



FREDERICK INSTITUTE OF TECHNOLOGY
Mechanical Engineering Department

2. METAL CASTING PROCESSES

Casting was first used around 4000 B.C. to make ornaments, copper arrowheads, and various other objects.

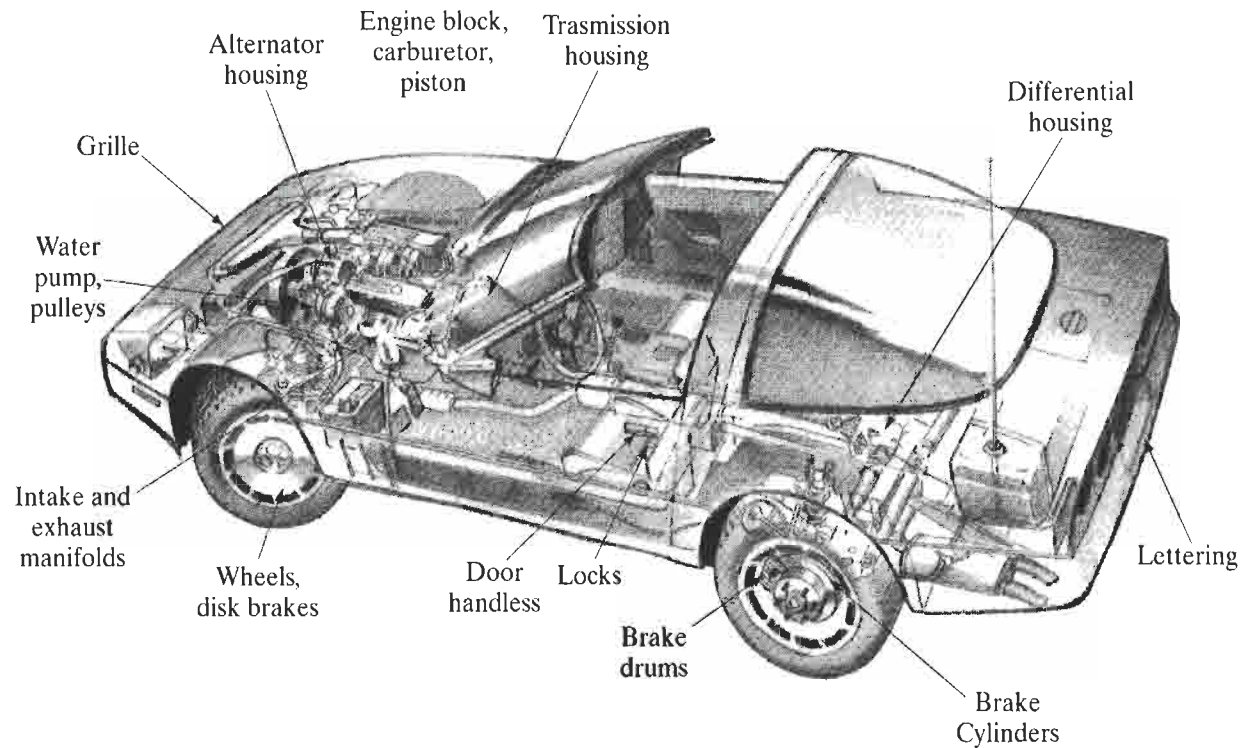
Casting processes are most often selected for the following reasons:

- Casting can produce complex shapes with internal cavities or hollow sections
- It can produce very large parts
- It can utilize workpiece materials that are difficult or uneconomical to process by other means
- Casting is competitive with other processes

Metal Casting

Sand casting
Shell mold casting
Lost foam
Vacuum casting
Pressure casting
Die casting
Centrifugal casting

Cast parts in a typical automobile.



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Title: Metal casting processes

SUBJECT: Manufacturing Processes

Instructor: Dr. A. Lontos

Mechanical Engineering Department

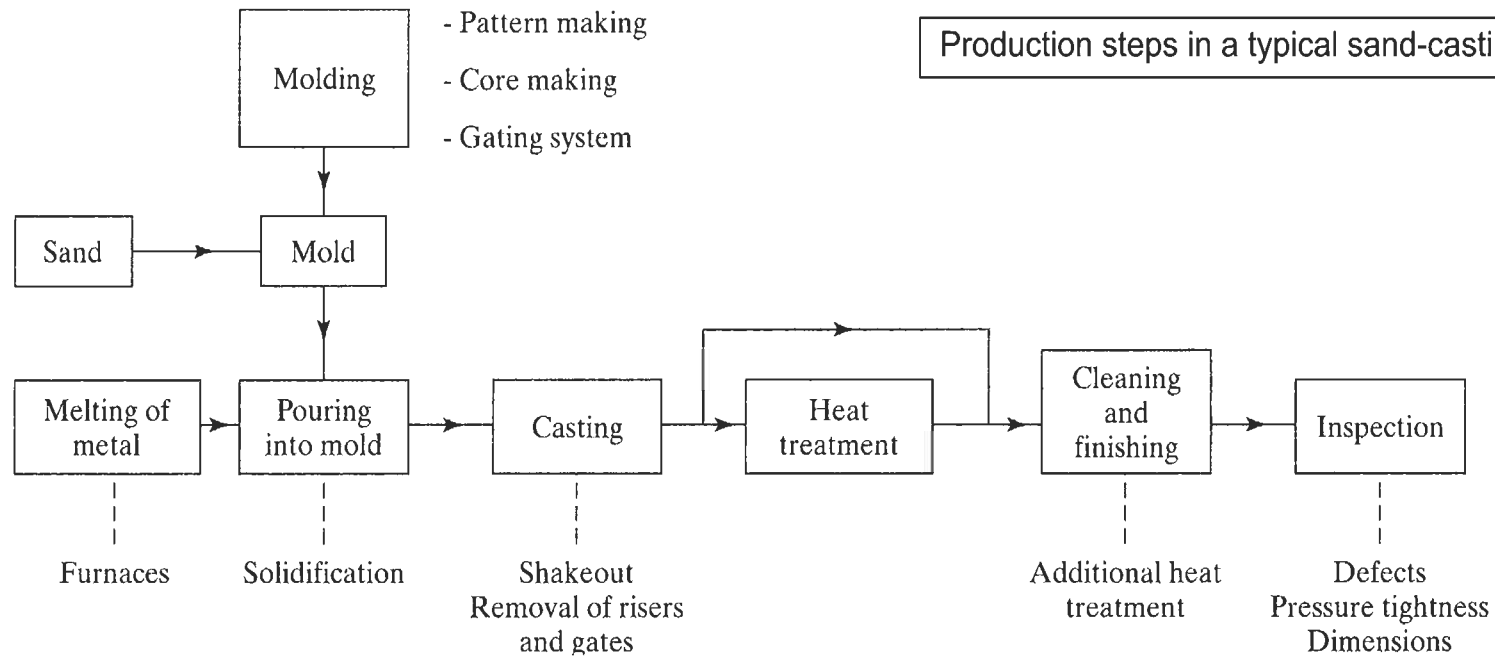
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Figure 1-a

