

MANUFACTURING TECHNOLOGY – I

Unit 1-Metal Castings



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Reference books

**“Manufacturing, Engineering & Technology” (4th Edition) by
Serope Kalpakjian, Steven Schmid**

Metal Castings - Introduction

- ❖ Metal Casting is one of the oldest materials shaping methods.
- ❖ Casting means pouring molten metal into a mould with a cavity of the shape to be made, and allowing it to solidify.
- ❖ When solidified, the desired metal object is taken out from the mould and the solidified object is called the casting.
- ❖ By this process, intricate parts can be obtained with strength and rigidity frequently not obtainable by any other manufacturing process.

Metal Castings - Introduction

- ❖ The mould, into which the metal is poured, is made of some heat resisting material.
- ❖ Sand is most often used as it resists the high temperature of the molten metal. Permanent moulds of metal can also be used to cast products.
- ❖ The metal casting industry plays a key role in all the major sectors of our economy.
- ❖ There are castings in locomotives, cars, trucks, aircraft, office buildings, factories, schools, and homes.

Metal Castings



Figure some metal cast parts.

Metal Castings



Figure some metal cast parts.

Steps in making casting

- Make a pattern out of wood , metal or plastic
- In case of sand casting , select, test and prepare the sand mixture for mold and core making
- With the help of pattern prepare the mould cavity and cores
 - Mould, core
- Melt the metal/alloy to be cast
- Pour the molten metal/alloy into the mould and remove the casting from the mould after metal solidifies
- Clean and finish the casting
- Test and inspect casting
- Remove the defects
- Relieve the casting stresses by heat treatment
- Inspect and ship for use

Steps in Sand Casting

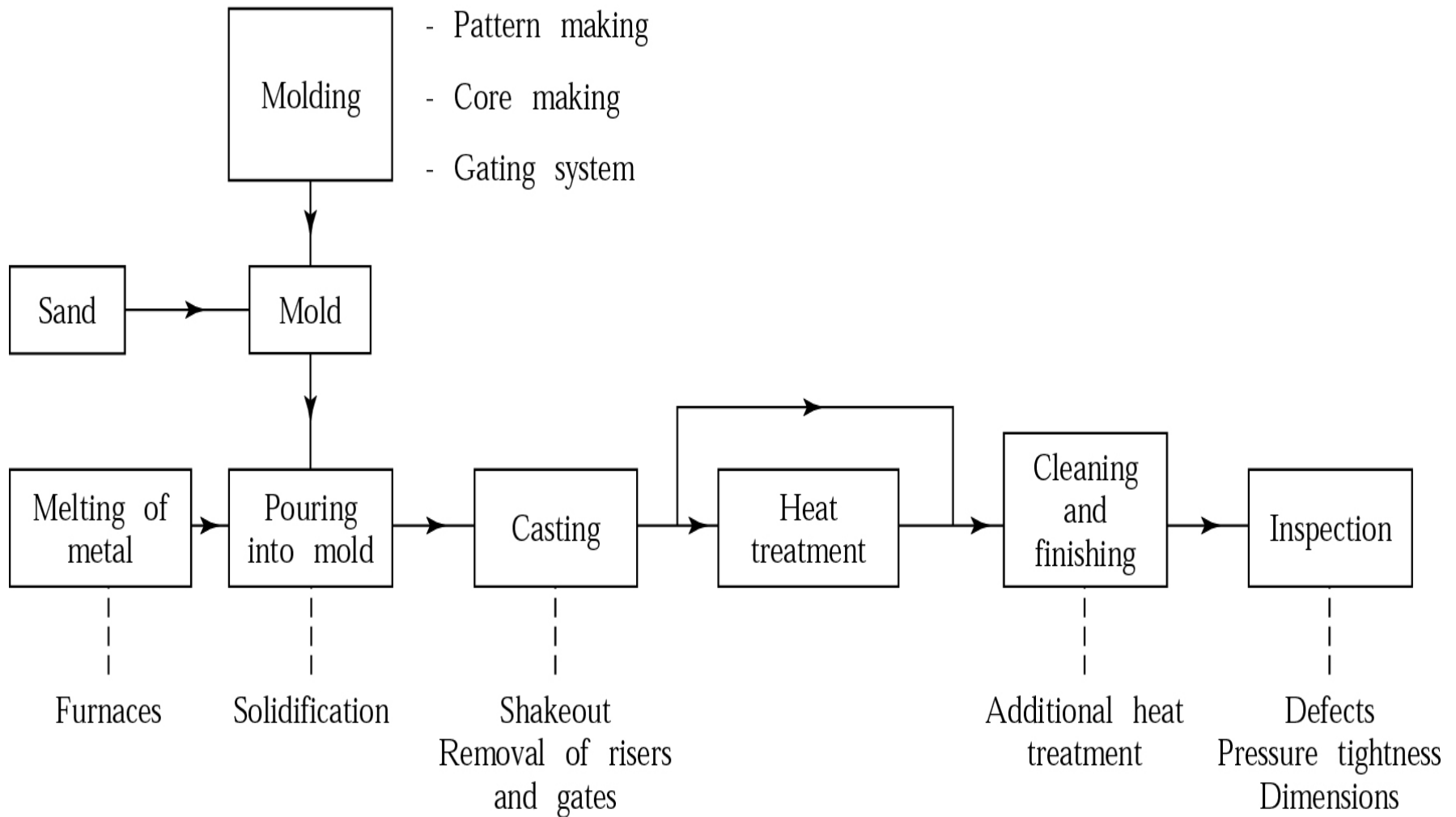


Fig: Outline of production steps in a typical sand-casting operation.

Foundry industry

- Foundry may be defined as a commercial set-up for manufacturing castings
 - Castings-it is the basic tool of shaping metal or alloys
- It can shape parts weighing from a few grams to hundreds of tons.
- Big foundrys in India are
 - Chittaranjan locomotives works, asansol
 - Durgapur , bhilai and rourkela steel plants
 - Heavy electrics ltd bhopla
 - Hindusthan machine tools, bangalore

Types of foundries

Foundries are classified according to the nature of work the undertake as follows

- Captive foundry
- Jobbing foundry
- Production foundry
- Semi- production foundry
- Ferrous foundry
- Non-ferrous foundry

Sections of foundry

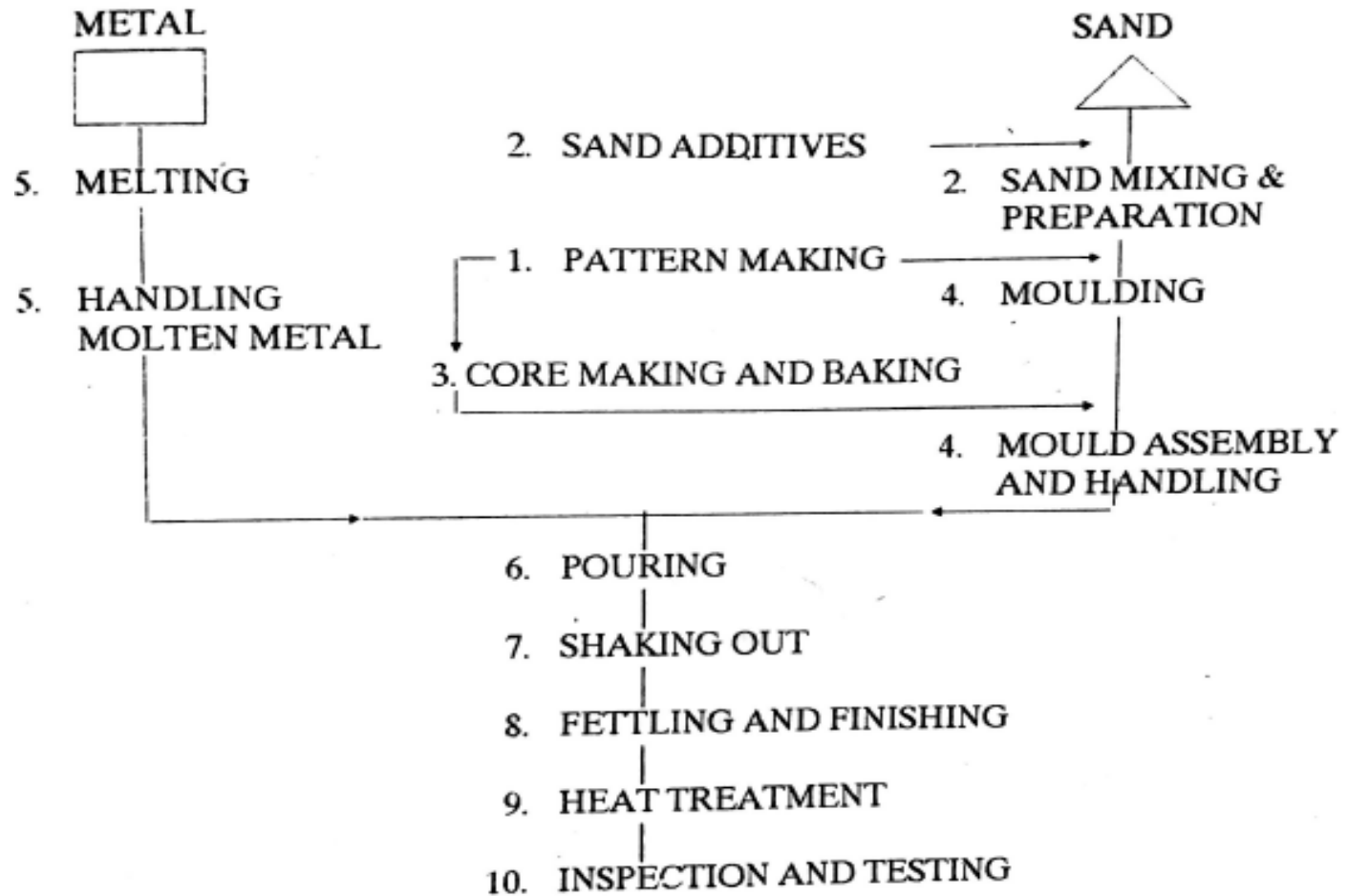
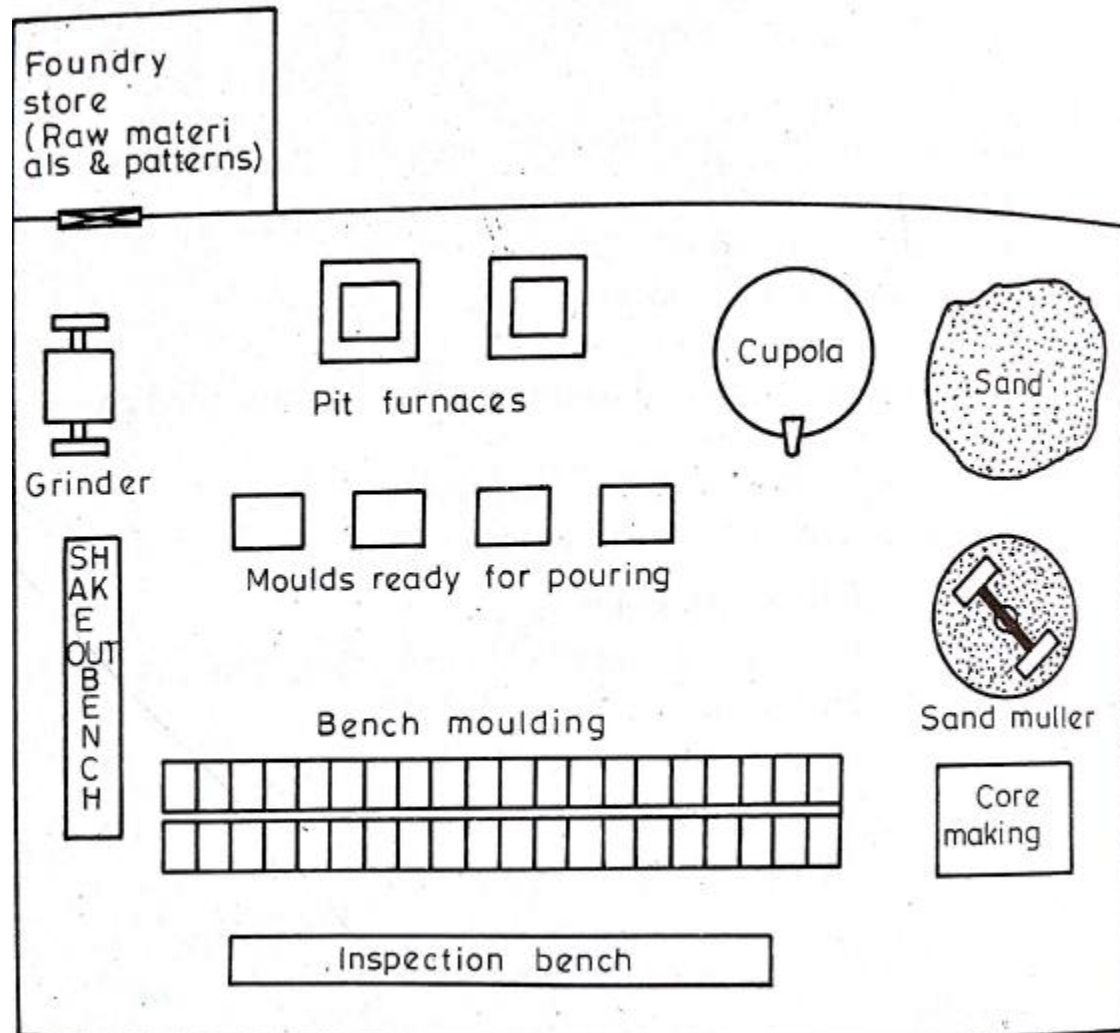


