Department of Materials Engineering
General Materials Branch

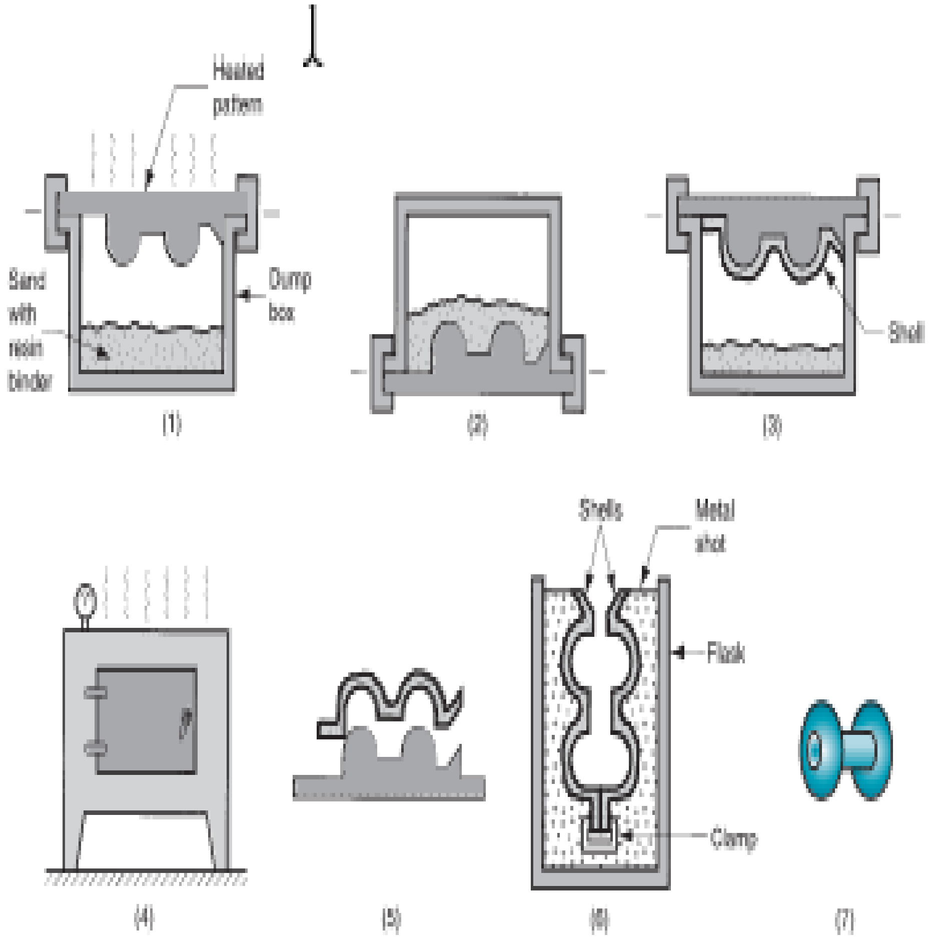
Fourth Class

Casting Technology (I)

