MANUFACTURING

Manufacturing in its broadest sense is the process of converting raw materials into useful products.

It includes

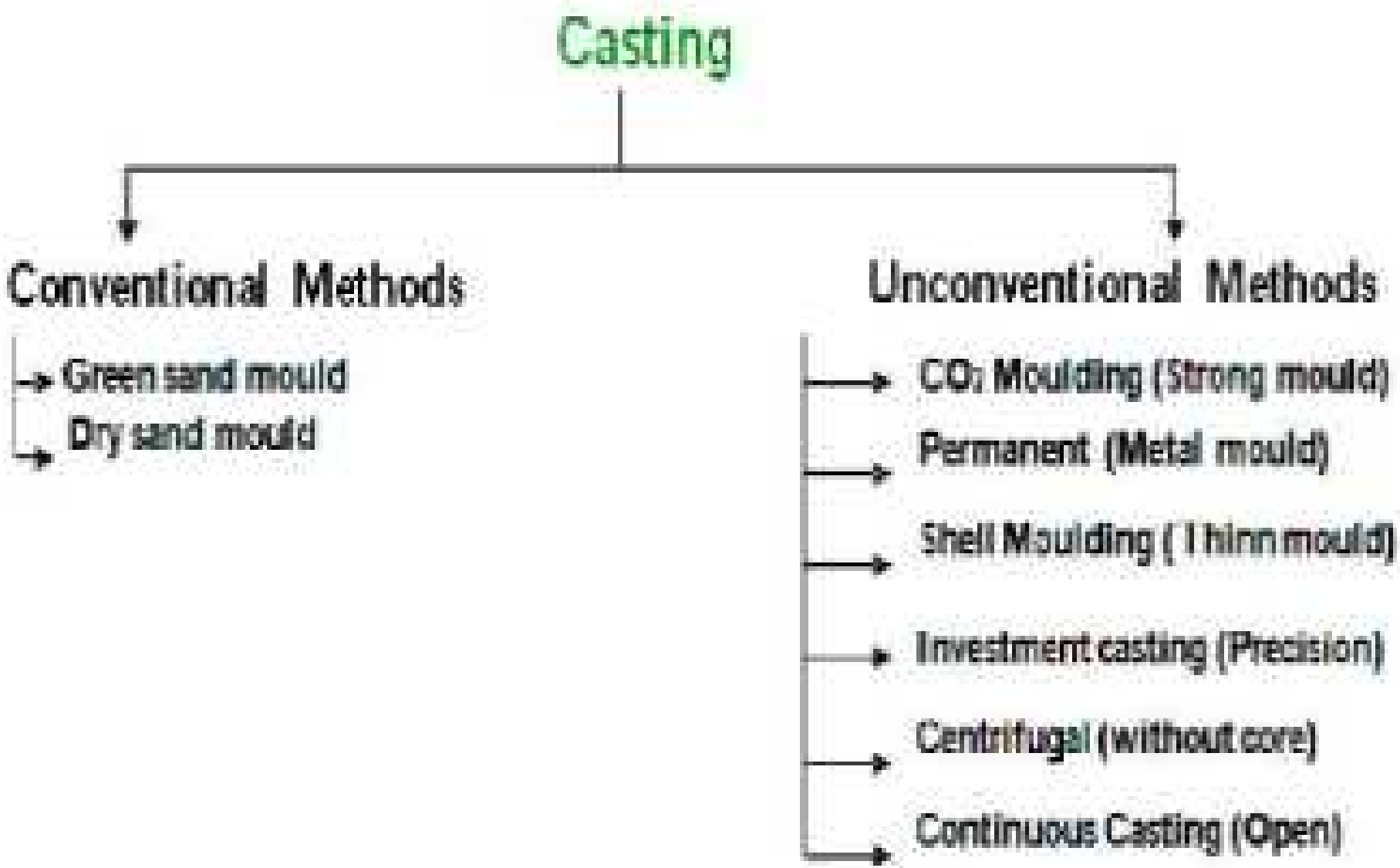
i) Design of the product

ii) Selection of raw materials and

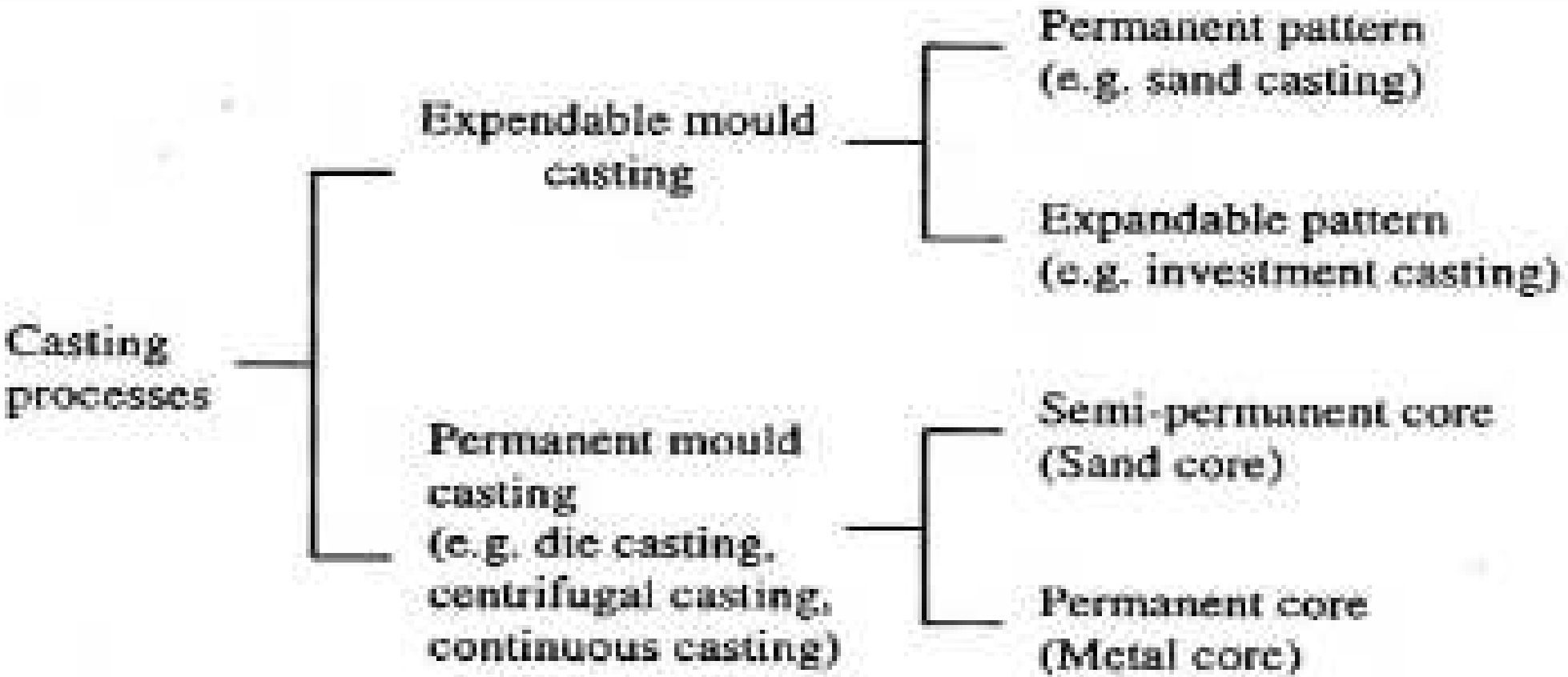
iii) The sequence of processes through which the product will be manufactured

CASTING

Casting is the process of producing metal parts by pouring molten metal into the mould cavity of the required shape and allowing the metal to solidify. The solidified metal piece is called as "casting".


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)

Classification of casting processes



Advantages

- ✓ Design flexibility
- ✓ Reduced costs
- ✓ Dimensional accuracy
- ✓ Versatility in production

Disadvantages

- ✓ Lot of molten metal is wasted in riser & gating
- ✓ Casting may require machining to remove rough surfaces

SAND MOULDING

Sand Casting is simply melting the metal and pouring it into a preformed cavity, called sand moulding

- Most widely used casting process.
- Parts ranging in size from small to very large
- Production quantities from one to millions.

Patterns and Cores

Solid, Split, Match-plate and Cope-and-drag Patterns – Cores – achieve the internal surface of the part

Molds

- Sand with a mixture of water and bonding clay
- Typical mix: 90% sand, 3% water, and 7% clay
- to enhance strength and/or permeability

Sand – Refractory for high temperature

Types of sand

a) Green-sand molds - mixture of sand, clay, and water;

"Green" means mold contains moisture at time of pouring.

b) Dry-sand mold - organic binders rather than clay and mold is baked to improve strength

c) Skin-dried mold - drying mold cavity surface of a green-sand

– mold to a depth of 10 to 25 mm, using torches or heating

Moulding Tools

Shovel

It is just like rectangular pan fitted with a handle. It is used for mixing the moulding sand and for moving it from one place to the other

Riddle

It is used for removing foreign materials like nails, shot metal splinters of wood etc from the moulding sand

Rammer

It is a wooden tool used for ramming or packing the sand in the mould. Rammers are made in different shapes.

Strike-off bar

It is a cast iron or wrought iron bar with a true straight edge. It is used to remove the surplus sand from the mould after the ramming has been completed.

Vent wire

It is a mild steel wire used for making vents or openings in the mould.

Lifter

It is a metal piece used for patching deep section of the mould and removing loose sand from pockets of the mould.

Slick

Different types of slicks are used for repairing and finishing moulds.

Trowel

It contains of a flat and thick metal sheet with upwards projected handle at one end. It is used for making joints and finishing flat surface of a mould.

Swab

It is made of flax or hemp. It is used for applying water to the mould around the edge of the pattern.