Fig. 1.2. Sections of foundry

Foundry layout



Advantages

The metal casting process is extensively used in manufacturing because of its many advantages.

1. Molten material can flow into very small sections so that intricate shapes can be made by this process. As a result, many other operations, such as machining, forging, and welding, can be minimized or eliminated.
2. It is possible to cast practically any material that is ferrous or non-ferrous.
3. As the metal can be placed exactly where it is required, large saving in weight can be achieved.
4. The necessary tools required for casting moulds are very simple and inexpensive. As a result, for production of a small lot, it is the ideal process.
5. There are certain parts made from metals and alloys that can only be processed this way.
6. Size and weight of the product is not a limitation for the casting process.

Limitations

1. Dimensional accuracy and surface finish of the castings made by sand casting processes are a limitation to this technique. Many new casting processes have been developed which can take into consideration the aspects of dimensional accuracy and surface finish. Some of these processes are die casting process, investment casting process, vacuum-sealed moulding process, and shell moulding process.
2. The metal casting process is a labour intensive process

Sand Mould Features

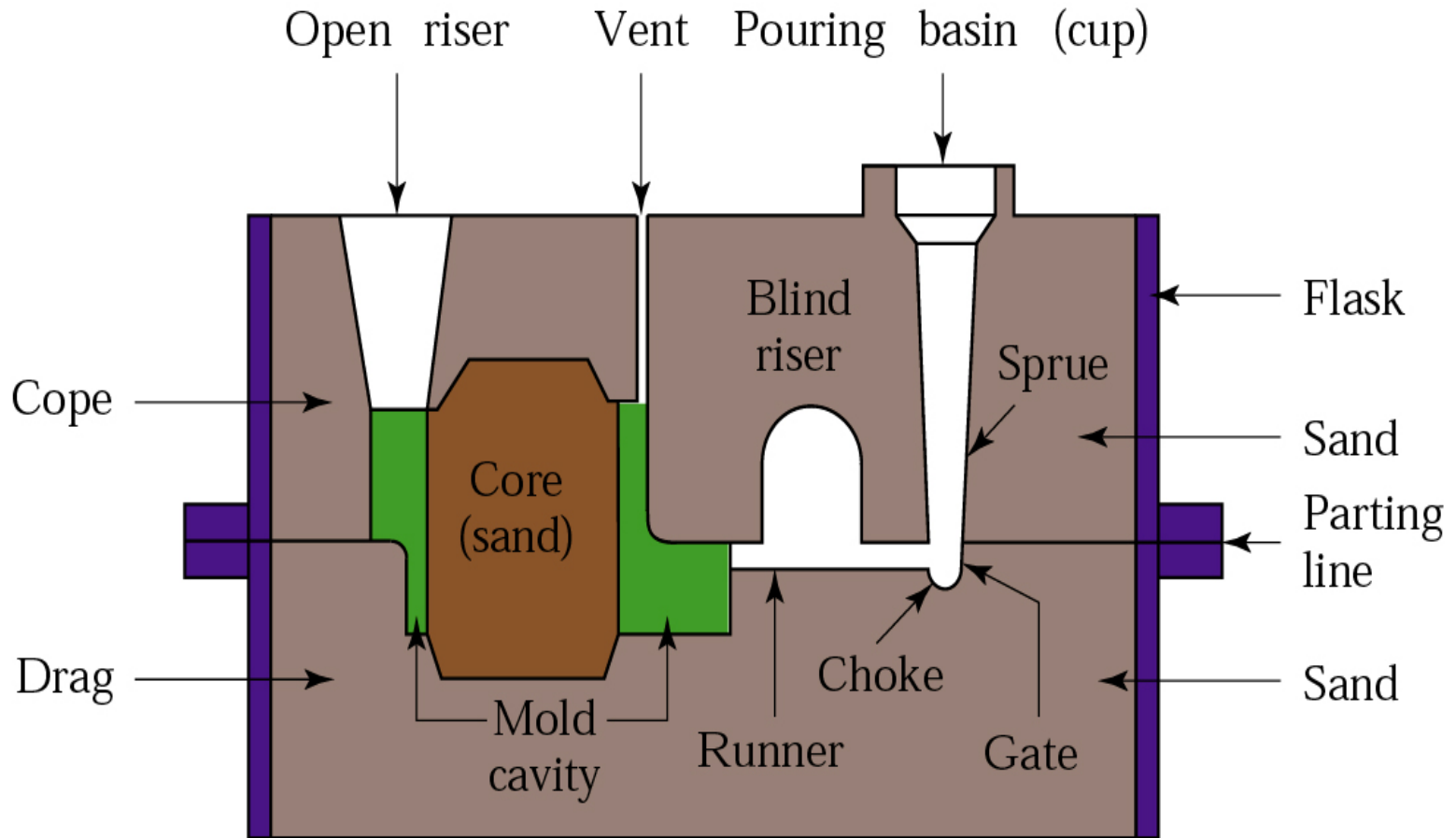


Fig: Schematic illustration of a sand mould, showing various features.

Casting Terms

- ❑ **Flask:** A metal or wood frame, without fixed top or bottom, in which the mould is formed. Depending upon the position of the flask in the moulding structure, it is referred to by various names such as drag – lower moulding flask, cope – upper moulding flask, cheek – intermediate moulding flask used in three piece moulding.
- ❑ **Pattern:** It is the replica of the final object to be made. The mould cavity is made with the help of pattern.
- ❑ **Parting line:** This is the dividing line between the two moulding flasks that makes up the mould.

Casting Terms

- ❑ **Moulding sand:** Sand, which binds strongly without losing its permeability to air or gases. It is a mixture of silica sand, clay, and moisture in appropriate proportions.
- ❑ **Facing sand:** The small amount of carbonaceous material sprinkled on the inner surface of the mould cavity to give a better surface finish to the castings.
- ❑ **Core:** A separate part of the mould, made of sand and generally baked, which is used to create openings and various shaped cavities in the castings.
- ❑ **Pouring basin:** A small funnel shaped cavity at the top of the mould into which the molten metal is poured.

Casting Terms

- ❑ **Sprue:** The passage through which the molten metal, from the pouring basin, reaches the mould cavity. In many cases it controls the flow of metal into the mould.
- ❑ **Runner:** The channel through which the molten metal is carried from the sprue to the gate.
- ❑ **Gate:** A channel through which the molten metal enters the mould cavity.

Casting Terms

- ❑ **Chaplets:** Chaplets are used to support the cores inside the mould cavity to take care of its own weight and overcome the metallostatic force.
- ❑ **Riser:** A column of molten metal placed in the mould to feed the castings as it shrinks and solidifies. Also known as “feed head”.
- ❑ **Vent:** Small opening in the mould to facilitate escape of air and gases.

Steps in Making Sand Castings

There are six basic steps in making sand castings:

1. Patternmaking
2. Core making
3. Moulding
4. Melting and pouring
5. Cleaning

1. Pattern making

- The pattern is a physical model of the casting used to make the mould.
- The mould is made by packing some readily formed aggregate material, such as moulding sand, around the pattern.
- When the pattern is withdrawn, its imprint provides the mould cavity, which is ultimately filled with metal to become the casting.
- If the casting is to be hollow, as in the case of pipe fittings, additional patterns, referred to as cores, are used to form these cavities.

2. Core making

- Cores are forms, usually made of sand, which are placed into a mould cavity to form the interior surfaces of castings.
- Thus the void space between the core and mould-cavity surface is what eventually becomes the casting.

3. Moulding

- Moulding consists of all operations necessary to prepare a mould for receiving molten metal.
- Moulding usually involves placing a moulding aggregate around a pattern held with a supporting frame, withdrawing the pattern to leave the mould cavity, setting the cores in the mould cavity and finishing and closing the mould.

4. Melting and Pouring

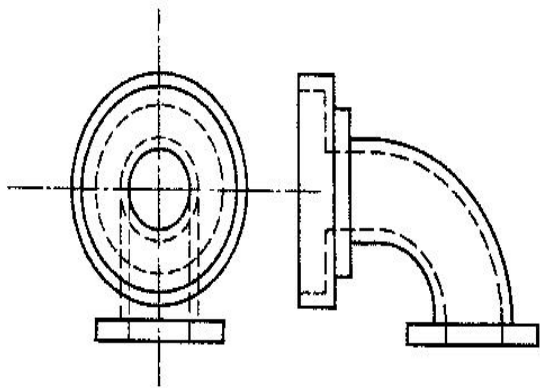
- The preparation of molten metal for casting is referred to simply as melting.
- Melting is usually done in a specifically designated area of the foundry, and the molten metal is transferred to the pouring area where the moulds are filled.