Lecture 7 : Other expandable Mold Casting

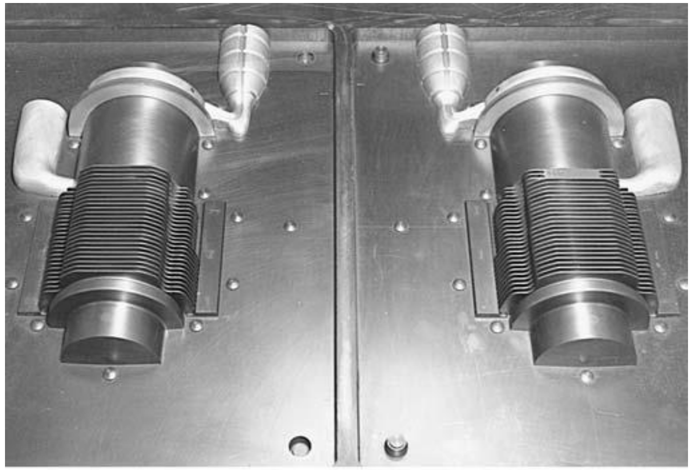
Shell Casting

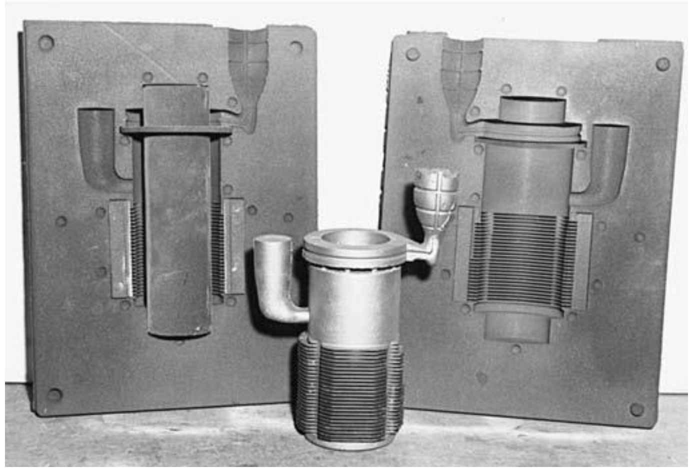
1. a match-plate or cope-and-drag metal pattern is heated and placed over a box containing sand mixed with thermosetting resin;
2. Box is inverted so that sand and resin fall onto the hot pattern, causing a layer of the mixture to partially cure on the surface to form a hard shell;
3. Box is repositioned so that loose, uncured particles drop away;
4. Sand shell is heated in oven for several minutes to complete curing;
5. Shell mold is stripped from the pattern;
6. Two halves of the shell mold are assembled, supported by sand or metal shot in a box, and pouring is accomplished.
7. The finished casting with sprue removed



Shell Casting

(Top) Two halves of a shell-mold pattern. (Bottom) The two shells before clamping, and the final shell mold casting with attached pouring basin, runner, and riser. *(Courtesy of Shalco Systems, Lansing, MI.)*





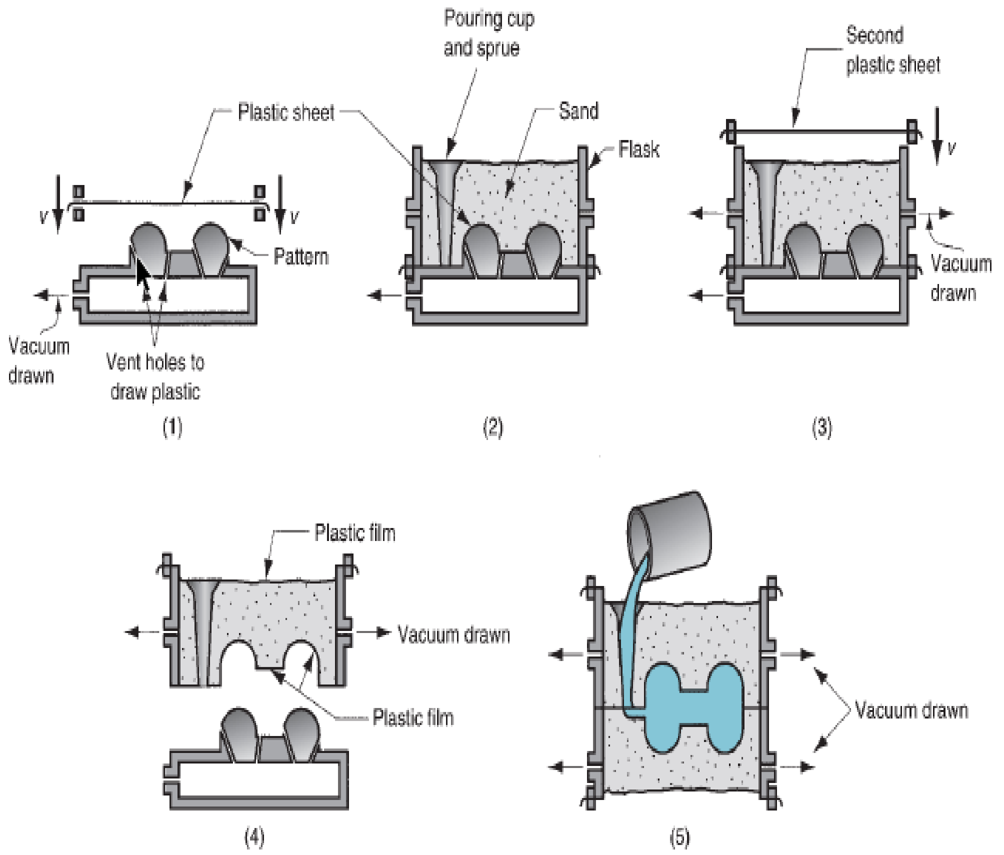
Shell Casting in Summrey

- ***Process:*** Sand coated with a thermosetting plastic resin is dropped onto a heated metal pattern, which cures the resin .The shell segments are stripped from the pattern and assembled. When the poured metal solidifies, the shell is broken away from the finished casting.
- ***Advantages:*** Faster production rate than sand molding, high dimensional accuracy with smooth surfaces.
- ***Limitations:*** Requires expensive metal patterns. Plastic resin adds to cost; part size is limited.
- *Common metals:* Cast irons and casting alloys of aluminum and copper.
- ***Size limits:*** 30 g (1 oz.) minimum; usually less than 10 kg (25 lb.); mold area usually less than 0.3 m^2 (500 in^2).
- ***Thickness limits:*** Minimums range from 0.15 to 0.6 cm (to in.), depending on material.
- ***Typical tolerances:*** Approximately 0.005 cm/cm or in/in.
- ***Draft allowance:*** *0.25* or 0.5 degree.
- ***Surface finish****: 0.5* –4.0 microns (50–150 μin.) rms.