Draw spike

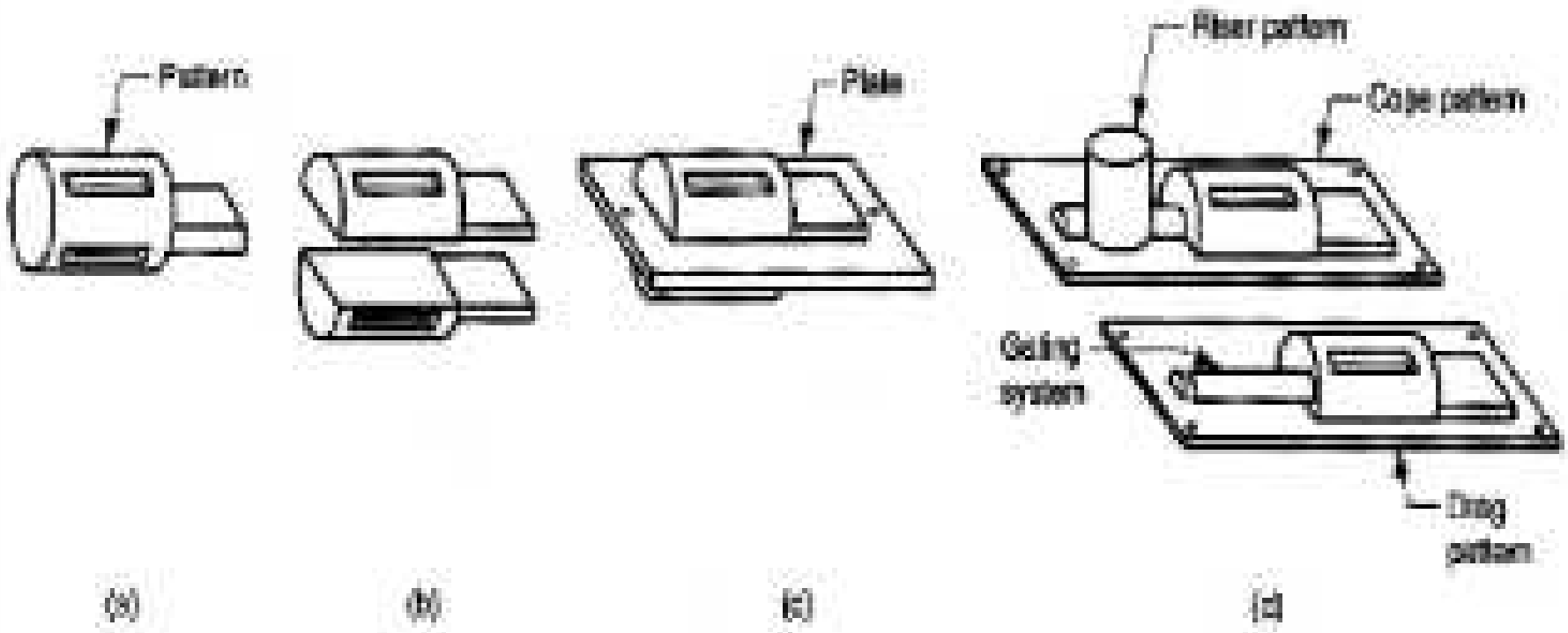
It is a metal rod with a pointed or screwed end. It is used for removing the pattern from the mould.


Finishing Trowel
Lifter / Cleaner
Swab
Vent Wire

MOULDING TOOLS

TYPES OF PATTERNS

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



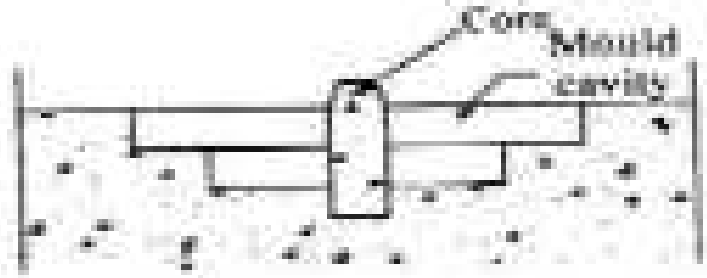
TYPES OF CORES

A core is a device used in casting and molding processes to produce internal cavities and reentrant angles. The core is normally a disposable item that is destroyed to get it out of the piece

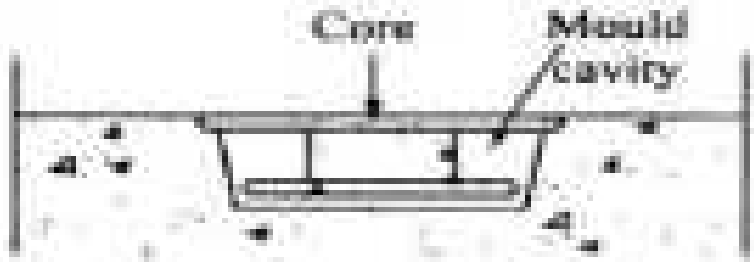
a) According to the state of core
   - i) Green sand core
   - ii) Dry sand core

