2.4_3 Casting Processes

- pouring a liquid material (molten metal) into a prepared mold
- materials:

iron	steel	aluminum
brass	bronze	magnesium
certain zinc alloys		

- iron is used most often
  - fluidity, low shrinkage, strength, rigidity, and ease of control

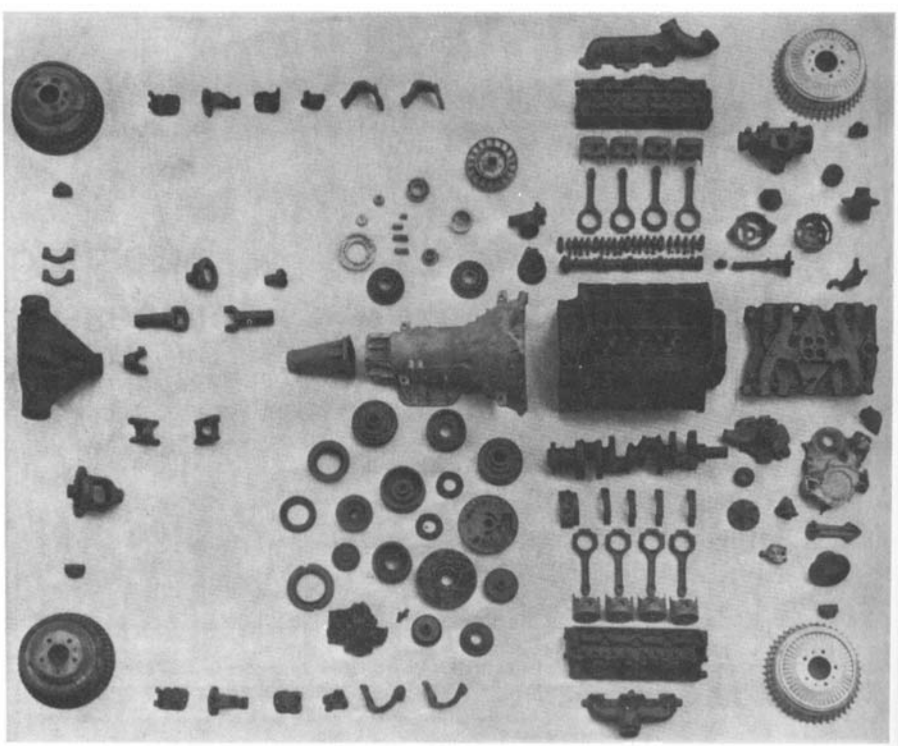


FIGURE 11-1. Cast metal parts in a typical American automobile.

- Six factors of the casting process:

1) A mold cavity must be produced.
   - must have desired shape
   - must allow for shrinkage of the solidifying metal
   - a new mold must be made for each casting, or a permanent mold must be made
2) A suitable means must exist to melt the metal.
   - high temperatures
   - quality mix
   - low cost
3) The molten metal must be introduced into the mold so that all air or gases in the mold will escape. The mold must be completely filled so that there are no air holes.
4) The mold must be designed so that it does not impede the shrinkage of the metal upon cooling.
5) It must be possible to remove the casting from the mold.
6) Finishing operations must usually be performed on the part after it is removed from the mold.

Seven major casting processes:

1) Sand casting
2) Shell-mold casting
3) Permanent-mold casting
4) Die casting
5) Centrifugal casting
6) Plaster-mold casting
7) Investment casting

Sand Casting

- sand is used as the mold material
- the sand (mixed with other materials) is packed around a pattern that has the shape of the desired part
- the mold is made of two parts (drag (bottom) & cope (top))
- a new mold must be made for every part
- liquid metal is poured into the mold through a *sprue hole*
- the sprue hole is connected to the cavity by *runners*
- a *gate* connects the runner with the mold cavity
- *risers* are used to provide "overfill"

