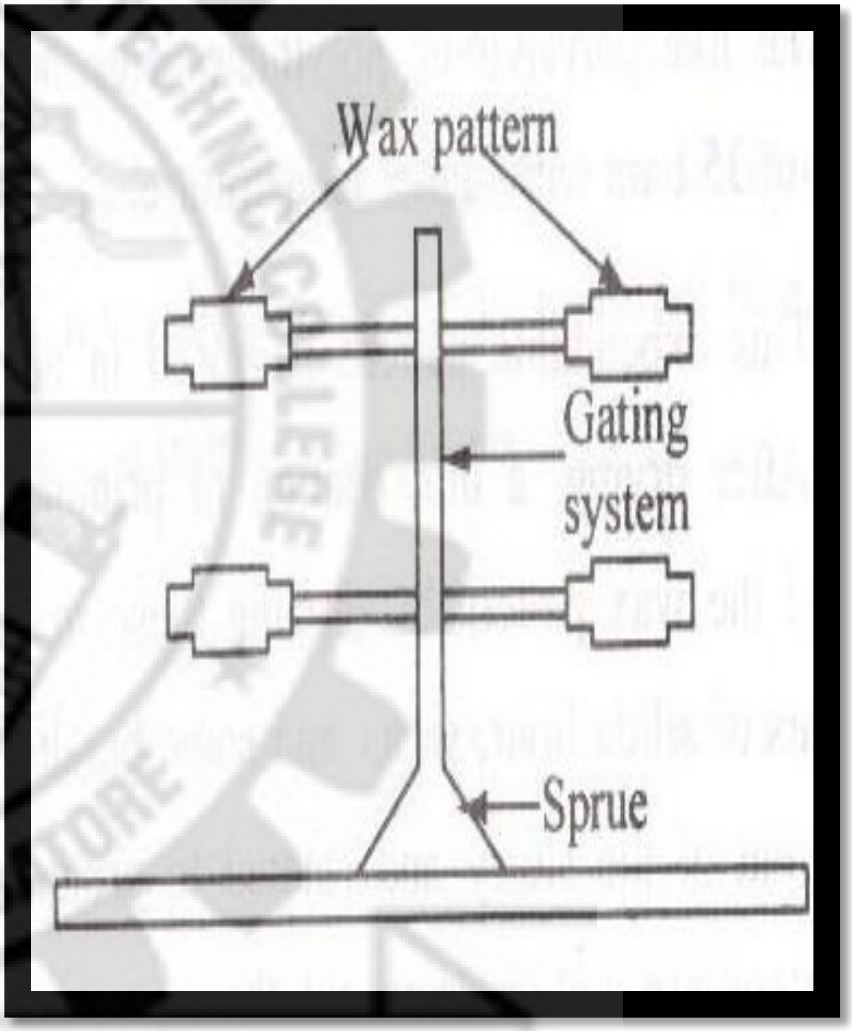
SHELL MOULD CASTING

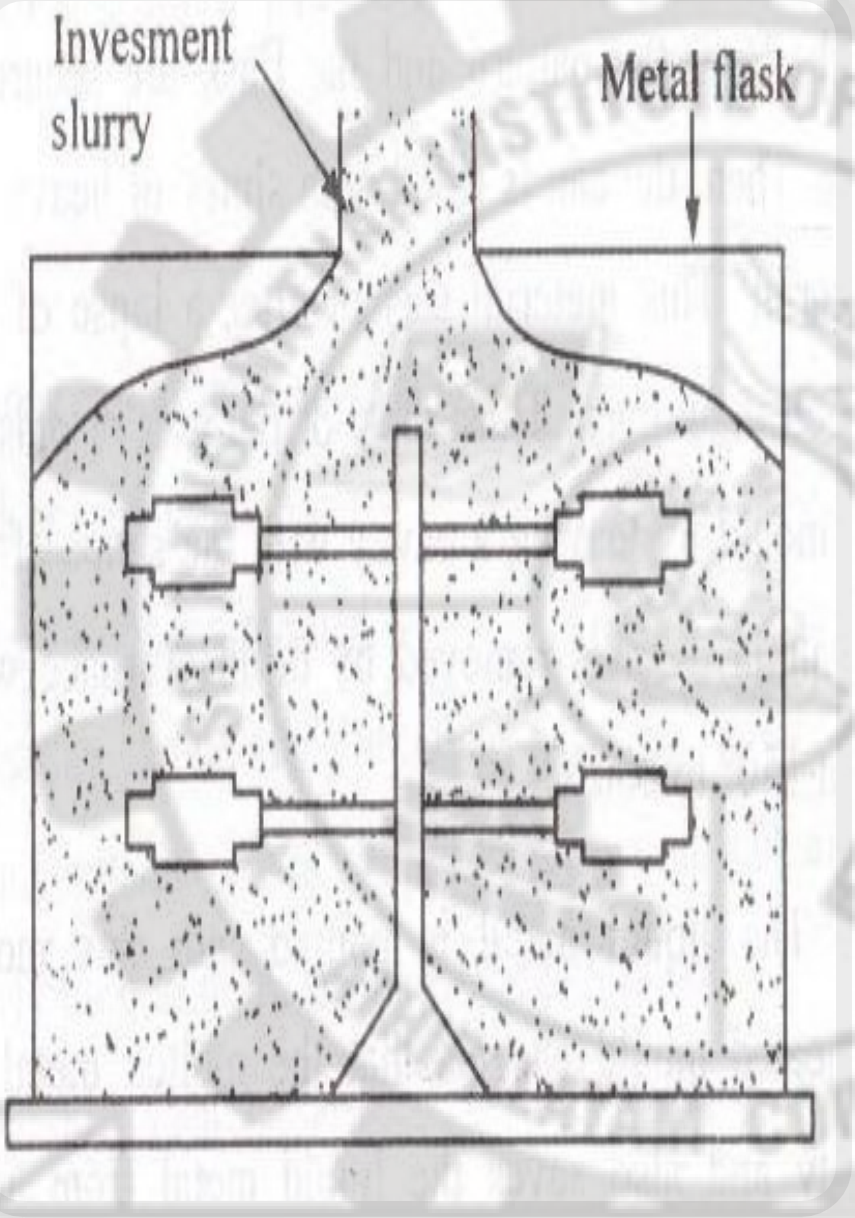


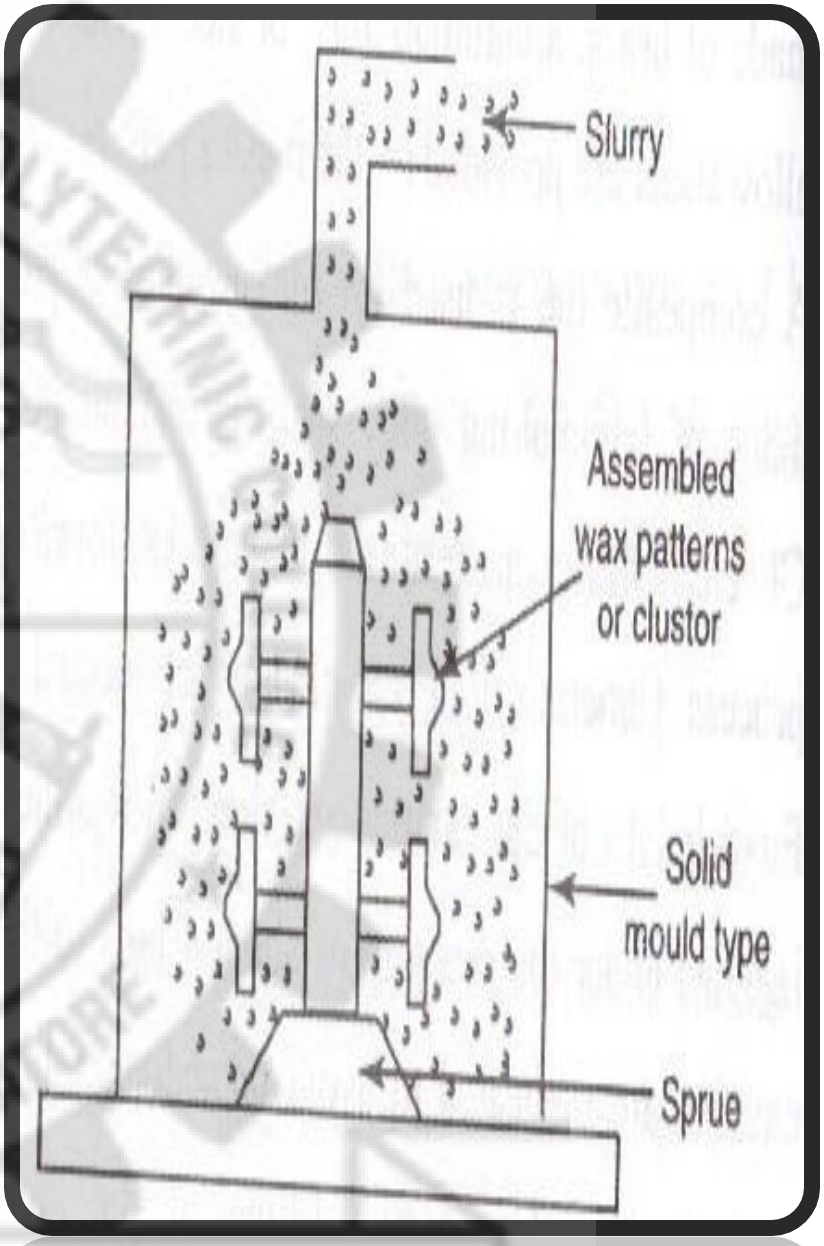
- *5 to 10% - Phenolic resin mixed with fine dry silica (Mixer – dry oil or presence of alcohol)*
- *No water*
- *230 – 600°C*
- *Release Agent – Silicone (sprayed over pattern)*
- *Thickness of shell – time of contact of the mixture with the heated pattern (Ex: 20-30 sec, 6 mm)*
- *Then the mould is heated in an Oven at 300°C for 15-60 sec.*
- *After cooling &Solidification, the shells are broken or shaken away from the castings.*
- *Brake drums, Bushings, Cams, Cam shaft, rollers etc.,*