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

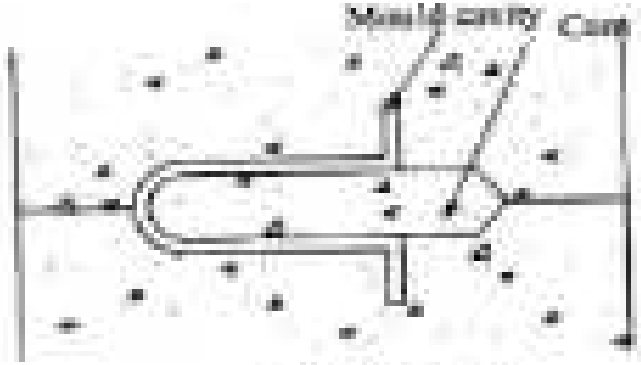
Horizontal core



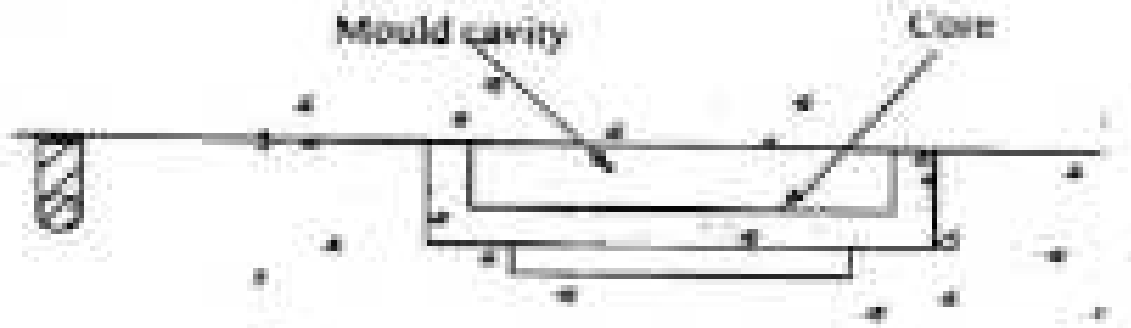
Vertical core



Hanging core

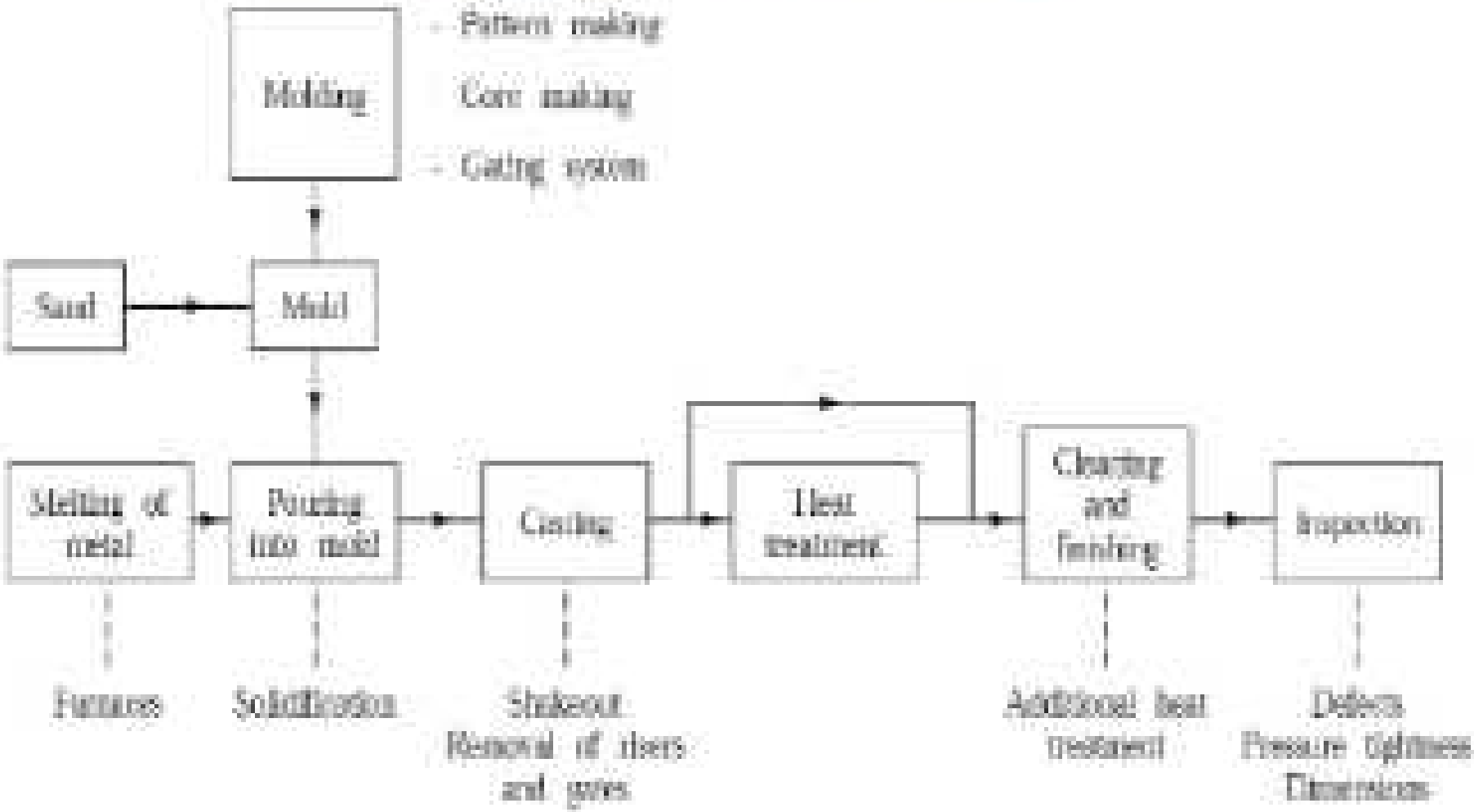


Balanced core

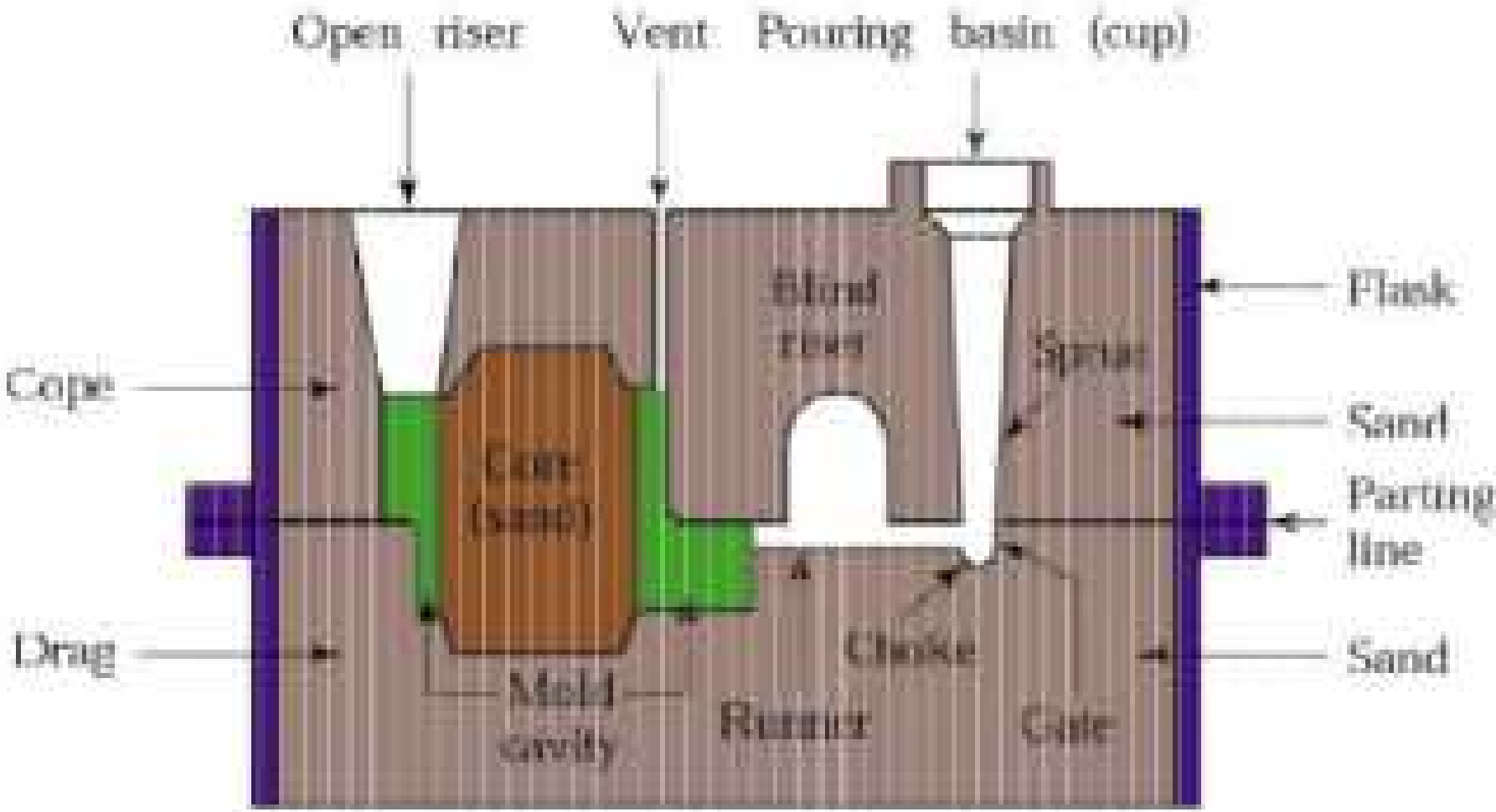


Drop core

SAND CASTING



SAND MOLD FEATURES



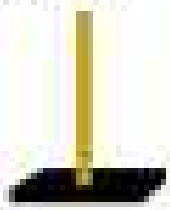
SAND CASTING

Basic materials & equipment for green sand-casting

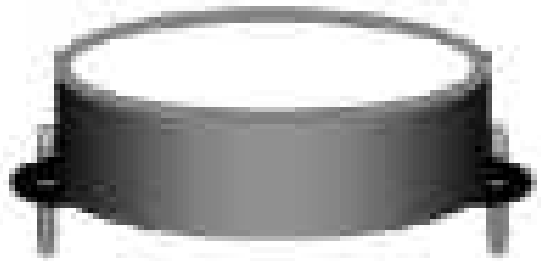
Pattern
(a copy of the shape you want to produce, made of wood, plastic or metal)

Sand
mixed with clay binder & water (so it will hold its shape) plus coal dust to improve surface finish

Container of molten metal
(filled from furnace)



Rammer (tool to compact the sand; often a pressing machine is used)



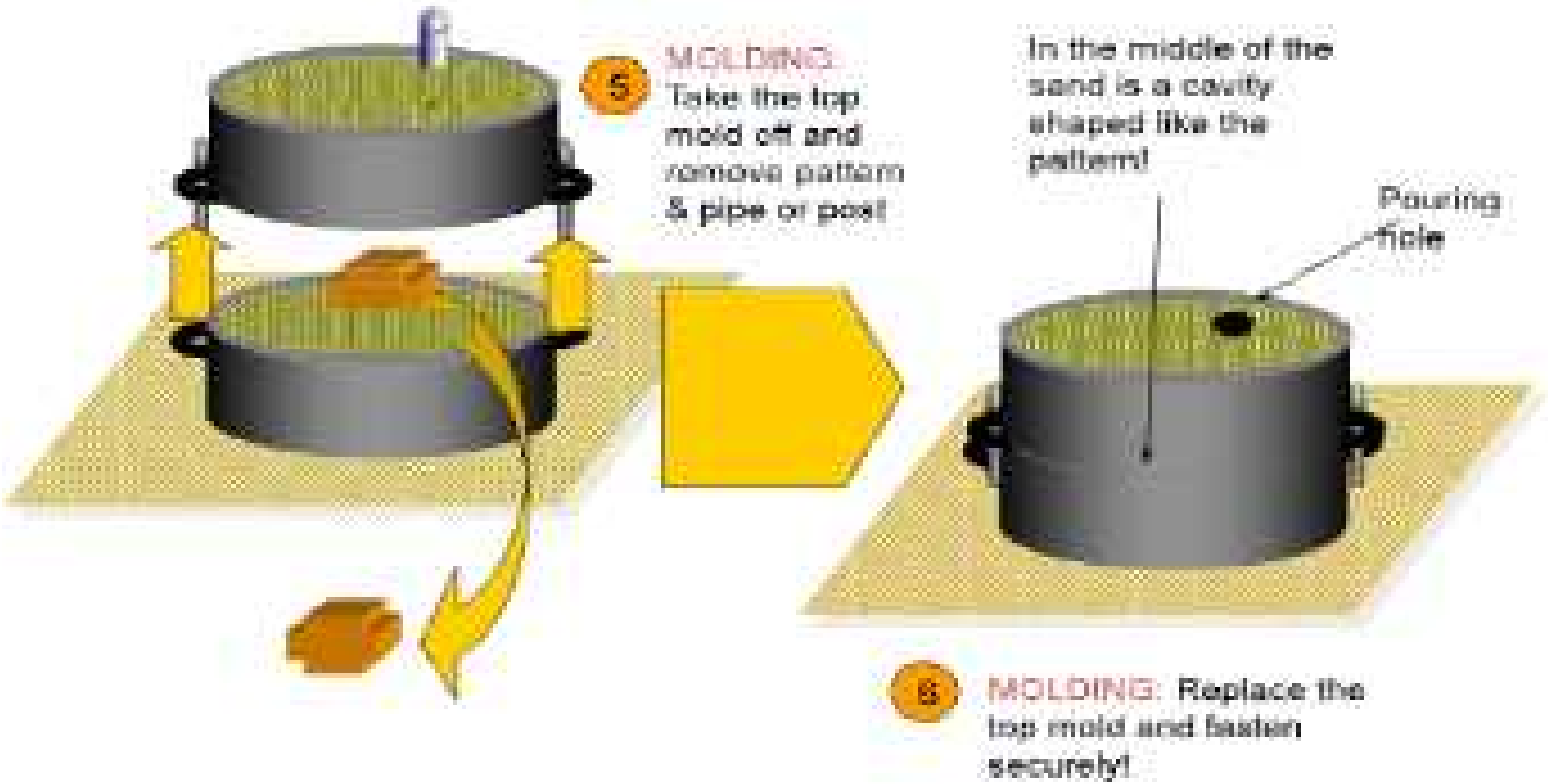
Top and bottom mold forms
(made of metal, open at top and bottom)

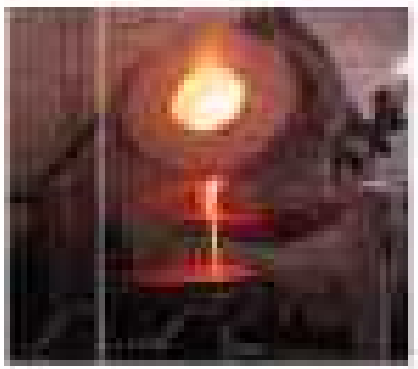
A very basic summary of the sand casting process. . .