5. Cleaning

- Cleaning refers to all operations necessary to the removal of sand, scale, and excess metal from the casting.
- Excess metal, in the form of fins, wires, parting line fins, and gates, is removed. Inspection of the casting for defects and general quality is performed.

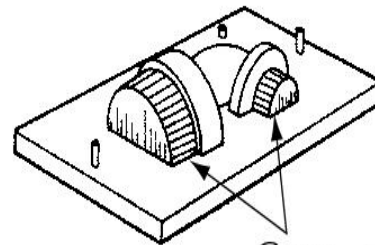
Sequence of Operations for Sand Casting (cont.)

(a)



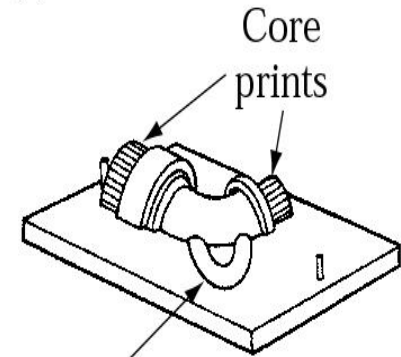
Mechanical drawing of part

(b)



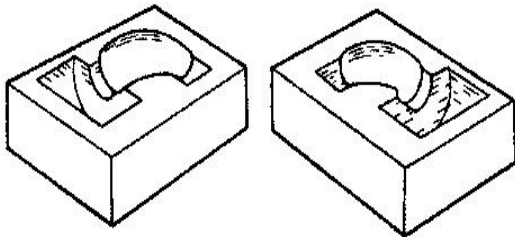
Core prints
Cope pattern plate

(c)



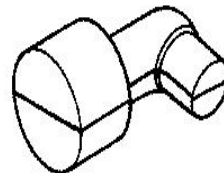
Core prints
Gate
Drag pattern plate

(d)



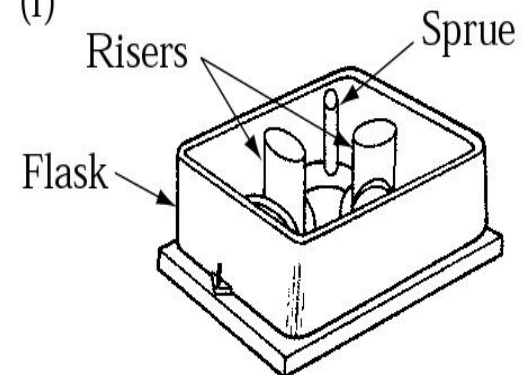
Core boxes

(e)



Core halves
pasted together

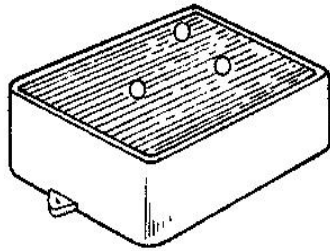
(f)



Risers
Sprue
Flask
Cope ready for sand

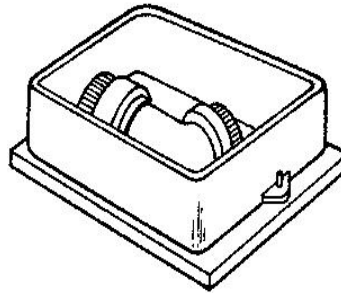
Sequence of Operations for Sand Casting (cont.)

(g)



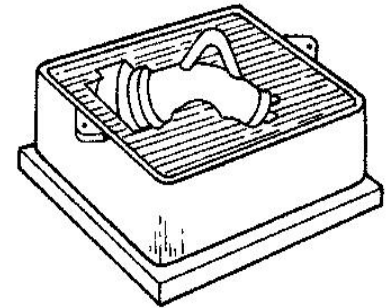
Cope after ramming with sand and removing pattern, sprue, and risers

(h)



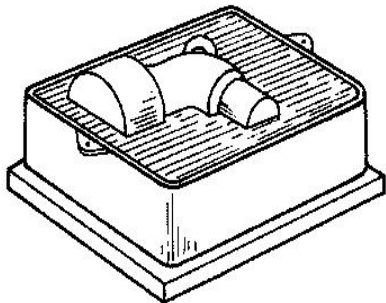
Drag ready for sand

(i)



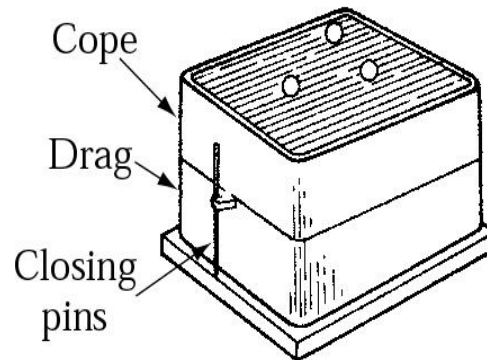
Drag after removing pattern

(j)



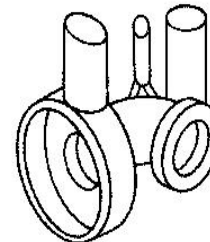
Drag with core set in place

(k)



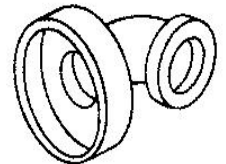
Cope and drag assembled ready for pouring

(l)



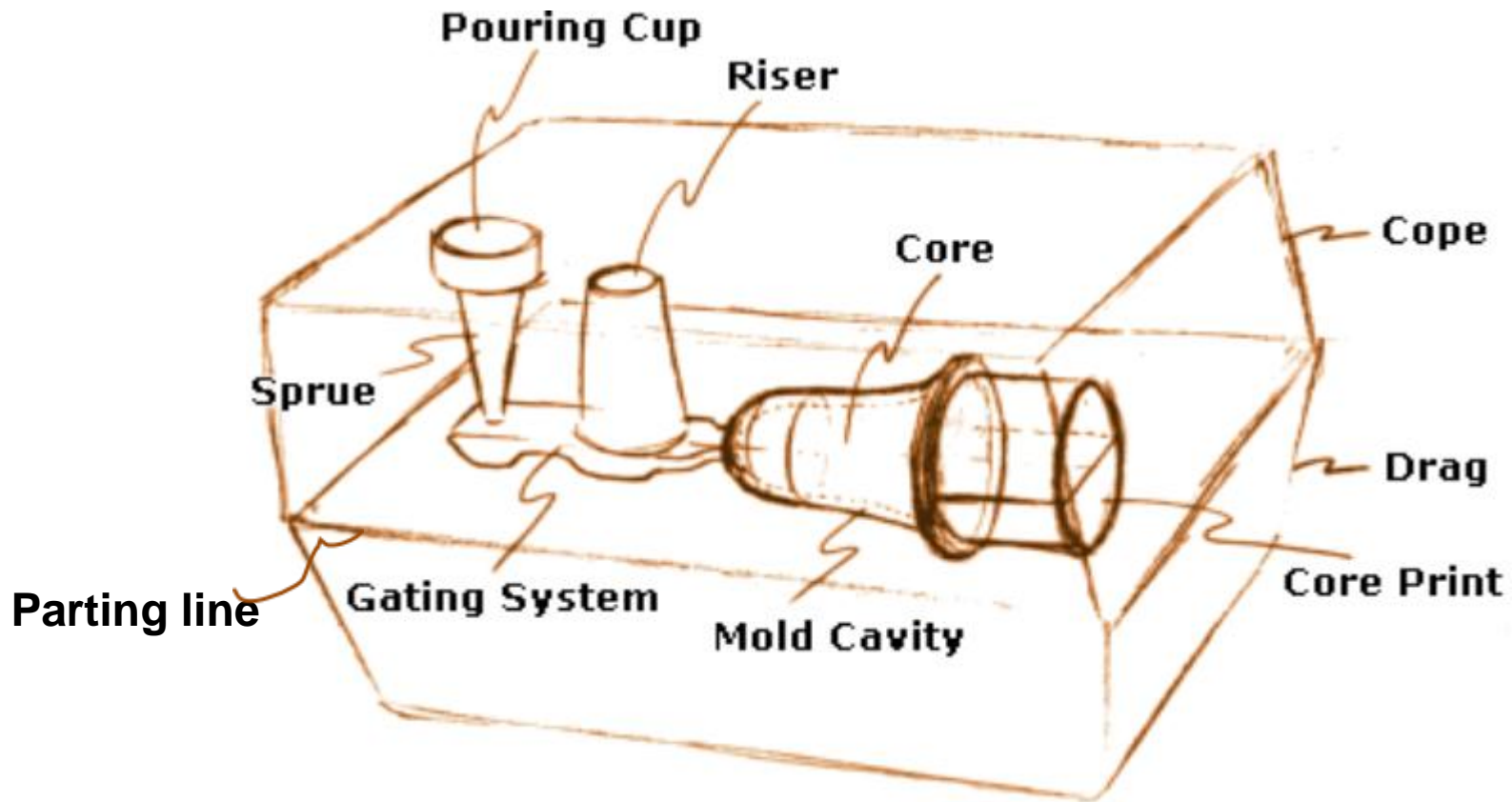
Casting as removed from mold; heat treated

(m)

