Course and Evaluation Plan

ME110 ELEMENTS OF MECHANICAL ENGINEERING (2-0-0) 2

Introduction to Mechanical Engineering, Stress and strains, Types of drives, I.C. Engines, Introduction to refrigeration, Turbines and compressors, Manufacturing Processes:Lathe operations, Drilling, casting, welding, brazing and soldering.

J.Wickert, An introduction to Mechanical Engineering, Cengage learning, 2nd edn. 2006
Gopalkrishna K.R., Mechanical Engineering Sciences. Subhas Publications, Bangalore 1999
Roy and Choudhary, Elements of Mechanical Engineering. Media Promoters and Publishers, Bombay 1975
Gupta, P.N., and Poona, M.P., Elements of Mechanical Engineering. 4th Edition, Standard Publications Ltd, 2009

Evaluation:

- Test, Quizzes, Assignments : 30%
- Mid semester exam : 20%
- End Semester Exam : 50%

Course Plan and Evaluation

1. Course Code : ME110

2. Course Title : Elements of Mechanical Engineering

3. L.T.P : 2 -0-0

4. Credits : 2

5. Prerequisite : Nil

6. Teaching department : Mechanical Engineering Department

Course Contents

Module – 1: Mechanics

Introduction to Mechanical Engineering, Emerging Trends and Its role,

Mechanics: Statics and dynamics, Moments, Stress-strain diagram, tension, compression, bending. **03**

Module – 2: Mechanical drives

Introduction to different drives, Belt drive, Chain drive, Gear drive, Gear trains. **03**

Module – 3: Prime movers and compressors **6 (3+2+1)**

Sources of Energy, power generation systems.

Heat Engines – Classifications, I.C engines – Components – Terminology, working of Two & Four stroke: diesel and petrol engine with PV diagram, Comparison between petrol & diesel; two & four stroke engines,

Turbines: Introduction to turbines, Types of turbines, steam turbines, classification, working, Compounding of steam turbines, Gas Turbines, Jet Propulsion, Jet Engines, Water Turbines.

Compressors: types, working principle, Calculation of work requirement for reciprocating compressor.

Module 4:Refrigeration: **04**

Introduction to Refrigeration, Terminology, Working principle – refrigeration cycles, Vapour compression and vapour absorption systems, COP, Properties of Refrigerant.

Module – 5: Manufacturing **10**

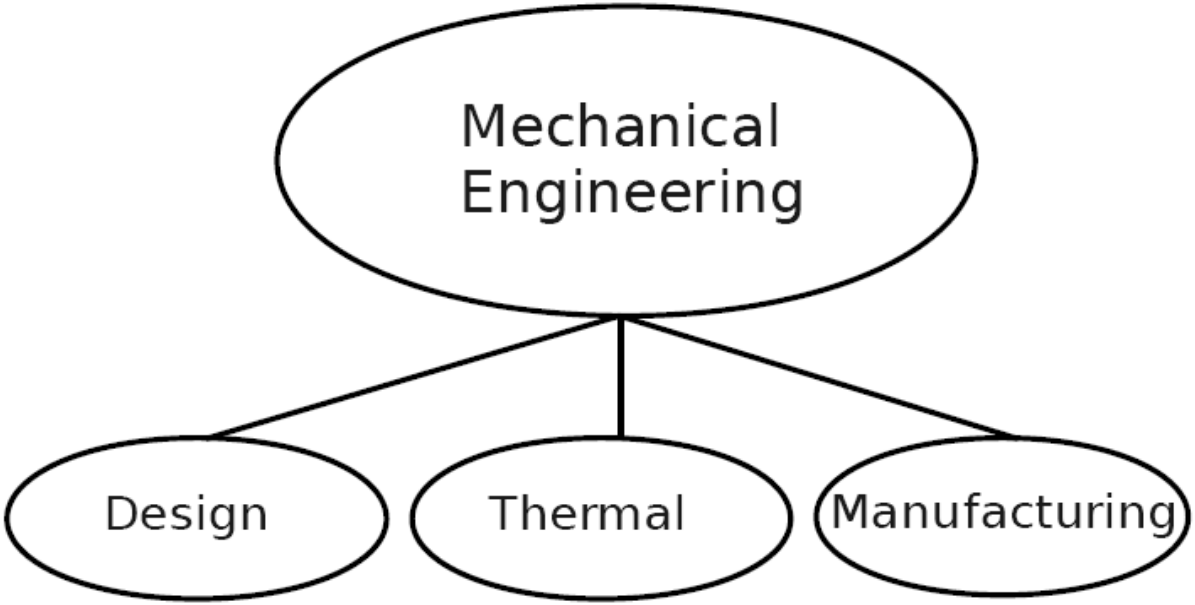
Casting- Types and Methods, Steps in making sand castings, Cope and drag, Gating system, Patterns, Core making, Casting defects, Advantages and disadvantages of casting, Introduction to machine tool; Lathe: Functions of different parts, Operations: Turning, Taper turning (compound rest), boring, thread cutting, knurling, facing, drilling; Drilling machine and operations; Welding, Brazing, Soldering,

Reference books:

1. Elements of Mechanical Engineering – K. R. Gopalkrishna
2. An introduction to Mechanical Engineering – J. Wickert
3. Elements of Mechanical Engineering – Roy and Choudhary
4. Elements of Mechanical Engineering – A A Kale and Karad
5. Elements of Mechanical Engineering – V.K. Manglik
6. Basic and applied thermodynamics- PK Nag

Evaluation:

- Test, Quizzes, Assignments – 30%,
- Mid semester exam – 20%,
- End Semester Exam – 50%



- Hero developed the world's steam engine in (10 - 70 AD).
- Evolved as a separate branch in 19th century
- Development of steam engine was critical to the birth of Mechanical Engineering

Examples

Examples

Introduction to Manufacturing

- Observe the objects around you:
  - *How did they become what they are?*

- What important role does manufacturing play in society?

- How do we define manufacturing?
  - Manufacturing is the ability to make goods and services to satisfy societal needs

What is Manufacturing?

- The word manufacture is derived from two Latin words *manus* (hand) and *factus* (make); the combination means "made by hand".

- "Made by hand" accurately described the fabrication methods that were used when the English word "manufacture" was first coined around 1567 A.D.

- Most modern manufacturing operations are accomplished by mechanized and automated equipment that is supervised by human workers.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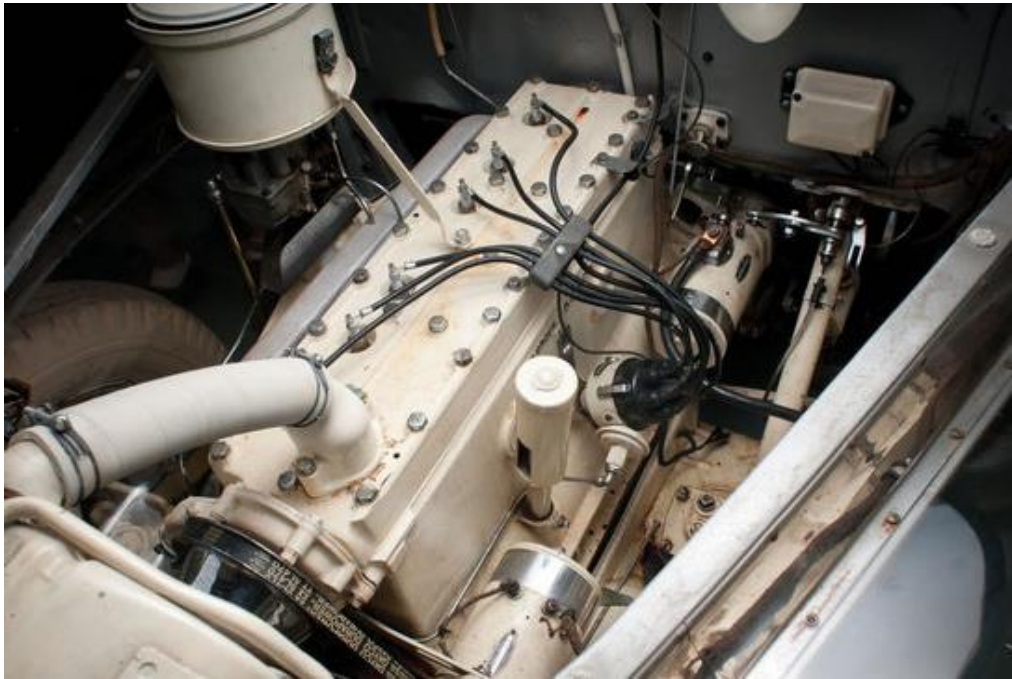
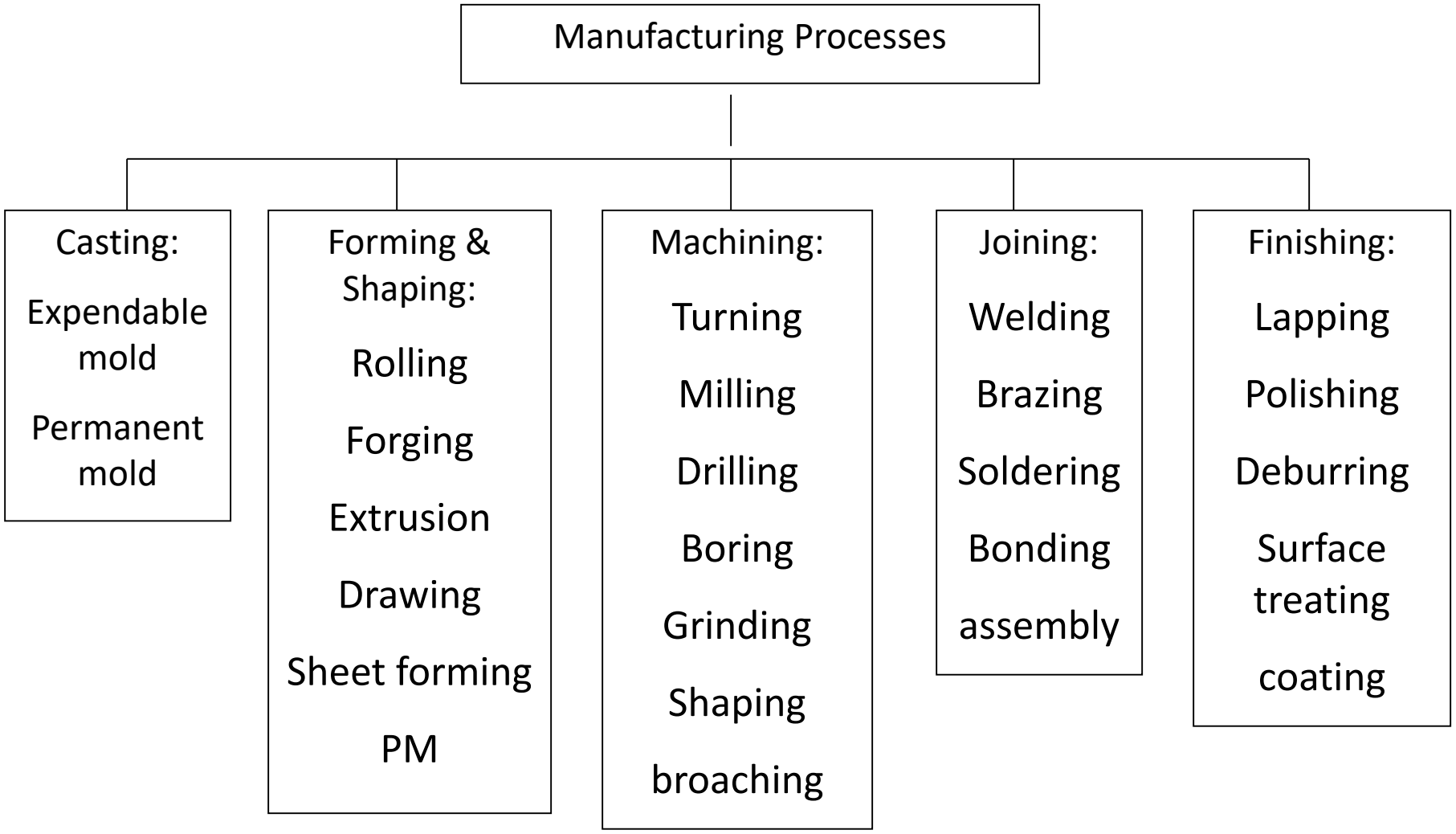
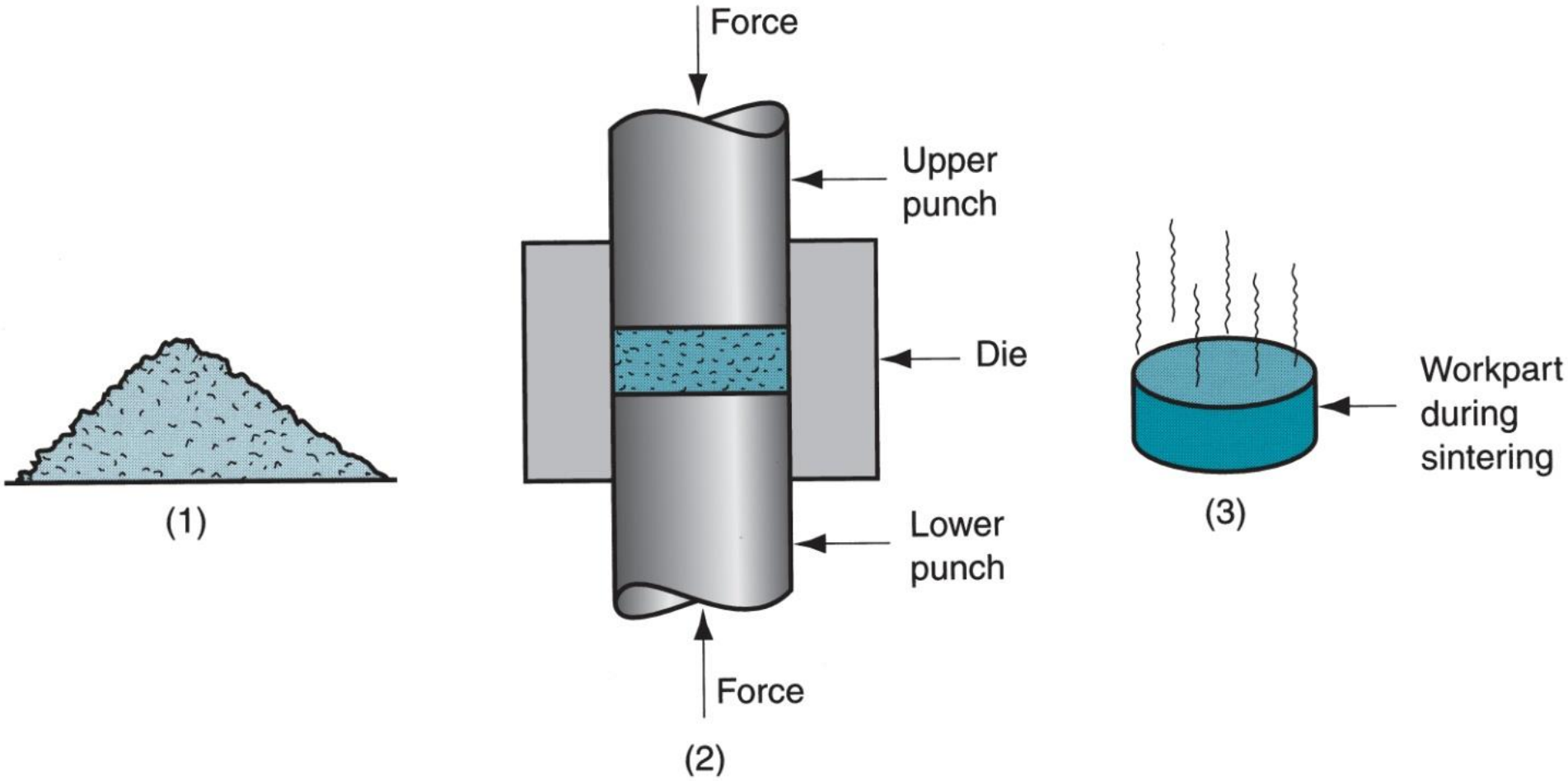