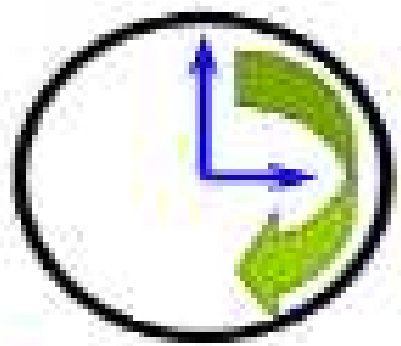
First of all,
mix the sand.

THEN


3
MOLDING: Add the top mold form
A tube or pipe provides a path to pour the metal in
Pattern is still inside!
4
MOLDING: Fill top form with compacted sand.

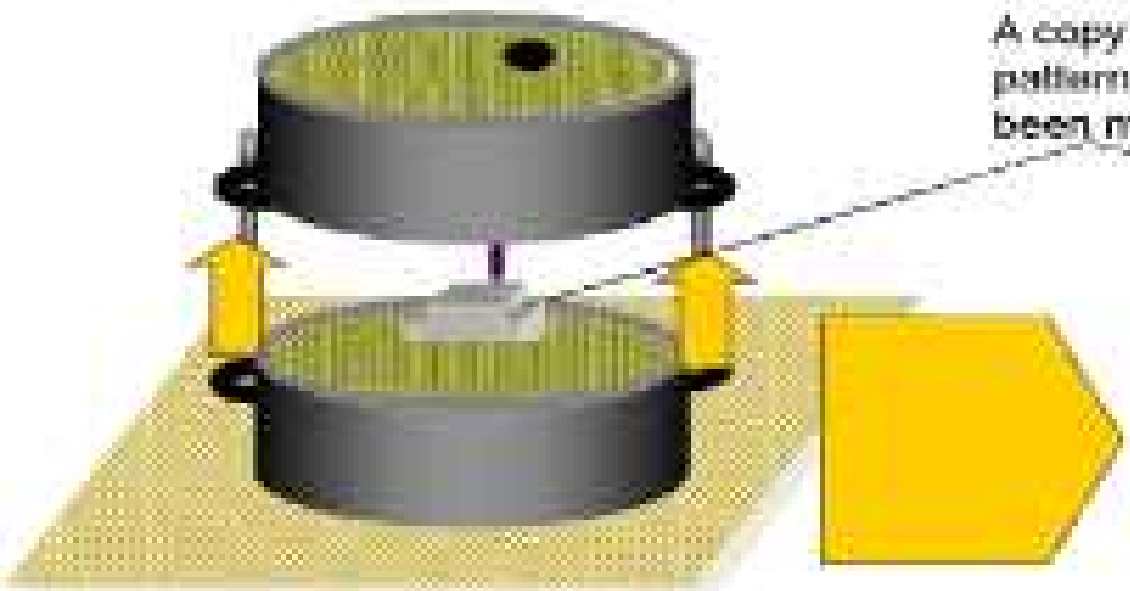

5
MOLDING:
Take the top
mold off and
remove pattern
& pipe or post
In the middle of the
sand is a cavity
shaped like the
pattern!
Pouring
hole
6
MOLDING: Replace the
top mold and fasten
securely!





7 CASTING:
Pour the metal (container is filled from furnace immediately before you are ready to pour)

8 Wait for the metal to cool (minutes to days, depending on the size of the casting)



A copy of the pattern has now been made in metal

9

CLEANING: Sand is cleaned off the part, the "tab" where metal flowed in must be removed.

8 SHAKE OUT: Break apart the two halves of the mold & take out the part—usually requires vibrating or striking the mold to break apart the sand

10 Mold forms are reused

11 Sand is broken up, screened to remove debris and clumps, and sent for remixing

Advantages

- ✓ Least Expensive in small quantities (less than 100)
- ✓ Ferrous and non - ferrous metals may be cast
- ✓ Possible to cast very large parts
- ✓ Least expensive tooling

Disadvantages

- ✓ Dimensional accuracy inferior to other processes, requires larger tolerances
- ✓ Castings usually exceed calculated weight
- ✓ Surface finish of ferrous castings usually exceeds 125 RMS

MELTING FURNACES

- ✓ Cupola furnace – For cast iron
- ✓ Open heart furnace – For steel
- ✓ Crucible furnace – For non- ferrous metal

1.Pit type furnace

2. Coke Fired stationary furnace

3. Oil fired tilting furnace

   a)Pot furnace

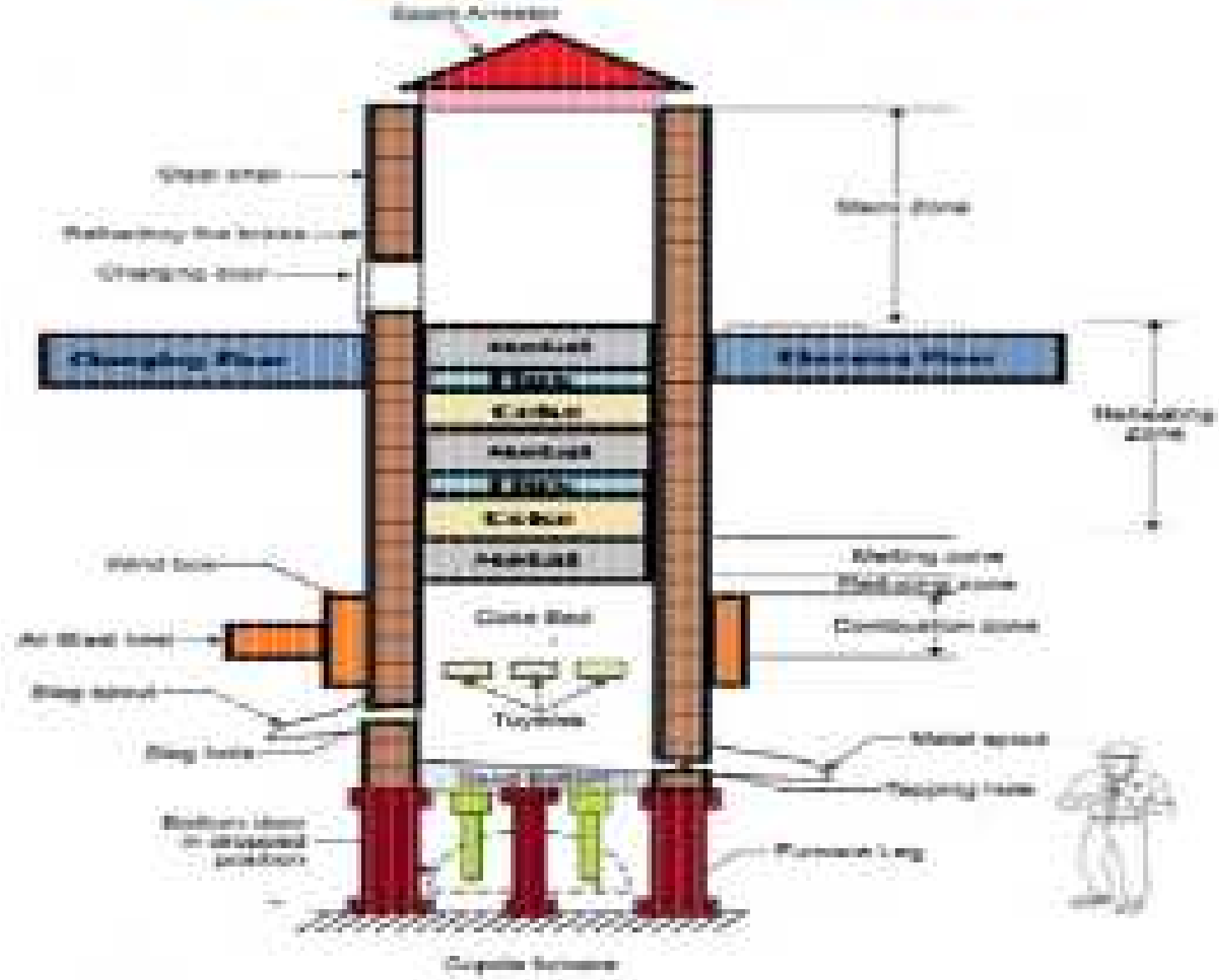
   b)Electric Furnace

4.Direct arc furnace

5.Indirect arc furnace

6.Induction furnace

CUPOLA FURNACE



Application:

cupola is used to melt cast iron

Advantages:

- ✓Initial cost is comparatively lower than other type of furnaces
- ✓It is simple in design
- ✓It requires less floor area
- ✓Operation and maintenance are simple
- ✓It can be operated continuously for many hours

SHELL MOULDING

Steps in shell molding

Shell-mold casting yields better surface quality and tolerances. The process is described as follows:

The 2-piece pattern is made of metal (e.g. aluminum or steel), it is heated to between 175°C - 370°C, and coated with a lubricant, e.g. silicone spray.