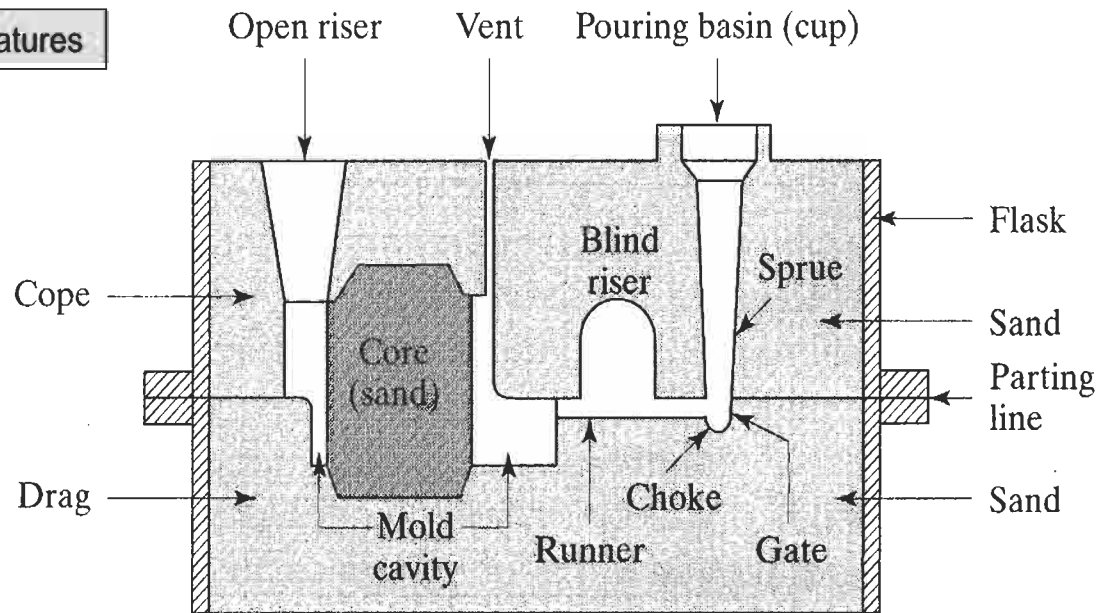
Process	Advantages	Limitations
Sand	Almost any metal cast; no limit to size, shape or weight; low tooling cost.	Some finishing required; somewhat coarse finish; wide tolerances.
Shell mold	Good dimensional accuracy and surface finish; high production rate.	Part size limited; expensive patterns and equipment required.
Expendable pattern	Most metals cast with no limit to size; complex shapes.	Patterns have low strength and can be costly for low quantities.
Plaster mold	Intricate shapes; good dimensional accuracy and finish; low porosity.	Limited to nonferrous metals; limited size and volume of production; mold making time relatively long.
Ceramic mold	Intricate shapes; close tolerance parts; good surface finish.	Limited size.
Investment	Intricate shapes; excellent surface finish and accuracy; almost any metal cast.	Part size limited; expensive patterns, molds, and labor.
Permanent mold	Good surface finish and dimensional accuracy; low porosity; high production rate.	High mold cost; limited shape and intricacy; not suitable for high-melting-point metals.
Die	Excellent dimensional accuracy and surface finish; high production rate.	Die cost is high; part size limited; usually limited to nonferrous metals; long lead time.
Centrifugal	Large cylindrical parts with good quality; high production rate.	Equipment is expensive; part shape limited.



Production steps in a typical sand-casting operation



Sand mold and various features



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Characteristics of Pattern Materials

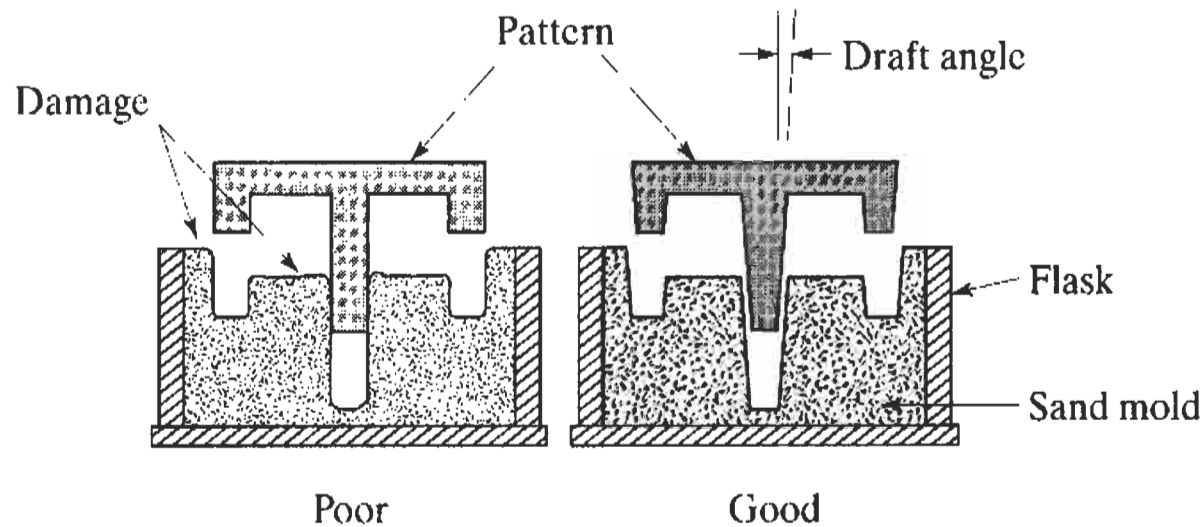
Characteristic	Rating ^a				
	Wood	Aluminum	Steel	Plastic	Cast iron
Machinability	E	G	F	G	G
Wear resistance	P	G	E	F	E
Strength	F	G	E	G	G
Weight ^b	E	G	P	G	P
Repairability	E	P	G	F	G
Resistance to:					
Corrosion ^c	E	E	P	E	P
Swelling ^c	P	E	E	E	E

^aE, excellent; G, good; F, fair; P, poor.

^bAs a factor in operator fatigue.

^cBy water.

Taper on patterns for ease of removal from the sand mold.