Vacuum Molding

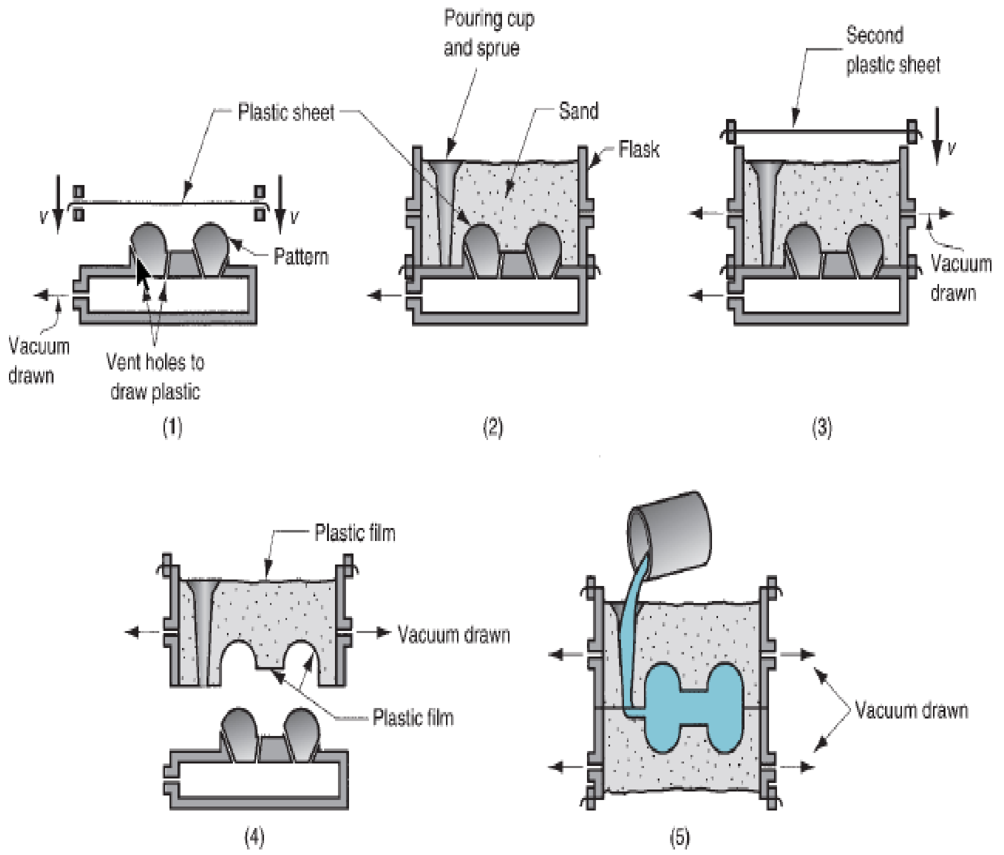
Steps in vacuum molding:

1. Thin sheet of preheated plastic is drawn over a match-plate or cope-and-drag pattern by vacuum—the pattern has small vent holes to facilitate vacuum forming;
2. A specially designed flask is placed over the pattern plate and filled with sand, and a sprue and pouring cup are formed in the sand;
3. Another thin plastic sheet is placed over the flask, and a vacuum is drawn that causes the sand grains to be held together, forming a rigid mold