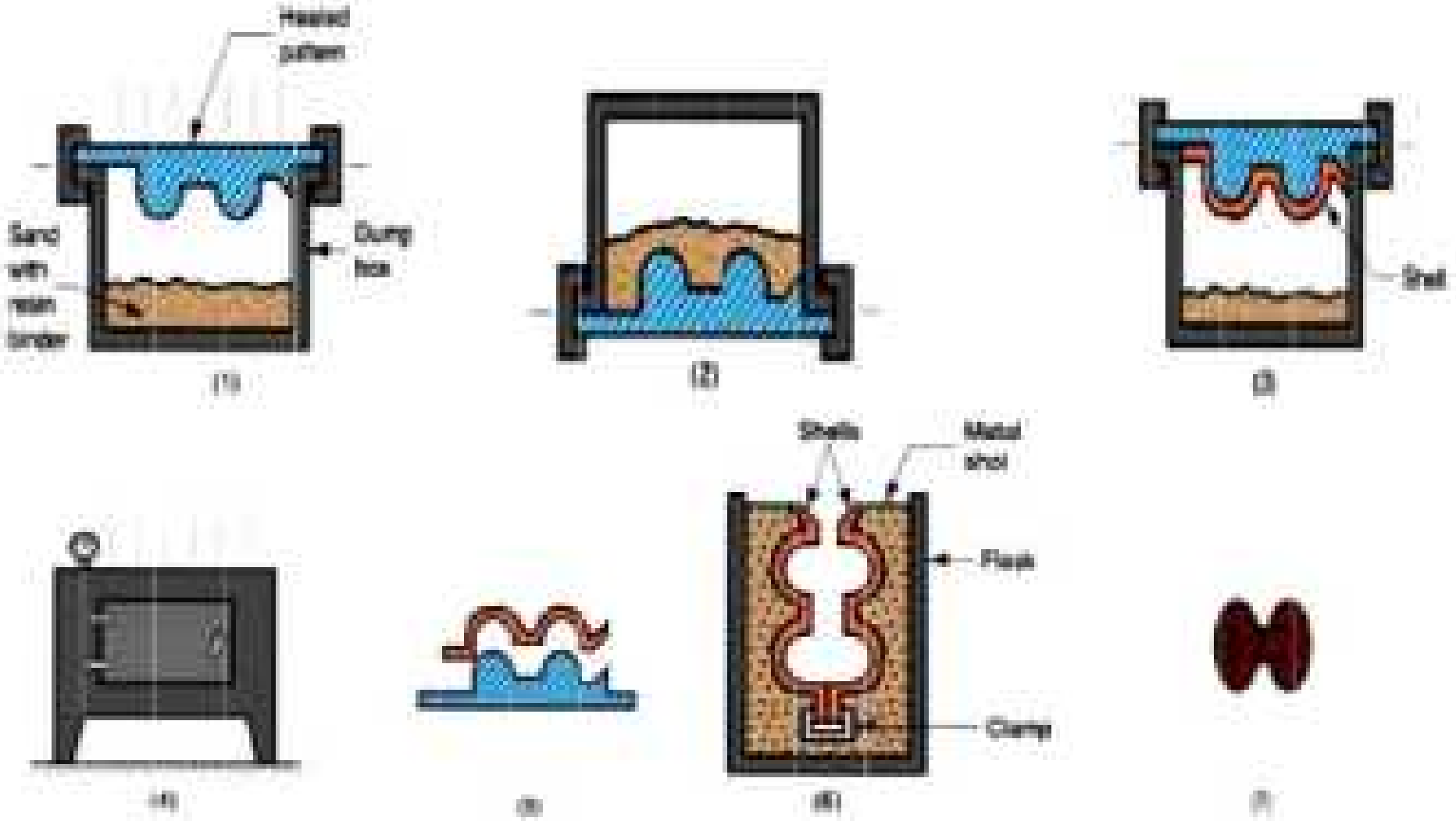
Each heated half-pattern is covered with a mixture of sand and a thermoset resin/epoxy binder.

The binder glues a layer of sand to the pattern, forming a shell. The process may be repeated to get a thicker shell.

The assembly is baked to cure it.

The patterns are removed, and the two half-shells joined together to form the mold; metal is poured into the mold.

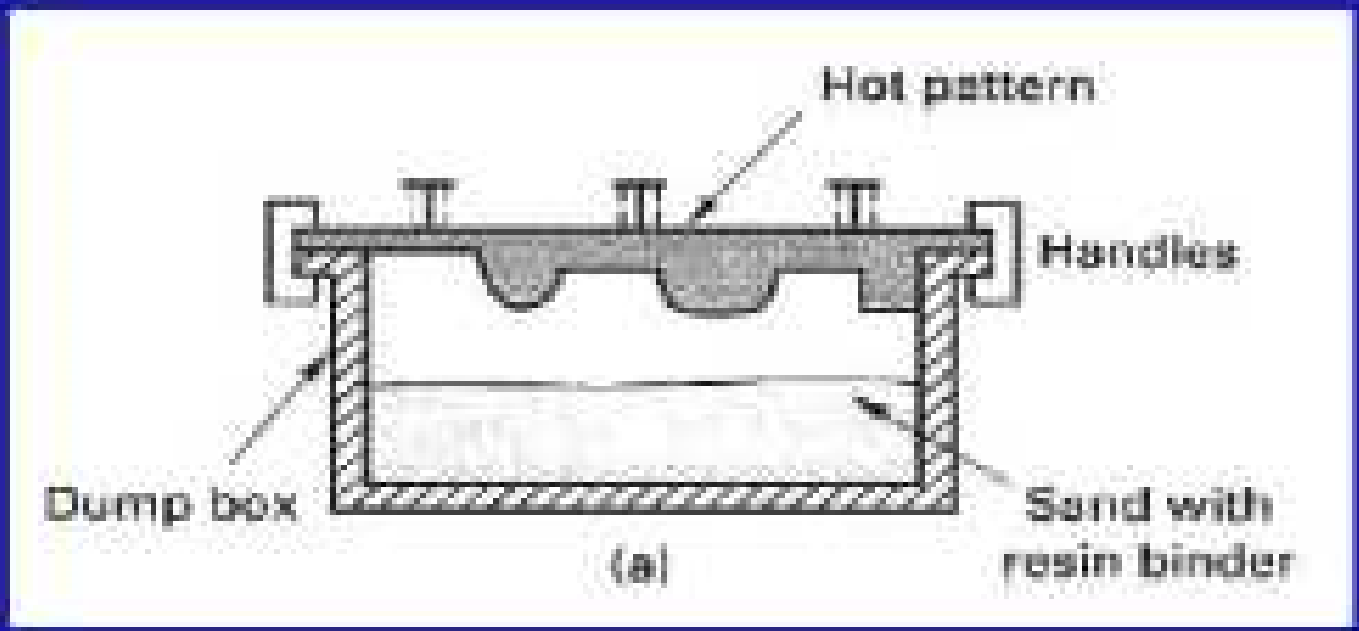
When the metal solidifies, the shell is broken to get the part.


Heated pattern
Sand with resin binder
Dump box
Shell
Shells
Metal shot
Flask
Clamp

SHELL-MOLD CASTING

(Sequential Operations)

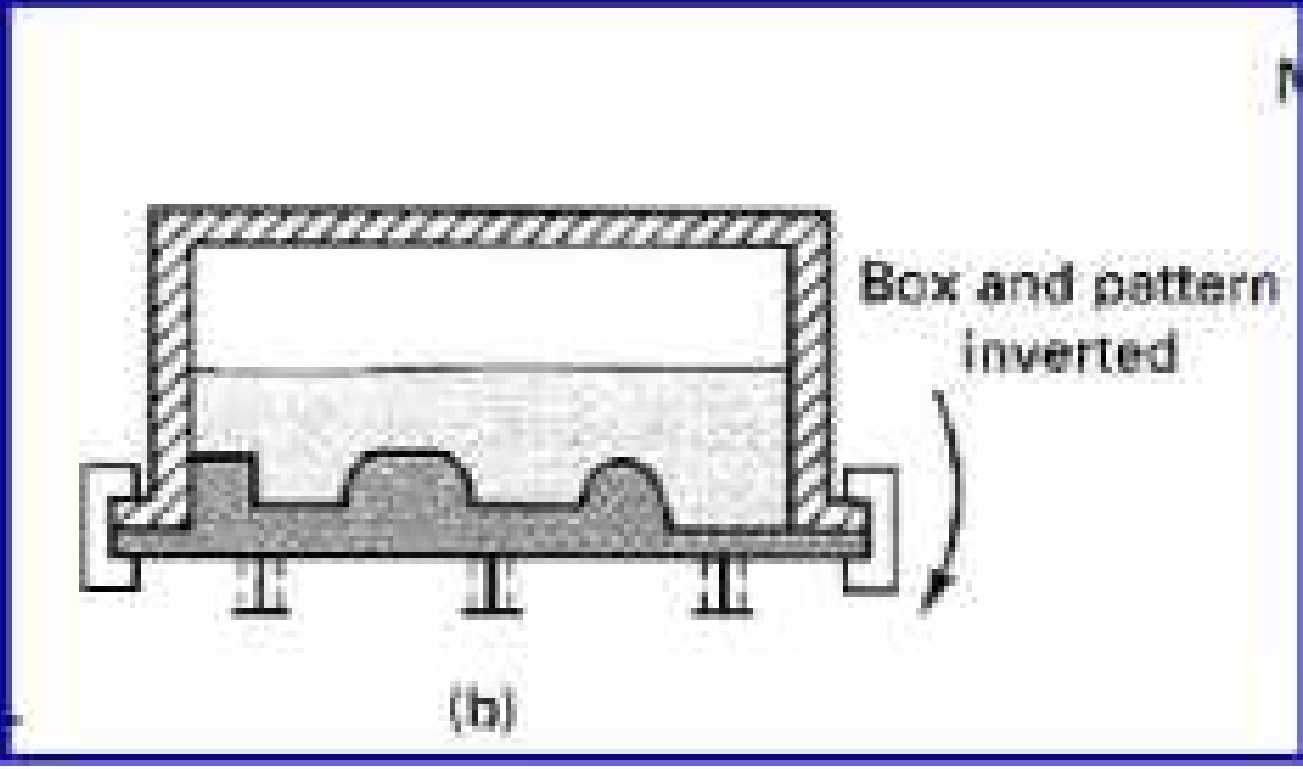
(a) A heated pattern is placed over a dump box containing a sand and resin mixture.