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Title: Patterns

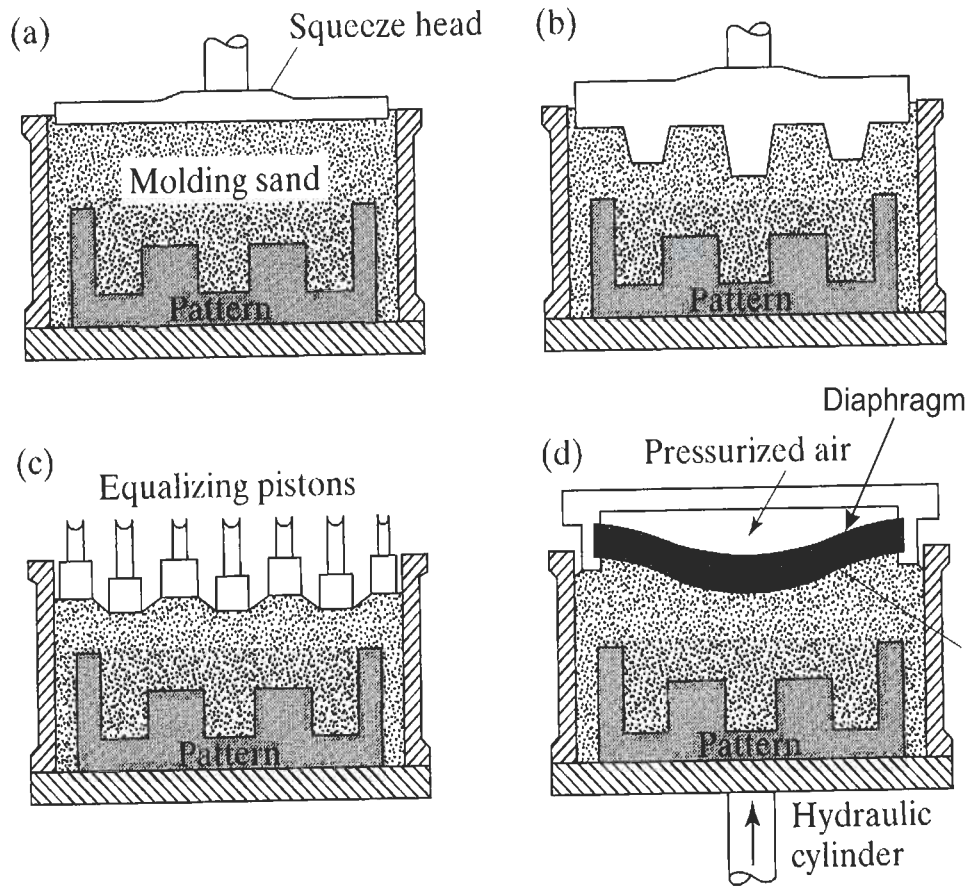
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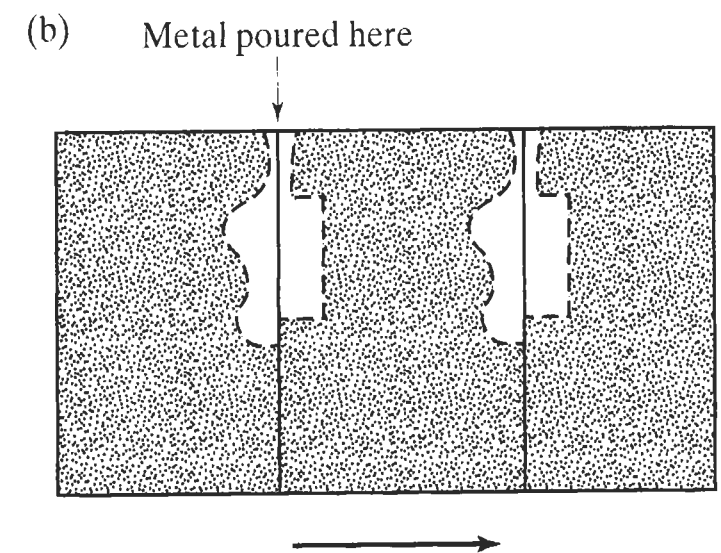
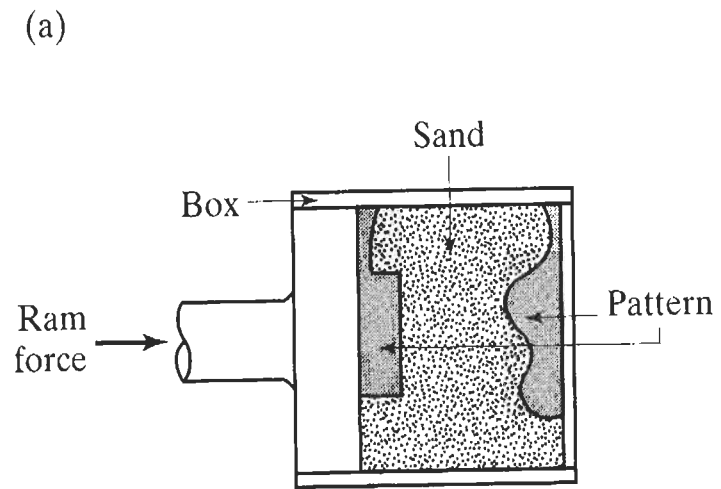
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Figure 3-a

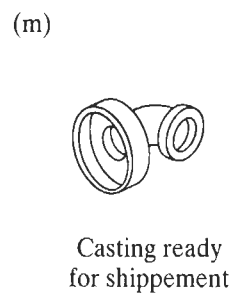
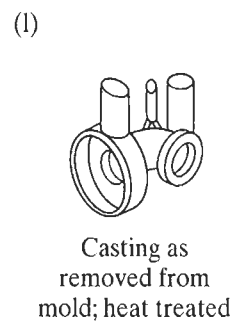
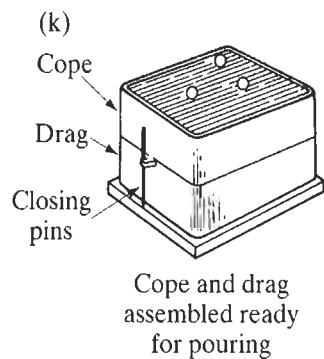
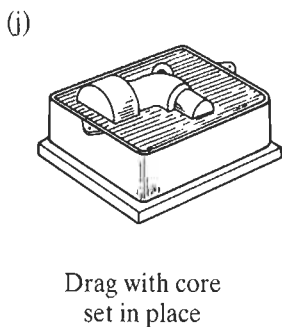
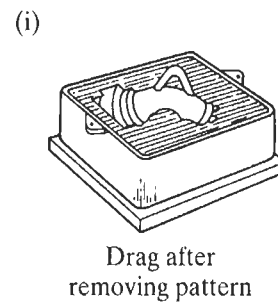
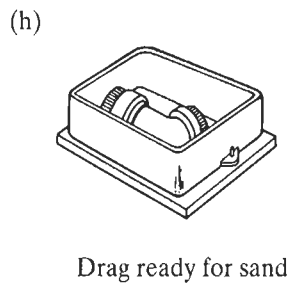
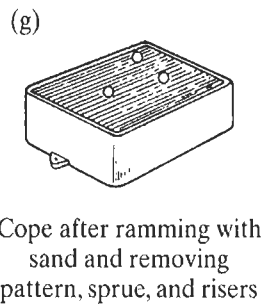
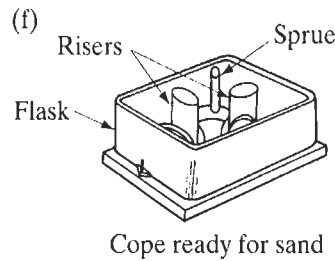
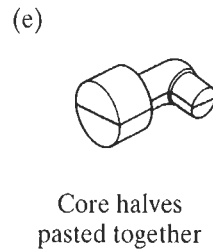
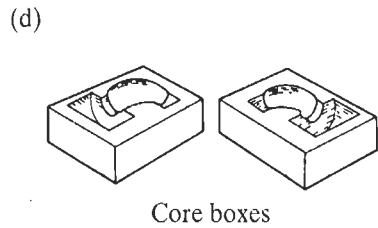
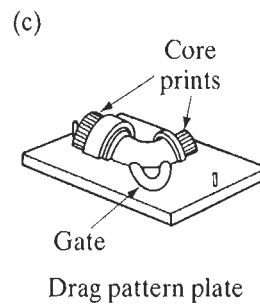
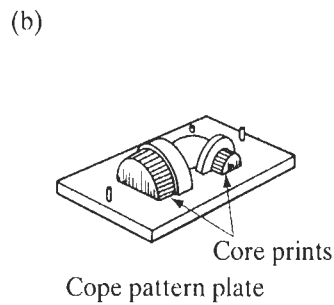
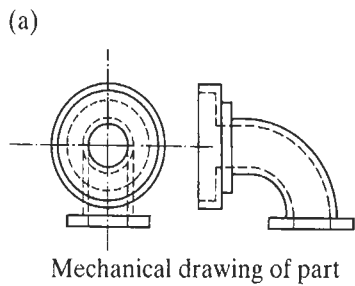