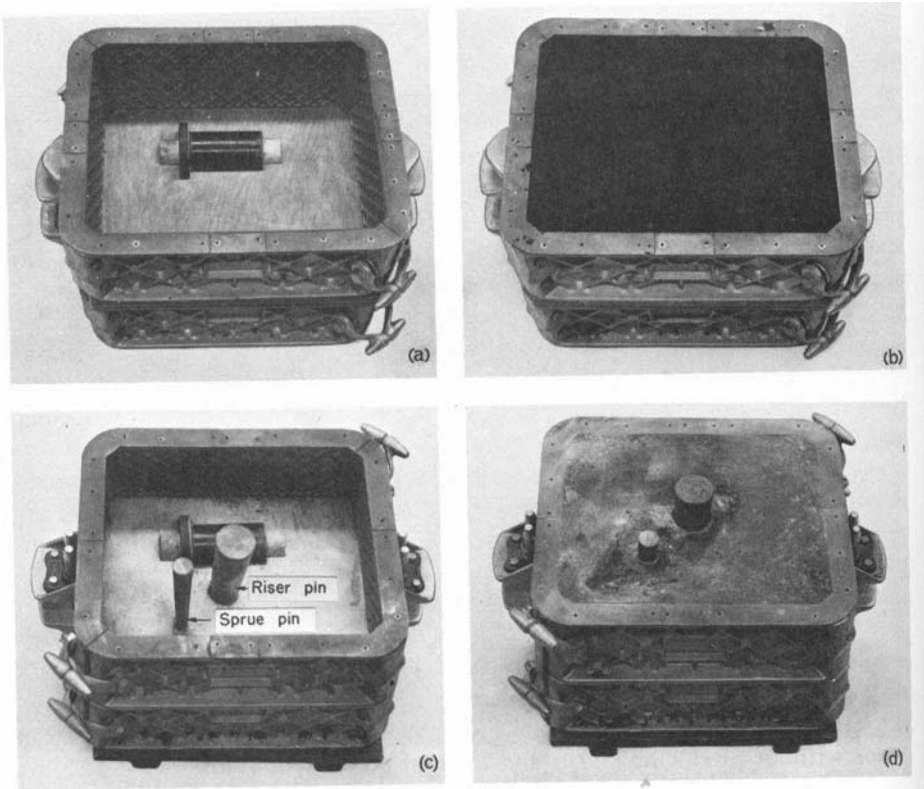
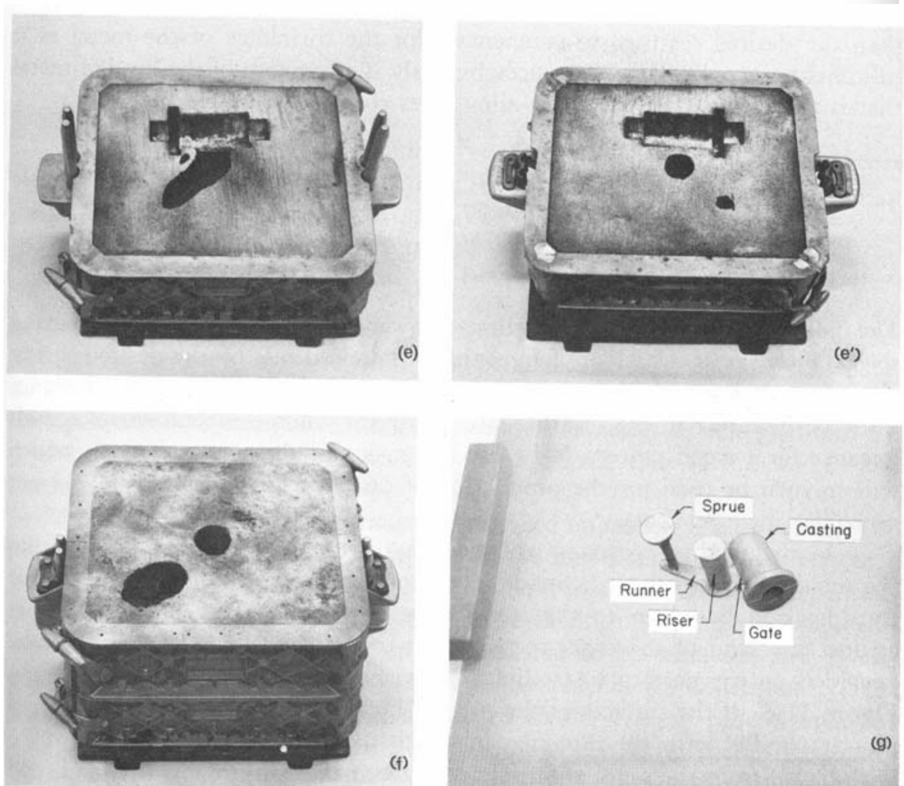