Manufacturing Processes



Particulate Processing

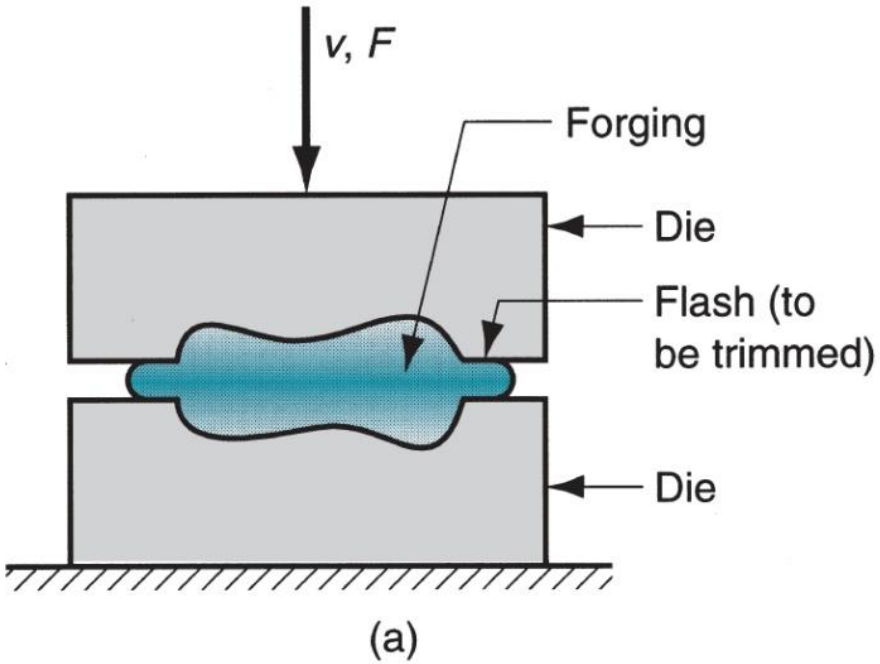
- (1) Starting materials are metal or ceramic powders, which are (2) pressed and (3) sintered

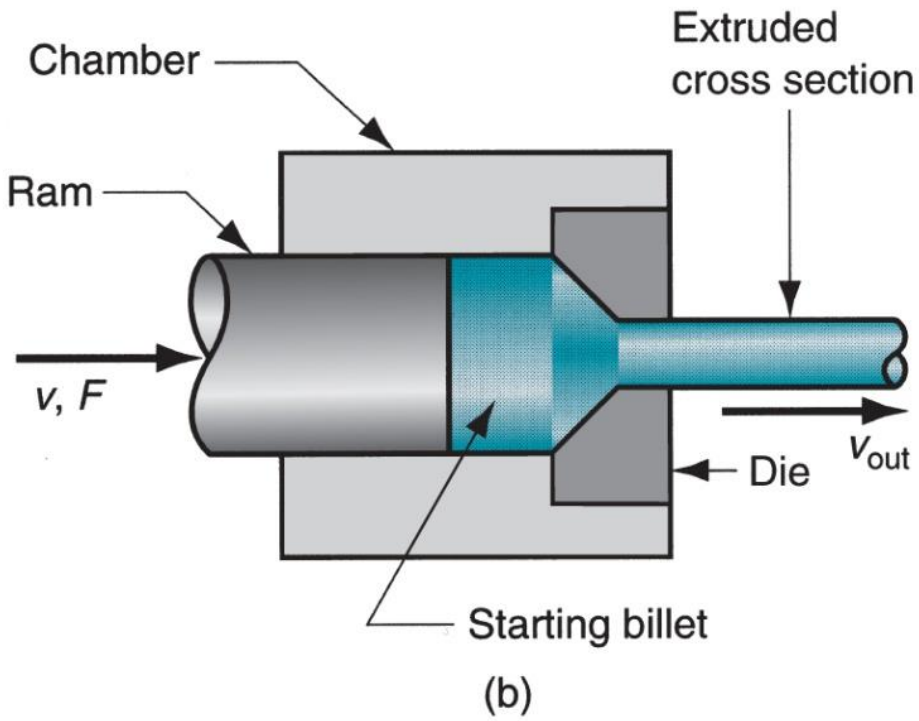


Deformation Processes

- Starting work part is shaped by application of forces that exceed the yield strength of the material.

- Examples: (a) forging and (b) extrusion

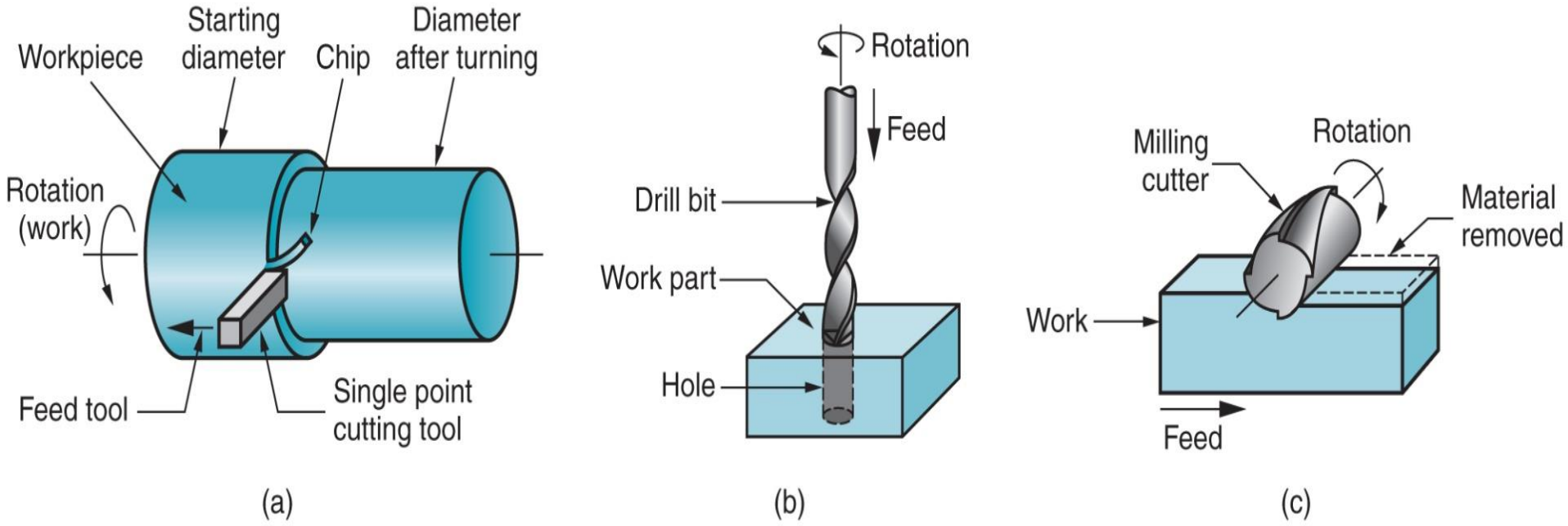




Material Removal Processes

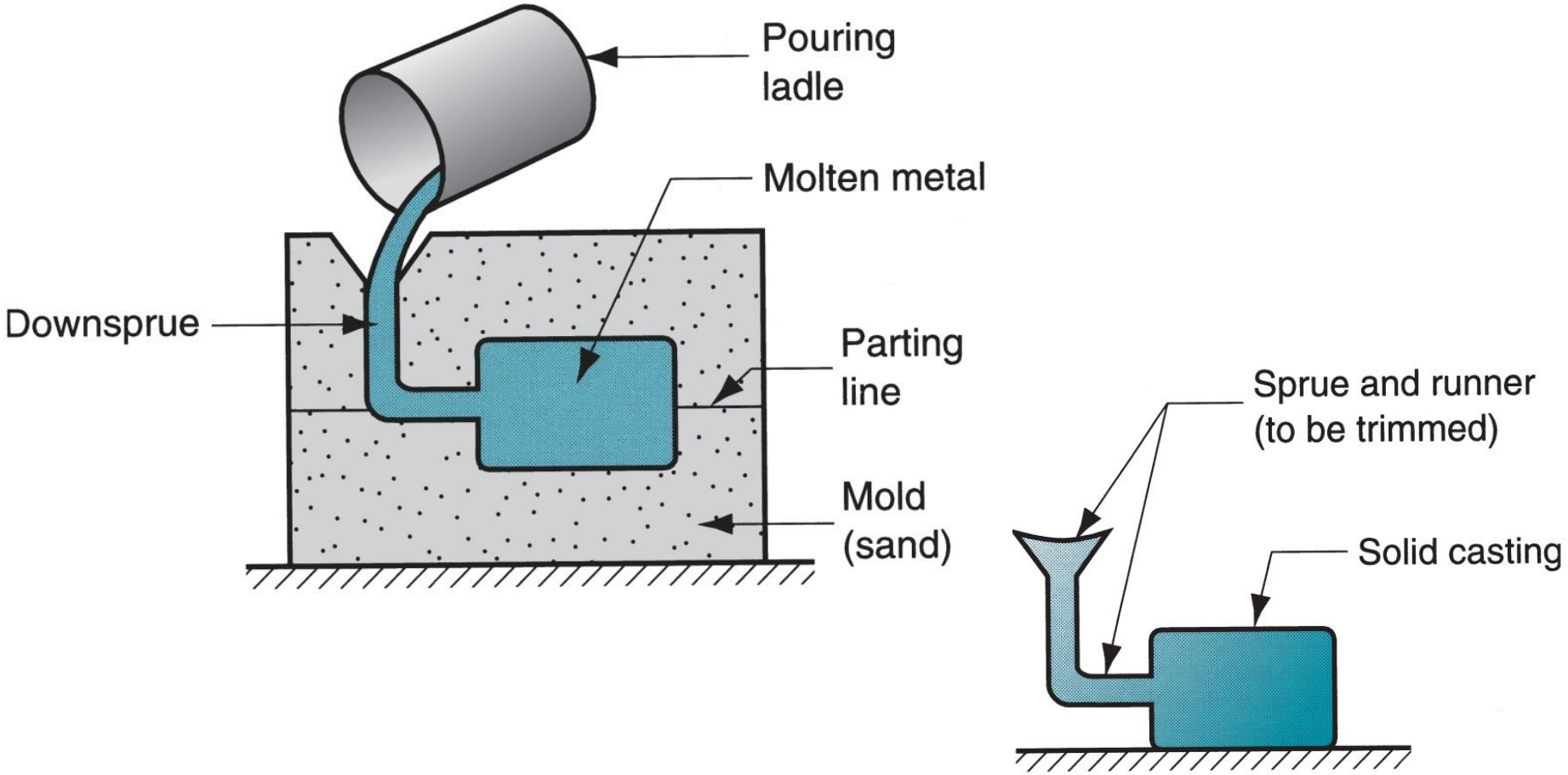
- Excess material removed from the starting piece so what remains is the desired geometry.

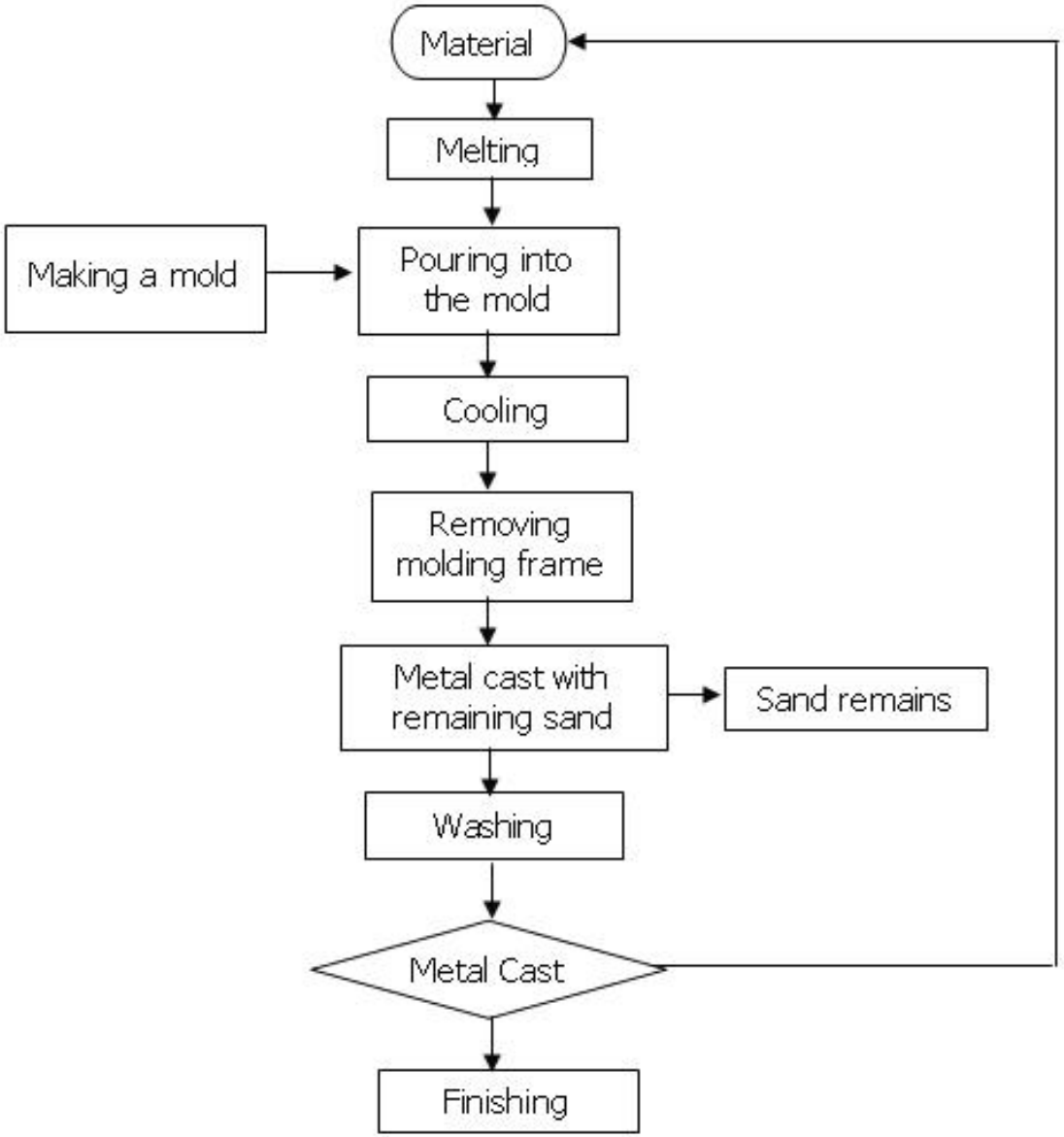
- Examples: (a) turning, (b) drilling, and (c) milling.