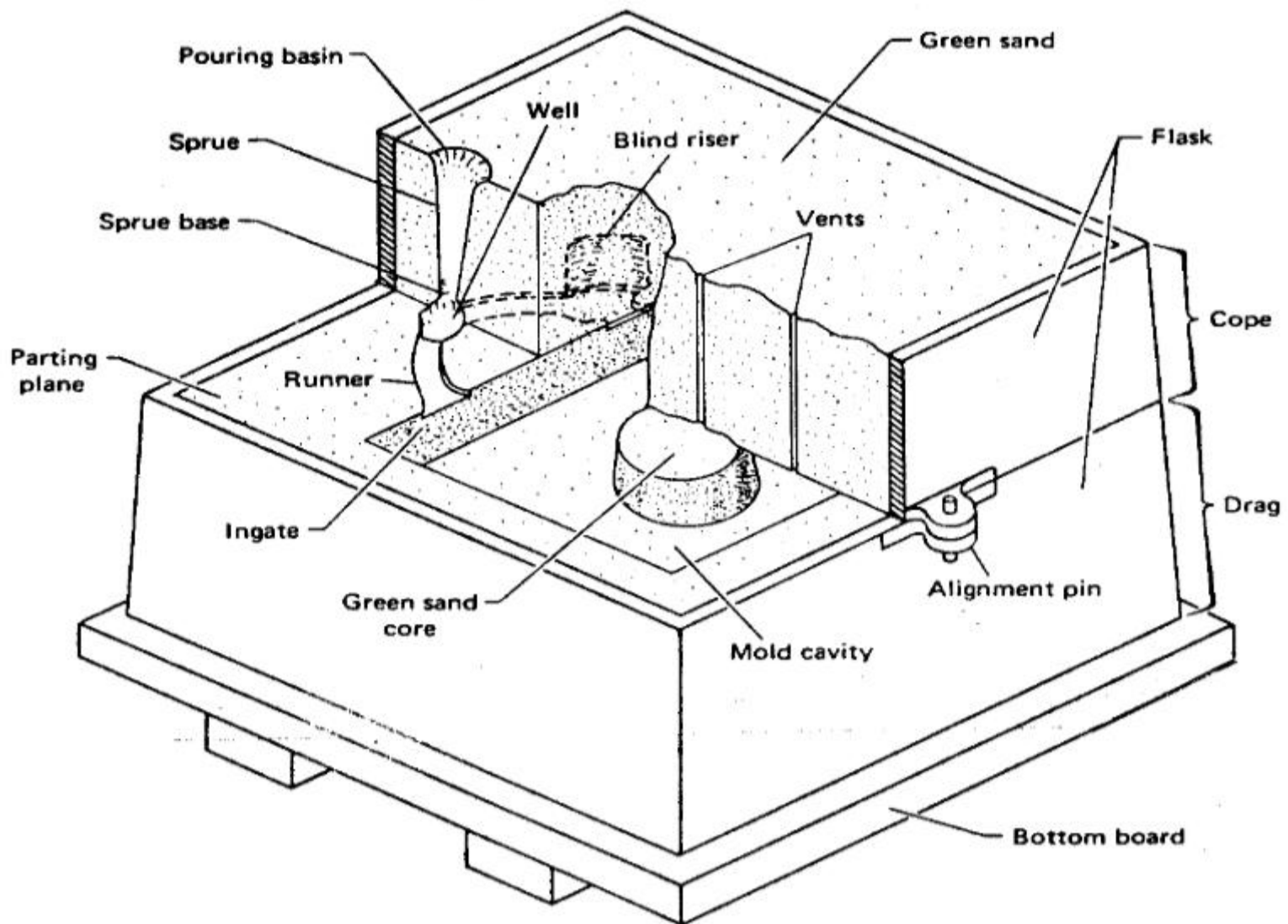


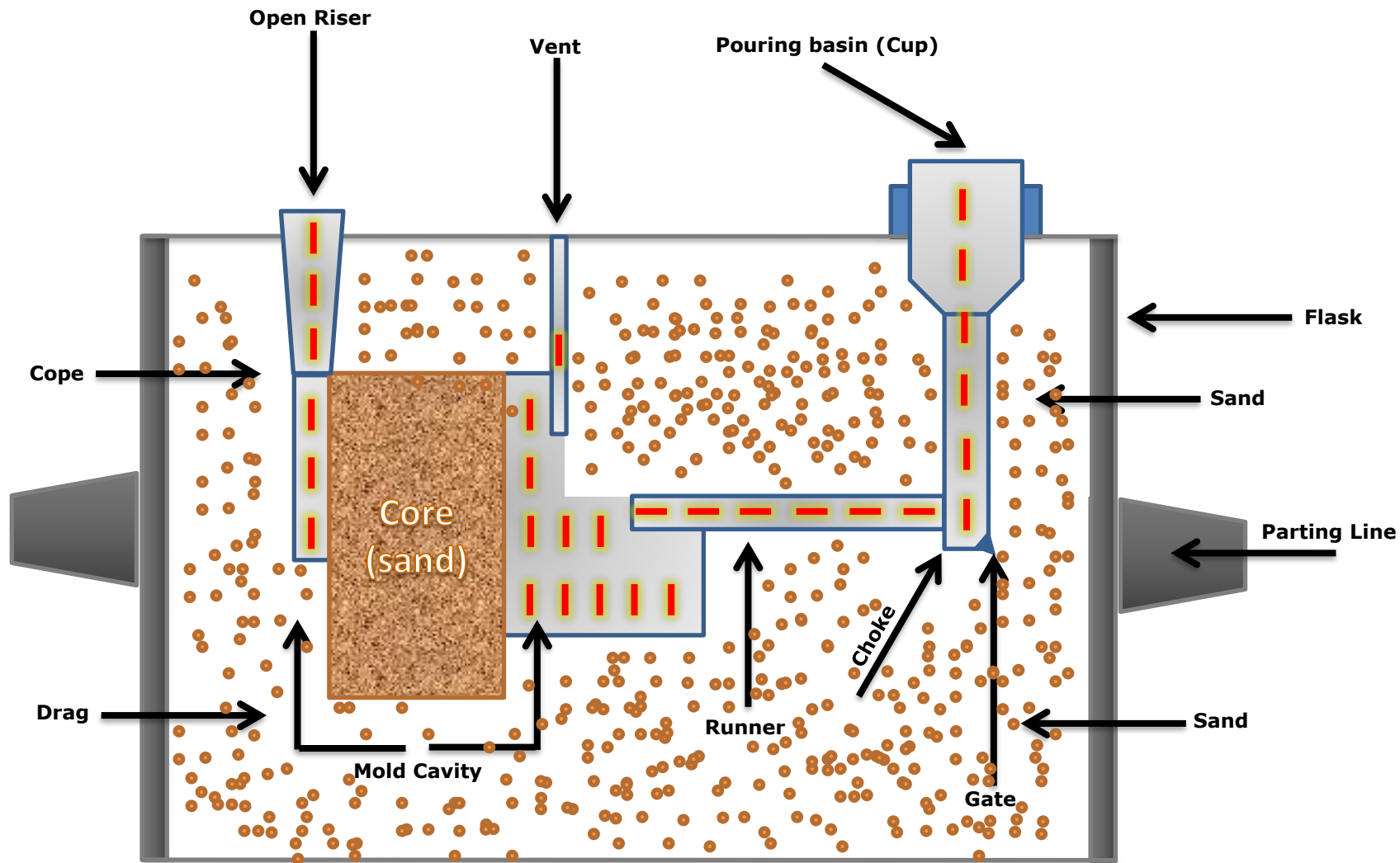
Casting ready for shipment

Casting Terminology



Sand Casting Configuration





MOLD SECTION SHOWING SOME CASTING TERMS

SAND-CASTING



Sand-casting is simple in concept, but demanding in execution. It is a process essential to making basic and advanced products. . . it is also hazardous and energy-intensive!

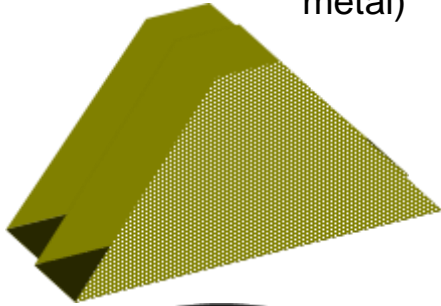
SAND-CASTING

Basic materials & equipment for green sand-casting



Pattern

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



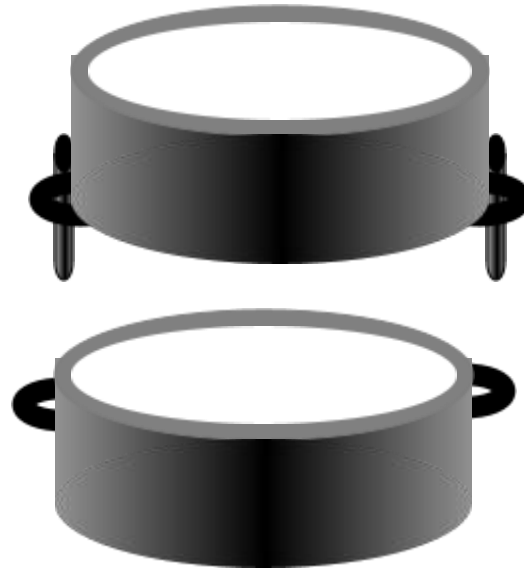
Sand, mixed with **clay binder** & **water** (so it will hold its shape) plus **coal dust** to improve surface finish



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)

SAND-CASTING

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

First of all,
mix the sand.

THEN

1

MOLDING:

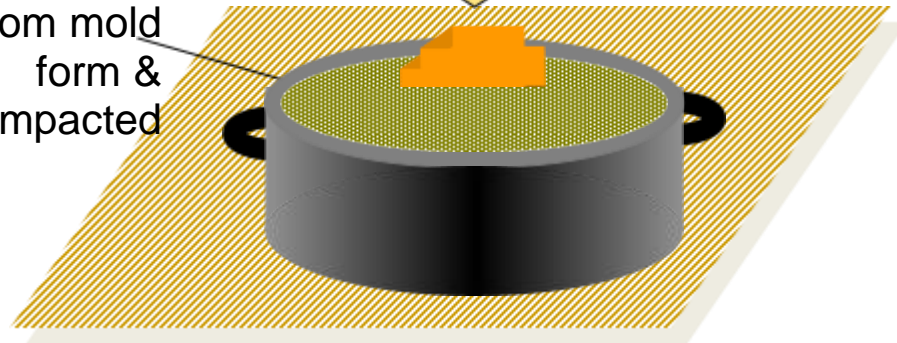
Sand placed into
bottom mold
form &
compacted