INVESTMENT CASTING



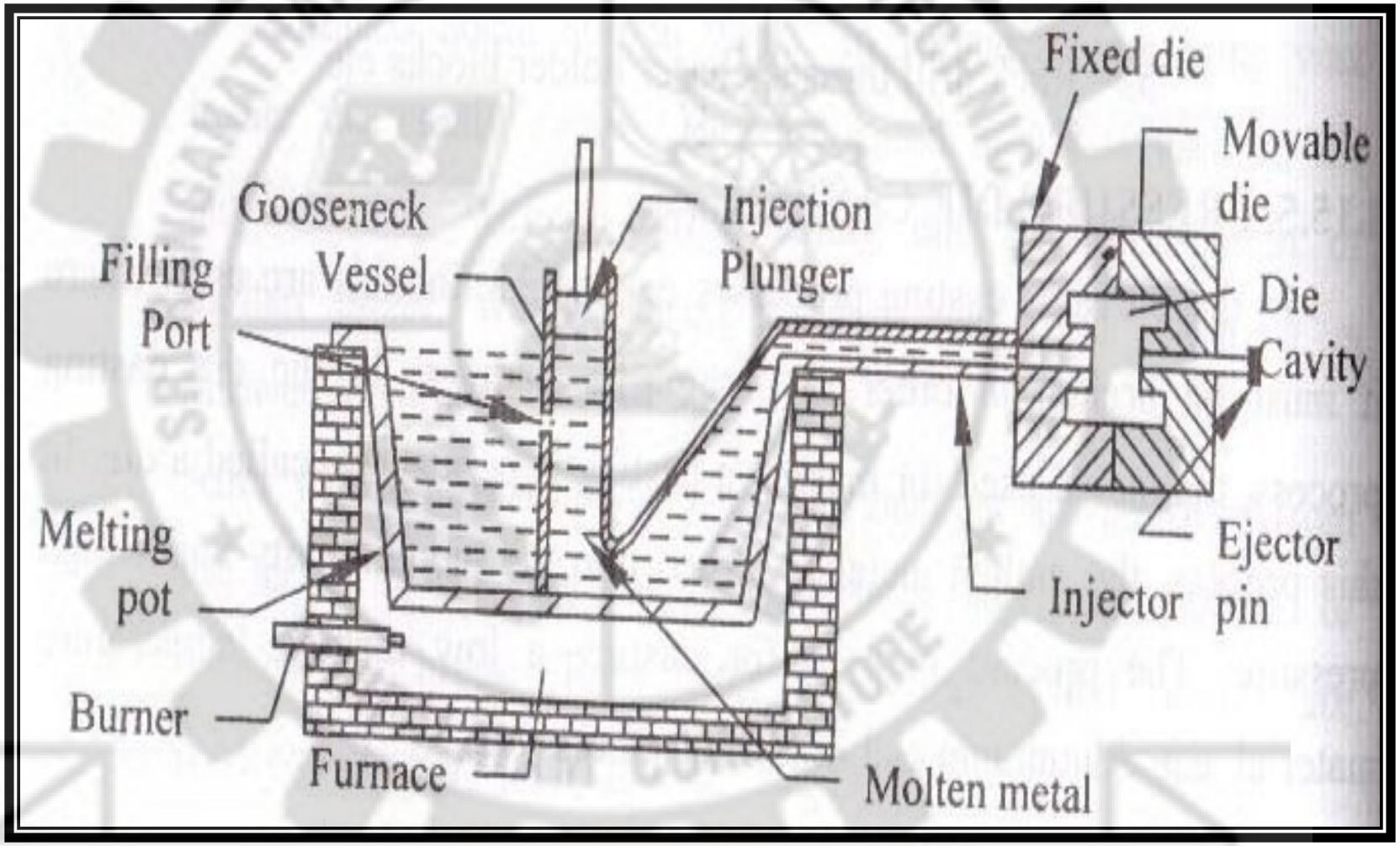



Invesment
slurry