Solidification Processes

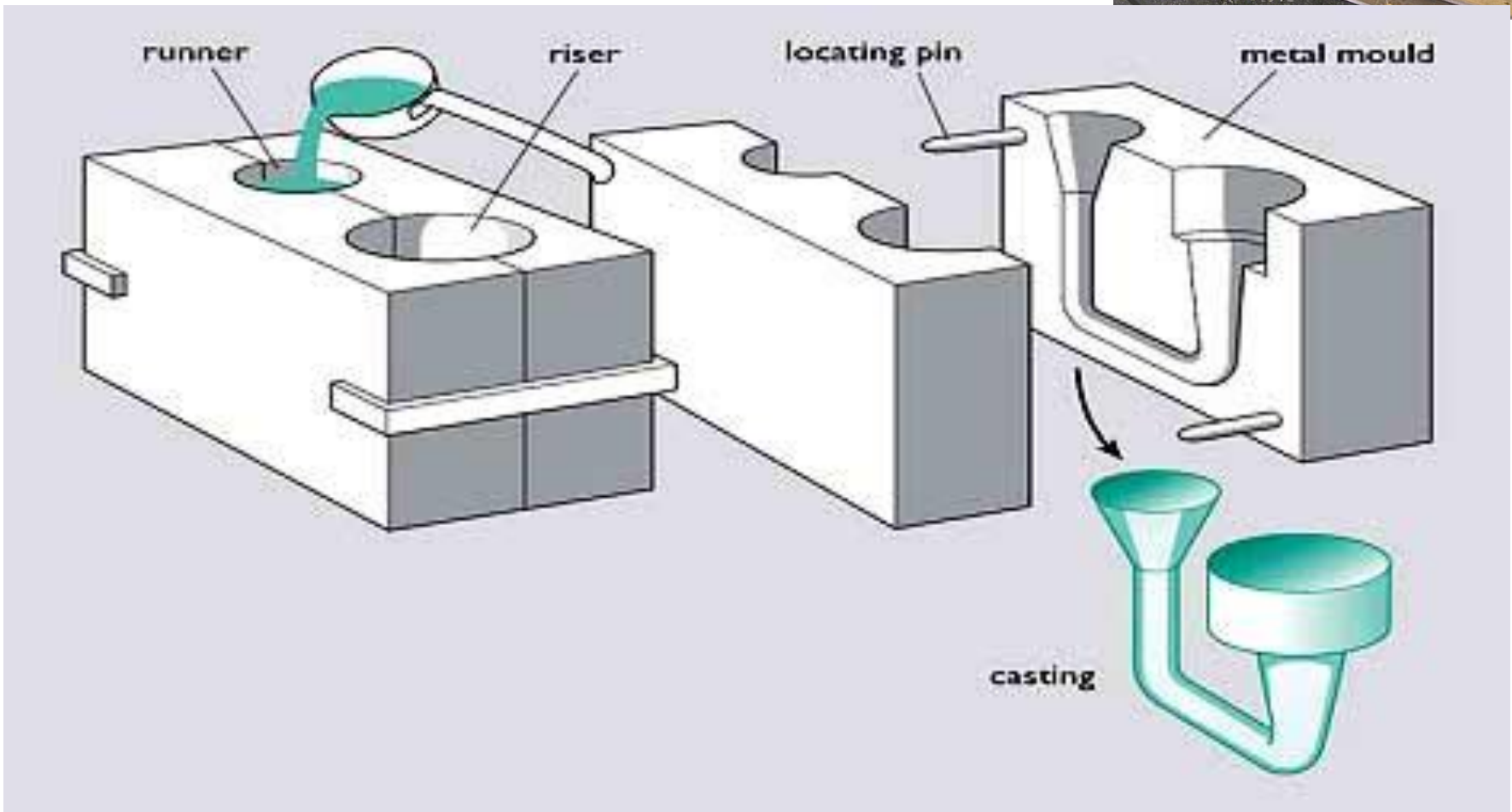
- Starting material is heated sufficiently to transform it into a liquid or highly plastic state.
- Casting process at left and casting product at right.



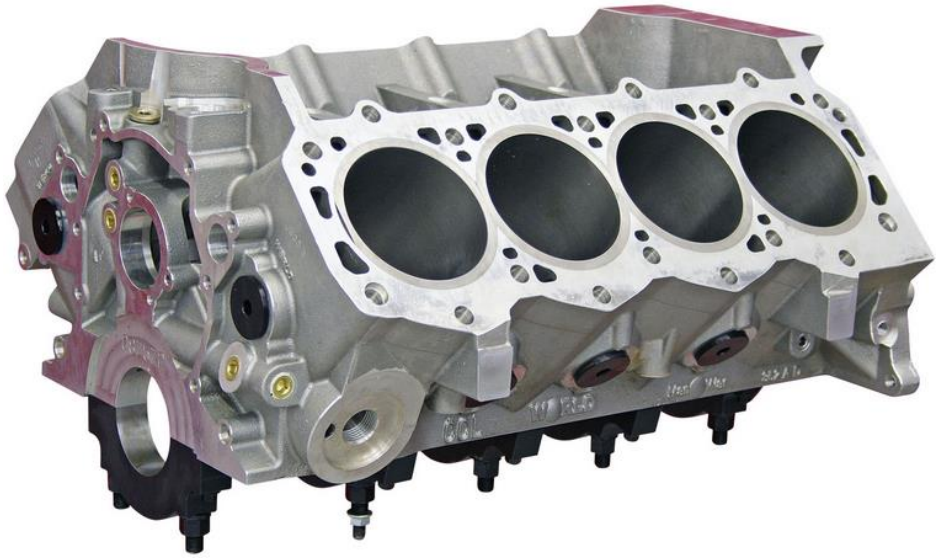

Material
Melting
Making a mold
Pouring into the mold
Cooling
Removing molding frame
Metal cast with remaining sand
Sand remains
Washing
Metal Cast
Finishing

Manufacture process

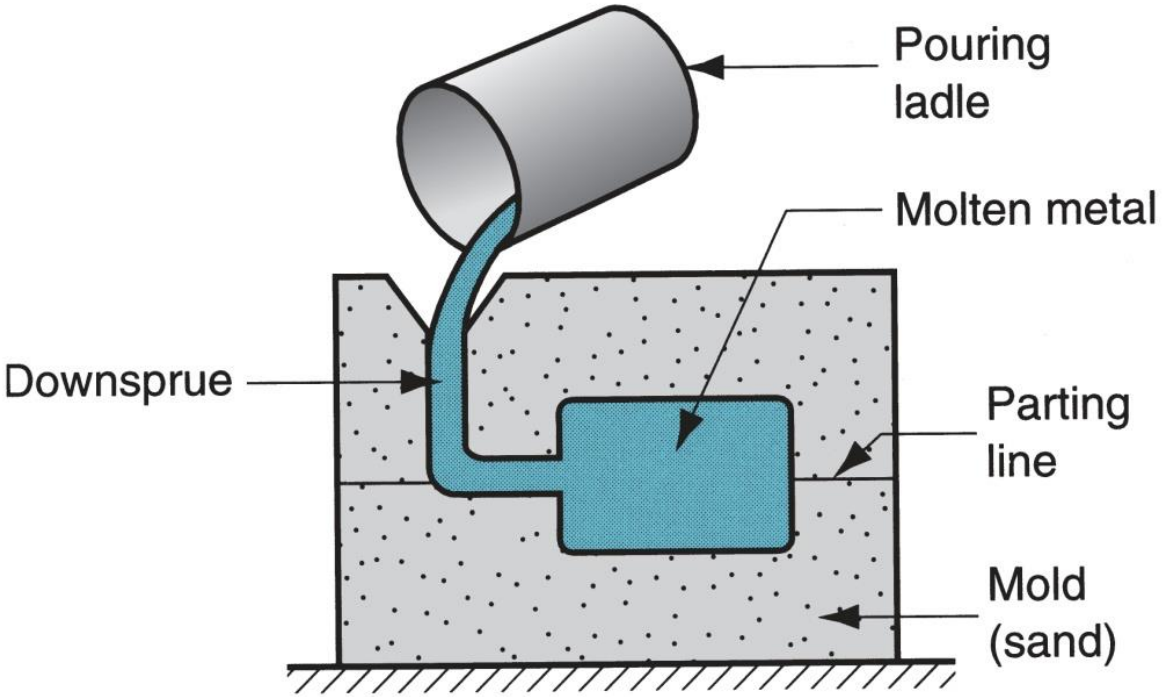
Mazak, an alloy of zinc and aluminium, is first melted in a crucible furnace. Molten metal is then poured by ladle into a open steel mould where it is allowed to cool and solidify. The mould is then turned upside down and tapped with a hammer to release the finished casting.

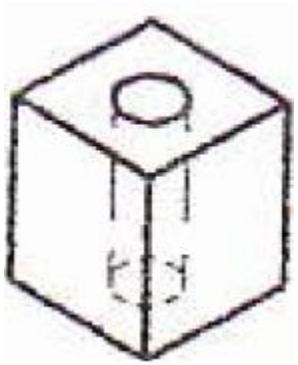


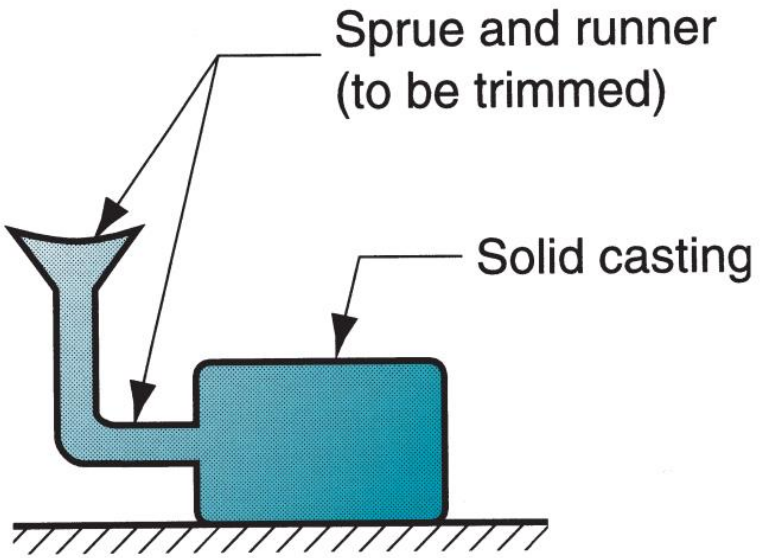
Products by Casting



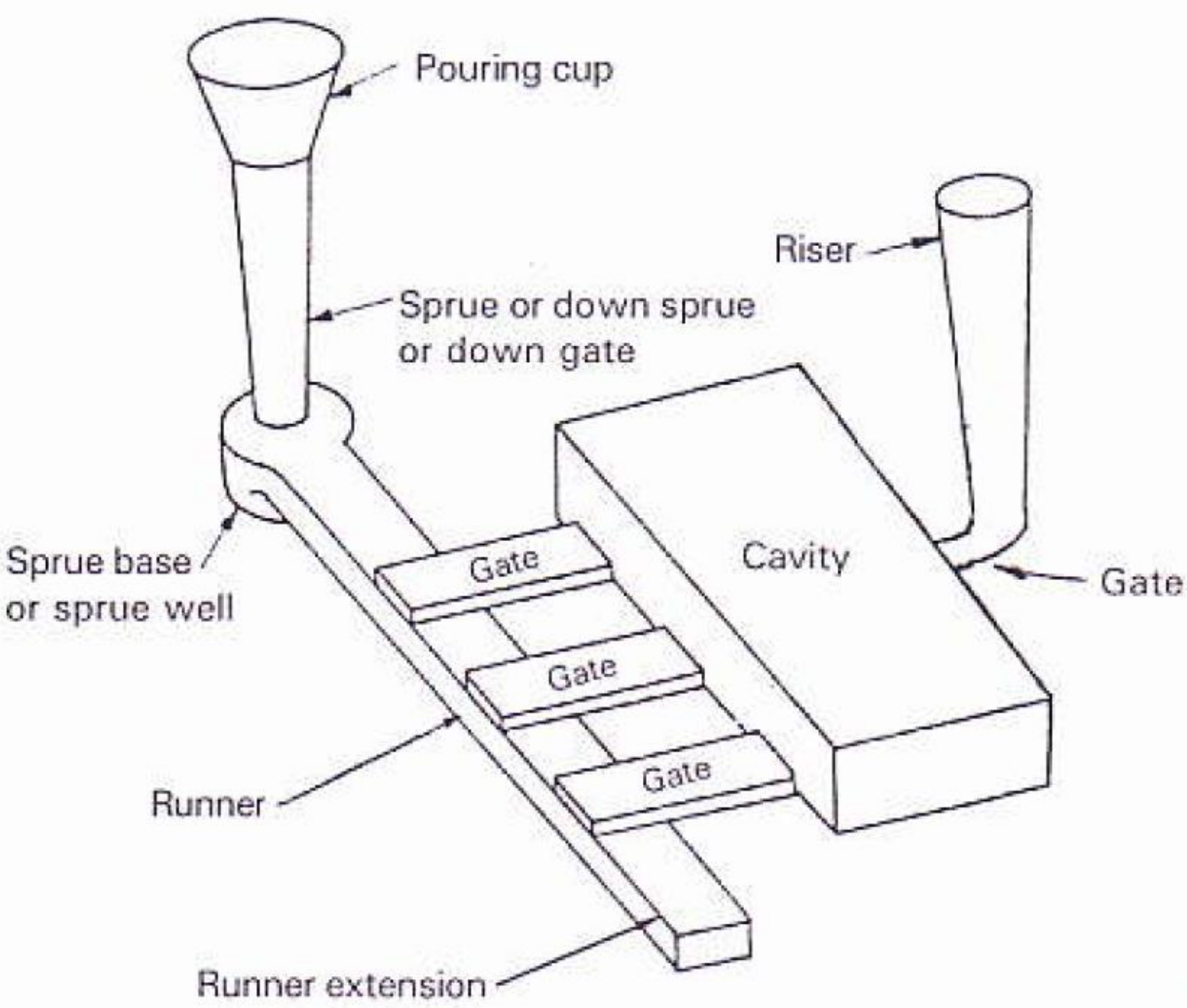
Casting


Pouring ladle
Molten metal
Downsprue
Parting line
Mold (sand)