FIGURE 11-2. Essential steps in sand casting. (a) Bottom (drag) half of pattern in place on mold board between halves of flask ready to receive sand. (b) Drag half of mold completed, ready for turning over. (c) Top (cope) half of pattern and sprue and riser pins in place. (d) Cope half of mold packed with sand. (e) Mold opened, showing parting surface



of drag half, with pattern drawn and runner and gate cut. (e') Parting surface of cope half of mold, with pattern and pins removed. (f) Mold closed, ready for pouring metal. (g) Casting removed from mold.

<u>Patterns</u>

- a pattern is a duplicate of the part being made
- pattern material is dependent upon the number of parts being made
    - wood is most common for small quantities
    - aluminum is used for larger quantities
- the pattern must be made slightly larger than the part
    - metal will shrink as it cools
    - cast iron 1/10 to 1/8 inch per foot
      steel 3/16 to 1/4
      aluminum 1/8 to 5/32
- the pattern maker uses a special *shrink ruler*
- split patterns are most common

FIGURE 11-7. Split pattern, showing the two sections together and separated. Light-colored portions are core prints.

- match-plate pattern

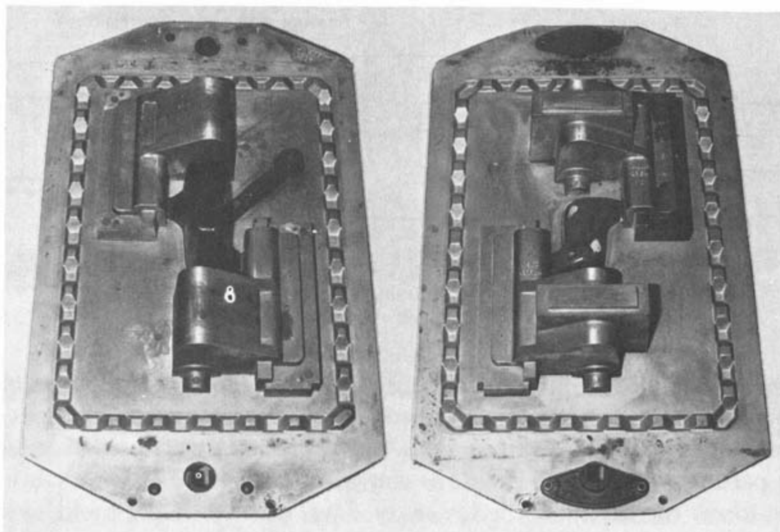


FIGURE 11-8. Match-plate pattern for molding two parts: (*left*) cope side; (*right*) drag side.

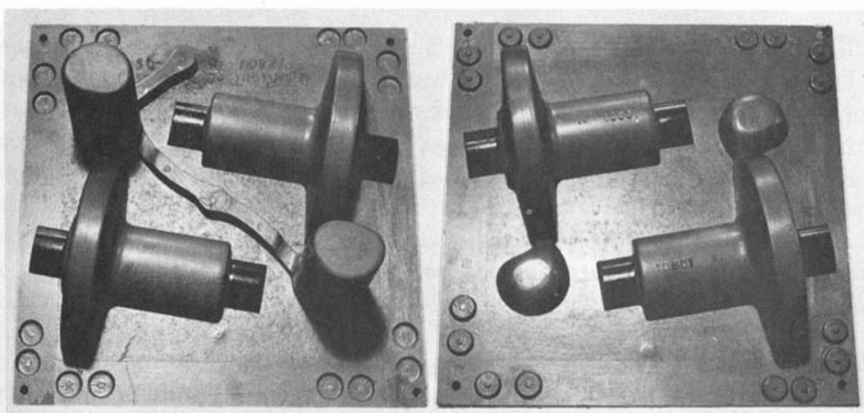


FIGURE 11-9. Cope-and-drag pattern for molding two heavy parts: cope section (*left*) drag section (*right*).