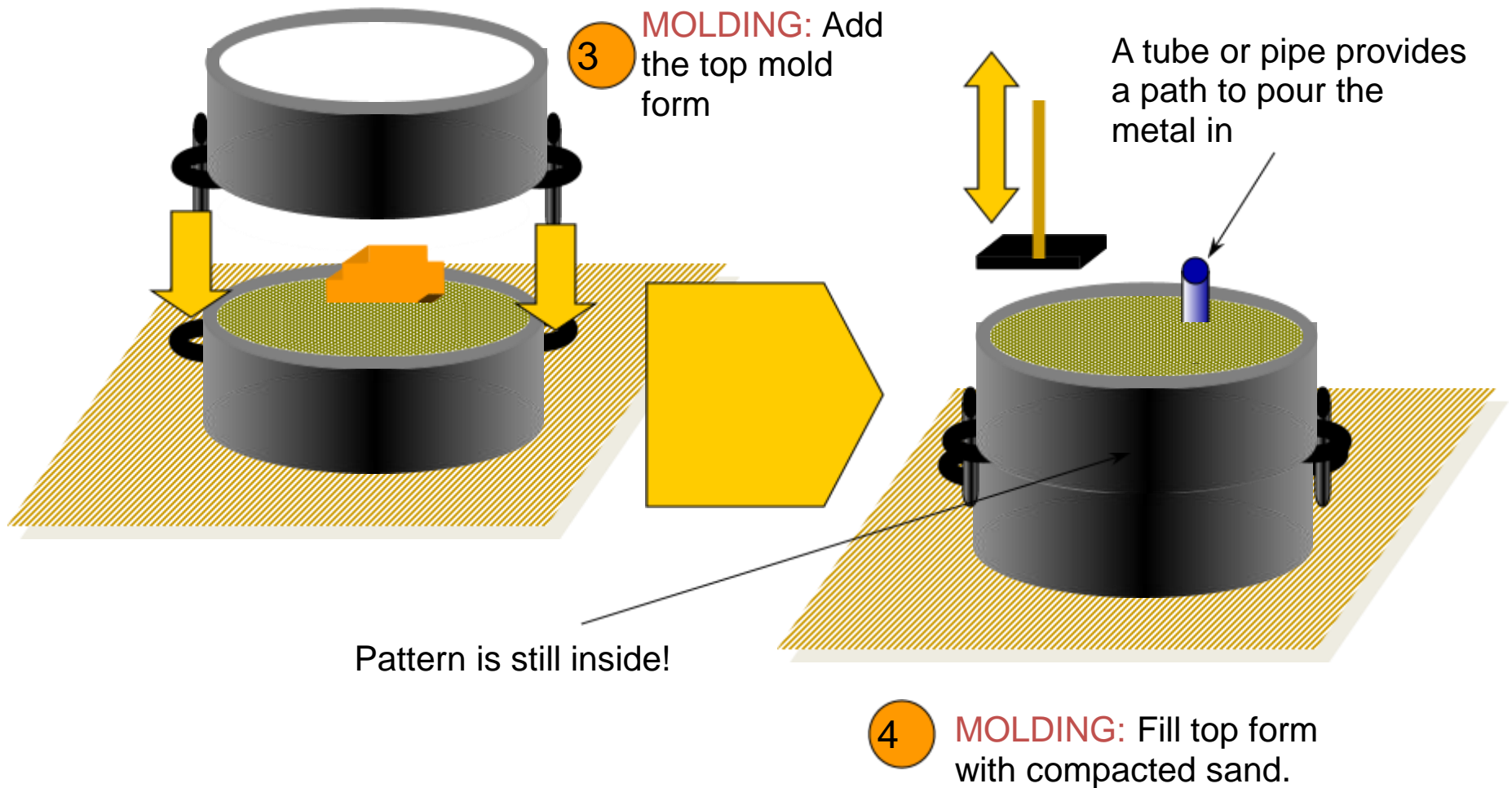
2

MOLDING:

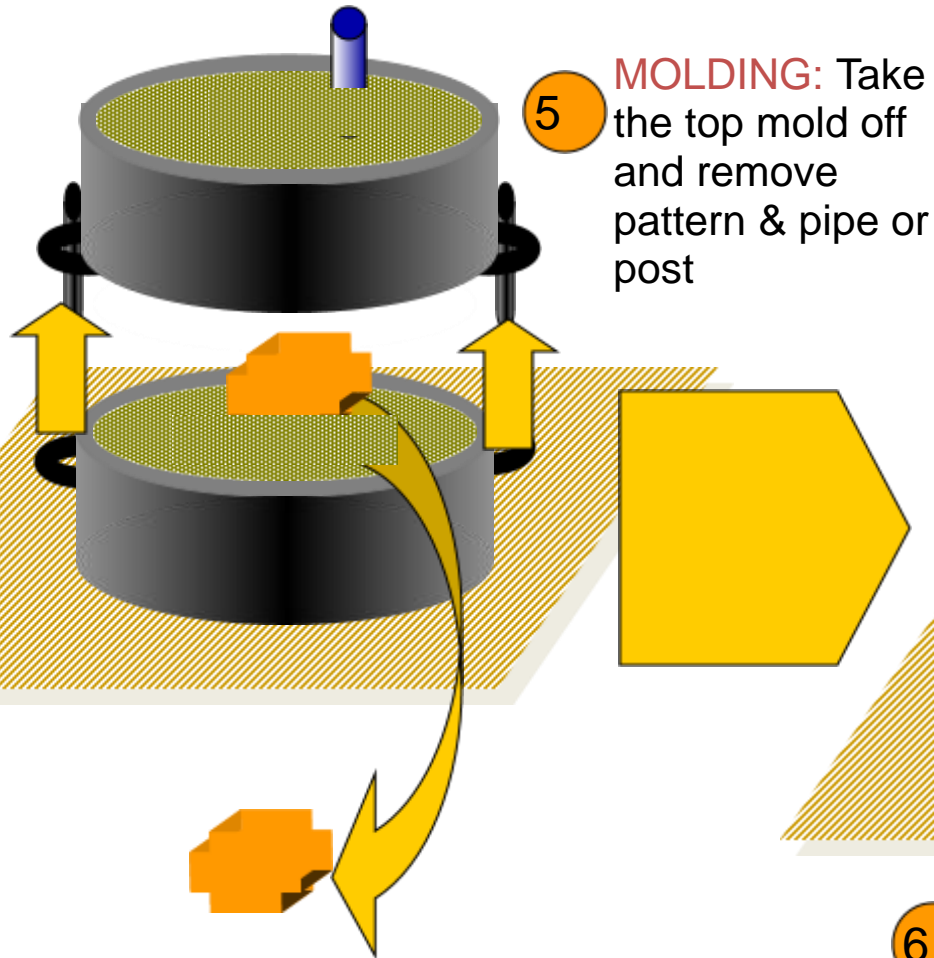
Pattern placed into mold



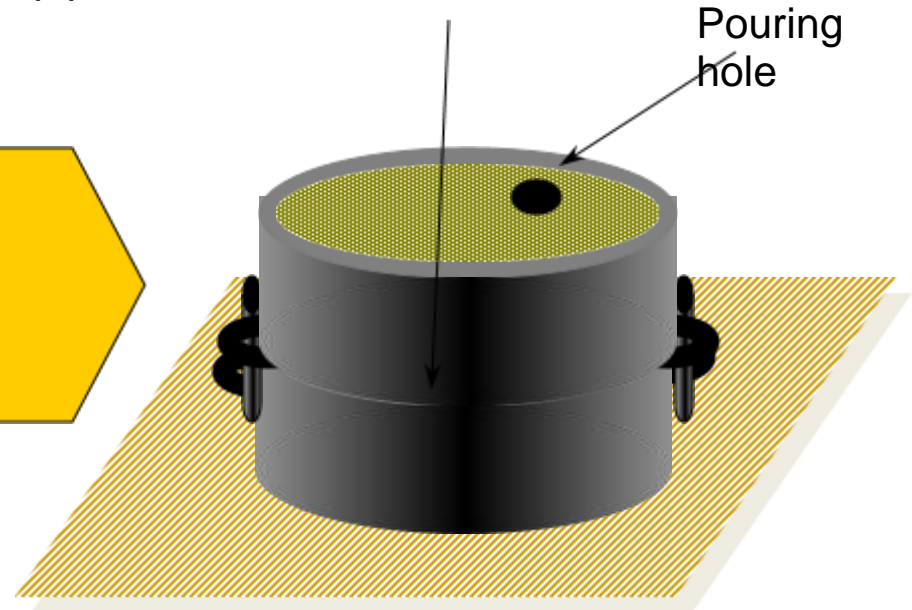
SAND-CASTING



SAND-CASTING

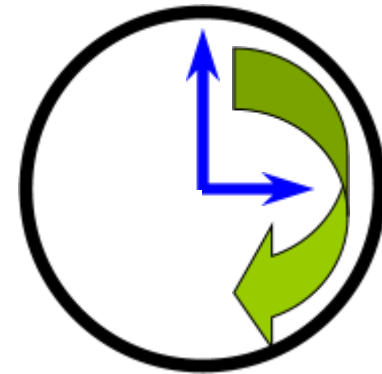
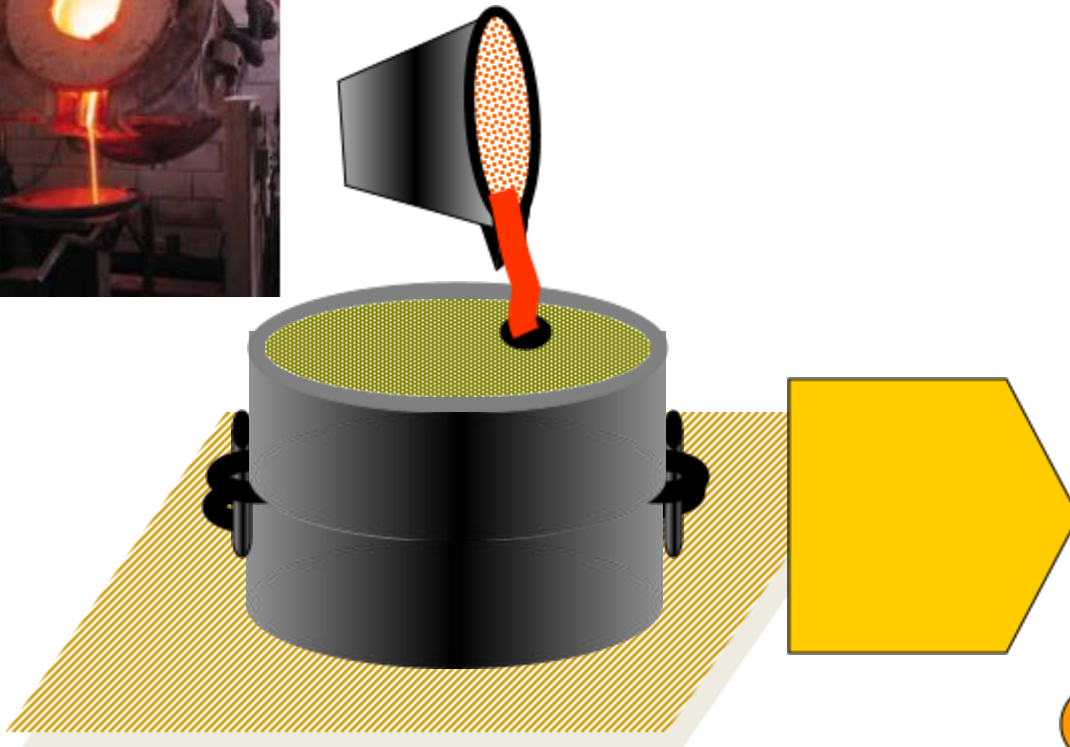


In the middle of the sand is a cavity shaped like the pattern!



6 **MOLDING:** Replace the top mold and fasten securely!