Sprue and runner (to be trimmed)
Solid casting

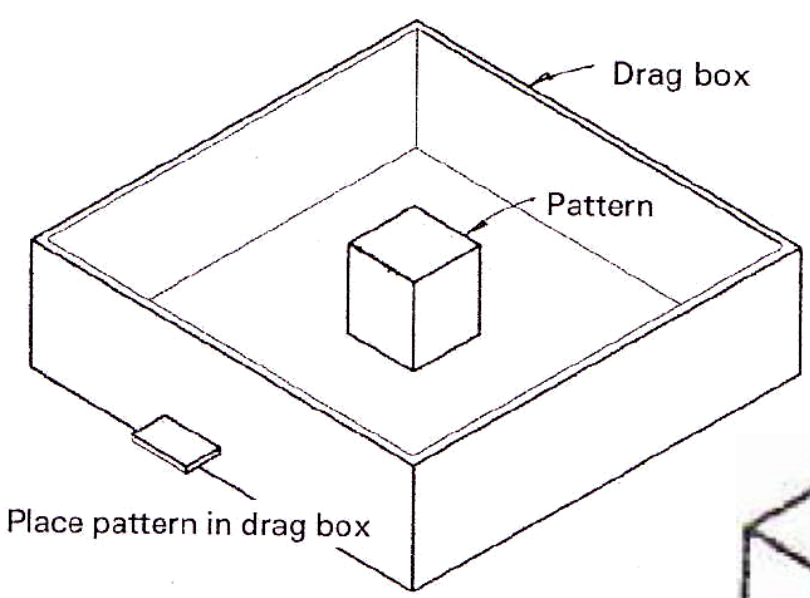
Gating and Risering

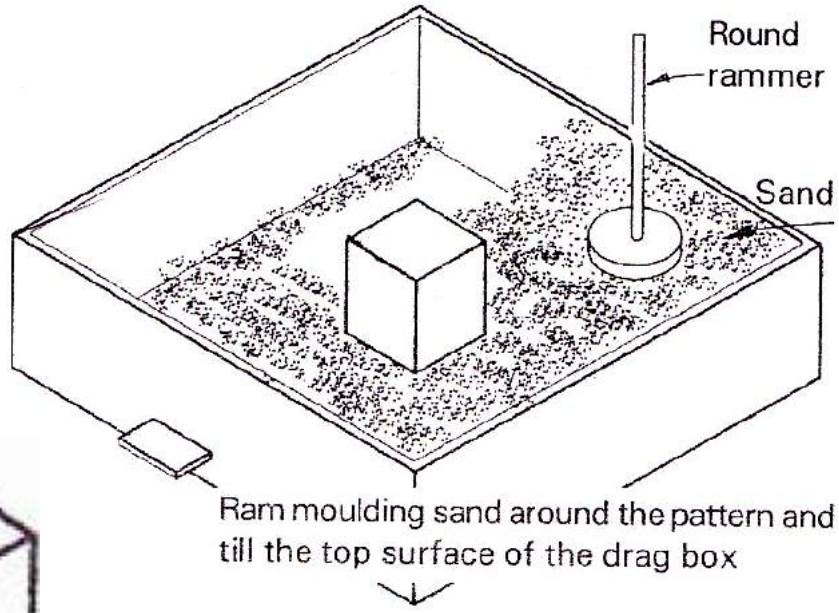


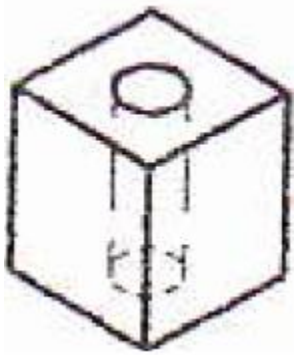
Steps in Casting

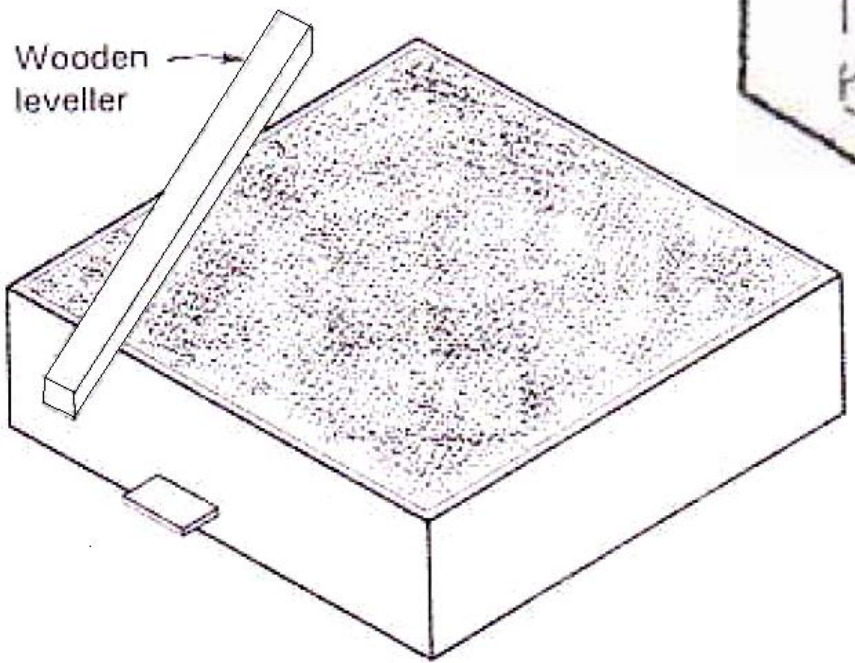
1. Pattern Making
2. Mold preparation
3. Core making
4. Melting and Pouring
5. Cleaning and Inspection