Various designs of squeeze heads for mold making:

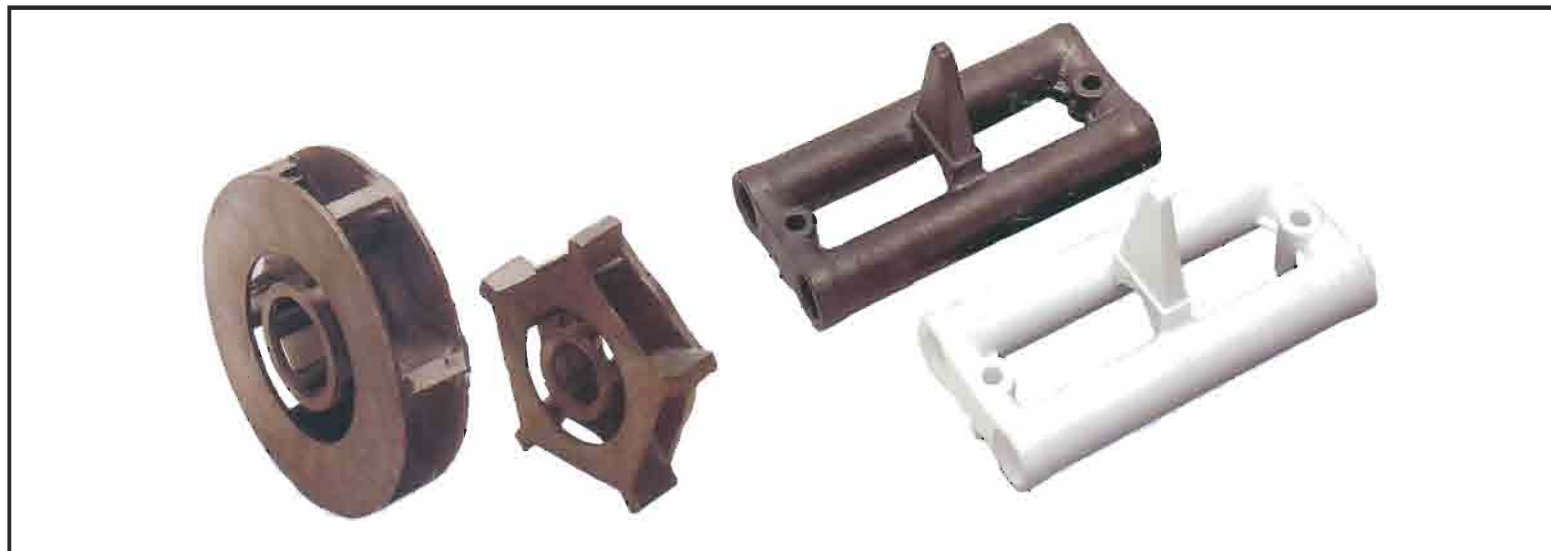
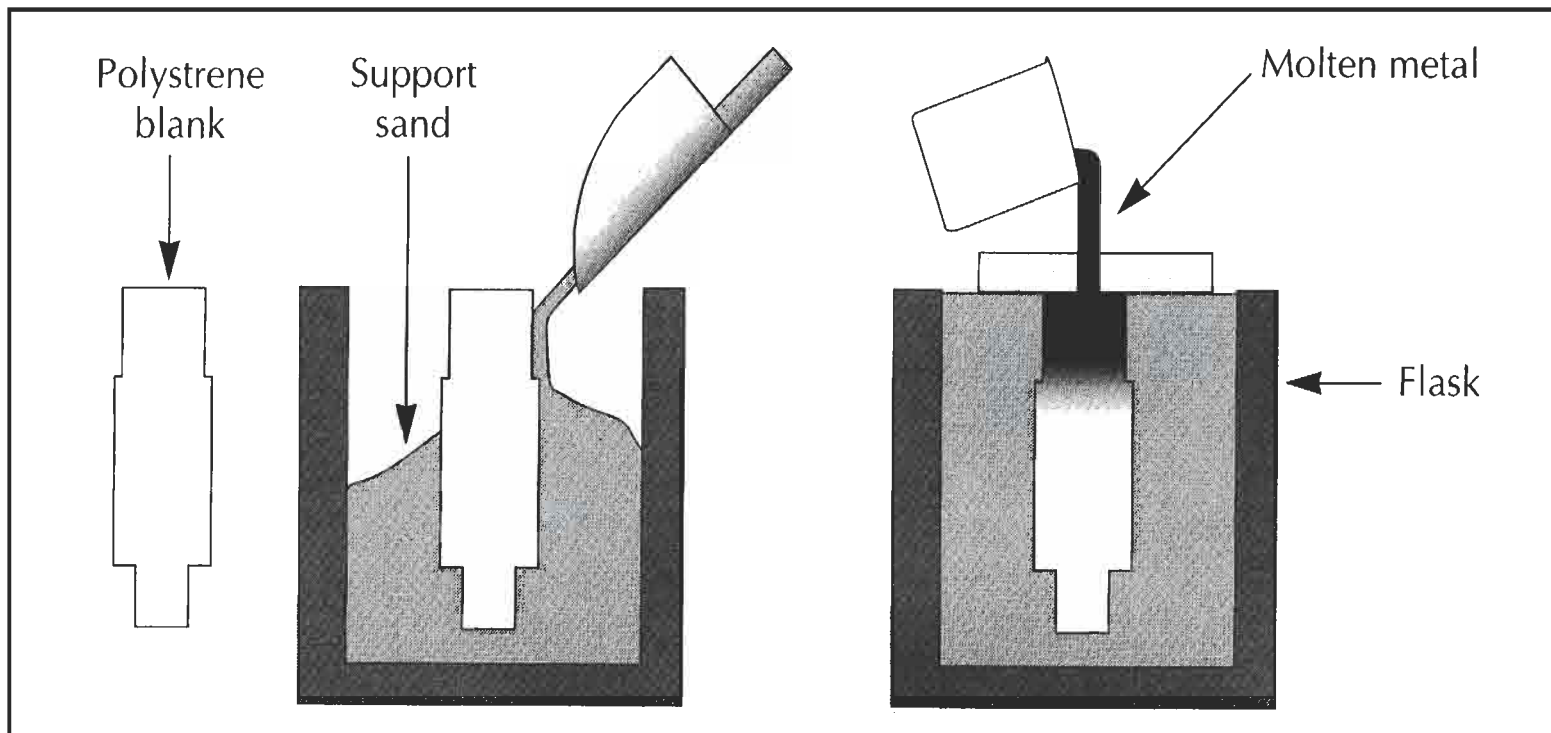
- a) conventional flat head
- b) profile head
- c) equalizing pistons
- d) Flexible diaphragm