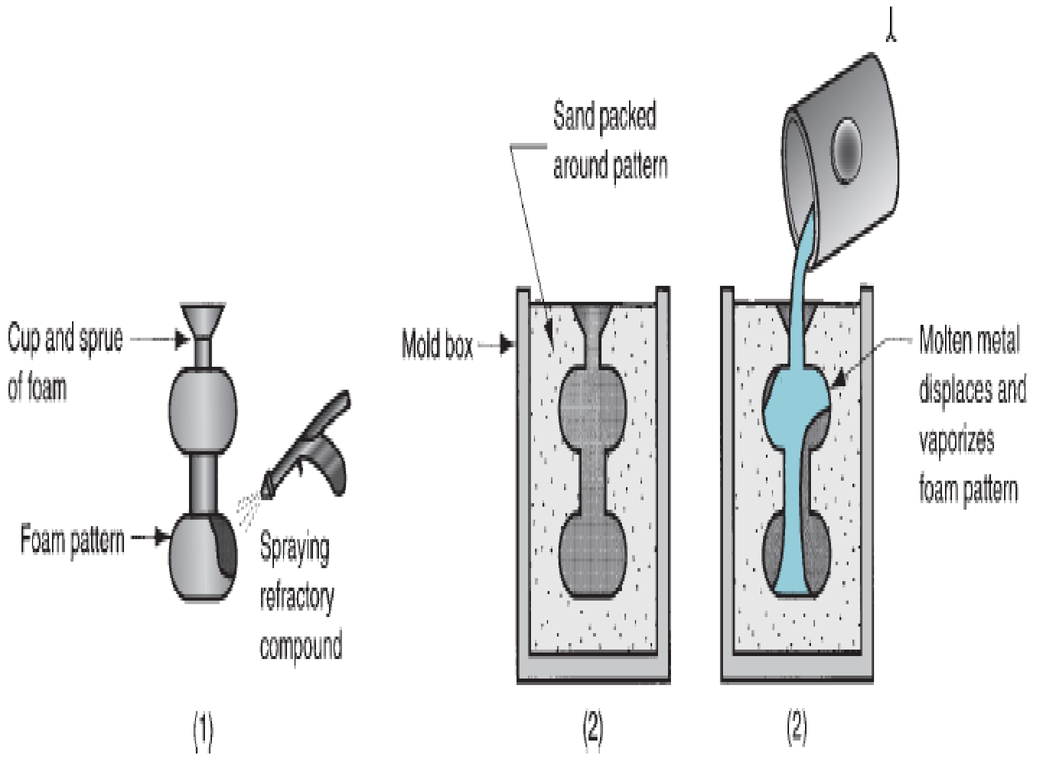
Vacuum Molding

4. the vacuum on the mold pattern is released to permit the pattern to be stripped from the mold;
5. this mold is assembled with its matching half to form the cope and drag, and with vacuum maintained on both halves, pouring is accomplished. The plastic sheet quickly burns away on contacting the molten metal. After solidification, nearly all of the sand can be recovered for reuse.