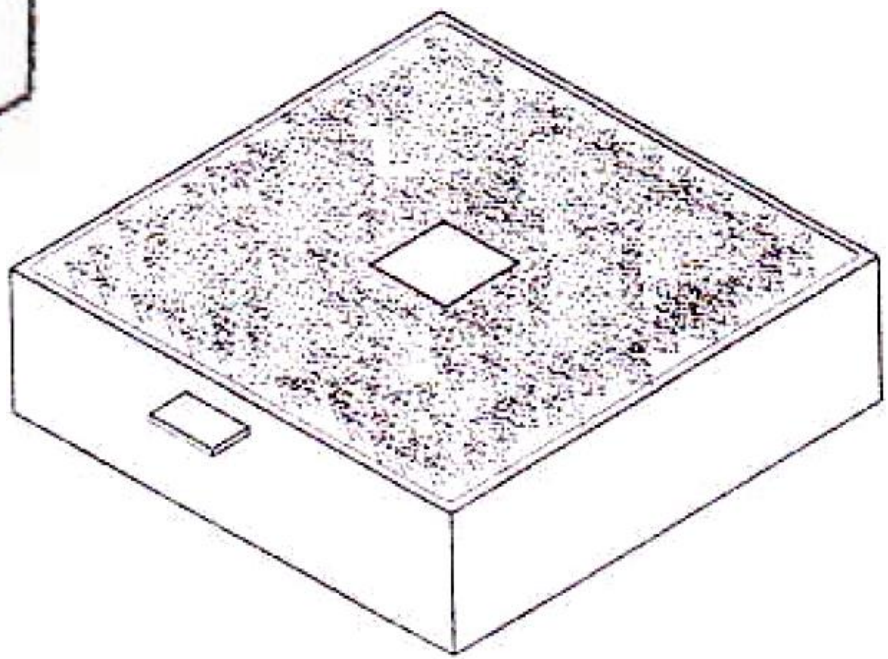
Procedure for Making a Casting



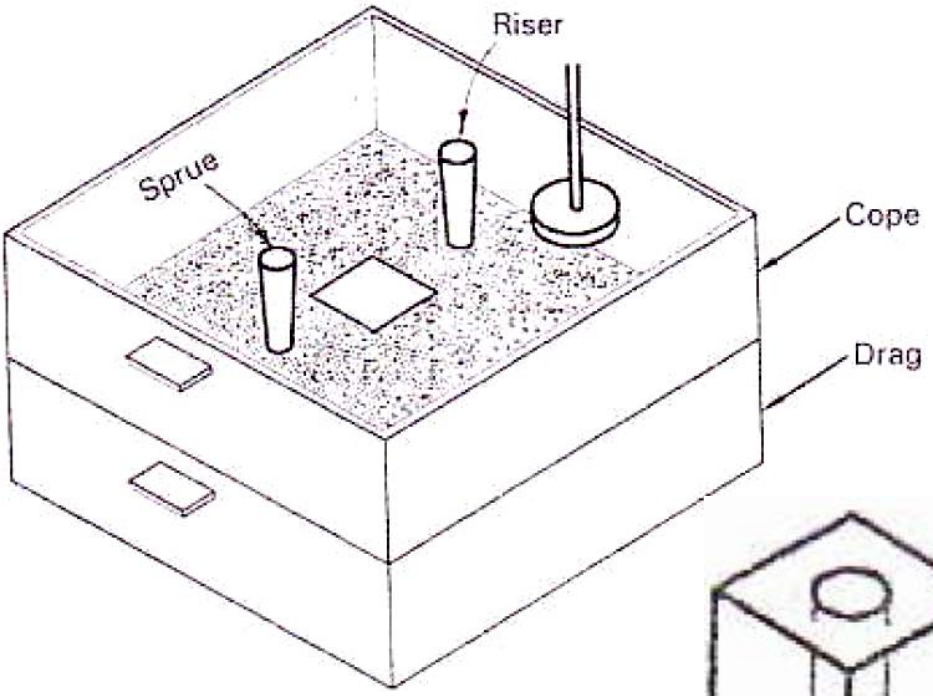


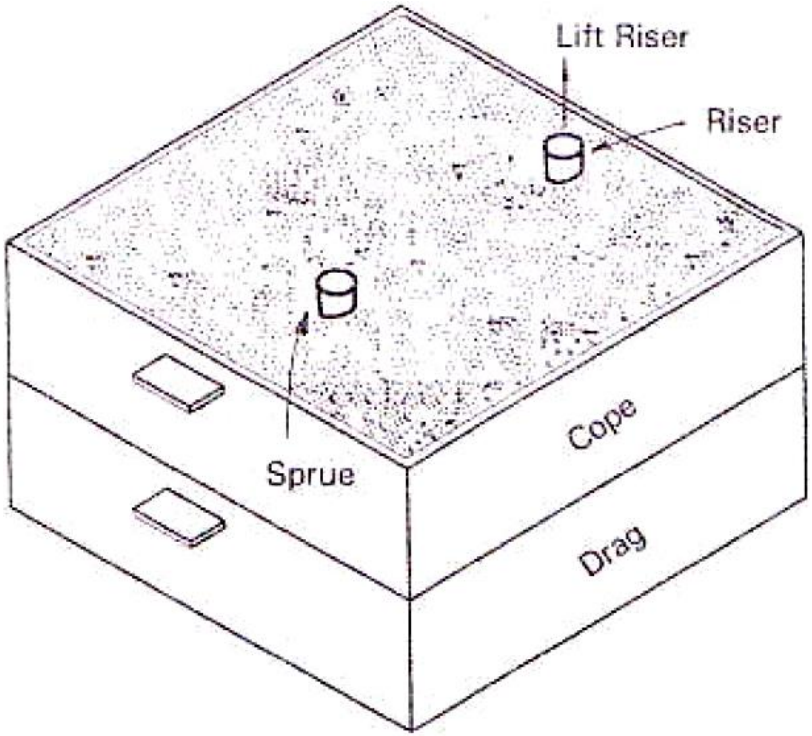


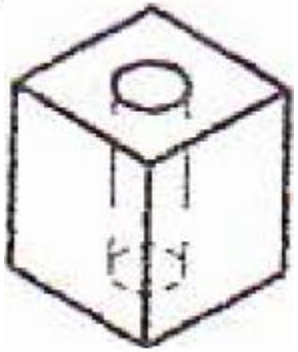


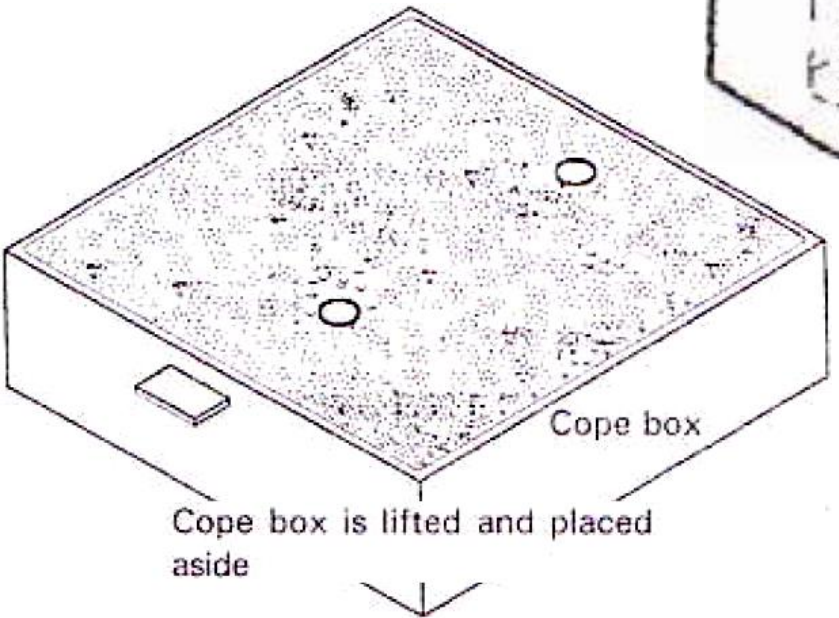


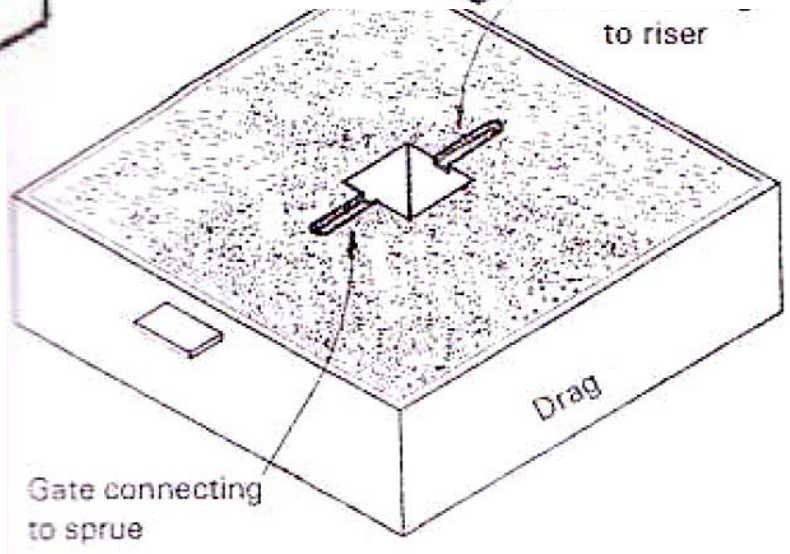
Procedure for Making a Casting



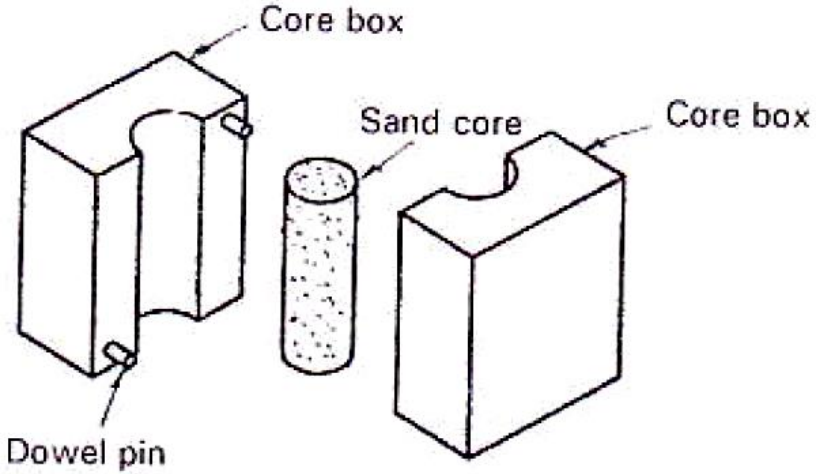


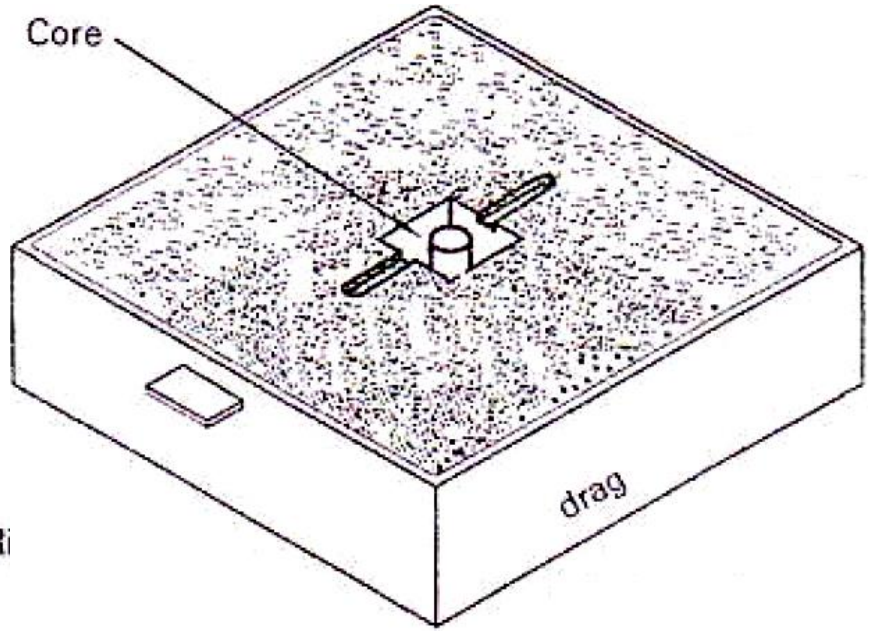


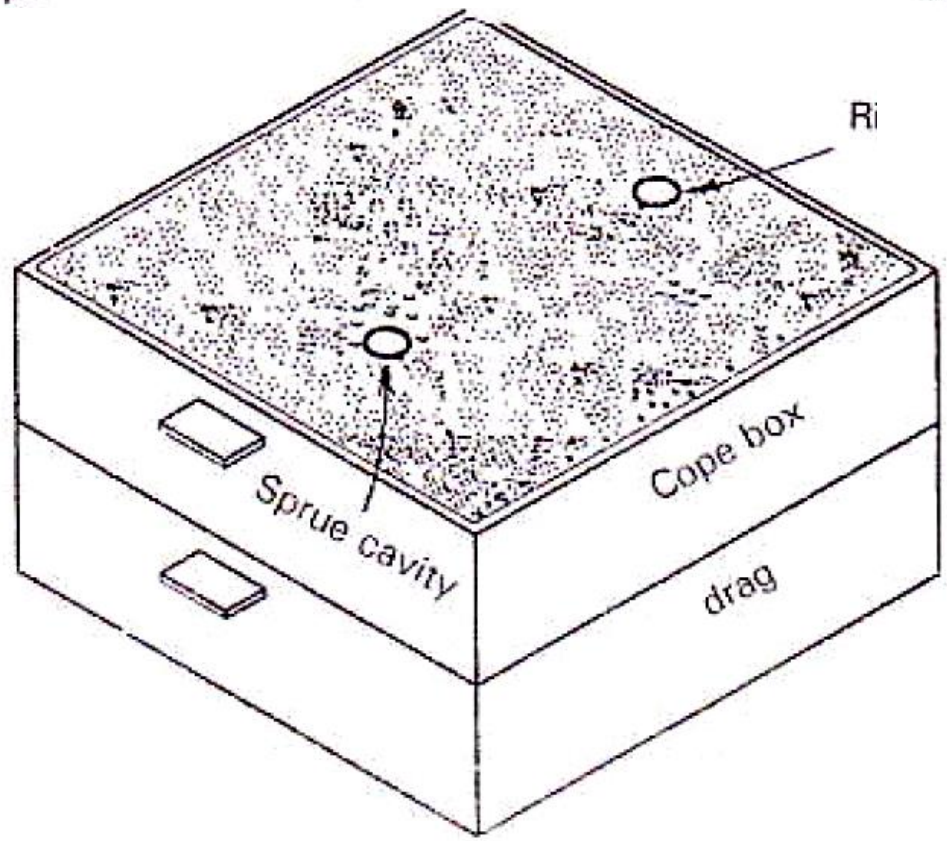


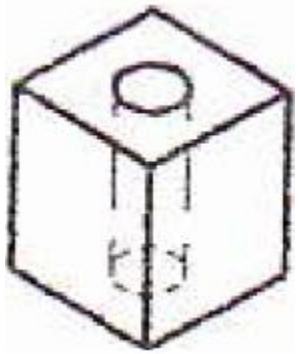


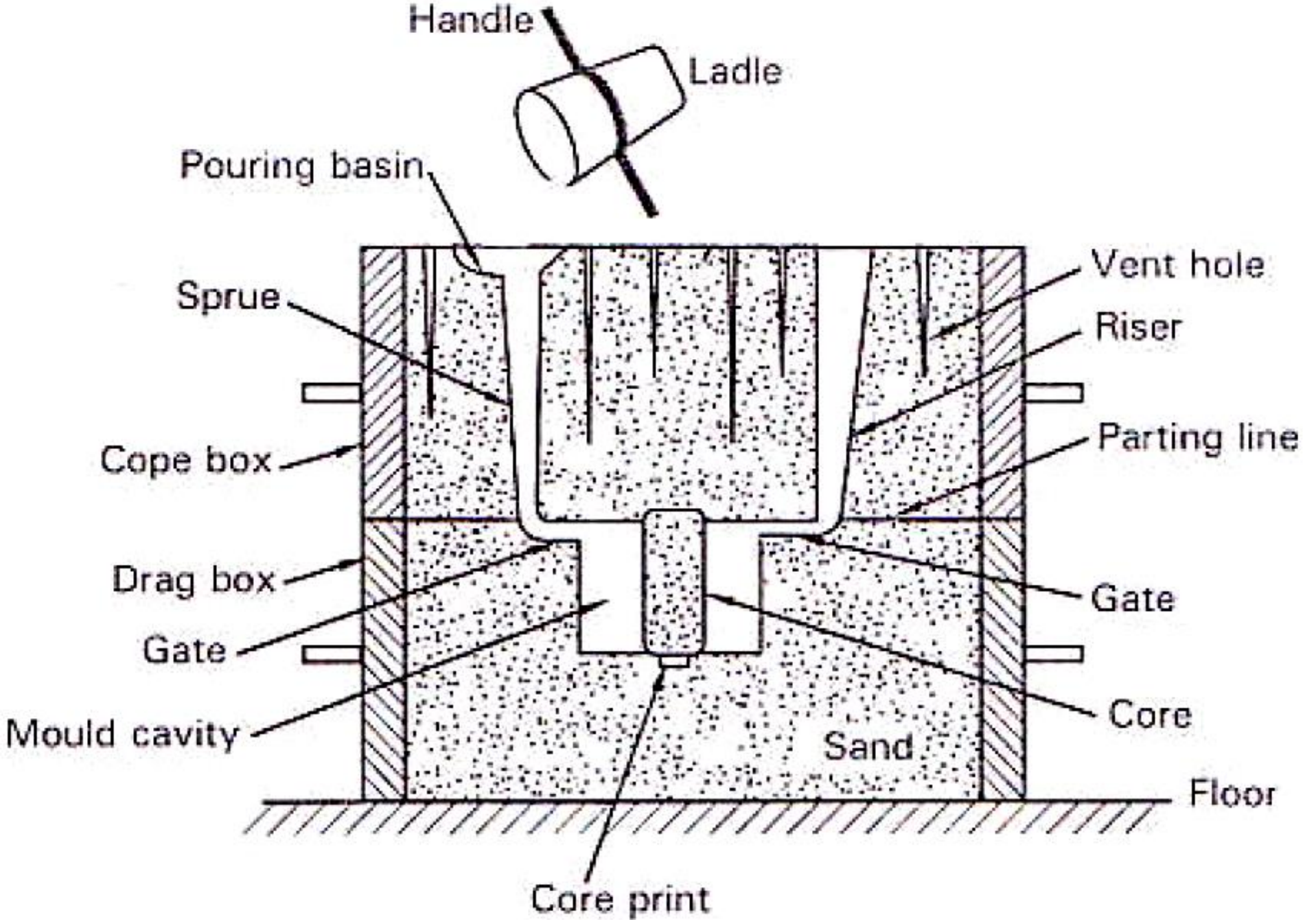
Procedure for Making a Casting



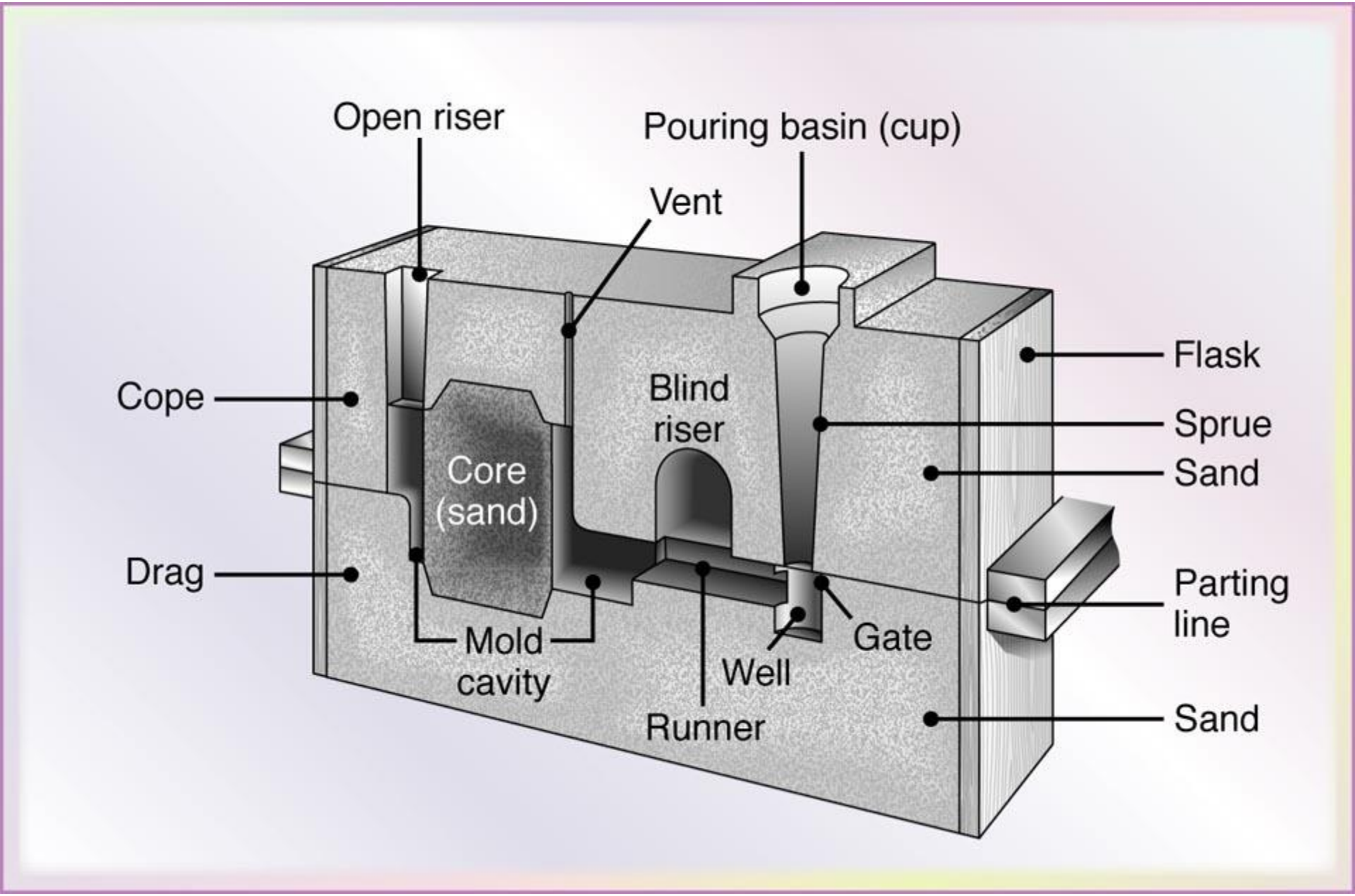







Handle
Ladle
Pouring basin
Sprue
Vent hole
Riser
Cope box
Parting line
Drag box
Gate
Gate
Mould cavity
Core
Sand
Floor
Core print

Sand Mold

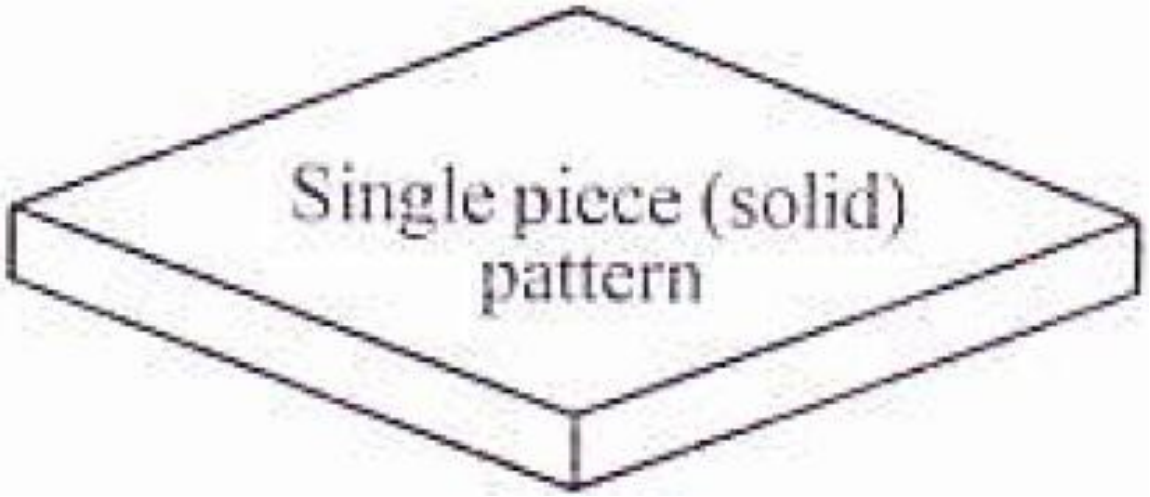


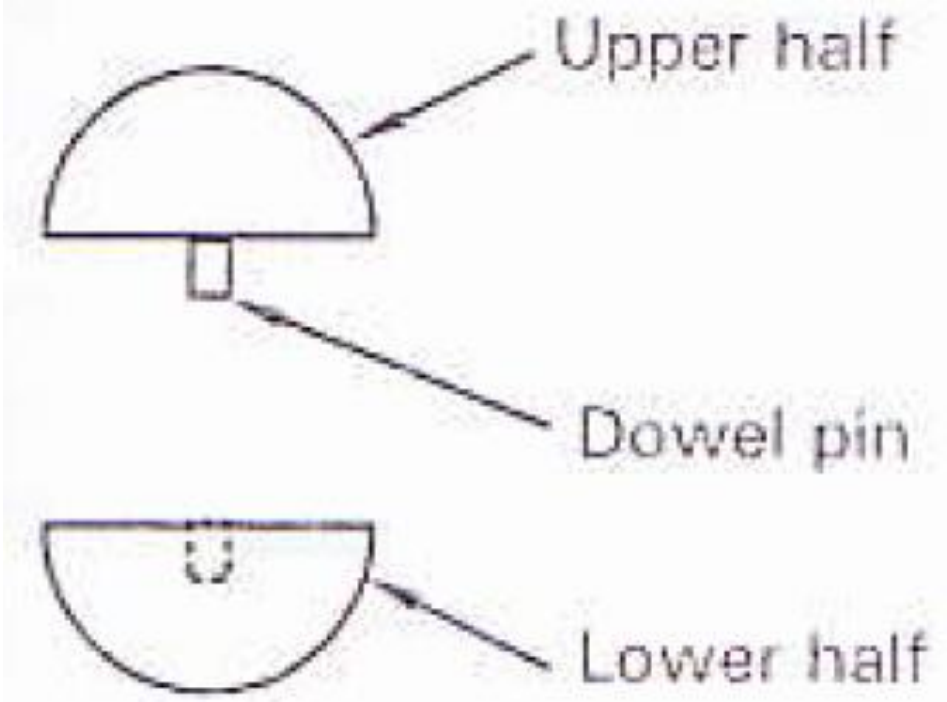
Schematic illustration of a sand mold, showing various features.

