

Solidification Processes

Metal Casting Basics

Casting Basics

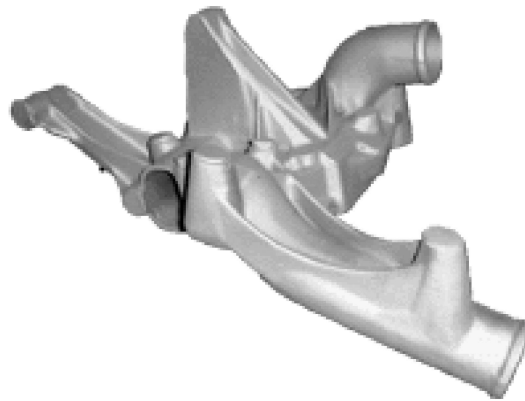
- A casting is a metal object obtained by *pouring molten metal into a mold* and allowing it to *solidify*.



Gearbox casting



Aluminum manifold



Magnesium casting



Cast wheel

[Click here for other examples](#)

Casting: Brief History

- 3200 B.C. – Copper part (a frog!) cast in Mesopotamia. Oldest known casting in existence
- 233 B.C. – Cast iron plowshares (in China)
- 500 A.D. – Cast crucible steel (in India)
- 1642 A.D. – First American iron casting at Saugus Iron Works, Lynn, MA
- 1818 A.D. – First cast steel made in U.S. using crucible process
- 1919 A.D. – First electric arc furnace used in the U.S.
- Early 1970's – Semi-solid metalworking process developed at MIT
- 1996 – Cast metal matrix composites first used in brake rotors of production automobile

Major Casting Processes

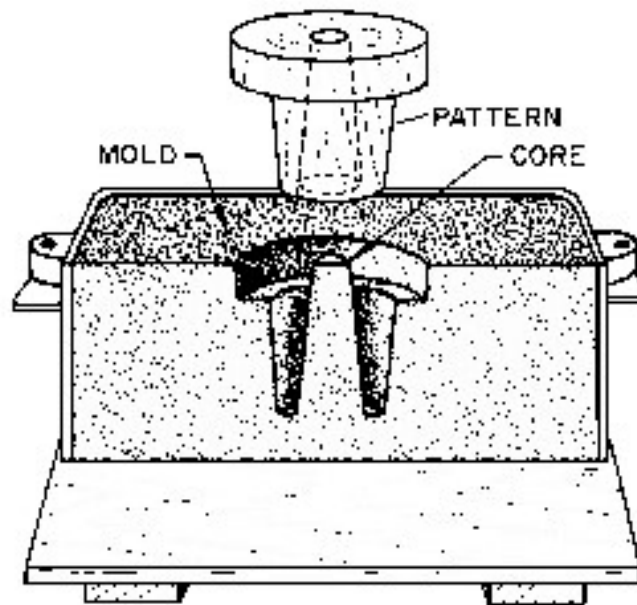
- Expendable (insulating) mold processes
 - Sand casting
 - Investment (or lost wax) casting
- Permanent (conducting) mold processes
 - Die casting

Casting: Basic Steps

- Basic steps in casting are:
 - Preparation of pattern(s), core(s) and mold(s)
 - Melting and pouring of liquefied metal
 - Solidification and cooling to room temperature
 - Removal of casting - shakeout
 - Inspection (for possible defects)

Pattern Making

- Pattern is a replica of the exterior surface of part to be cast – used to create the mold cavity
- Pattern materials – wood, metal, plaster



Pattern Making

- Pattern usually larger than cast part

Allowances made for:

- **Shrinkage**: to compensate for metal shrinkage during cooling from freezing to room temp

$$\text{Shrinkage allowance} = \alpha L(T_f - T_0)$$

expressed as *per unit length* for a given material

α = coeff. of thermal expansion, T_f = freezing temp

T_0 = room temp

e.g. Cast iron allowance = 1/96 in./ft

aluminum allowance = 3/192 in./ft

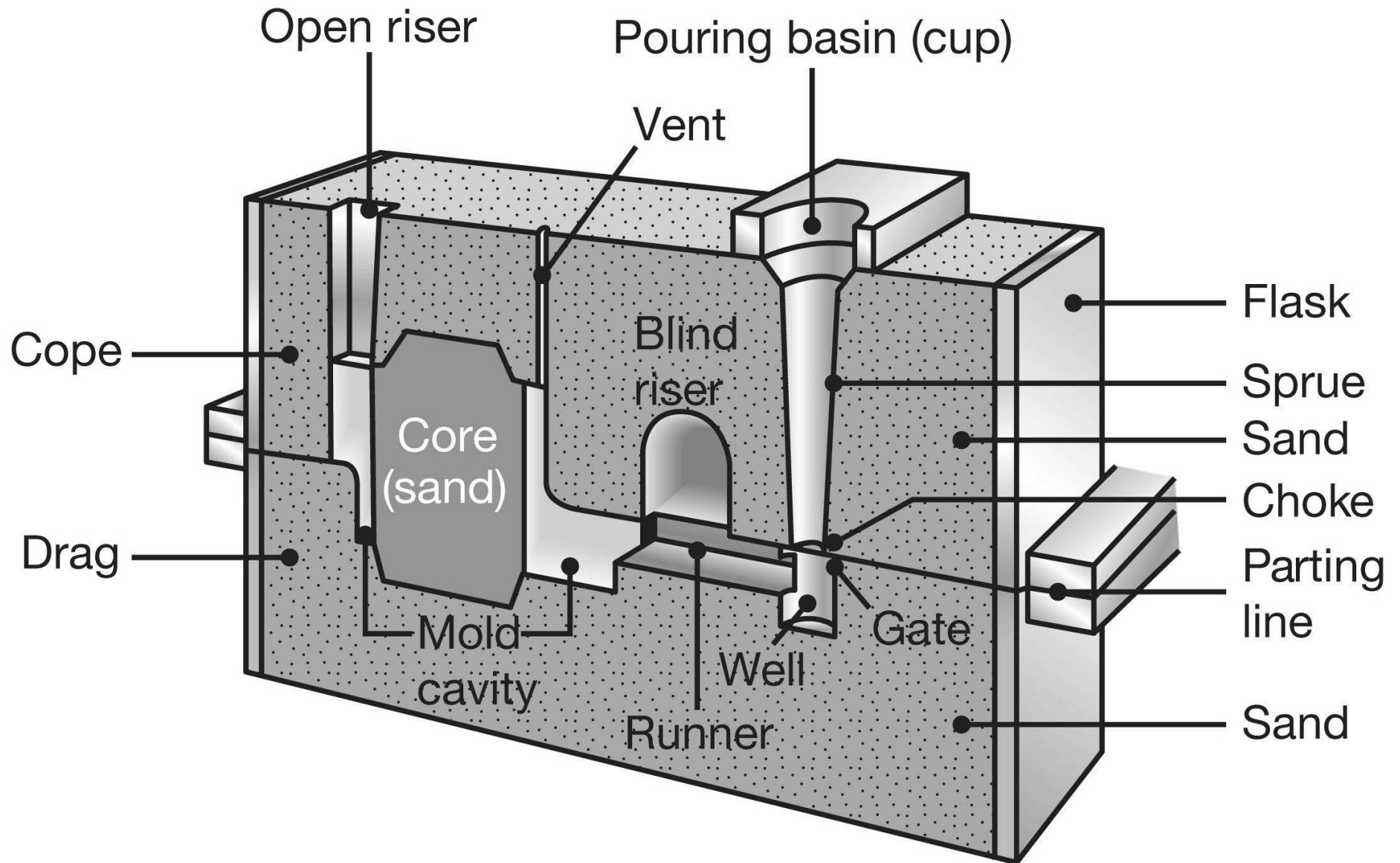
Pattern Making

- Pattern allowances made for:
 - ***Machining***: excess dimension that is removed by machining; depends on part dimension and material to be cast

e.g. cast iron, dimension 0-30 cm, allowance = 2.5 mm; aluminum, allowance = 1.5 mm

- ***Draft***: taper on side of pattern parallel to direction of extraction from mold; for ease of pattern extraction; typically 0.5~2 degrees