SHELL-MOLD CASTING

(Sequential Operations)

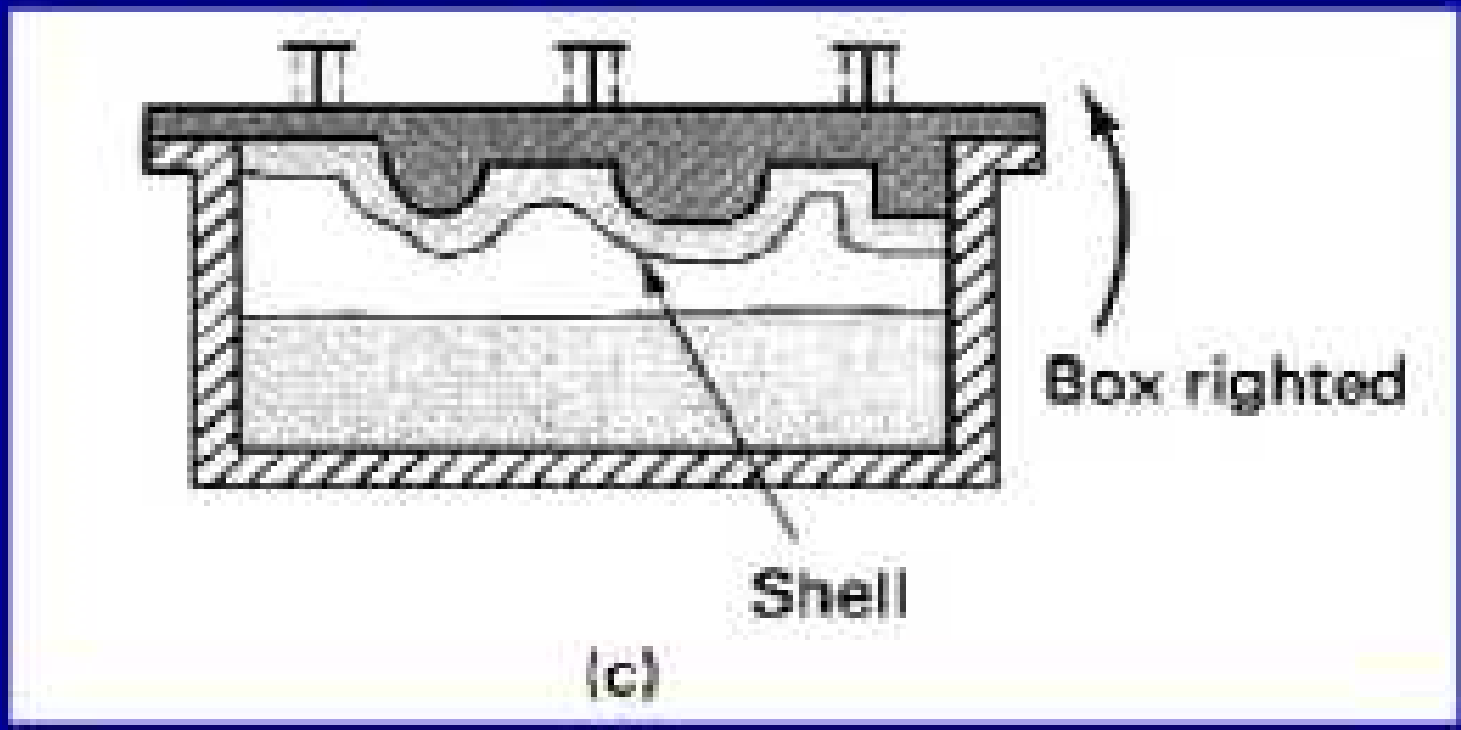
(b)The box is inverted and a shell partially cures around the pattern



SHELL-MOLD CASTING

(Sequential Operations)

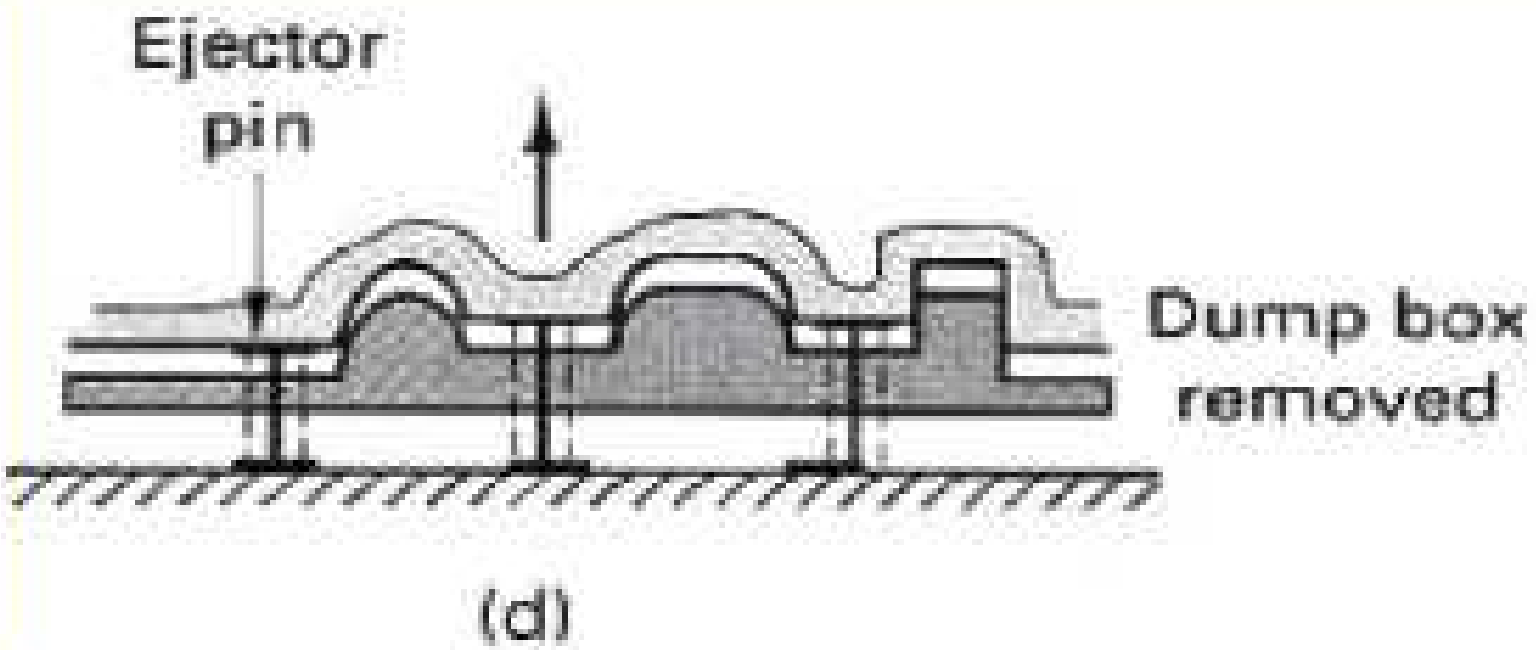
(c)The box is righted, the top is removed, and placed in an oven to further cure the shell.



SHELL-MOLD CASTING

(Sequential Operations)

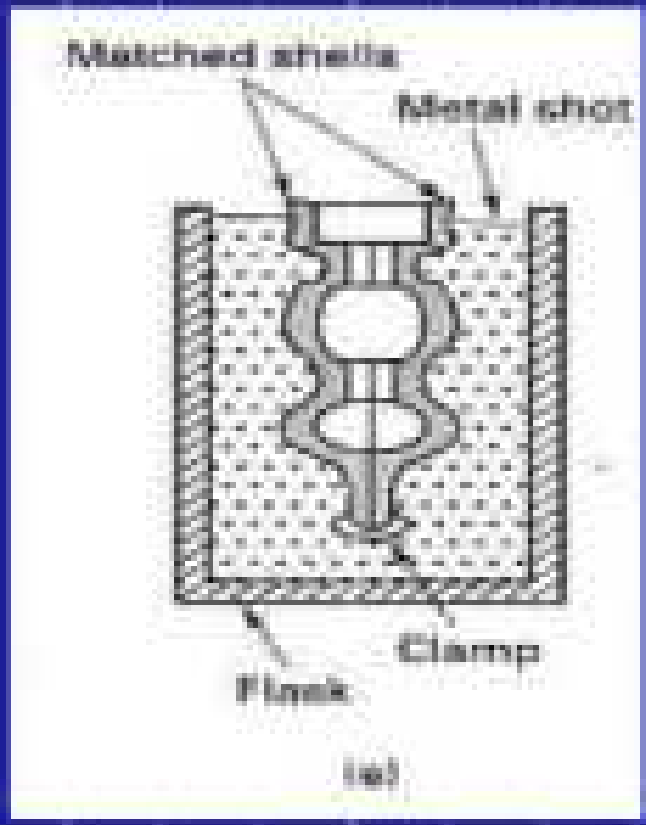
(d) The shell is stripped from the pattern