Cores

- an advantage of casting is that holes can be cast into a part with relative ease
- sand cores are inserted into the mold cavity

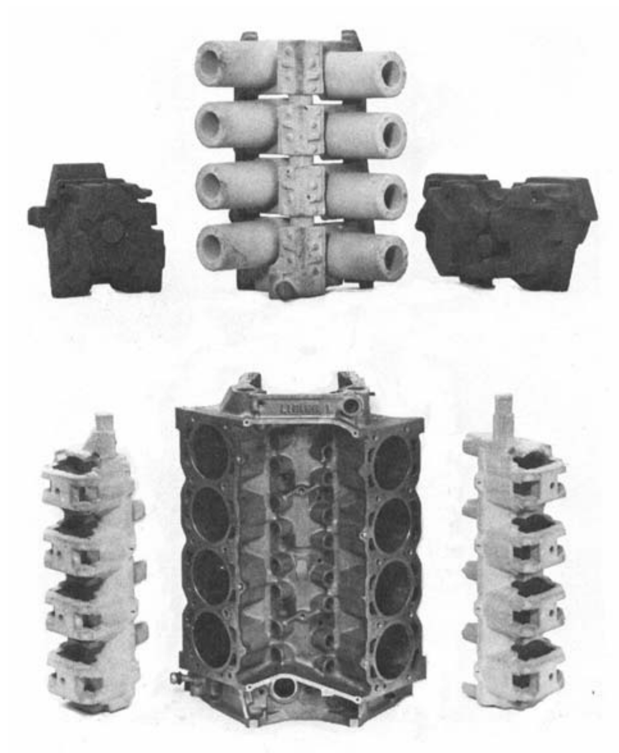
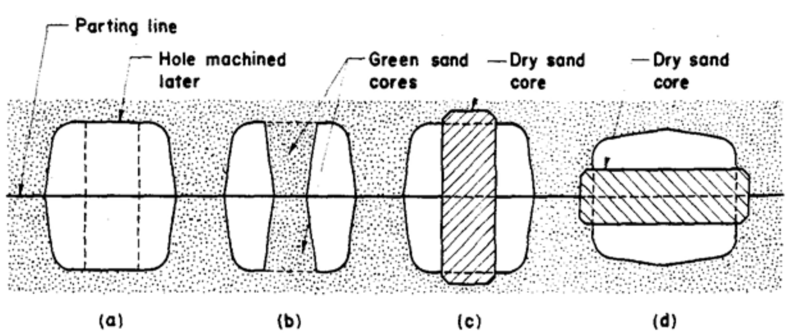


FIGURE 11-27. Dry-sand cores used in making the V-8 engine block shown at center, bottom. (*Courtesy Central Foundry Division, General Motors Corp.*)

FIGURE 11-28. Four methods of making a hole in a cast pulley.



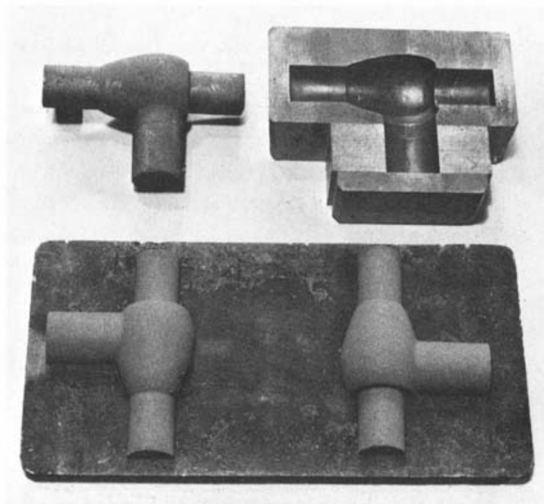


FIGURE 11-29. Core box, two core halves ready for baking, and completed core made by gluing two halves together.