Metal flask

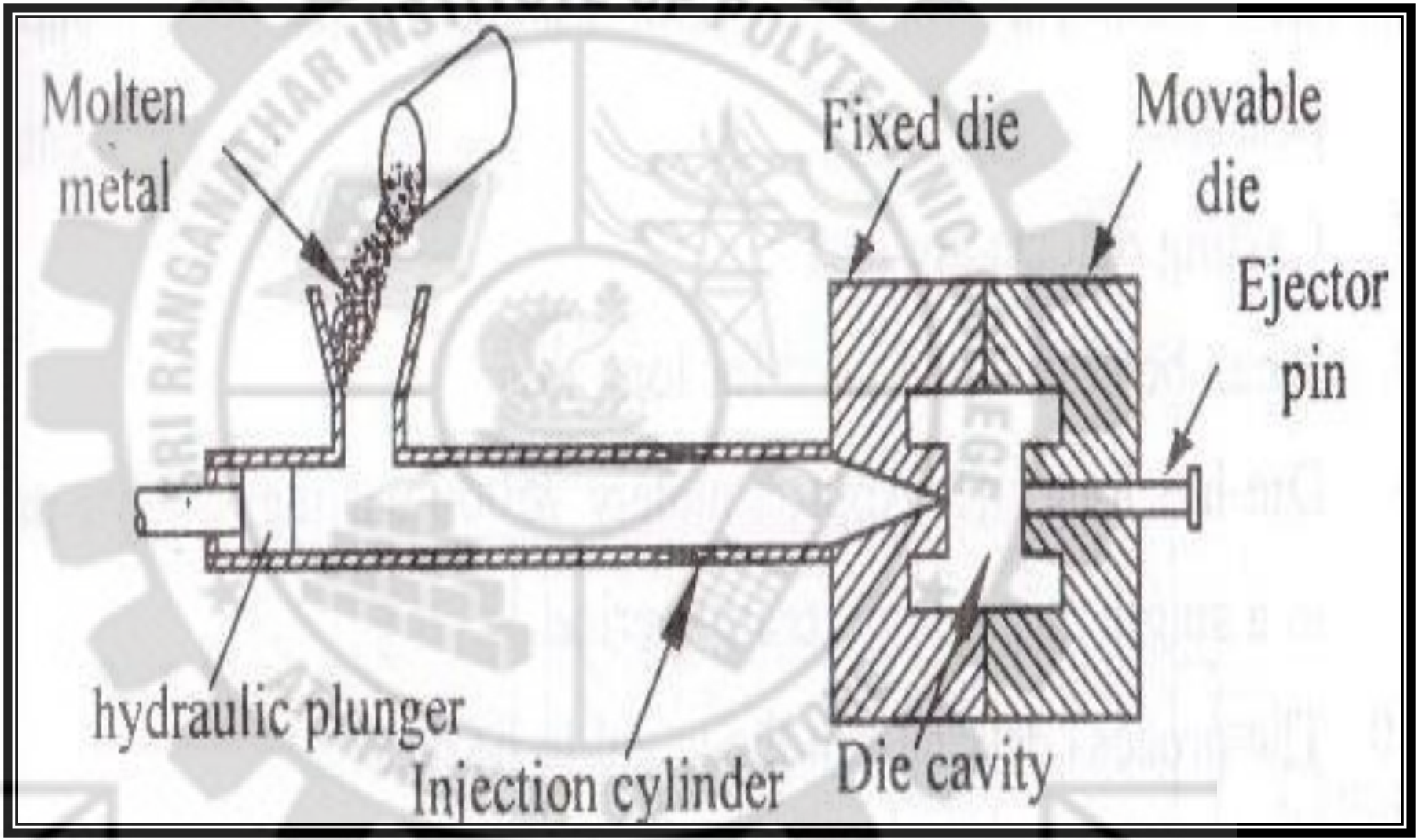

Slurry
Assembled
wax patterns
or clustor