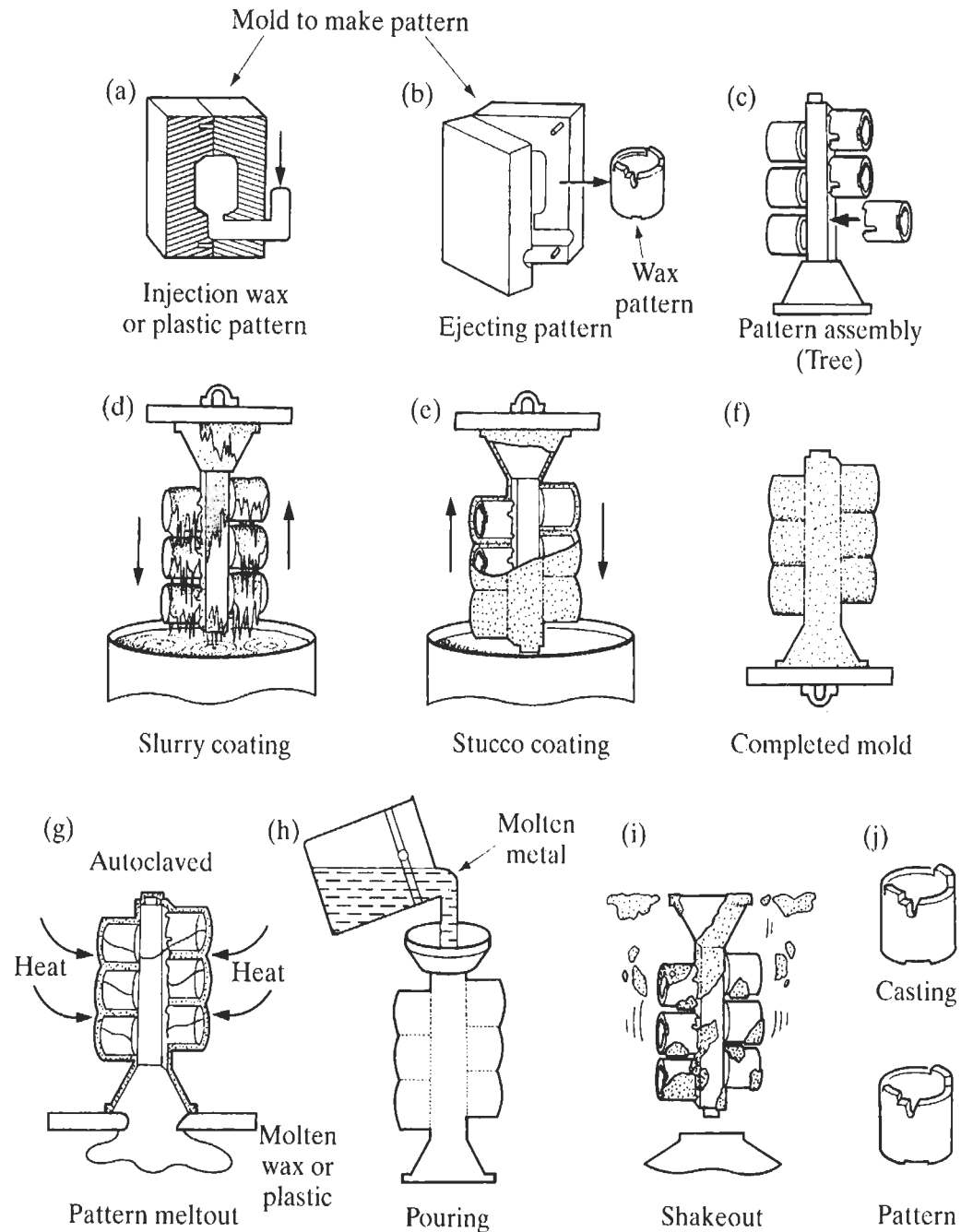
Vertical flaskless molding

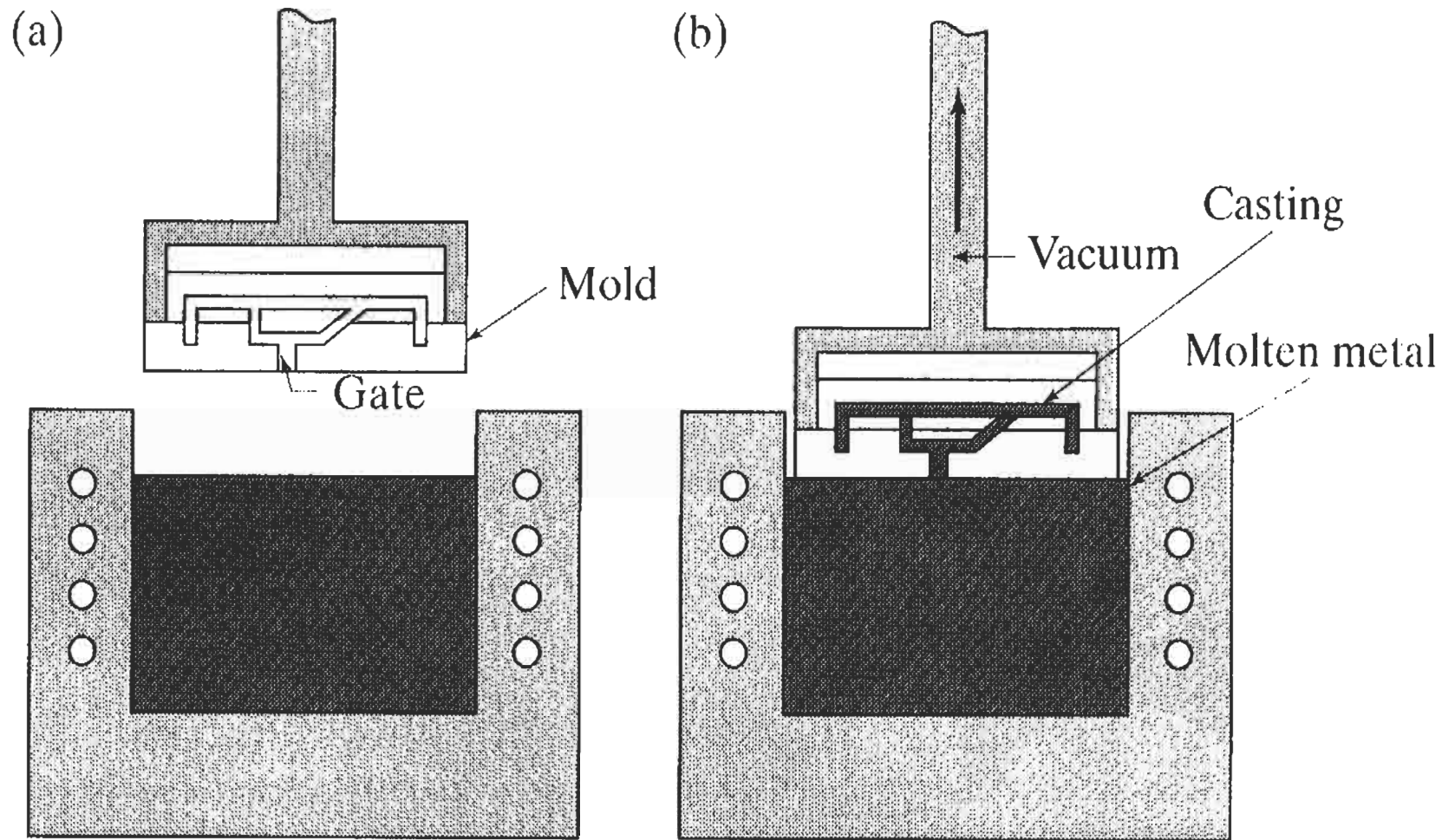


- (a) A mechanical drawing of the part is used to generate a design for the pattern
- (b-c) Patterns have been mounted on plates equipped with pins for alignment
- (d-e) Core boxes produce core halves, which are pasted together
- (f) The cope half of the mold is assembled by securing the cope pattern plate to the flask with aligning pins, and attaching inserts to form the sprue and risers
- (g) The flask is rammed with sand and the plate and inserts are removed
- (h) The drag half is produced in a similar manner, with the pattern inserted