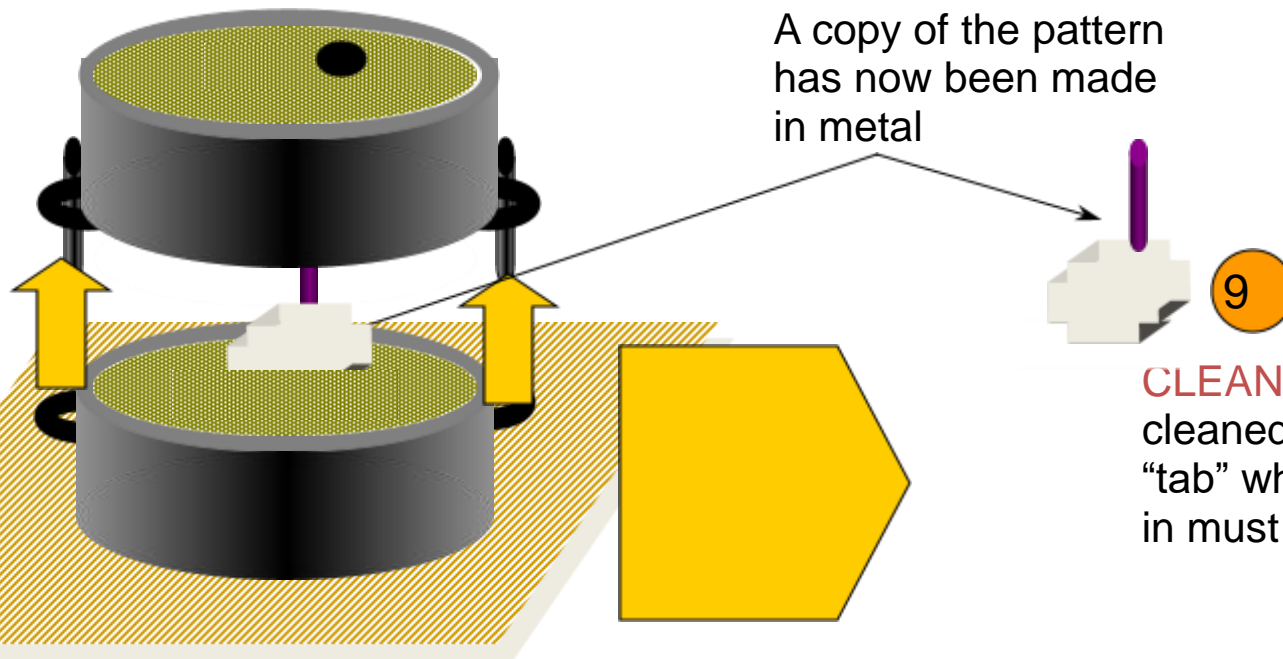
Sand-casting



- 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)

SAND-CASTING



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

Patterns

What is pattern?

- Approximate duplicate of product
- Its mold forming tool in foundry
- Patterns are made in the shape of the casting
- Pattern Materials: Wood, Plastic or metal.
- One piece or multiple piece pattern

Difference between pattern and casting

- Carries a shrinkage allowance
- Given with Machine allowance
- Given with draft allowance
- Carries core prints
- A pattern can be 2 or 3 pieces
- They are of different materials

Functions of pattern

- To prepare a mould cavity
- May contain a core to get hollow section
- Runner gates and risers can be accommodated
- Help to position the core
- Helps to identify the parting line
- Reduces casting defects
- Reduces overall costs

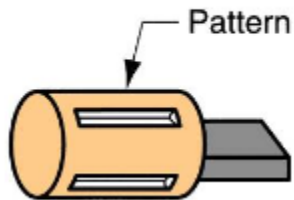
How do u select Pattern materials

- The number of casting to be produced
- Required dimensional accuracy
- Nature of molding process-sand/permanent
- Method of molding-machine /hand
- Shape and complexity
- Casting design parameter/shrinkage
- Type of molding material

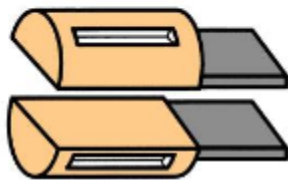
Types of Patterns

Types of patterns used in sand casting:

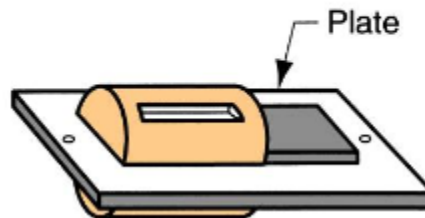
- (a) solid pattern
- (b) split pattern
- (c) match-plate pattern
- (d) cope and drag pattern



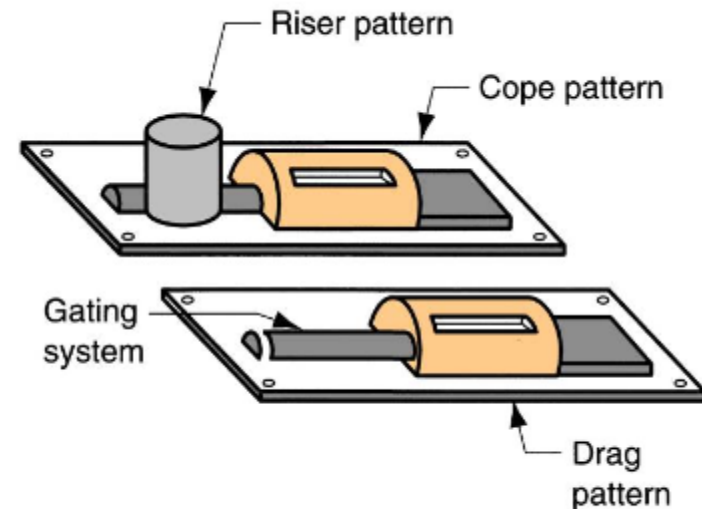
(a)



(b)



(c)



(d)

Cores

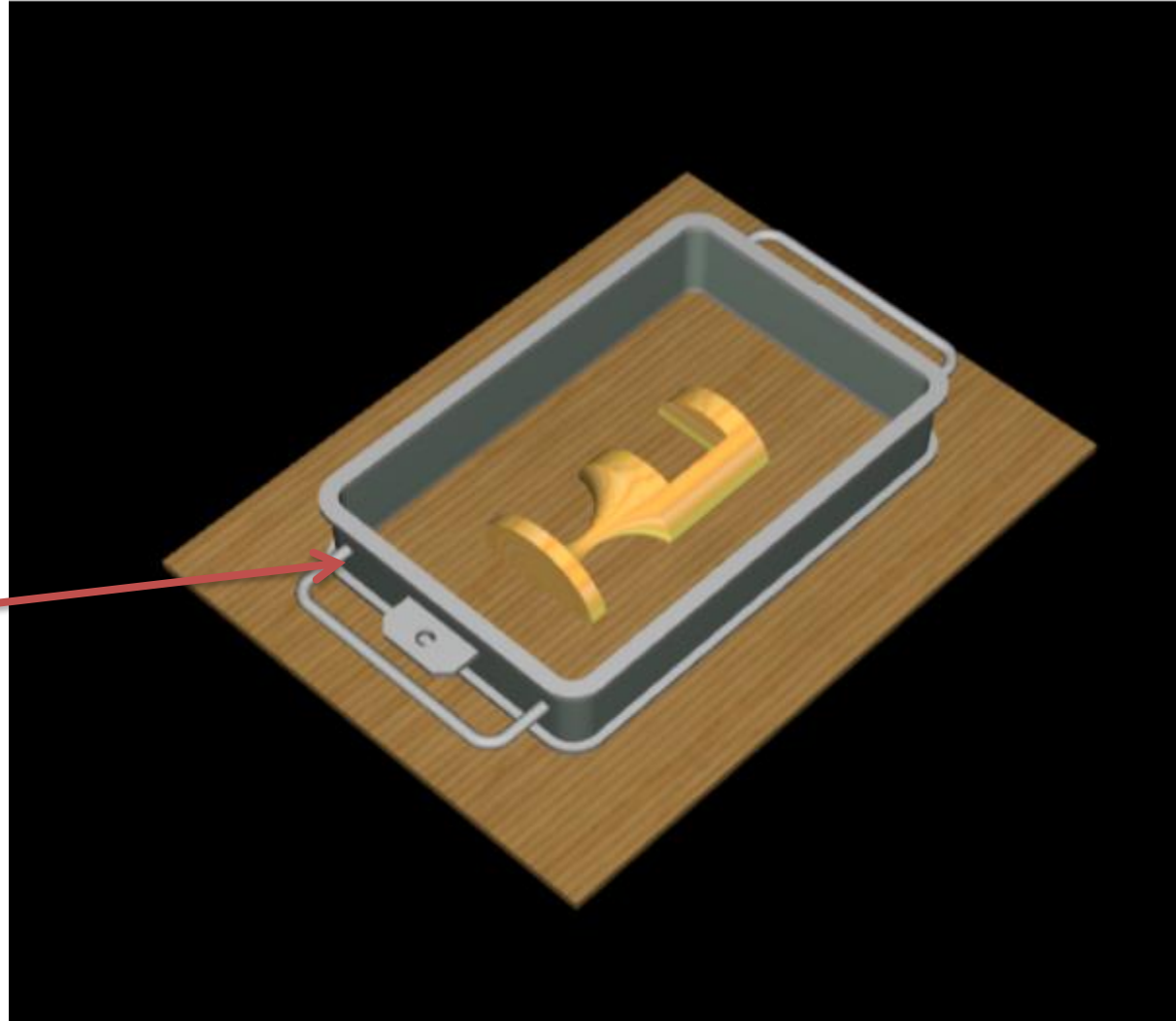
Cores

- Cores are used to create internal cavities.
- Should have similar properties as the mold.
- Shaken out after casting is produced.

1

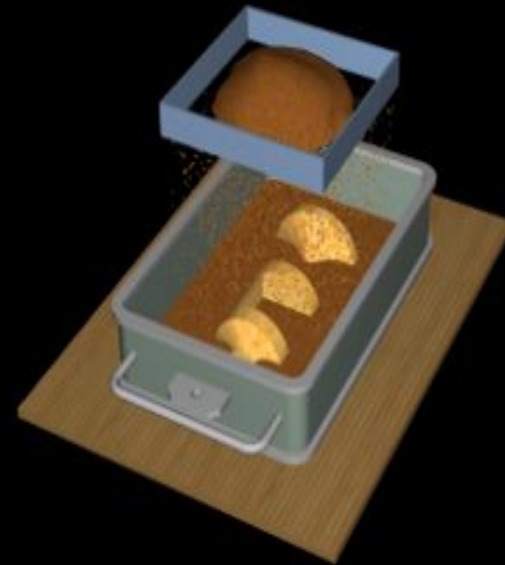
Sand-casting

Mould



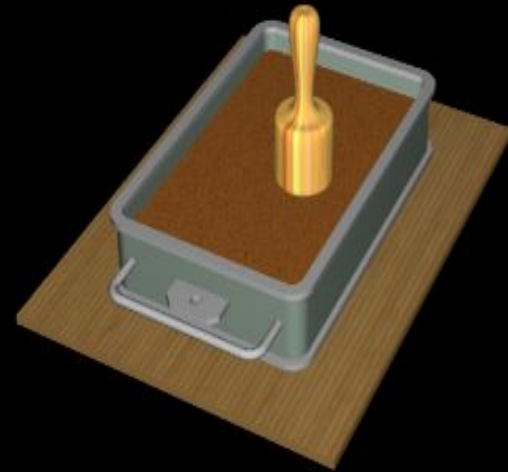
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Sand-casting



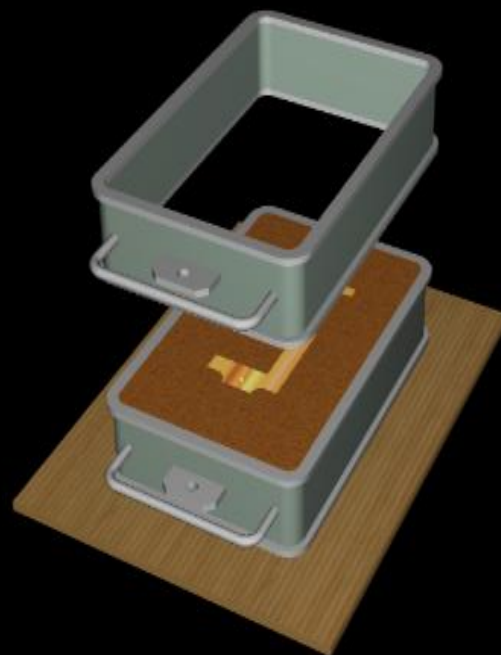
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Sand-casting