(Green) Sand Mold

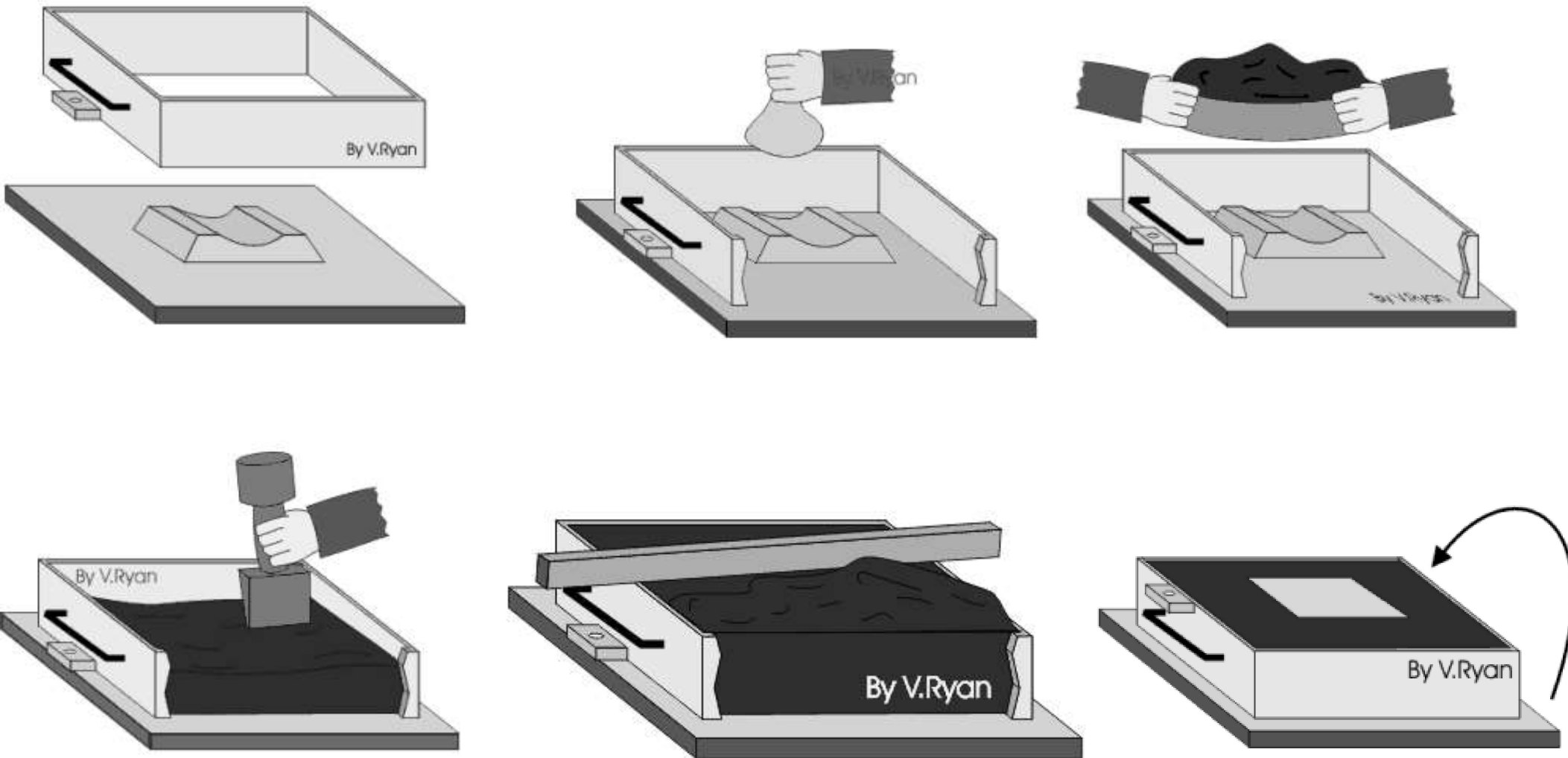


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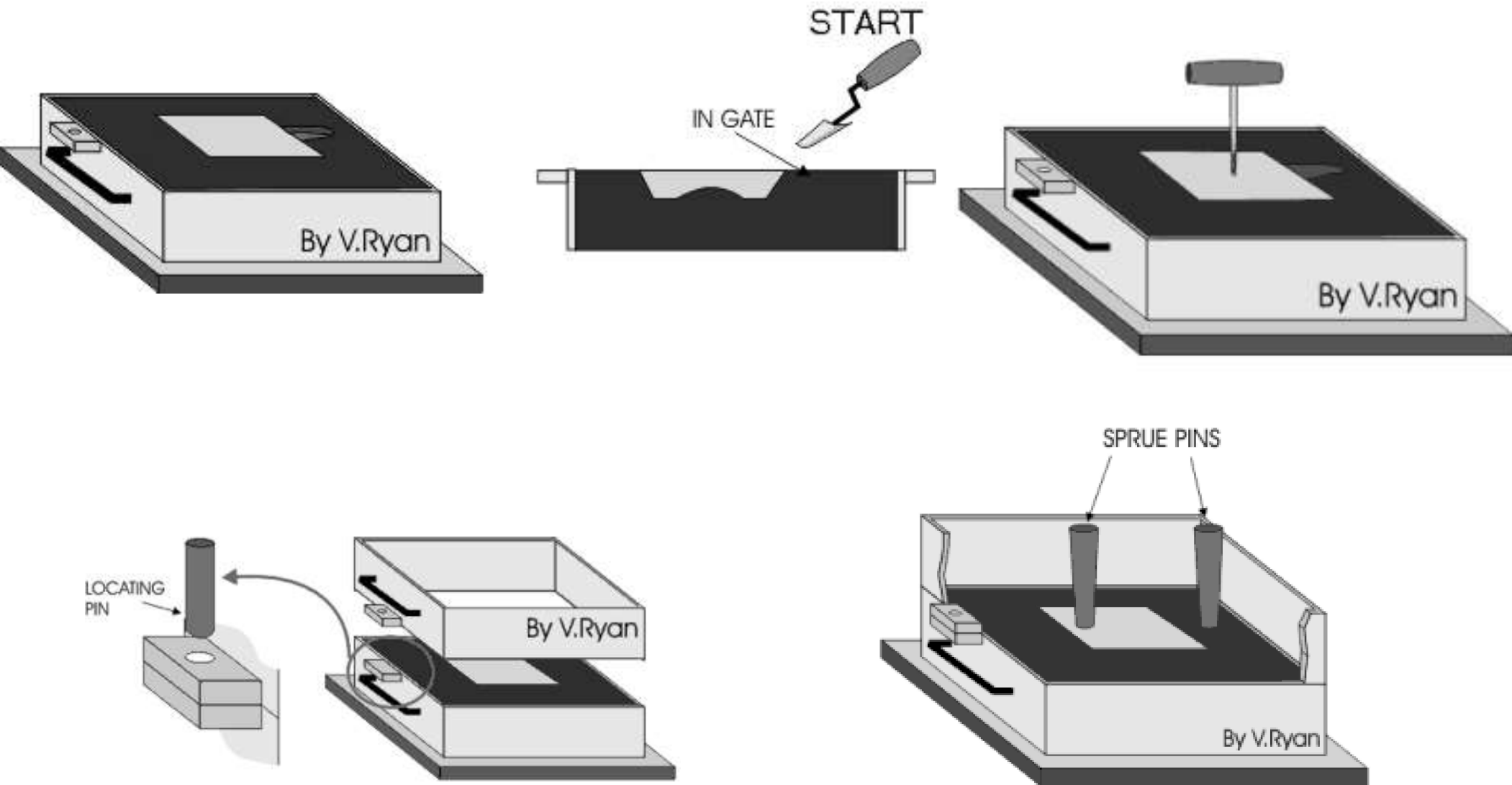
Sand Casting

- Green sand mold:
sand + clay + water + additives
- Typical composition (by wt.):
 - 70-85% sand, 10-20% clay, 3-6% water, 1-6% additives
- Important properties of molding sand:
 - Strength
 - Permeability
 - Deformation
 - Flowability
 - Refractoriness