- (i) The pattern, flask, and bottom board are inverted, and the pattern is withdrawn, leaving the appropriate imprint
- (j) The core is set in place within the drag cavity
- (k) The mold is closed by placing the cope on top of the drag and securing the assembly with pins
- (l) After the metal solidifies, the casting is removed from the mold
- (m) The sprue and risers are cut off and recycled, and the casting is cleaned, inspected, and heat treated (when necessary).



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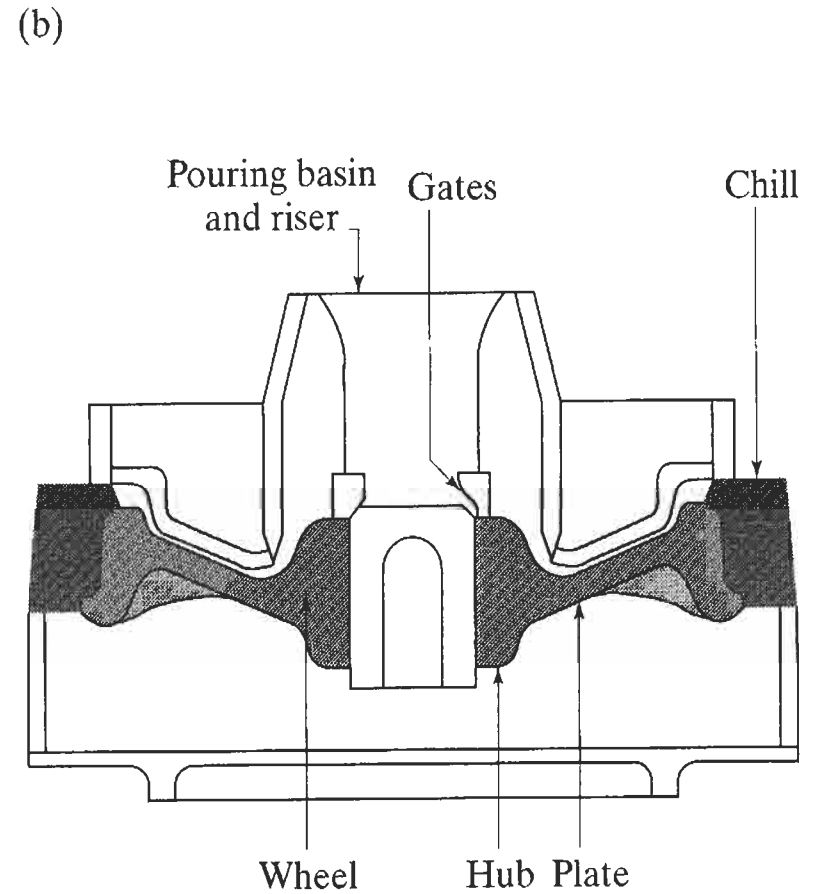
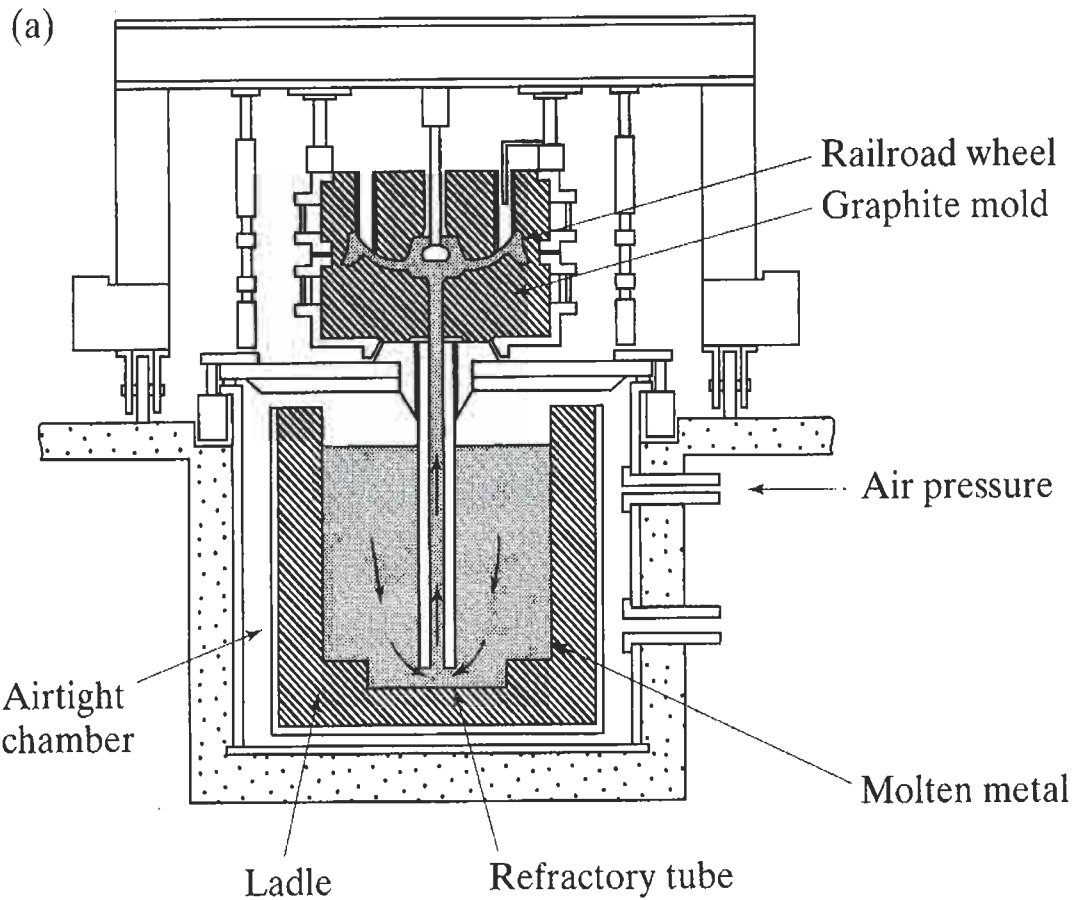