Materials Used for Pattern

1. Wood
2. Metal
3. Plastics
4. Plaster
5. Wax

Types of Patterns





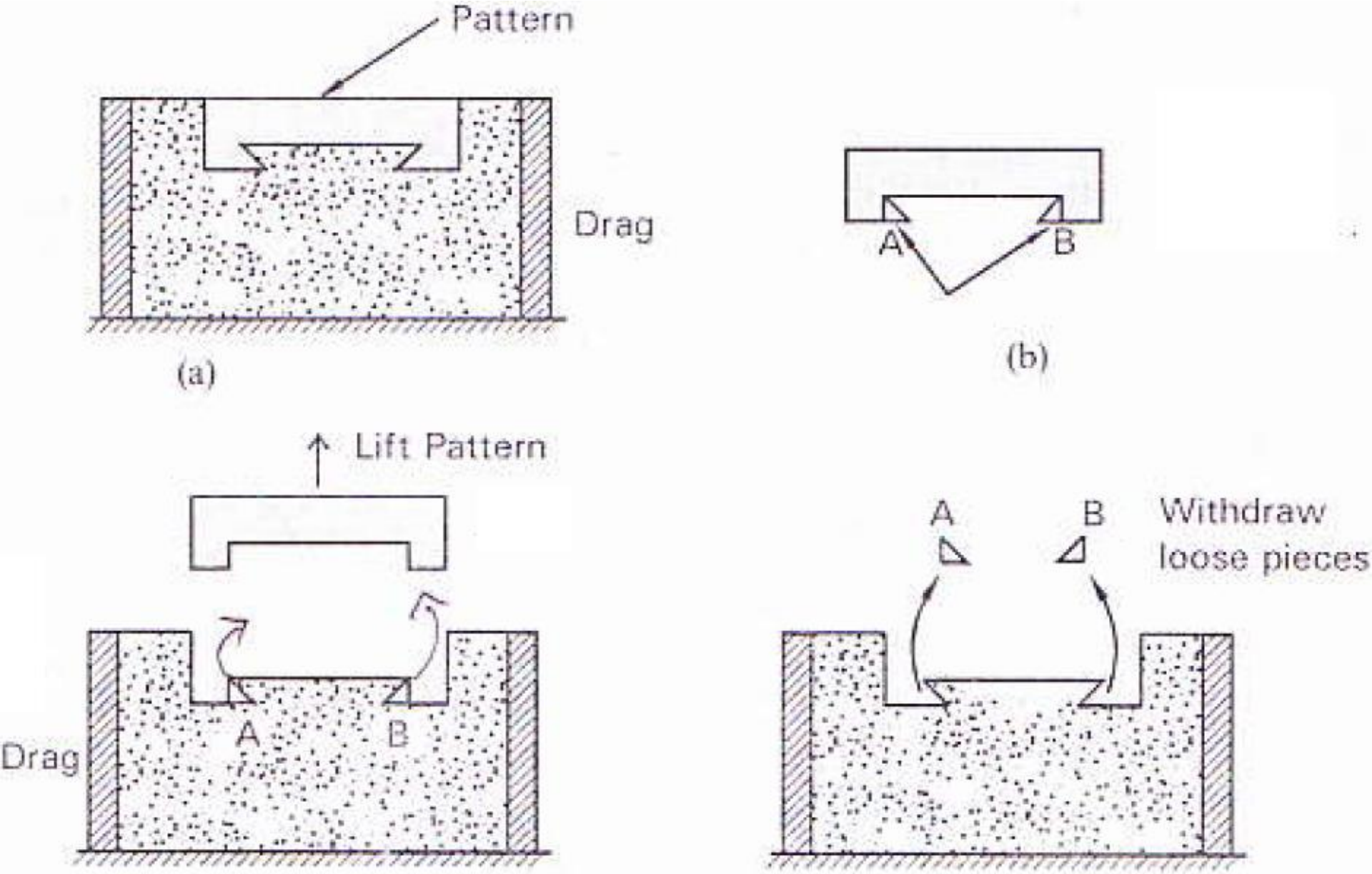


Figure 1.8 Loose piece pattern

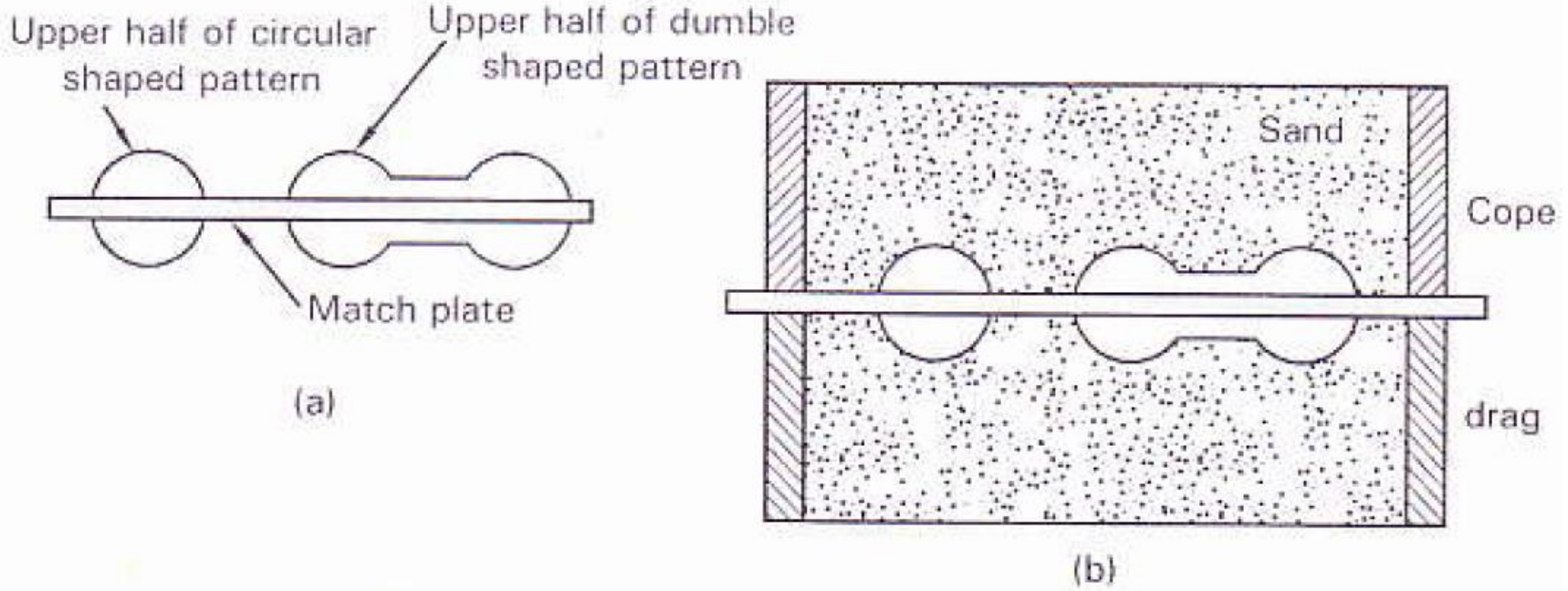


Figure 1.9 Match plate pattern

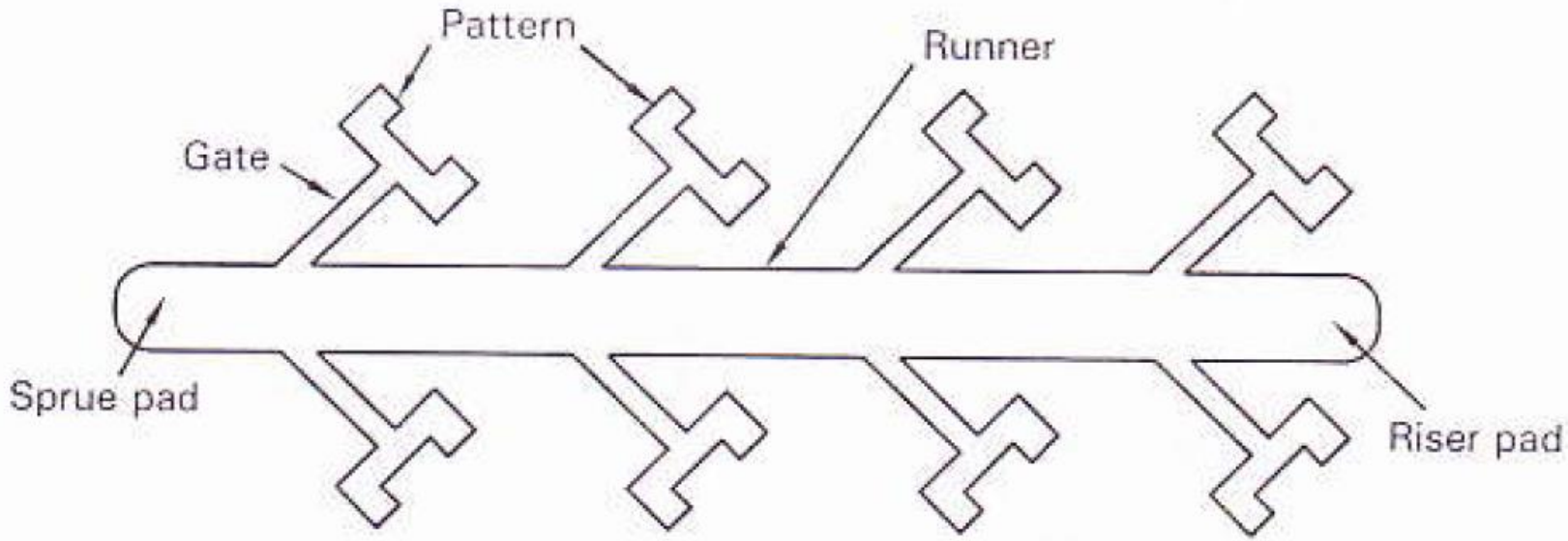


Figure 1.10 Gated pattern

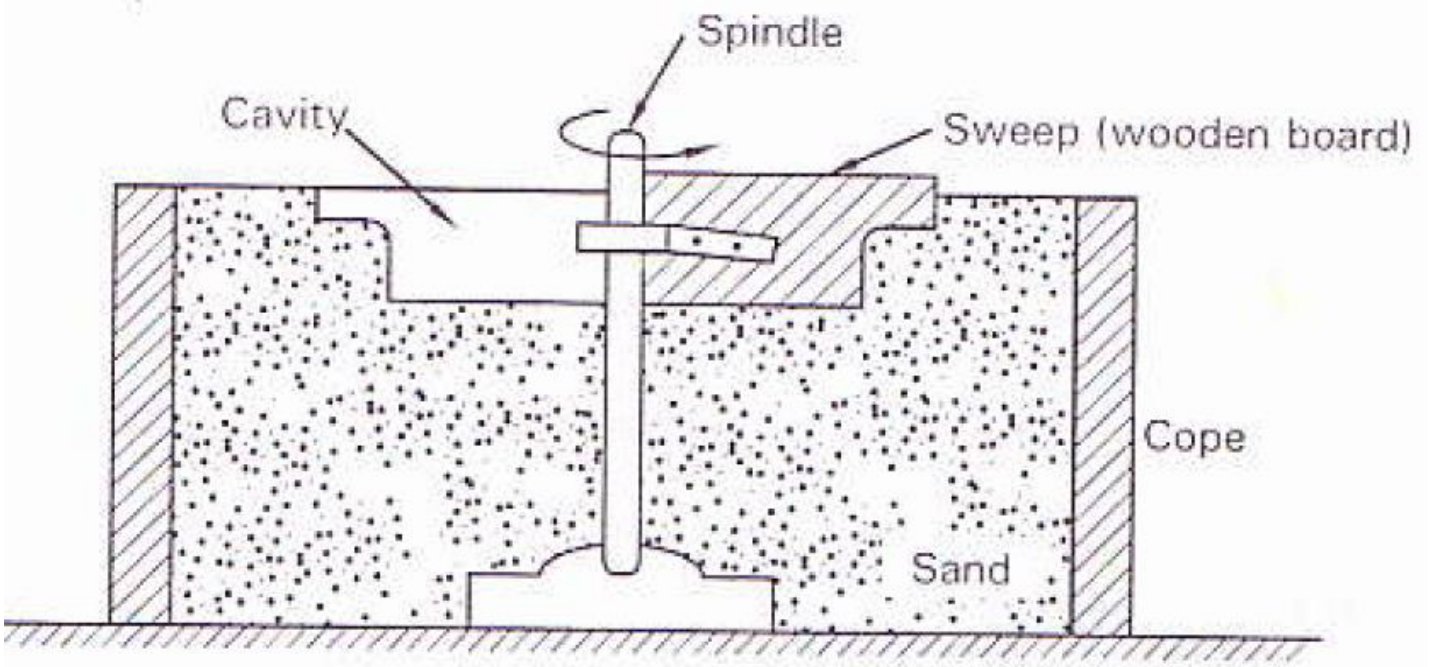


Figure 1.11 Sweep pattern

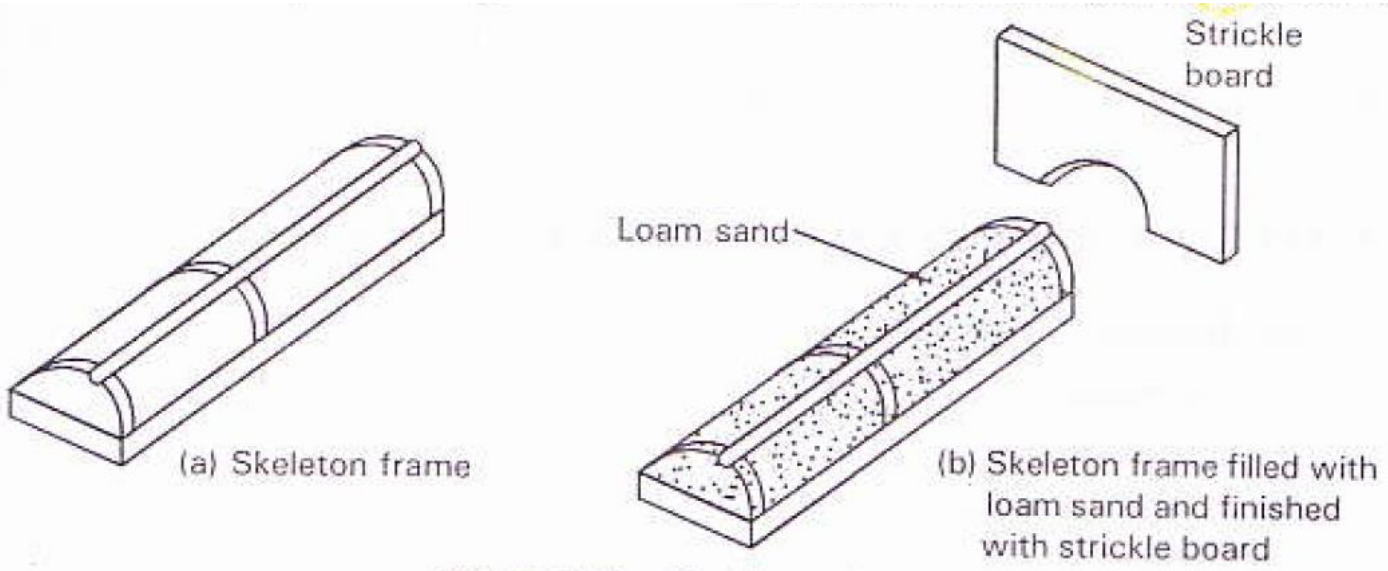
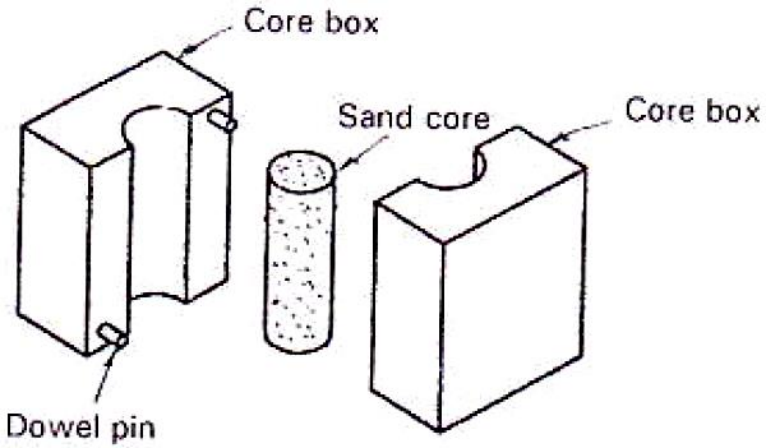
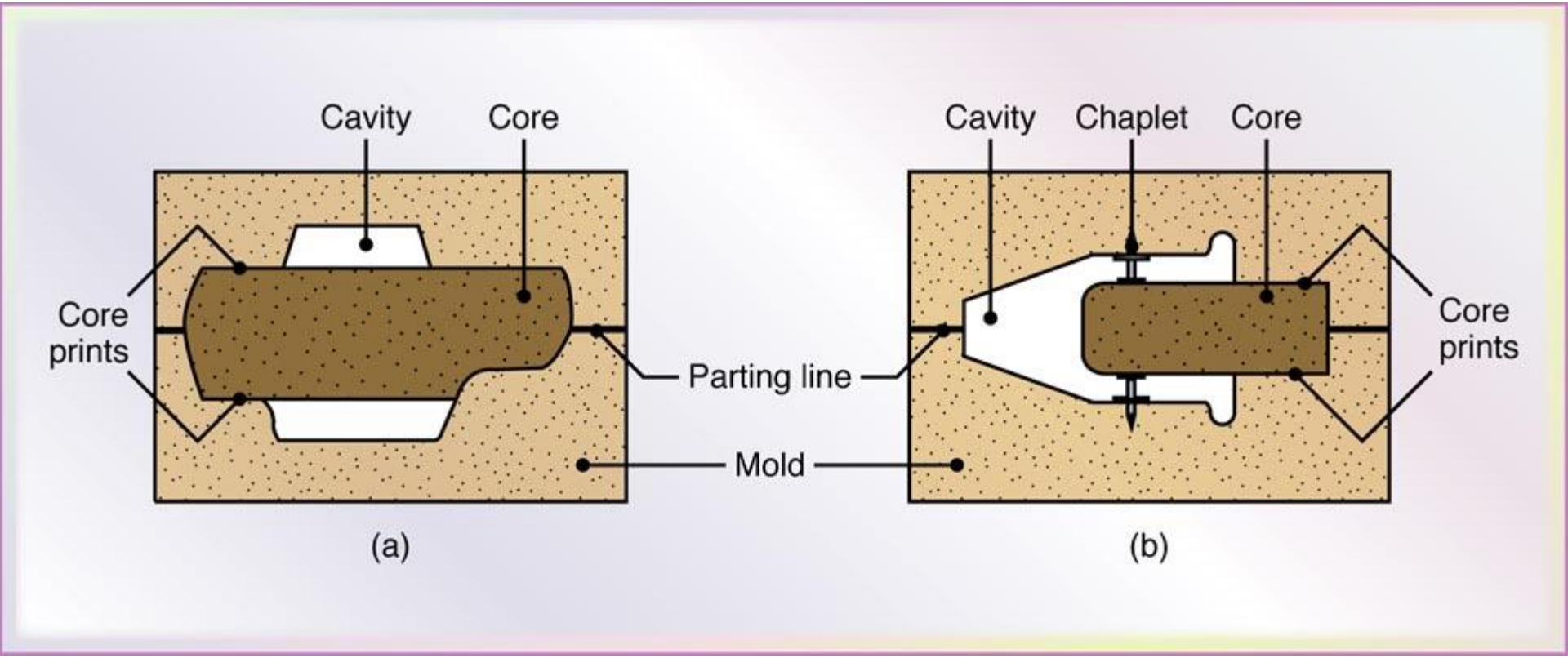