Permanent-Mold Casting Processes

- a disadvantage of sand castings is that a new mold must be made for every part
- permanent-mold casting only uses gravity to introduce the metal
- molds are made of cast iron or steel
- permanent molds are heated at the beginning of a pour
- permanent-mold castings have better dimensional accuracy and smoother surfaces than can be obtained with sand casting

Die Casting

- similar to permanent-mold casting, except the molten metal is forced into the molds by pressure and held under pressure during solidification
- die casting dies are usually made from alloy steel and are expensive to make
- excellent surface qualities are obtainable

FIGURE 11-37. Die-cast aluminum-alloy engine block for a modern compact car. (*Courtesy Chevrolet Motor Division, General Motors Corp.*)

Melting and Pouring

The furnace used to melt the metal should:

1) provide adequate temperature
2) minimize contamination
3) allow for holding the metal at high temperature without harmful effects for long period of time (while chemical composition is adjusted)
4) be economical
5) avoid atmospheric pollution

Pouring Practice

- must transfer the metal from the melting furnace into the molds
- a pouring device or a ladle are used
- metal must be kept at proper temperature during the pour

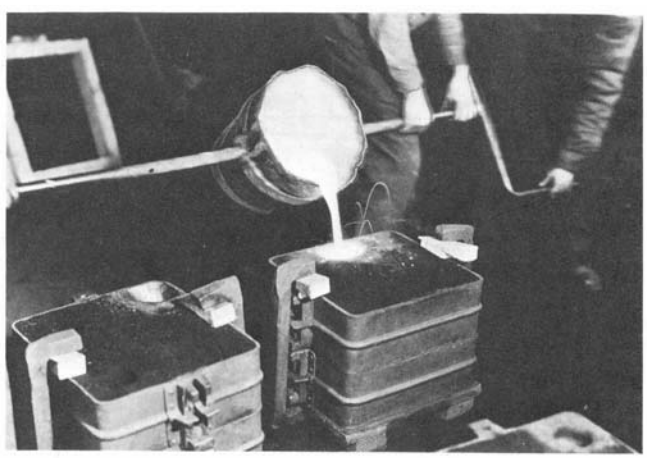
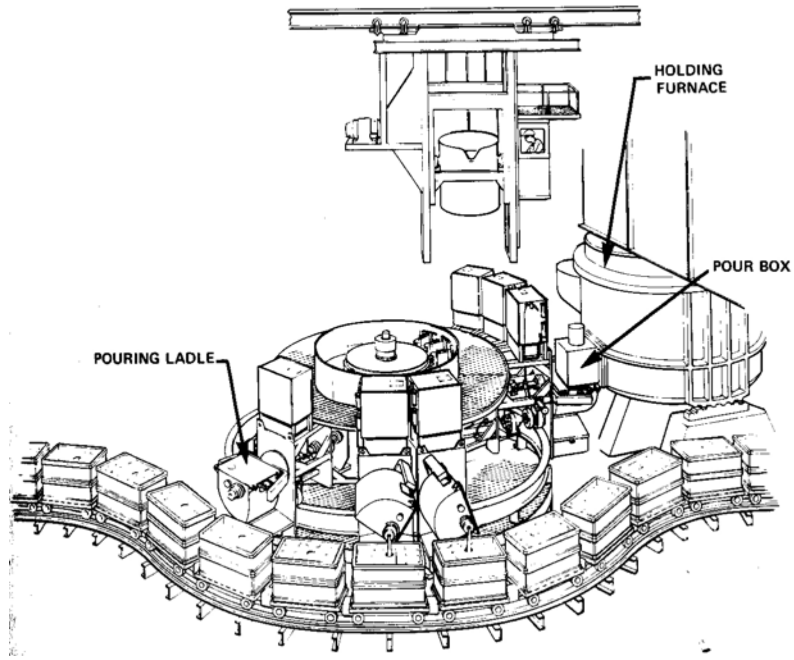


FIGURE 11-57. Pouring a mold from a shank-type ladle. (*Courtesy Steel Founders' Society of America.*)

FIGURE 11-59. Pouring molds on a conveyor line. (*Courtesy The Link-Belt Company.*)

FIGURE 11-60. Machine for automatic pouring of molds on a conveyor line. (*Courtesy Roberts Corporation.*)



Cleaning, Finishing, and Heat-Treating Castings

After removal from their molds, most castings require:

1) Removing cores.
2) Removing gates and risers.
3) Removing fins and rough spots from the surface.
4) Cleaning the surface.
5) Repairing any defects.

Castings are also often heated in order to:

1) reduce the hardness in rapidly cooled thin sections
2) reduce internal stresses that result from uneven cooling