Induction furnace

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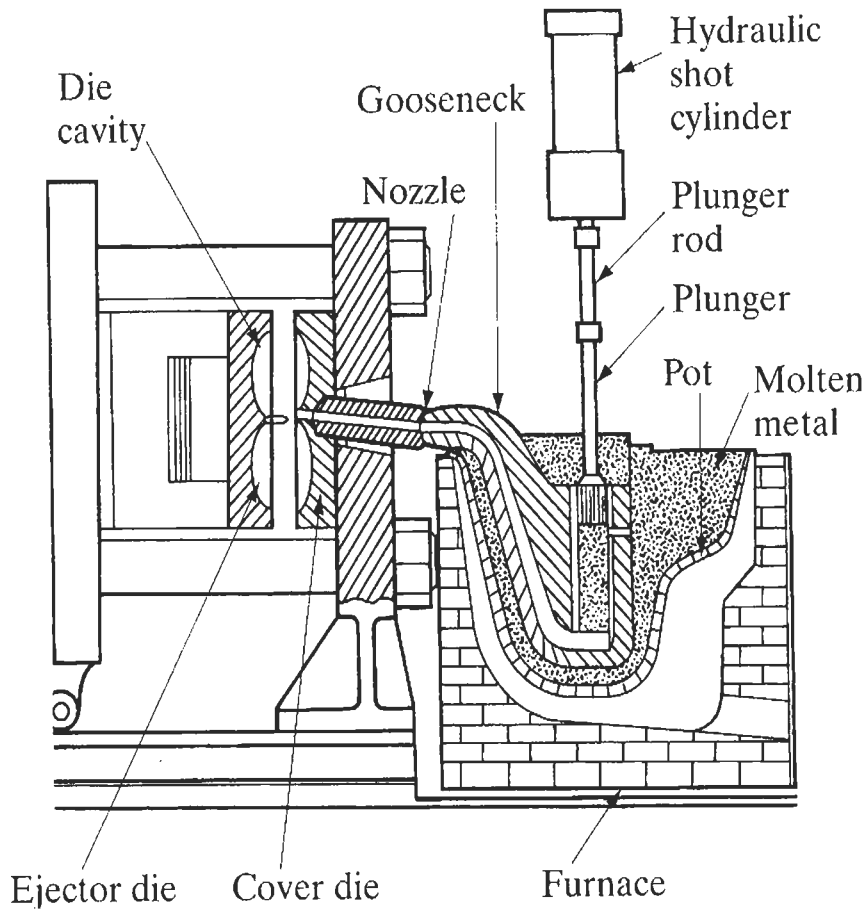