Figure 1.12 Skeleton pattern



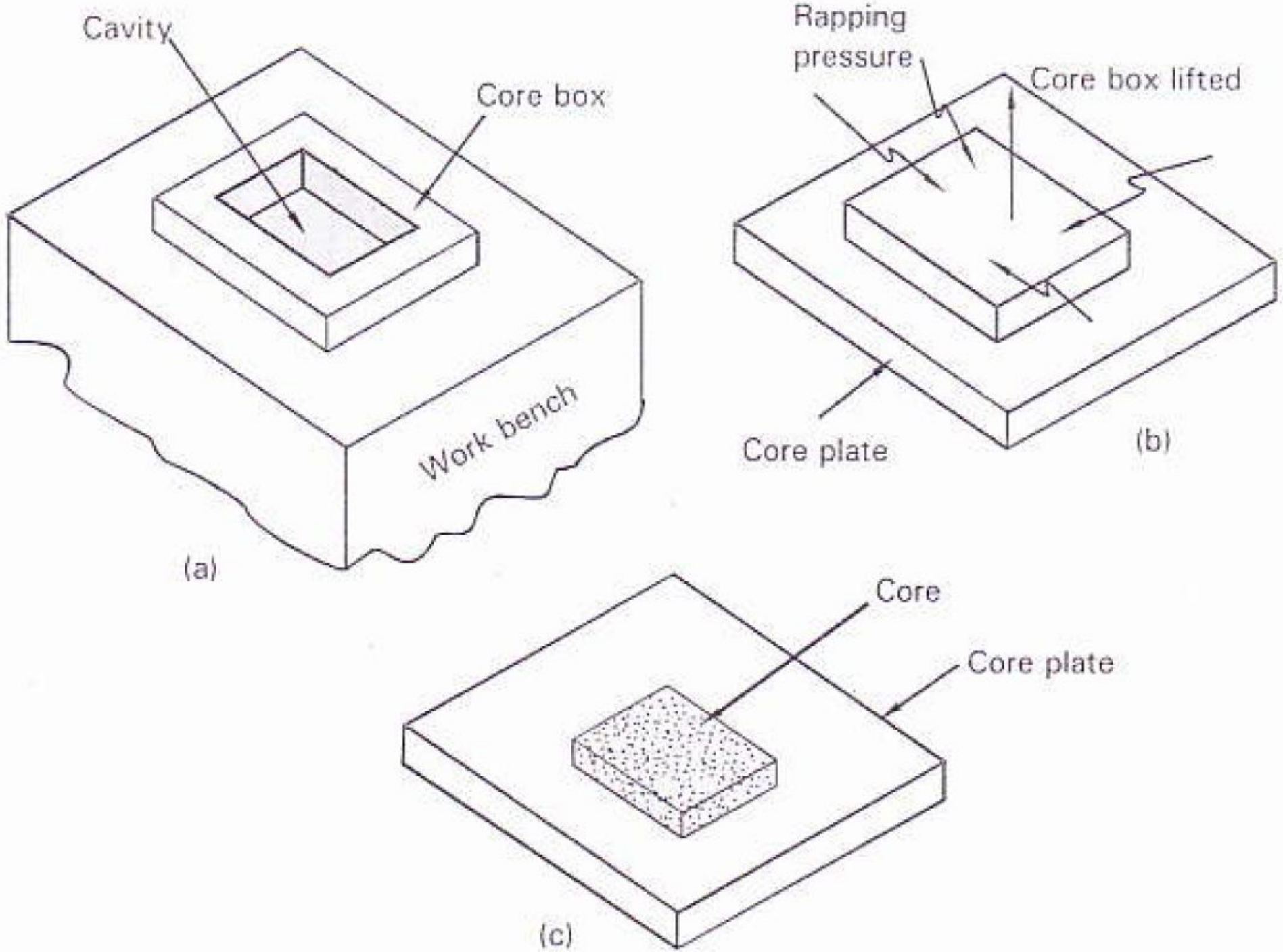
Core Making



Examples of sand cores showing core prints and chaplets to support cores.

Core Making

1. Core sand preparation
2. Core Molding
3. Core baking
4. Core finishing


Cavity
Core box
Work bench
(a)
Rapping
pressure
Core box lifted
Core plate
(b)
Core
Core plate
(c)

Capabilities and Advantages of Casting

- Can create complex part geometries.
- Can create both external and internal shapes.
- Some casting processes are *net shape;* others are *near net shape.*
- Can produce very large parts.
- Some casting methods are suited to mass production.

Disadvantages of Casting

- Different disadvantages for different casting processes:
  - Limitations on mechanical properties.
  - Poor dimensional accuracy and surface finish for some processes; e.g., sand casting.
  - Safety hazards to workers due to hot molten metals.
  - Environmental problems.

Desirable Mold 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* - Reuse of sand from broken mold

METAL CASTING PROCESSES

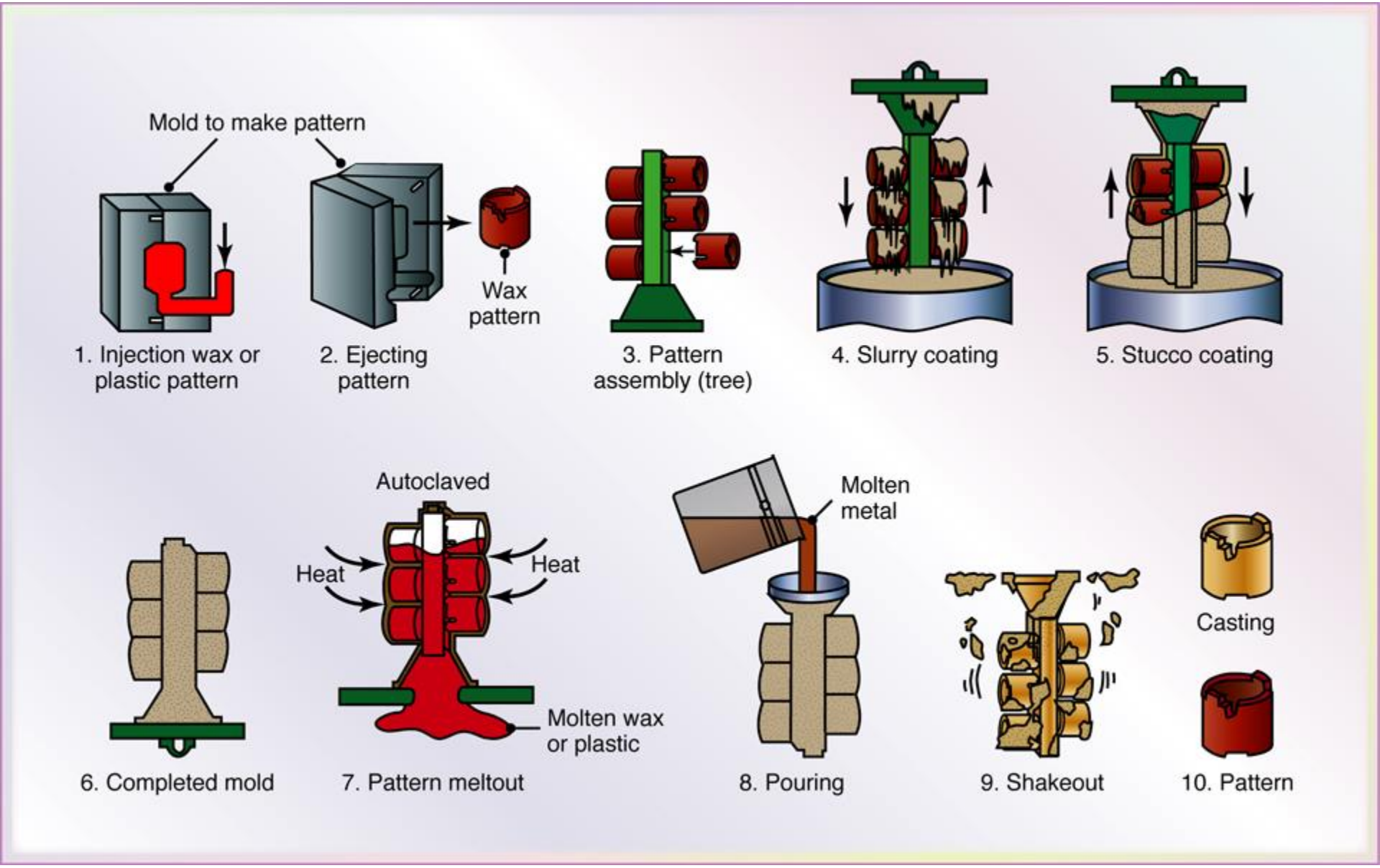
- Sand Casting.
- Other Expendable Mold Casting Processes.
- Permanent Mold Casting Processes.

Categories of Metal Casting Processes

1. *Expendable mold processes* - mold is sacrificed to remove part
   - Advantage: more complex shapes possible
   - Disadvantage: production rates often limited by time to make mold rather than casting itself

2. *Permanent mold processes* - mold is made of metal and can be used to make many castings
   - Advantage: higher production rates
   - Disadvantage: geometries limited by need to open mold

Investment casting (lost wax casting)



Die Casting

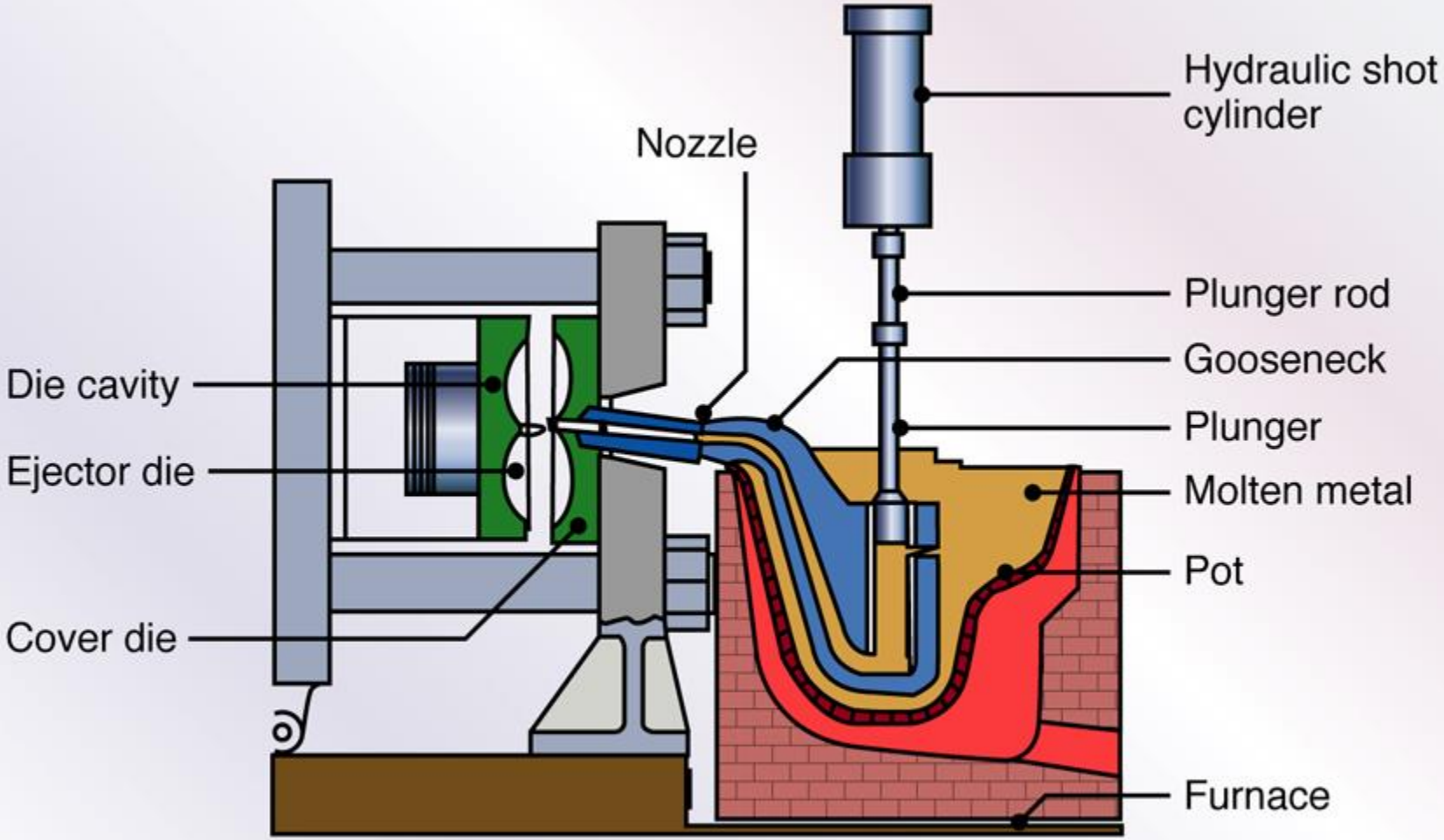
A permanent mold casting process in which molten metal is injected into mold cavity under high pressure

- Pressure is maintained during solidification, then mold is opened and part is removed
- Molds in this casting operation are called *dies*; hence the name die casting
- Use of high pressure (7 – 700 MPa) to force metal into die cavity is what distinguishes this from other permanent mold processes

Parts made from here range from:

Hand tools
Toys
Appliance components

- Two main types:
  1. Hot-chamber machine
  2. Cold-chamber machine



HOT CHAMBER: (low mp e.g. Zn, Pb; non-alloying)