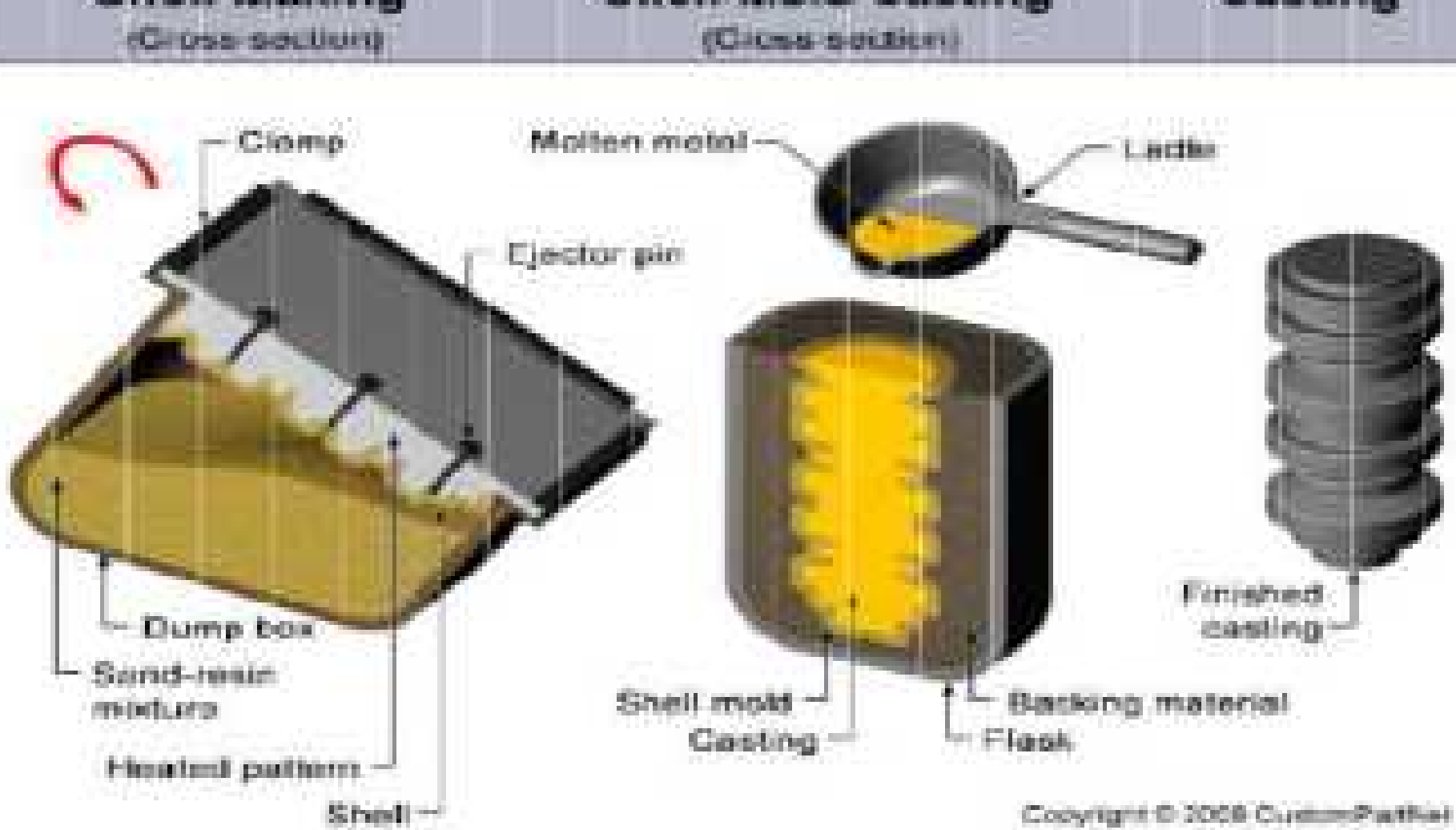
SHELL-MOLD CASTING

(Sequential Operations)

(e)Matched shells are then joined and supported in a flask ready for pouring.



SHELL-MOLD CASTING



Advantages

- Smoother cavity surface permits easier flow of molten metal and better surface finish on casting
- Good dimensional accuracy
- Machining often not required
- Mold collapsibility usually avoids cracks in casting
- Can be mechanized for mass production

Disadvantages

- More expensive metal pattern
- Difficult to justify for small quantities

INVESTMENT MOULDING

"lost wax" process

1. Wax pattern

2. Dip in ceramic slurry

3. Heat
(sinter ceramic and melt wax)

4. Pour metal

5. Finished casting

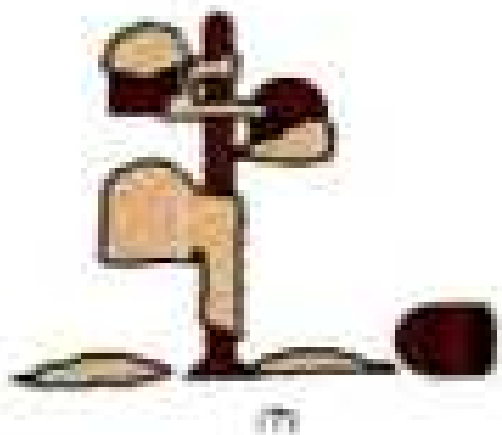

Wax pattern
Wax sprue
(1)
(2)


(3)


(4)


Wax
(5)


(6)


(7)

Advantages

- Parts of great complexity and intricacy can be cast
- Close dimensional control and good surface finish
- Wax can usually be recovered for reuse
- Additional machining is not normally required - this is a net shape process