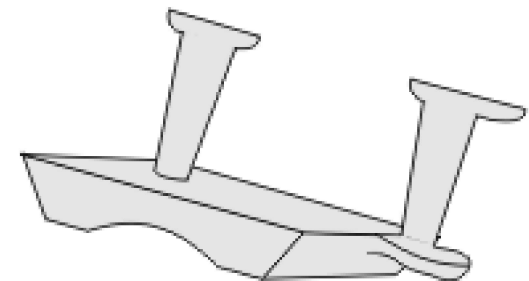
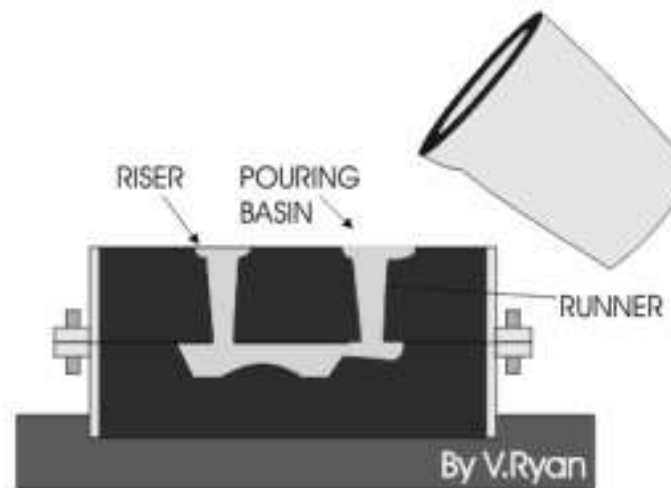
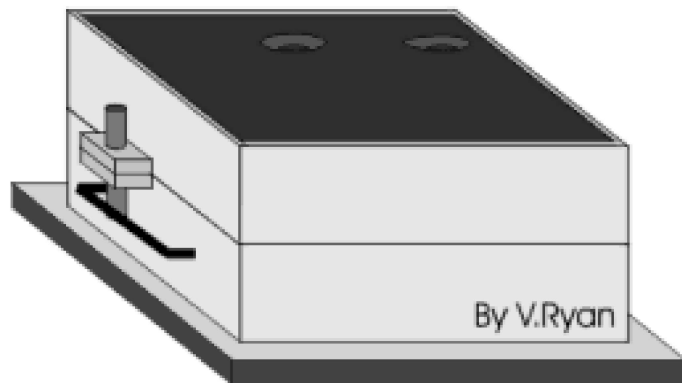
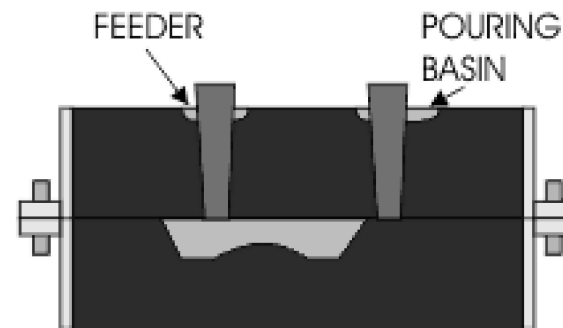
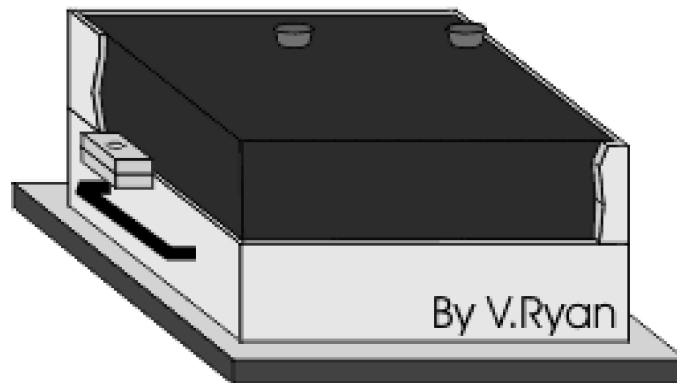
Mold Making: Sand Casting



Mold Making: Sand Casting



Mold Making: Sand Casting



Videos of Major Casting Processes

- Sand casting
- Investment casting
- Die casting