Solid
mould type
Sprue

PRESSURE DIE CASTING

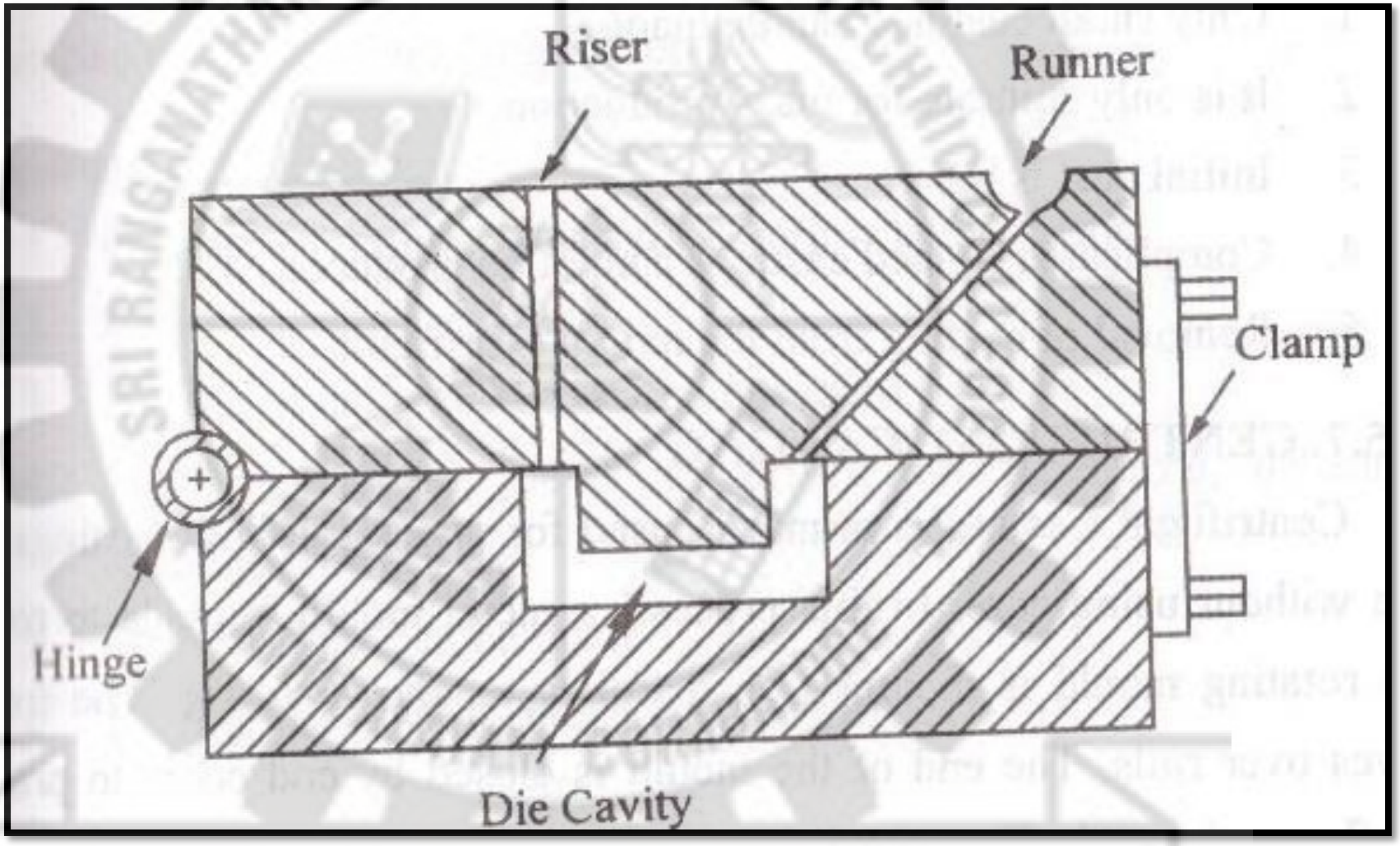