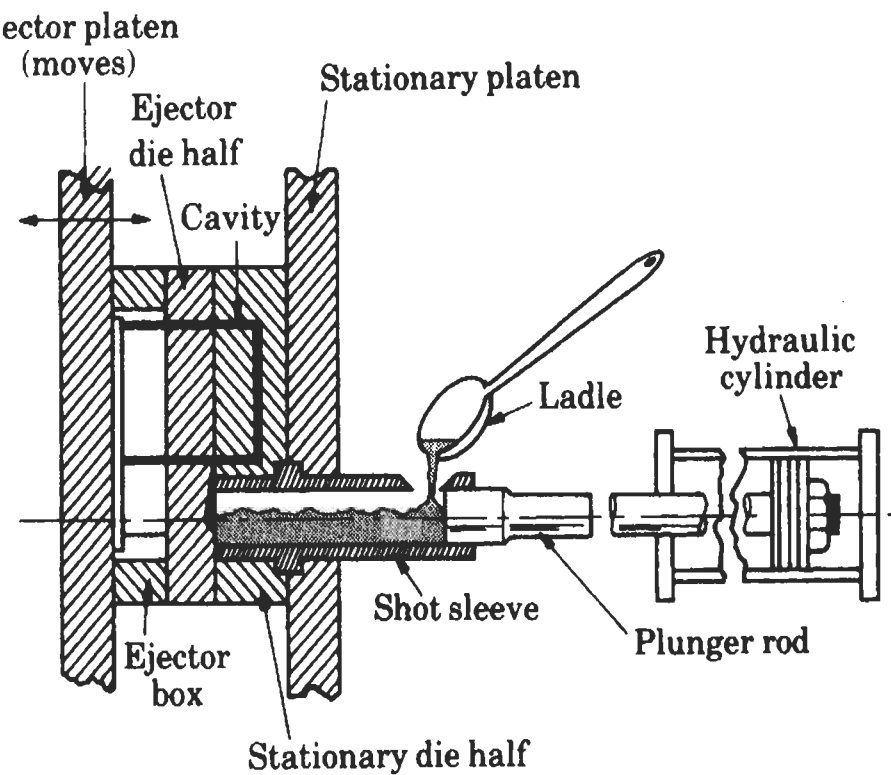
Hot chamber die-casting process

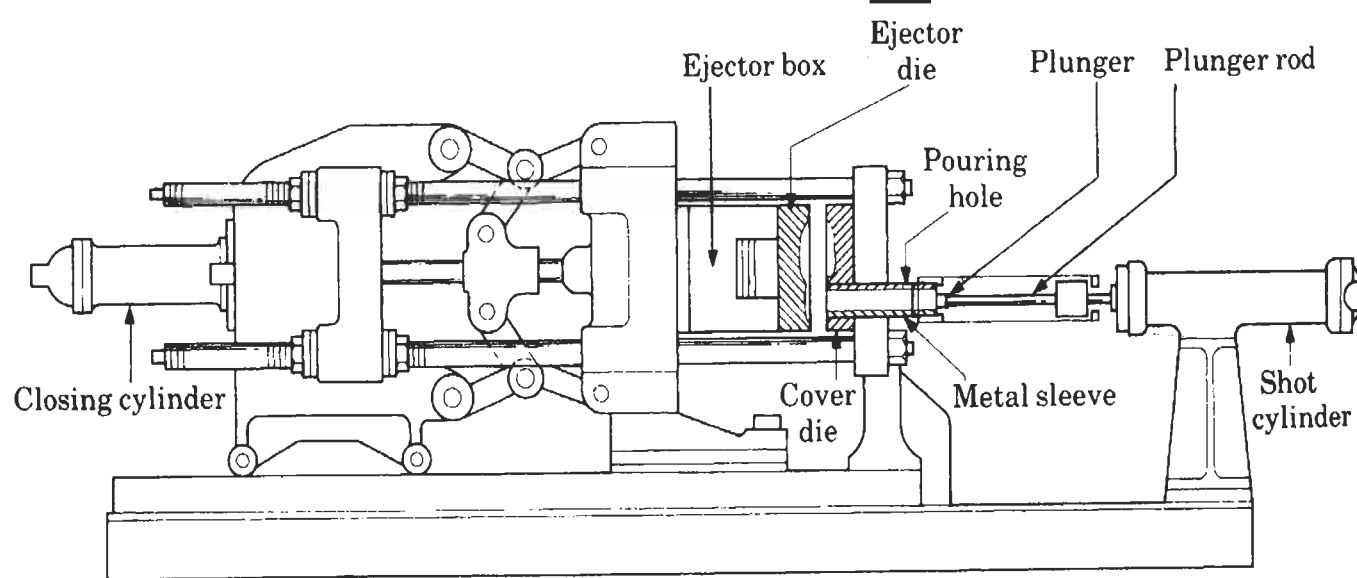
Cold chamber die-casting process

(a)

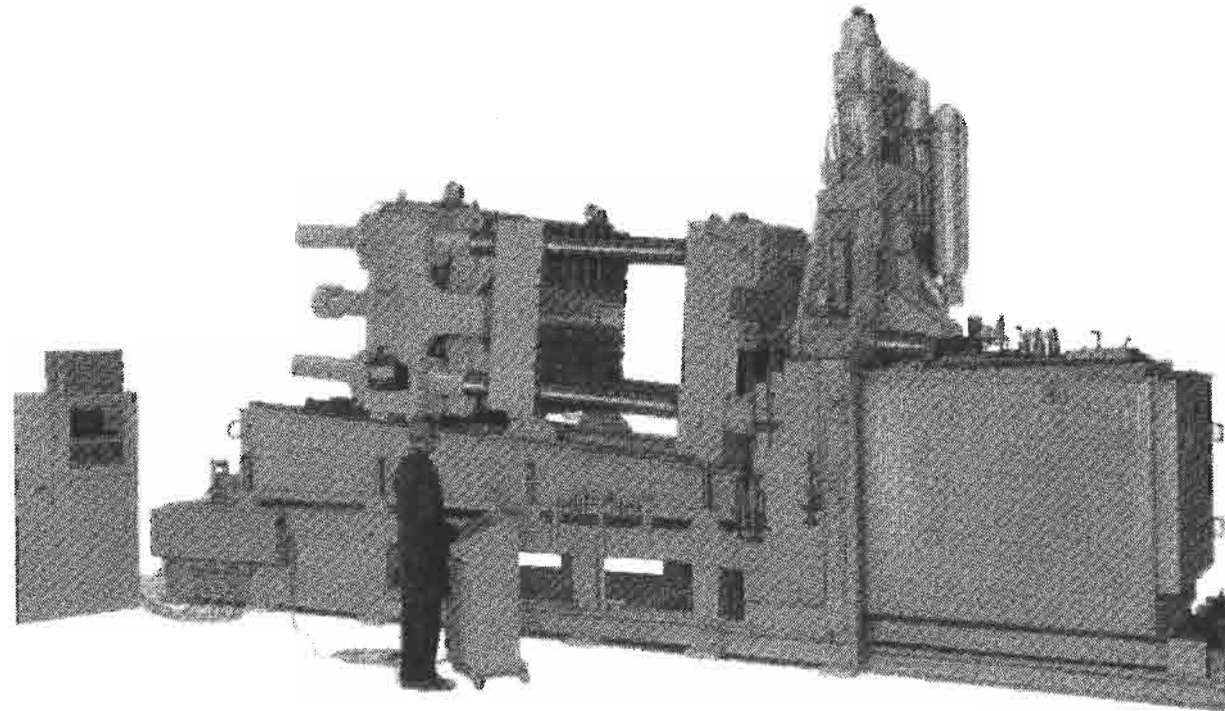


(b)



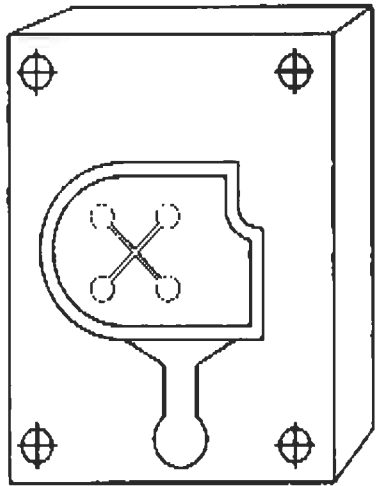


(a)

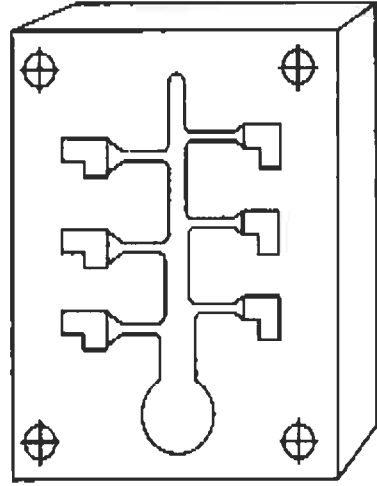


(b)

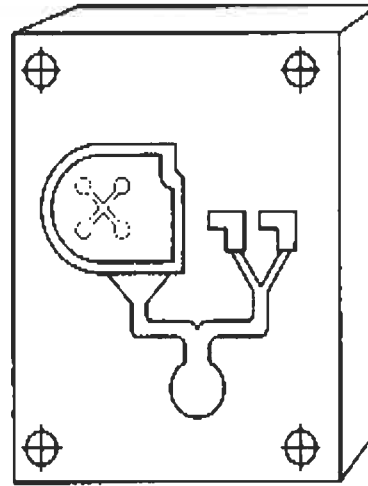




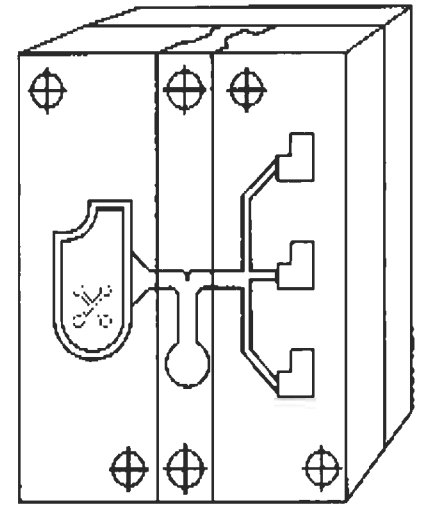
(a) Single-cavity die



(b) Multiple-cavity die



(c) Combination die



(d) Unit die