4

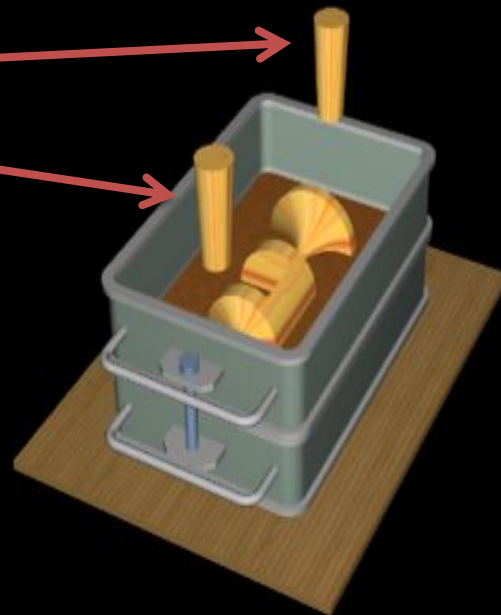
Sand-casting



5

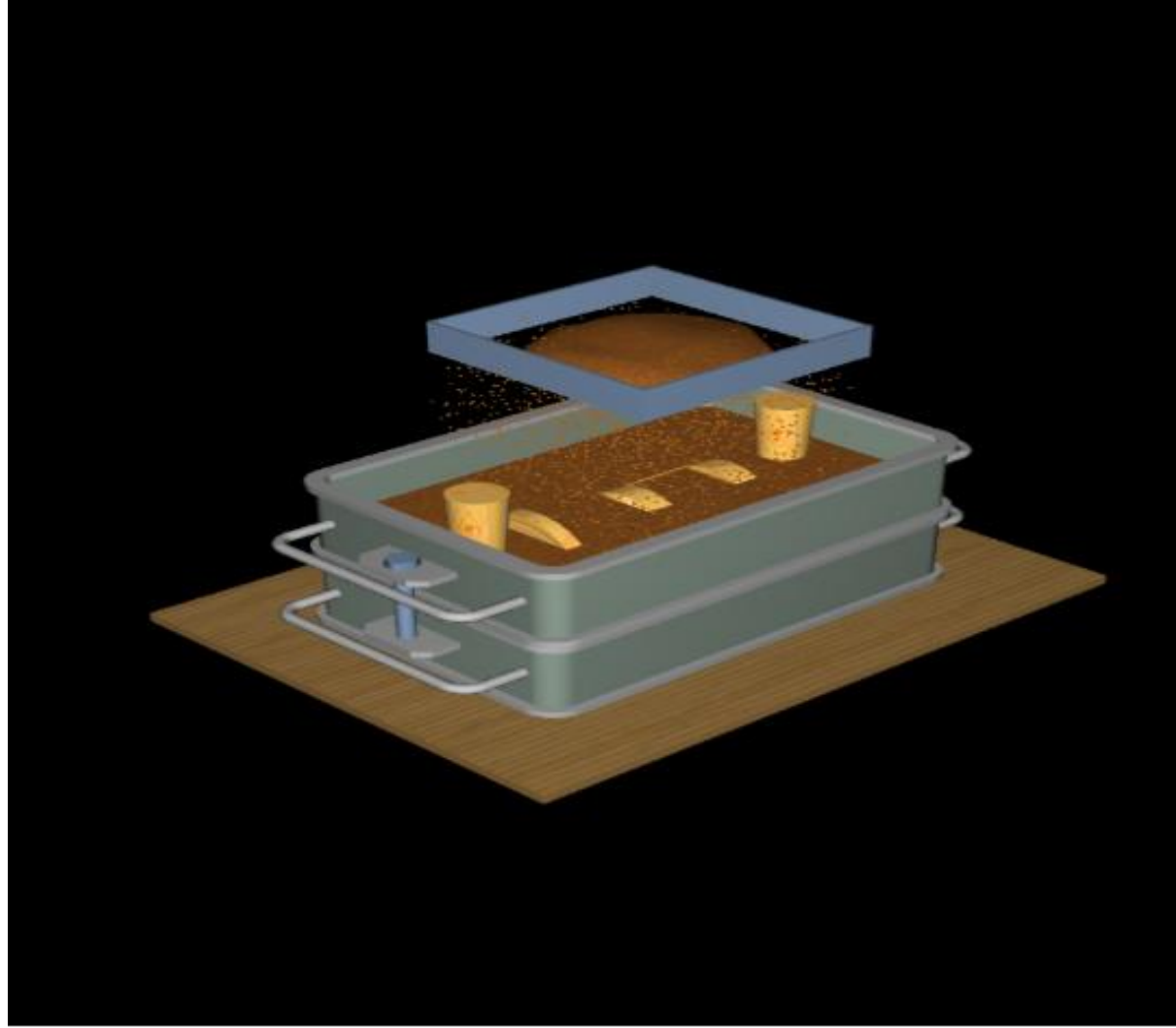
Sand-casting

Sprue
Pins



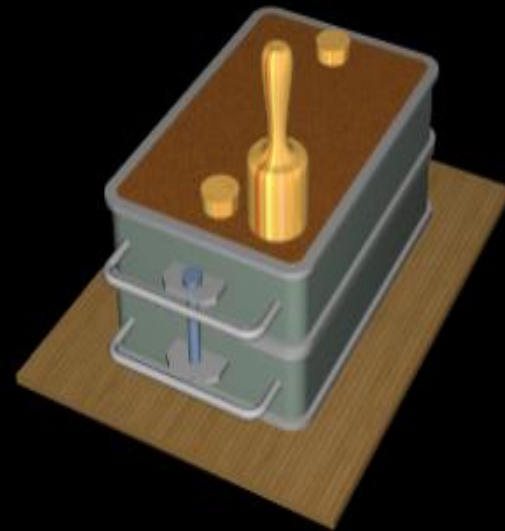
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Sand-casting



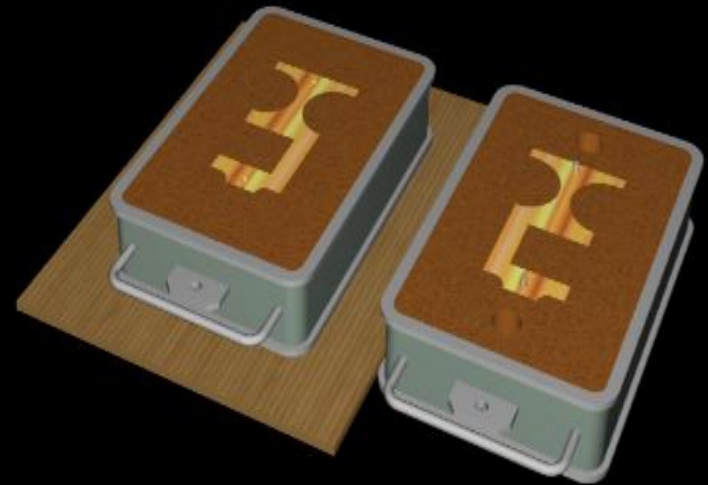
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Sand-casting



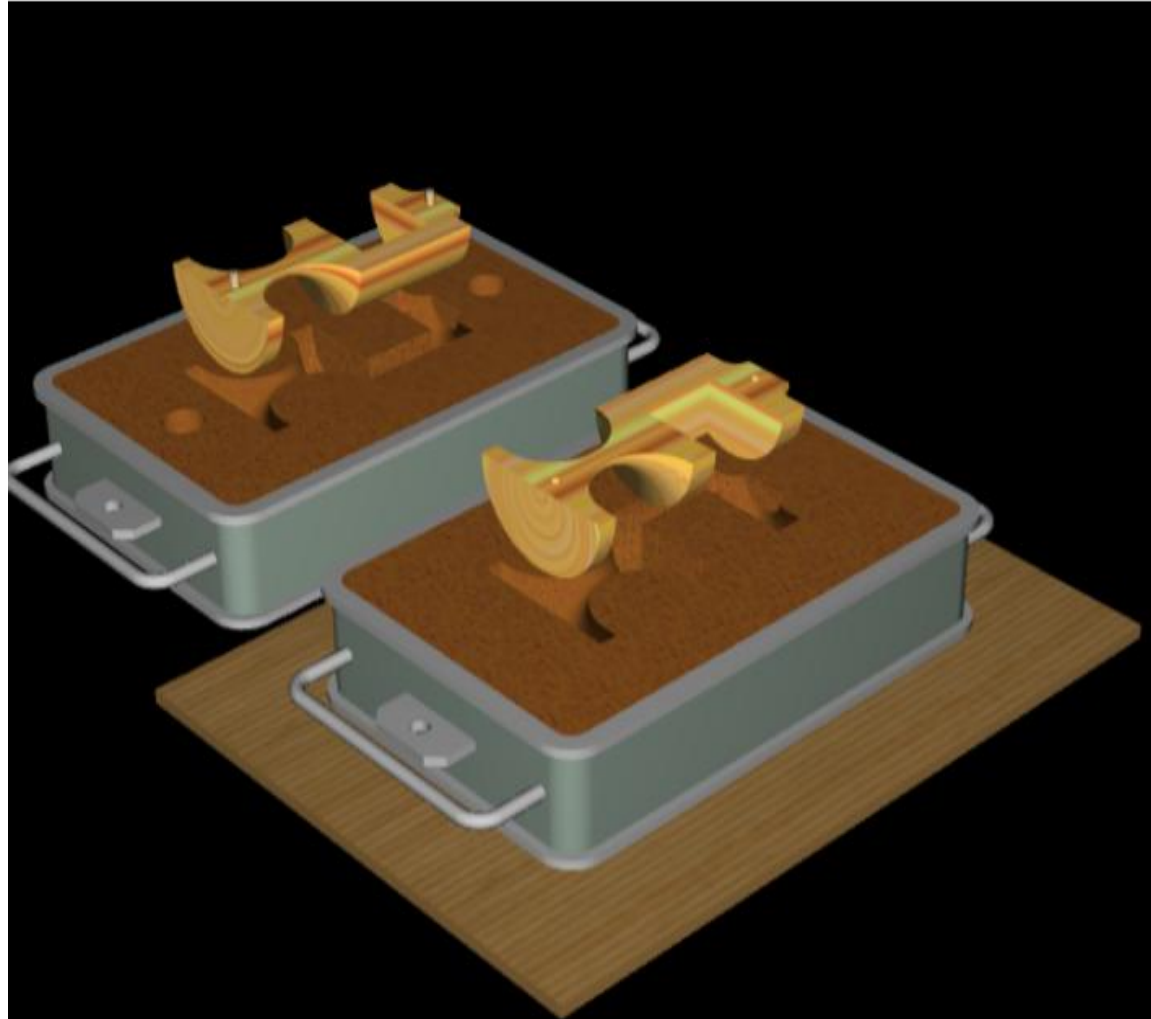
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Sand-casting