PDC - HOT CHAMBER



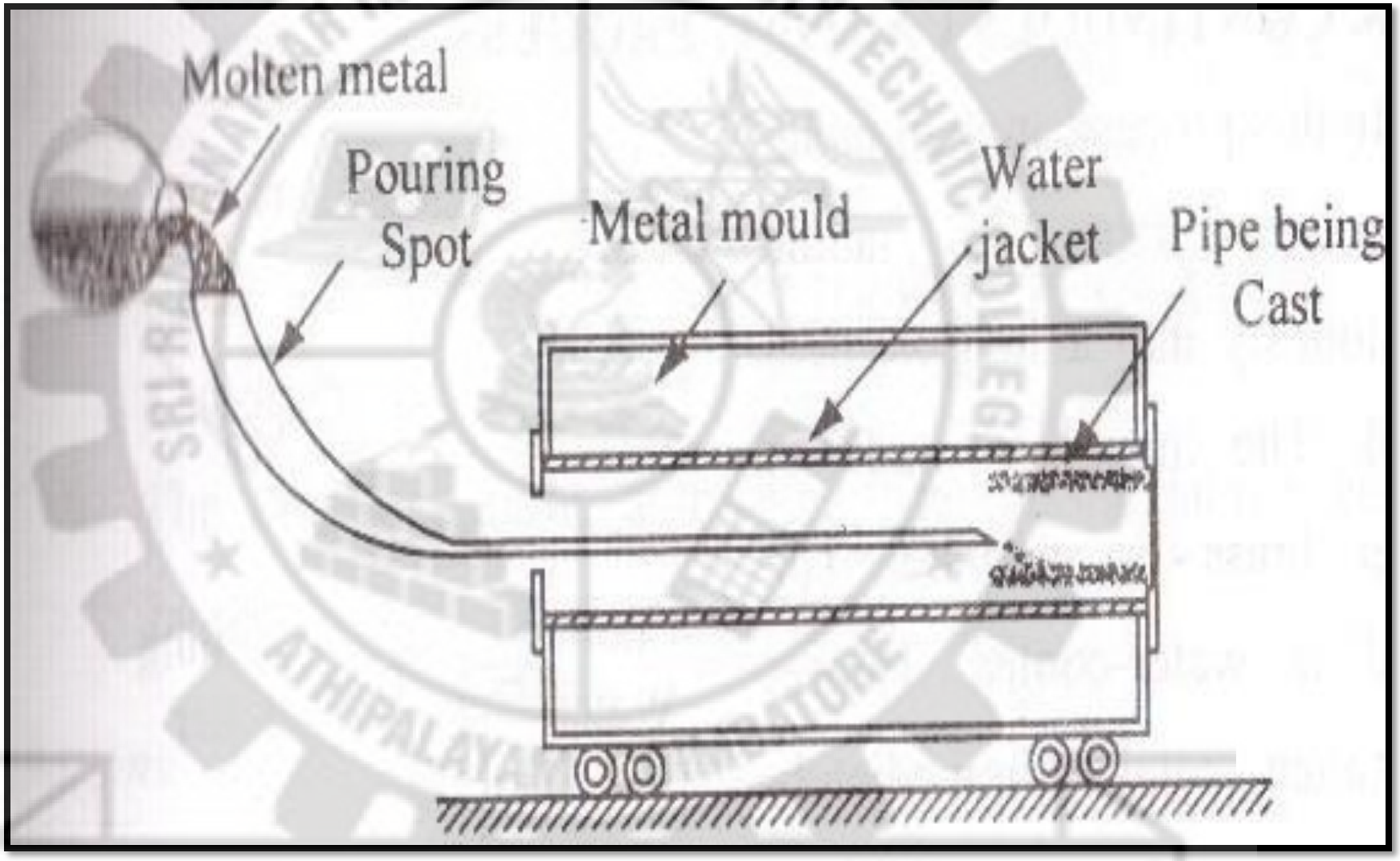
PDC - COLD CHAMBER