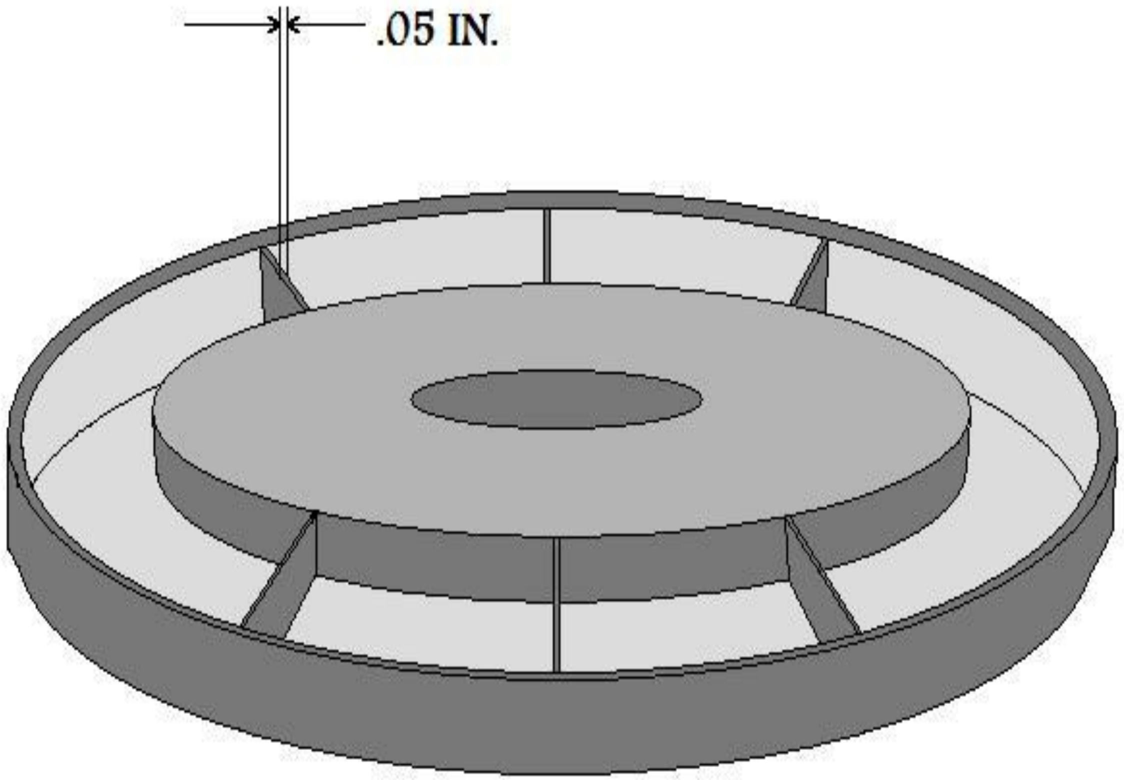
EXPANDED POLYSTYRENE PROCESS

1. pattern of polystyrene is coated with refractory compound
2. Foam pattern is placed in mold box, and sand is compacted around the pattern
3. Molten metal is poured into the portion of the pattern that forms the pouring cup and sprue. As the metal enters the mold, the polystyrene foam is vaporized ahead of the advancing liquid, thus allowing the resulting mold cavity to be filled



PLASTER-MOLD CASTING

1. Evacuating air from the mold cavity before pouring;
2. Aerating the plaster slurry prior to mold making so that the resulting hard plaster contains finely dispersed voids
3. Using a special mold composition and treatment known as the Antioch process



Antioch process

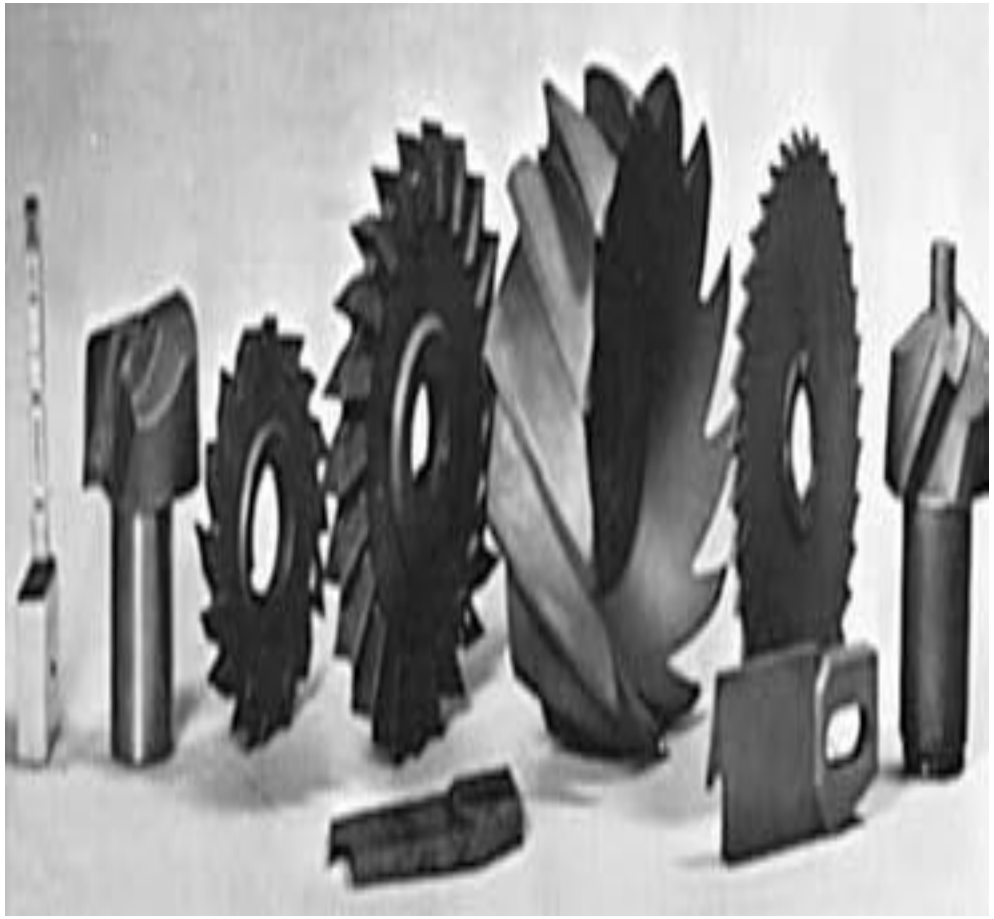
- Antioch process:-This process involves using about 50% sand mixed with the plaster, heating the mold in an autoclave (an oven that uses superheated steam under pressure), and then drying. The resulting mold has considerably greater permeability than a conventional plaster mold