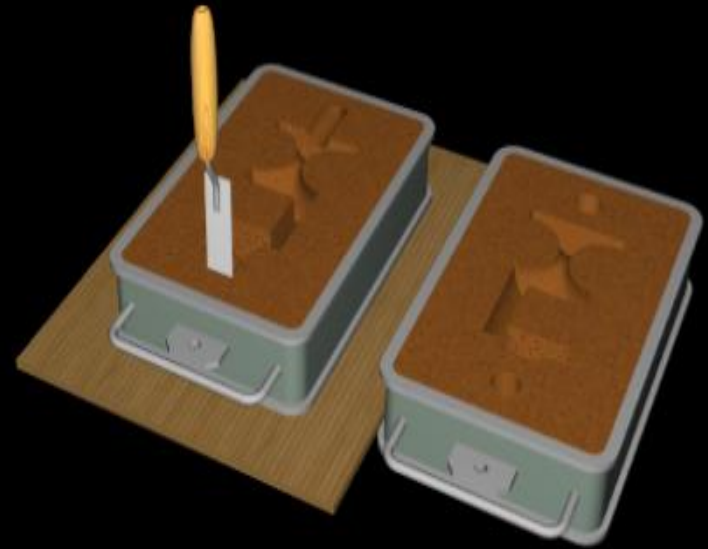
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Sand-casting



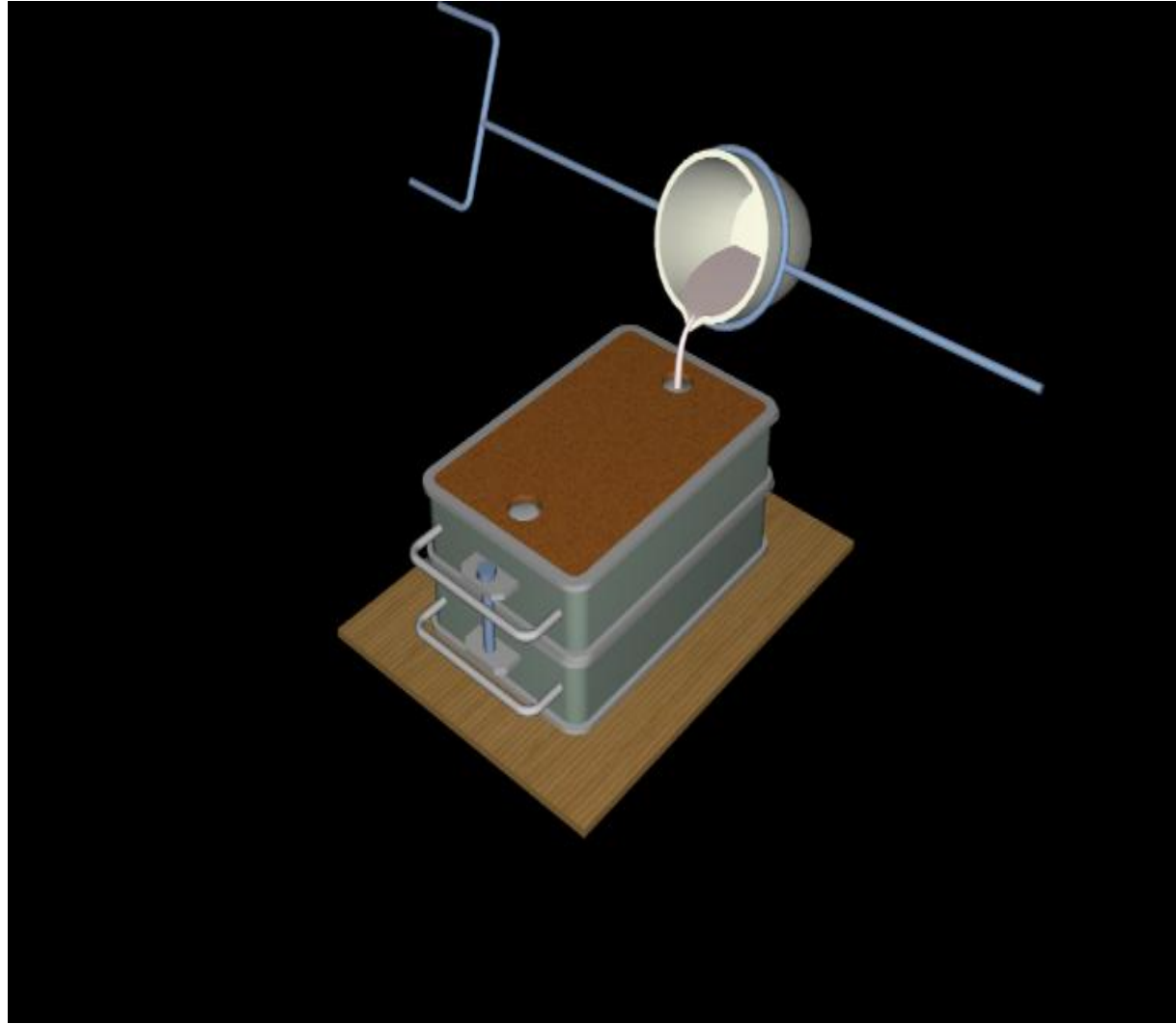
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Sand-casting



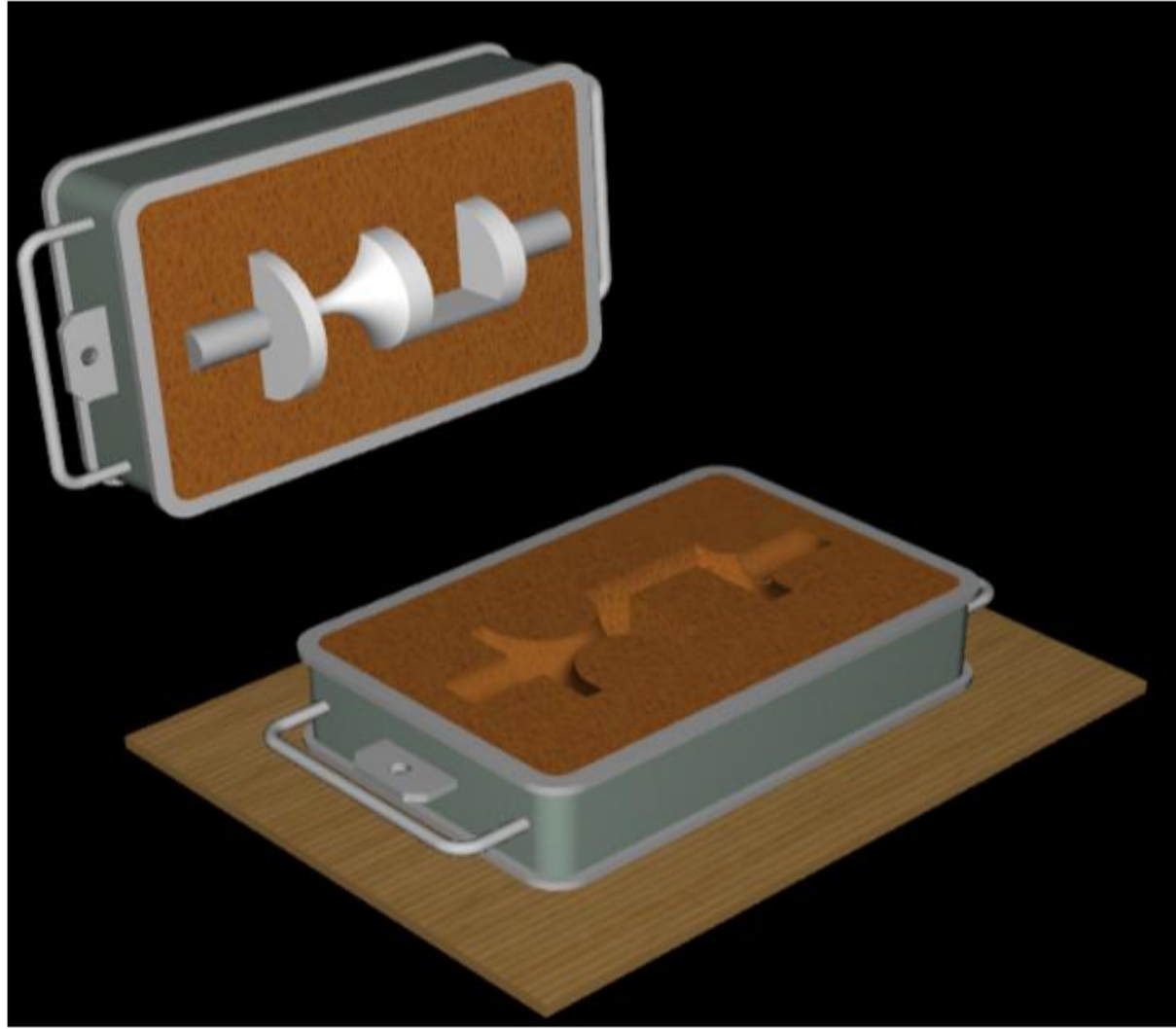
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Sand-casting



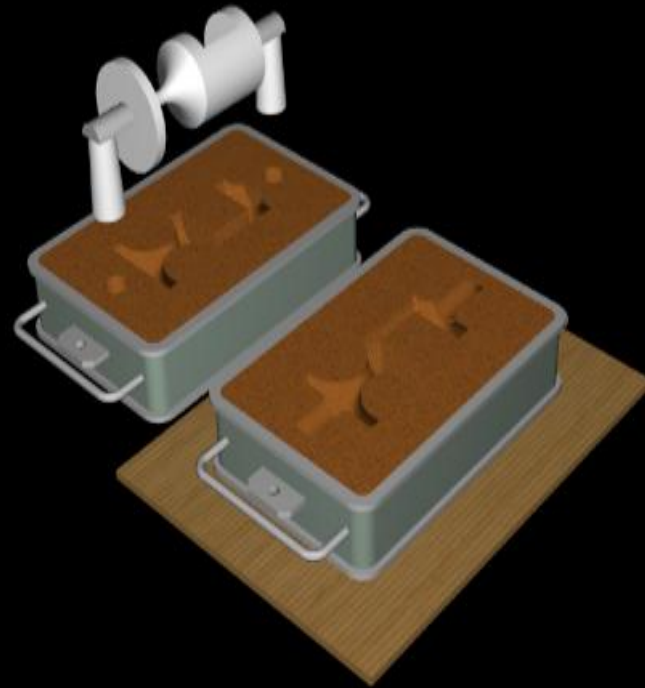
12

Sand-casting



13

Sand-casting



Sand-casting

[Complete Sand Casting Process Video](#)
[\(Click Here\)](#)

Casting is the process where metal is heated until molten. While in the molten or liquid state it is poured into a mold or vessel to create a desired shape.

Forging is the application of thermal and mechanical energy to steel billets or ingots to cause the material to change shape while in a solid state.