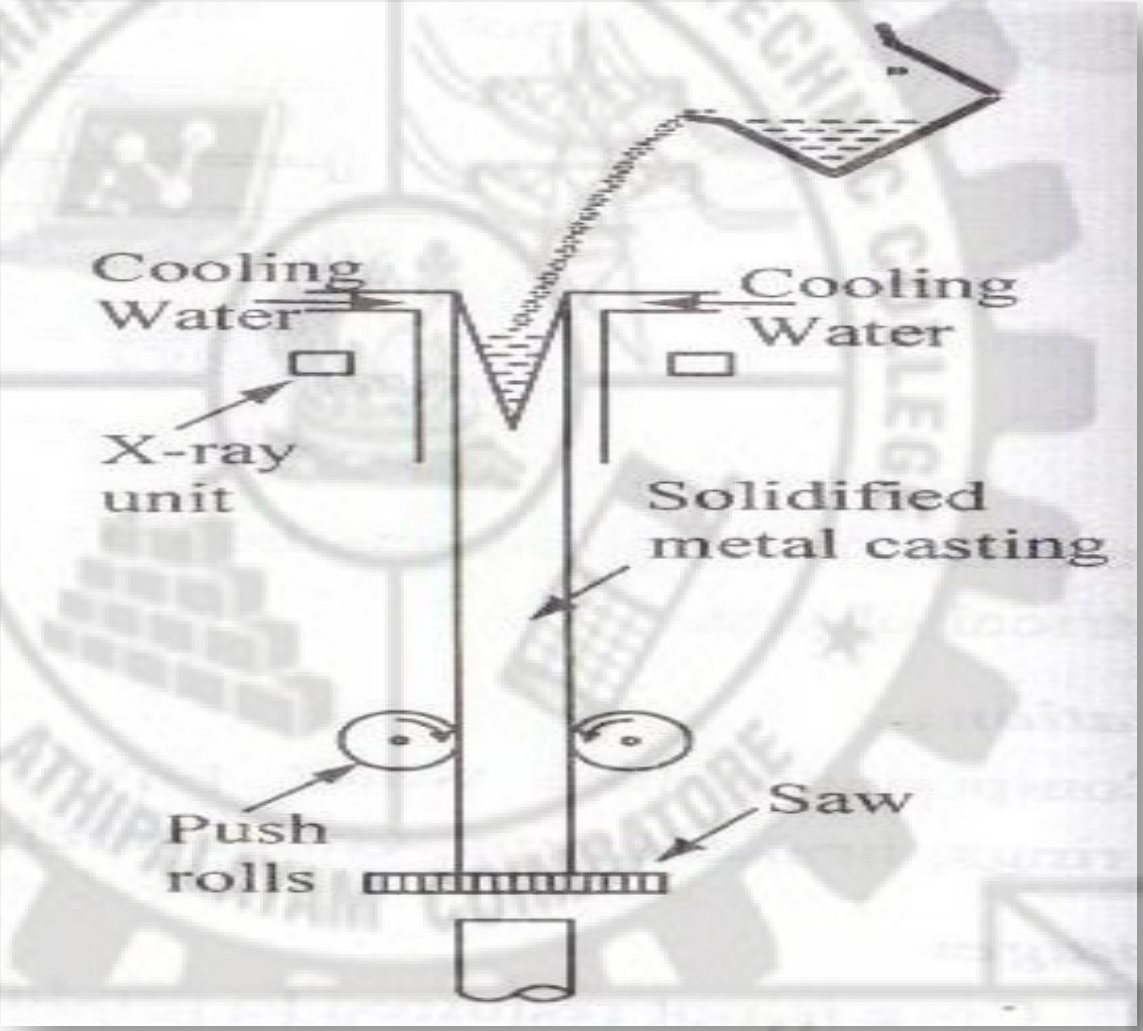
GRAVITY DIE CASTING
(Permanent mold casting)