Plaster Casting

- *Process:* A slurry of plaster, water, and various additives is poured over a pattern and allowed to set. The pattern is removed, and the mold is baked to remove excess water. After pouring and solidification, the mold is broken and the casting is removed.
- *Advantages:* High dimensional accuracy and smooth surface finish; can reproduce thin sections and intricate detail to make net- or near-net-shaped parts.
- *Limitations:* Lower-temperature nonferrous metals only; long molding time restricts production volume or requires multiple patterns; mold material is not reusable; maximum size is limited.
- *Common metals:* Primarily aluminum and copper.
- *Size limits:* As small as 30 g (1 oz.) but usually less than 7 kg (15 lb.).
- *Thickness limits:* Section thickness as small as 0.06 cm (0.025 in.).
- *Typical tolerances:* 0.01 cm on first 5 cm (0.005 in. on first 2 in.), 0.002 cm per additional cm (0.002 in. per additional in.)
- *Draft allowance: 0.5* –1 degree.
- *Surface finish:* 1.3–4 microns (50–125 μin.) rms.

CERAMIC MOLD CASTING

- *Ceramic mold casting* is similar to plaster mold casting, except that the mold is now made from a ceramic material that can withstand the higher melting- temperature metals. Much like the plaster process, ceramic molding can produce thin sections, fine detail, and smooth surfaces, thereby eliminating a considerable amount of finish machining



Ceramic Mold Casting

- ***Process:*** Stable ceramic powders are combined with binders and gelling agents to produce the mold material.
- ***Advantages:*** Intricate detail, close tolerances, and smooth finish.
- ***Limitations:*** Mold material is costly and not reusable.
- ***Common metals:*** Ferrous and high-temperature nonferrous metals are most common; can also be used with alloys of aluminum, copper, magnesium, titanium, and zinc.
- ***Size limits:*** 100 grams to several thousand kilograms (several ounces to several tons).
- ***Thickness limits:*** As thin as 0.13 cm (0.050 in.); no maximum.
- ***Typical tolerances****:* 0.01 cm on the first 2.5 cm (0.005 in. on the first in.), 0.003 cm per each additional cm (0.003 in. per each additional in.).
- ***Draft allowances****:* 1° preferred.
- ***Surface finish:*** 2–4 microns (75–150 μin.) rms.

CONTINUOUS CASTING

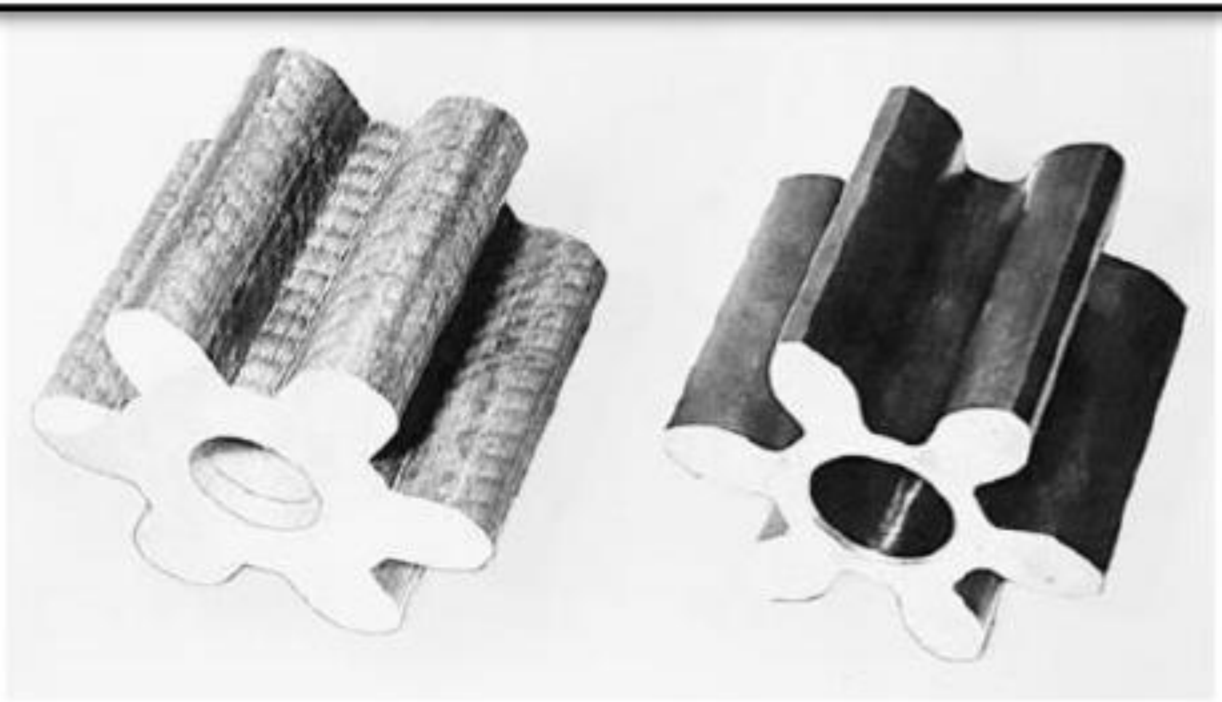


FIGURE 13-13 Gear produced by continuous casting. (Left) As-cast material; (right) after machining. *(Courtesy of ASARCO, Tucson, AZ.)*