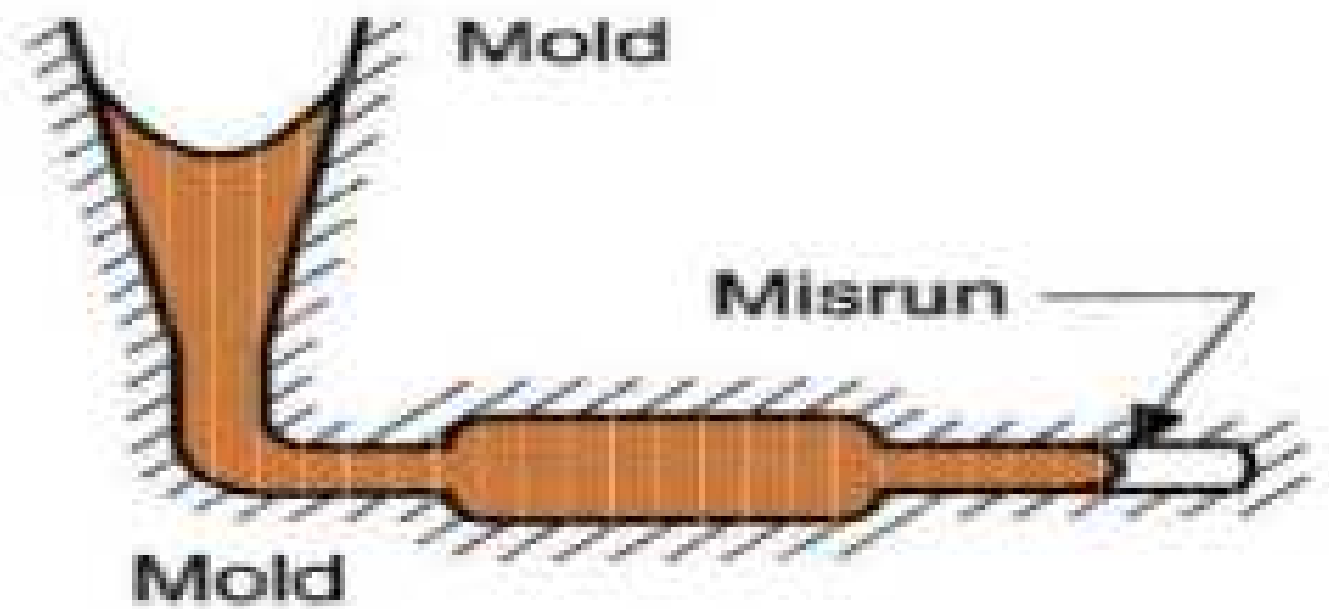
Disadvantages

- Many processing steps are required
- Relatively expensive process

CASTING DEFECTS

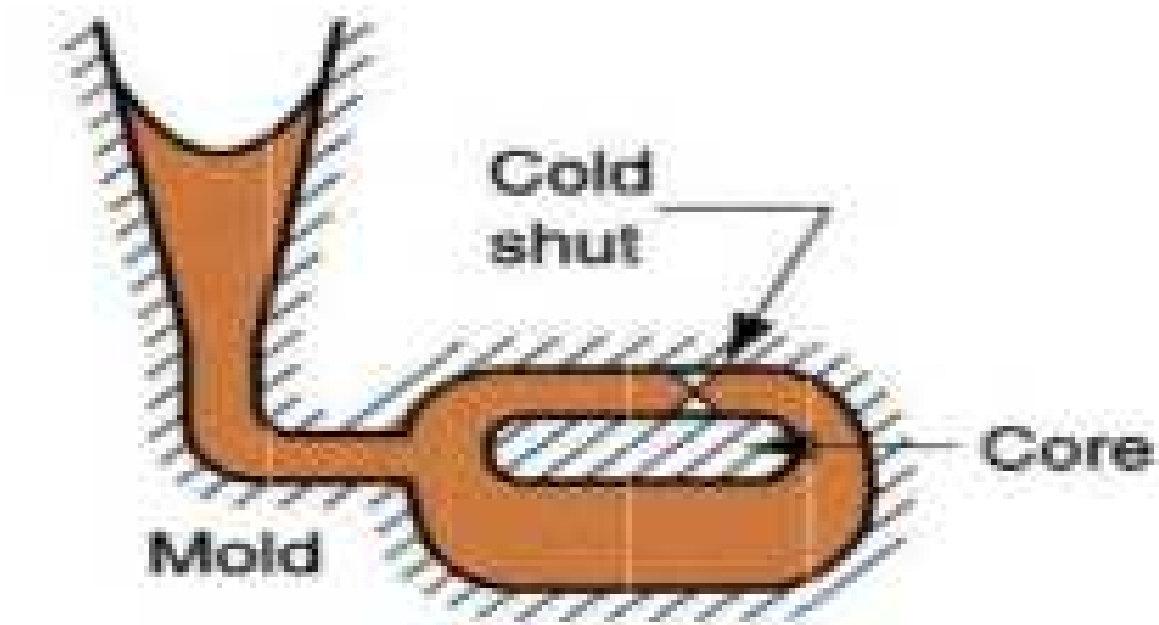
✓ **MISRUN**

A casting that has solidified before completely filling mould cavity



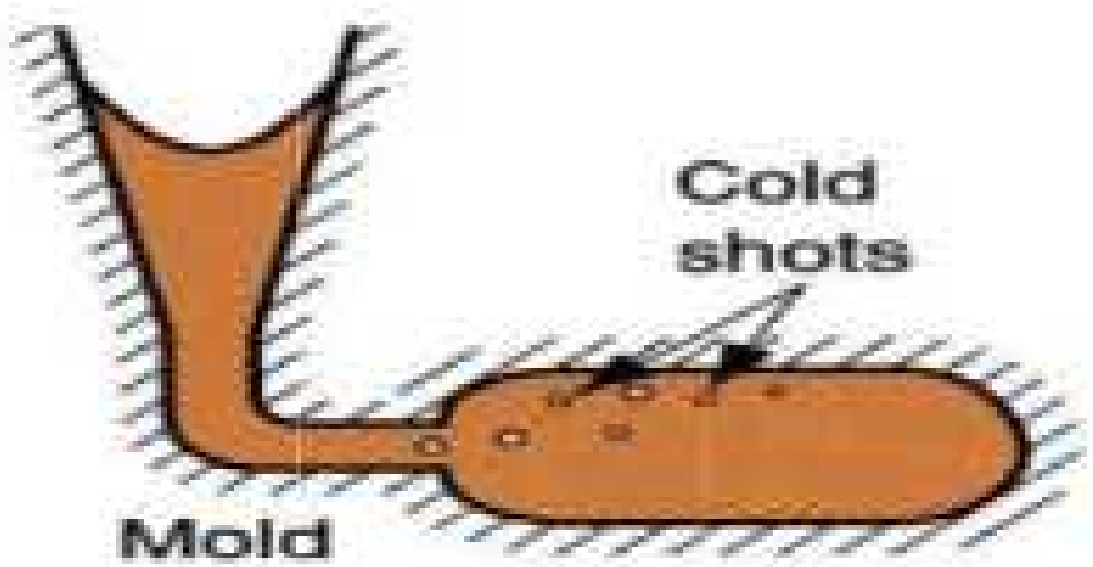
✓COLD SHUT

Two portions of metal flow together but there is a lack of fusion due to premature freezing



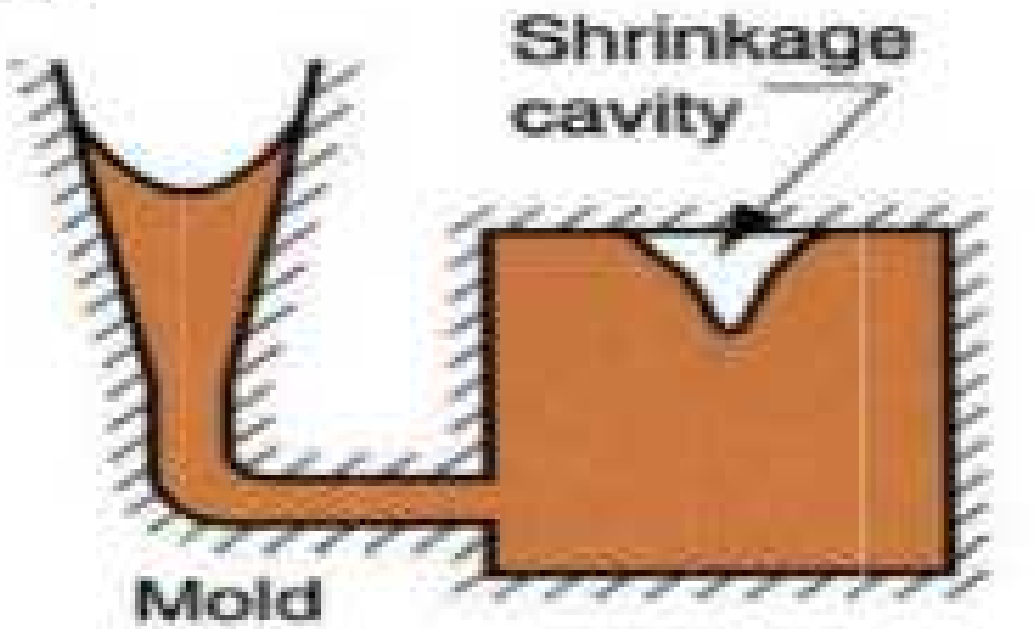
✓COLD SHOT

Metal splatters during pouring & solid globules from & become entrapped in casting



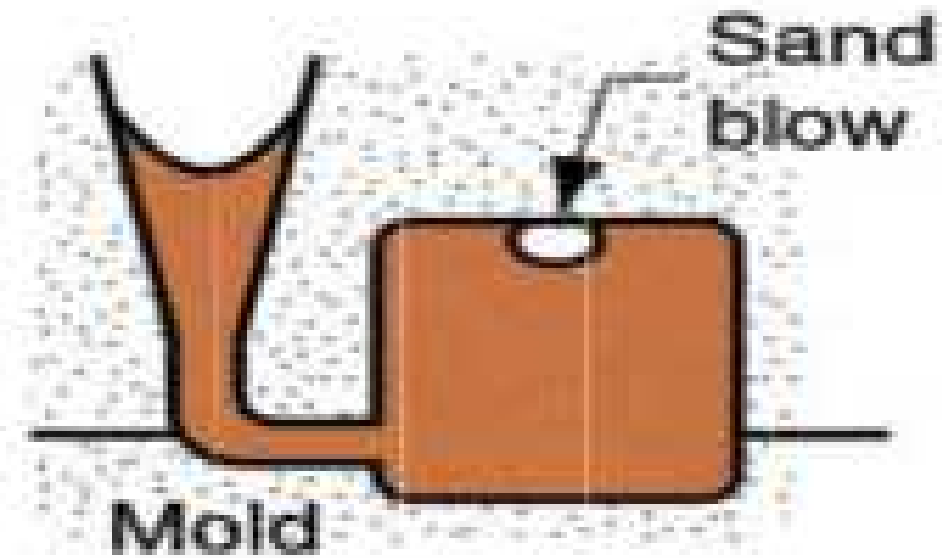
✓SHRINKAGE CAVITY

Depression in surface or internal void caused by solidification shrinkage that restricts amount of molten metal available in last region to freeze



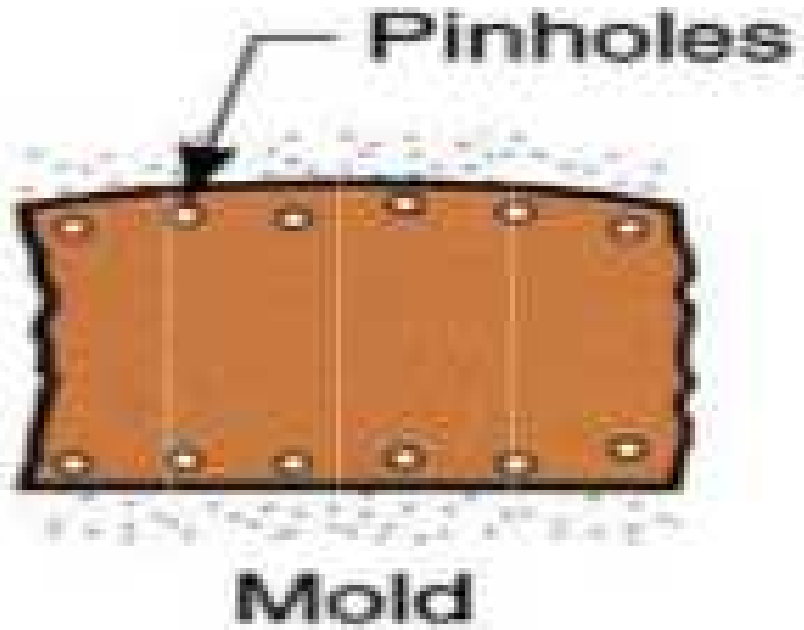
✓SAND BLOW

Balloon shaped gas cavity caused by release of mold gases during pouring



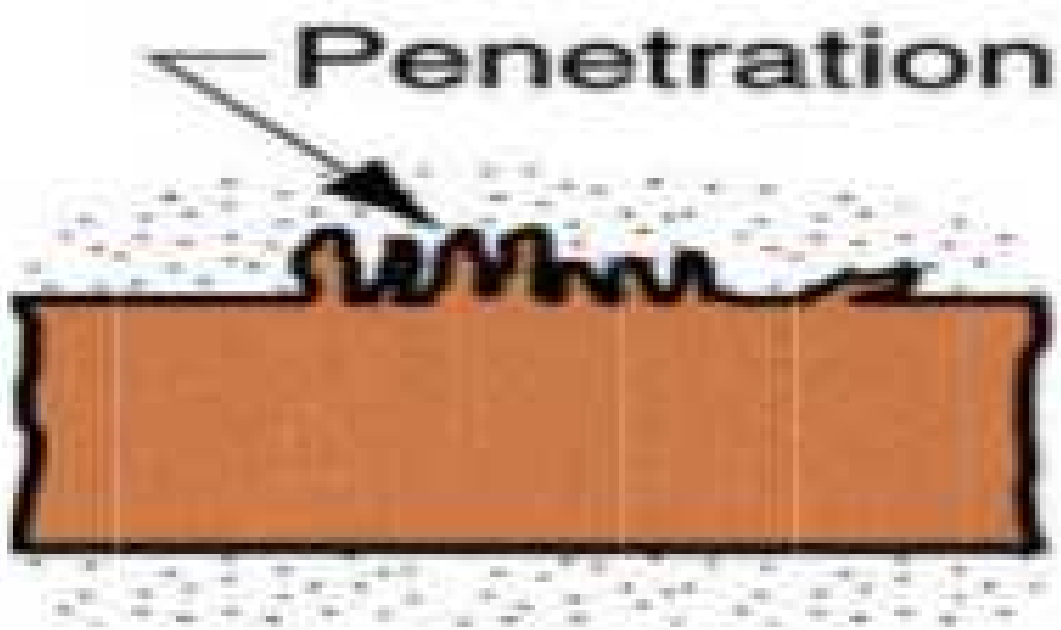
✓PIN HOLES

Formation of many small gas cavities at or slightly below surface of casting



✓PENETRATION

When fluidity of liquid metal is high, it may penetrate into sand mold or sand core, causing casting surface to consist of a mixture of sand grains and metal



✓MOLD SHIFT

A step in cast product at parting line caused by sidewise relative displacement of cope & drag