CENTRIFUGAL CASTING



CONTINUOUS CASTING PROCESS



OTHER CASTING METHODS

- LOST WAX PROCESS
- CERAMIC MOULD CASTING

DEFECTS

1. Shrinkage
2. Blow holes
3. Scab
4. Swell
5. Hard Spots
6. Run out
7. Honey combing
8. Cracks
9. Shift
10. Cold Shut
11. Inclusions
12. Fins
13. Dress
14. Rat tail
15. Blister

INSPECTION METHODS

1. Visual Inspection
2. Pressure Test
3. Magnetic Particle Inspection
4. Dye-Penetrant Inspection
5. Radiographic Inspection
6. Ultrasonic Inspection
7. Thermography Inspection

Queries……..?

(QB) ASSIGNMENT - I

Two Marks

1. *What are the different types of patterns used in foundry?*
2. *Define: Foundry, Casting, Mould, Pattern*
3. *Generally sweep patterns are used in _____ moulding.*
4. *What do you understand by core setting?*
5. *What is a core print? Mention its purpose.*
6. *Mention the specific advantages of CO_2 process?*
7. *What are the properties of good moulding and core sand.*

7. Write the composition of good moulding sand

8. List out any five moulding tools.

9. What are chaplets?

10. List the factors to be considered in the choice of metal melting furnaces.

11. What are the types of alloys cast in cold chamber die casting machines?

12. What is the need for providing chills in casting?

13. Blow holes in castings occur due to _____

14. How casting defects are identified?

15. Give any two casting defects and its reason and remedies.

16 marks

1. What are the pattern allowances? Explain briefly each.

2. Discuss the properties of moulding sand.

3. What are the different types of furnace used in foundry? Describe in detail with neat sketches any two of them.

4. State the different types of mould. Write a short notes on 'Green sand Mould' and 'Shell moulding'.

5. Explain briefly the various moulding methods used in foundaries.

6. Describe the various types of casting process.

ASSIGNMENT – I

7. Explain various testing methods Moulding sand and Core sand.

8. Enumerate the various casting defects and suggest suitable remedies.

9. Explain various inspection methods of cast products.

5x2 = 10

3x16 = 48

58

Given Date: **07.08.2013** Last Date: **12.08.2013**