CONTINUOUS CASTING

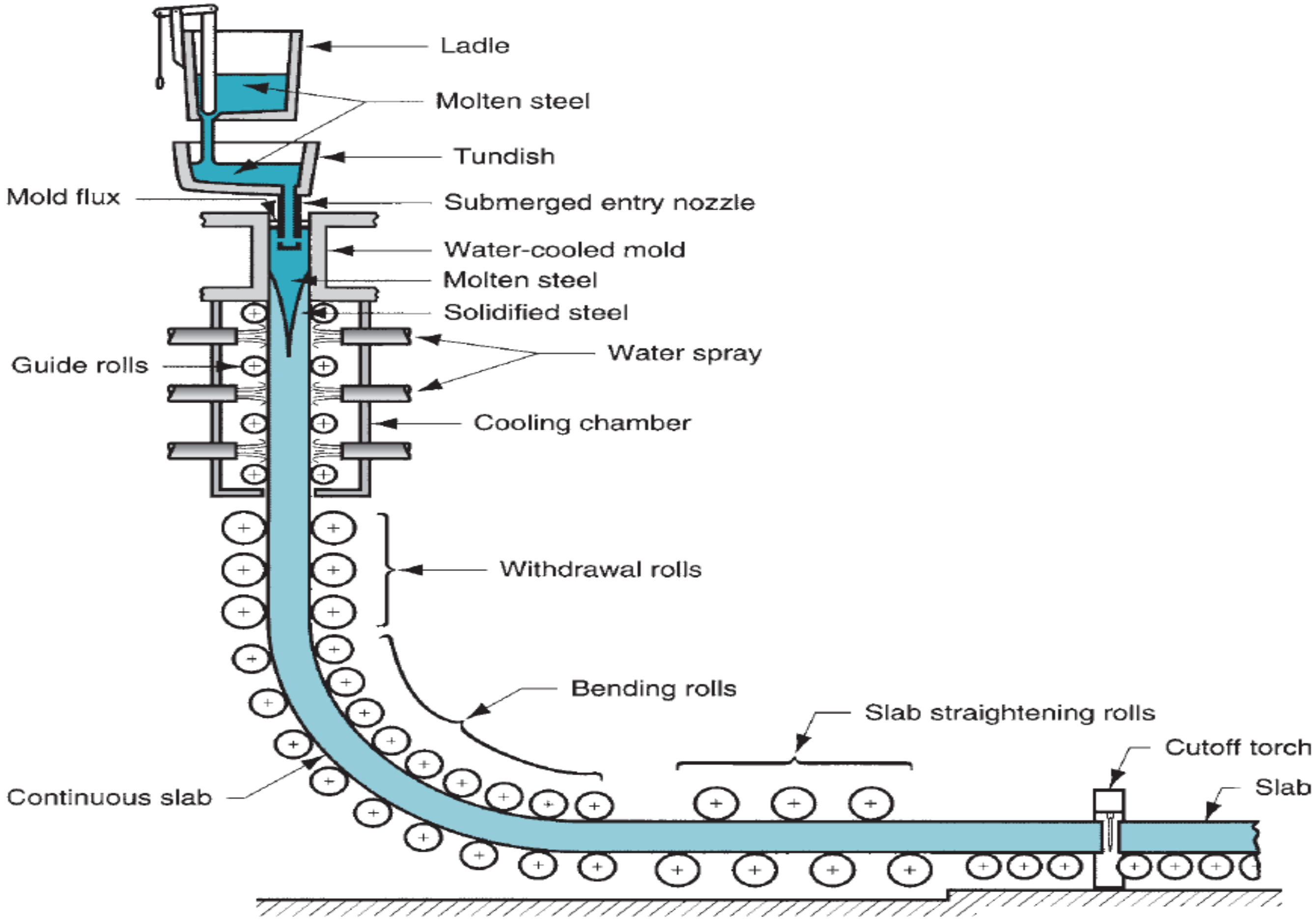
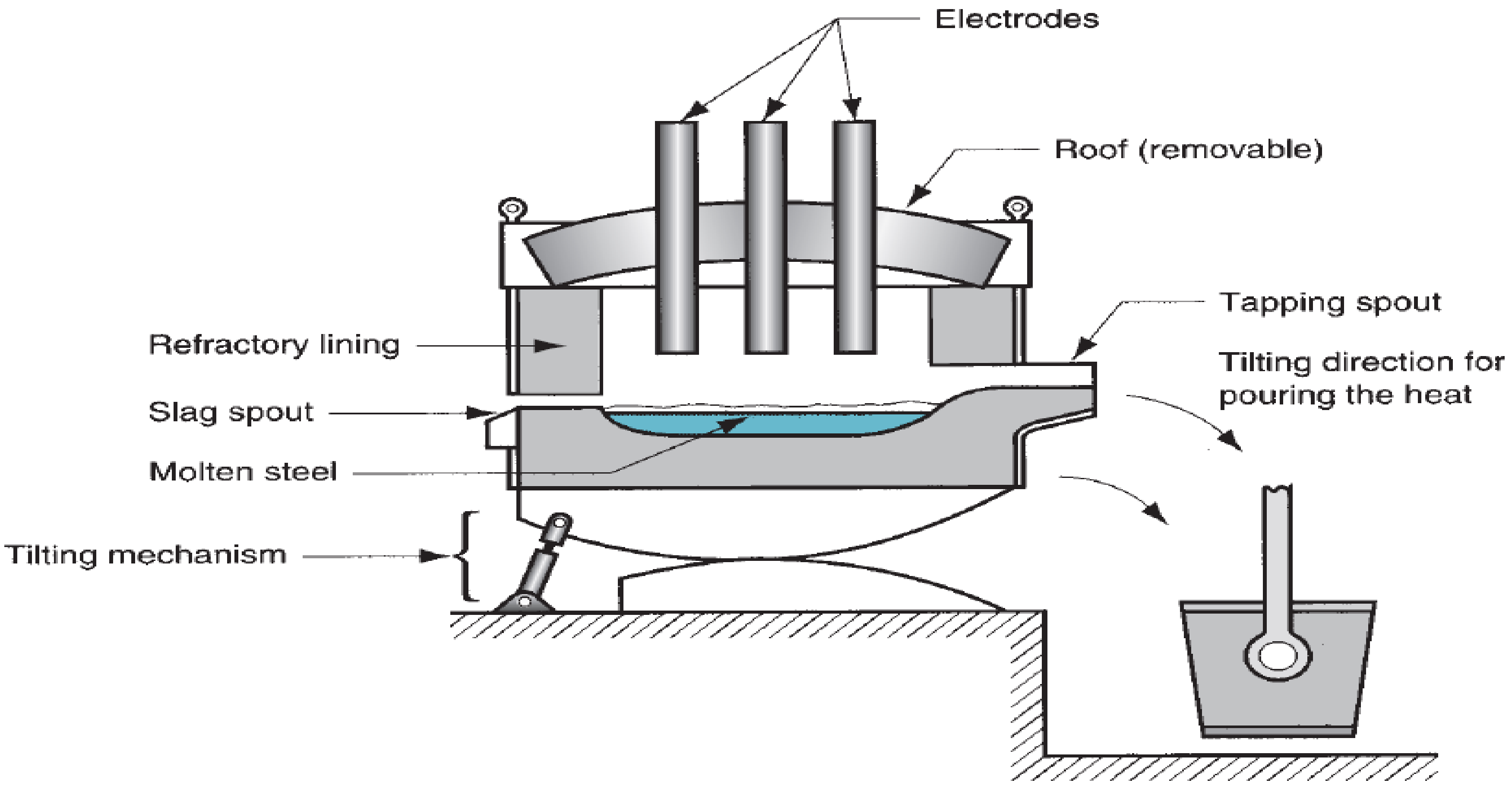


FIGURE 6.11
Continuous casting; steel is poured into tundish and distributed to a water-cooled continuous casting mold; it solidifies as it travels down through the mold. The slab thickness is exaggerated for clarity.

Ingot Casting



EXPENDABLE GRAPHITE MOLDS

- For metals such as titanium, which tend to react with many of the more common mold materials, powdered *graphite* can be combined with additives, such as cement, starch, and water, and compacted around a pattern. After "setting," the pattern is removed and the mold is fired at 1000°C (1800°F) to consolidate the graphite. The casting is poured, and the mold is broken to remove the product

RUBBER-MOLD CASTING

- Artificial elastomers can also be compounded in liquid form and poured over a pattern to produce a semi rigid mold. These molds are sufficiently flexible to permit stripping from an intricate shape or patterns with reverse-taper surfaces. Unfortunately, rubber molds are generally limited to small castings and low-melting-point materials. The wax patterns used in investment casting are often made by rubber-mold casting, as are small quantities of finished parts made from plastics or metals that can be poured at temperatures below 250°C (500°F).