(i) die is closed, gooseneck cylinder is filled with molten metal

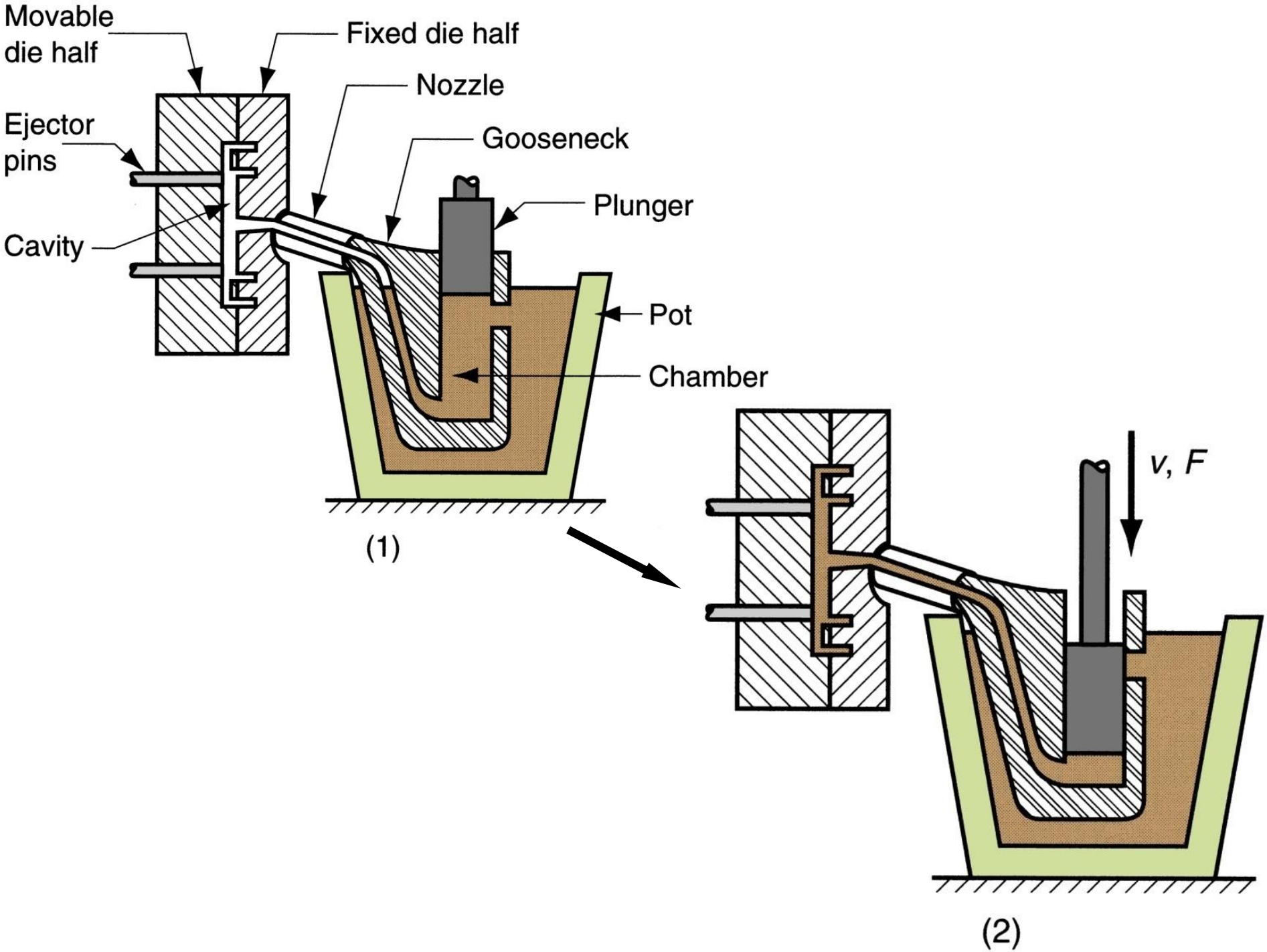
(ii) plunger pushes molten metal through gooseneck into cavity

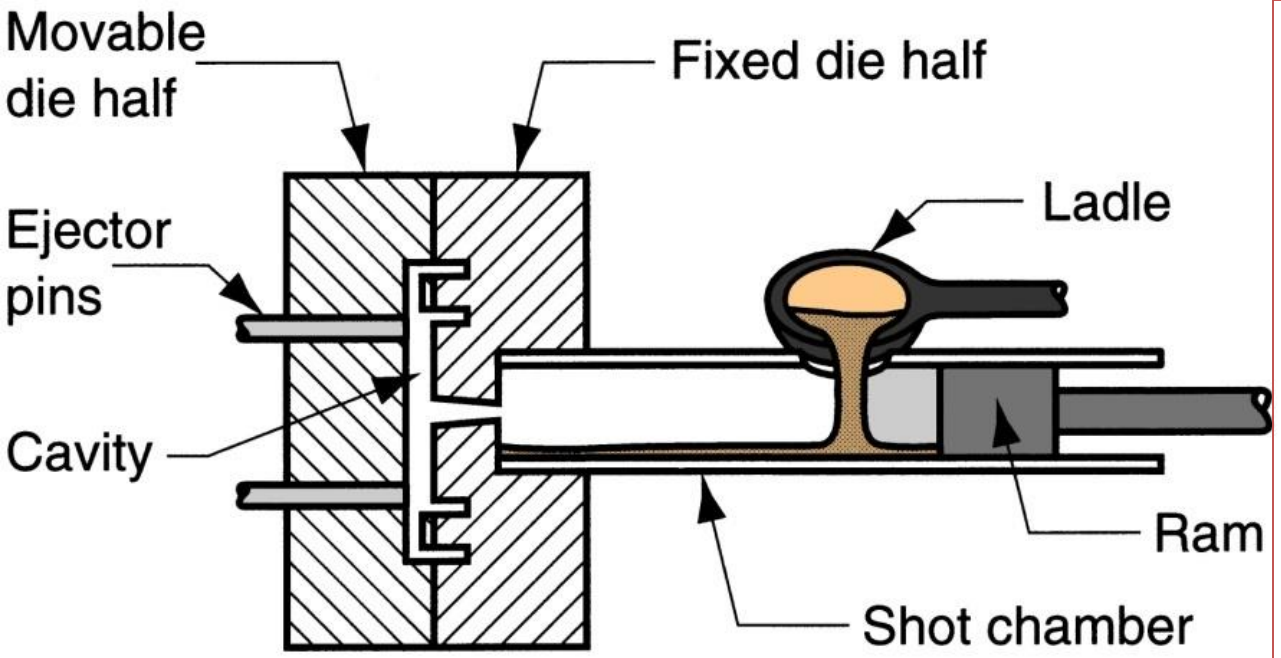
(iii) metal is held under pressure until it solidifies

(iv) die opens, cores retracted; plunger returns

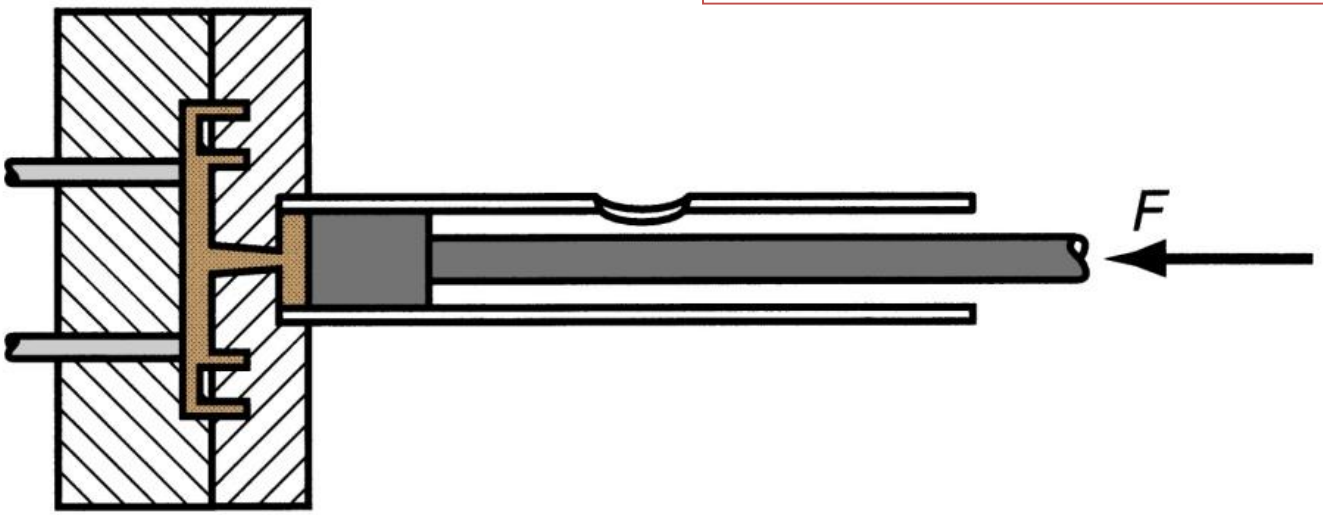
(v) ejector pins push casting out of ejector die

- common uses: components for rice cookers, stoves, fans, washing-, drying machines, fridges, motors, toys, hand-tools, car wheels


Movable die half
Fixed die half
Nozzle
Ejector pins
Gooseneck
Plunger
Cavity
Pot
Chamber
(1)
v, F
(2)



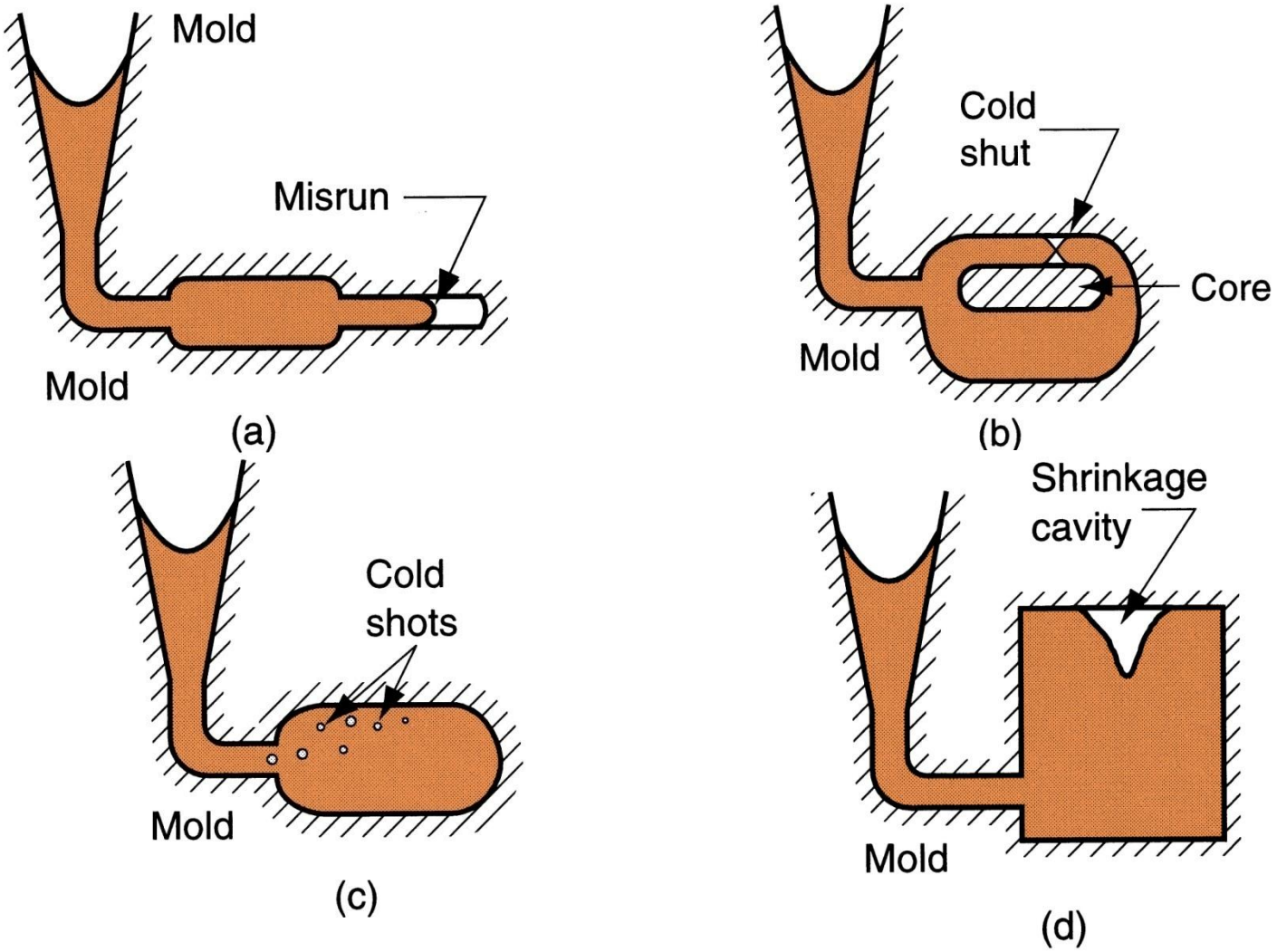
(1)



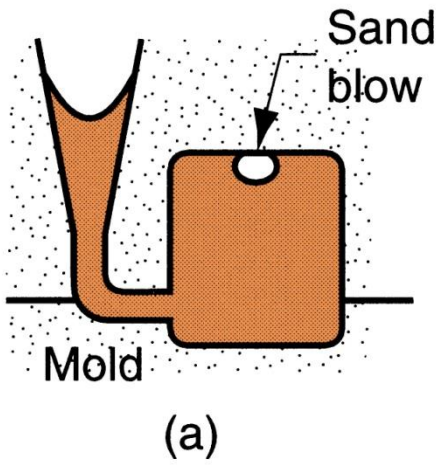
(2)

COLD CHAMBER: (high mp e.g. Cu, Al)
(i) die closed, molten metal is ladled into cylinder
(ii) plunger pushes molten metal into die cavity
(iii) metal is held under high pressure until it solidifies
(iv) die opens, plunger pushes solidified slug from the cylinder
(v) cores retracted
(iv) ejector pins push casting off ejector die

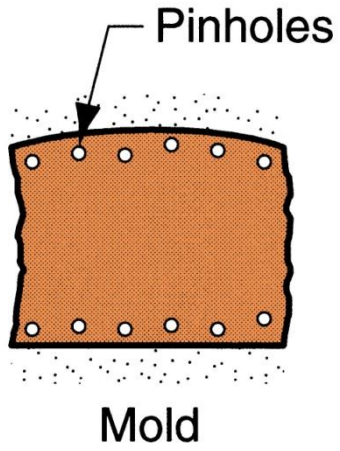
General Casting Defects



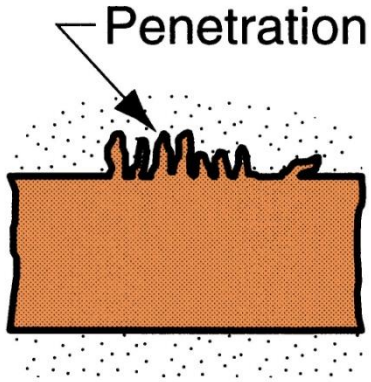
Sand Casting Defects



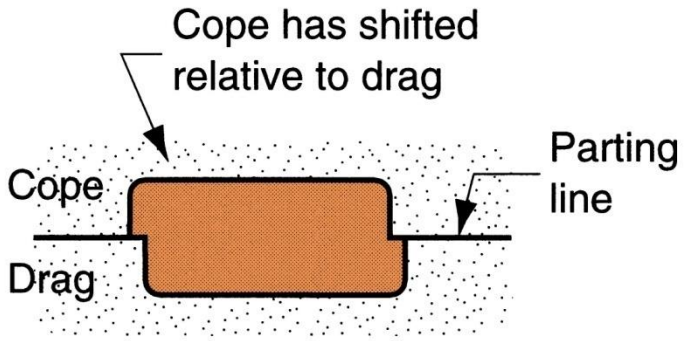
(a)



(b)



(e)



(f)