

A large industrial ladle, filled with bright orange molten metal, is tilted and pouring the liquid into a smaller, textured metal cup. The background is dark and industrial.

The Investment Casting Process

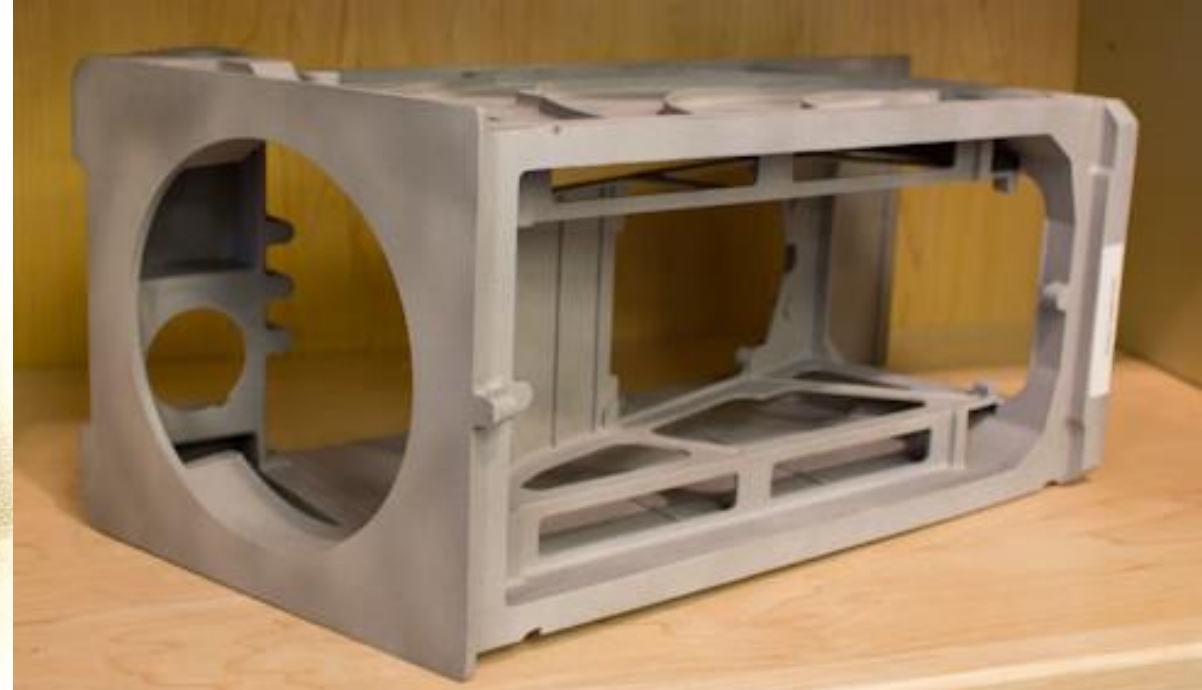


Joseph E. Fritz
Executive Director
Investment
Casting Institute

Background

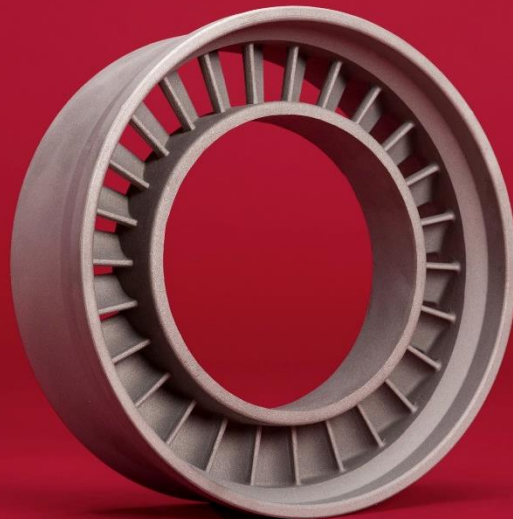
- Originally developed by ancient Chinese and Egyptian culture to create artwork
- Primarily used for art until development of the jet turbine engine at the end of World War II
- Since that time it has become an enabling technology in today's top industries
 - Aerospace and Defense
 - Power Generation
 - Automotive
 - Oil and Gas
 - Space Exploration
 - Medical / Orthopedics
 - Agriculture
 - Construction
 - Commercial and Consumer products





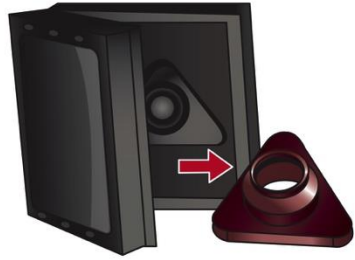
Some of the Benefits of Investment Casting

- Superior surface finish
- Wide range of alloys
- Complex, near net geometries
- Fine detail



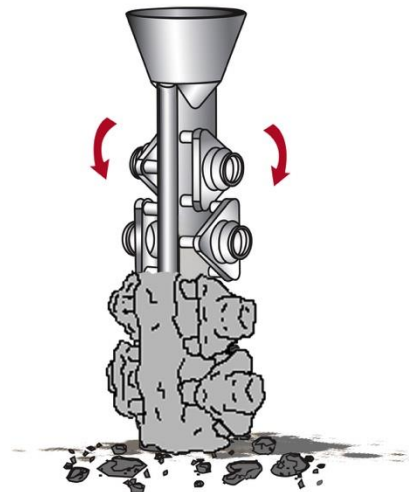
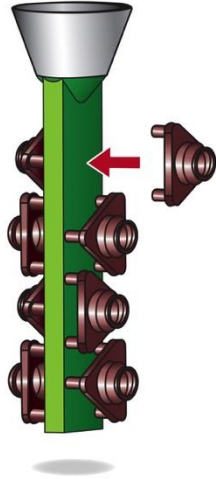
The Investment Casting Process

1. WAX PATTERN INJECTION



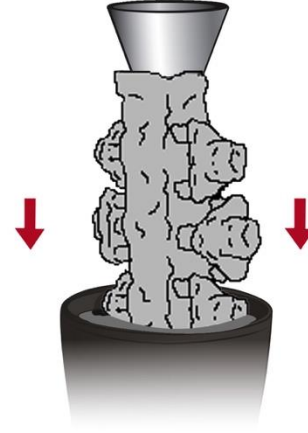
5. METAL POURING

2. Wax Tree Assembly

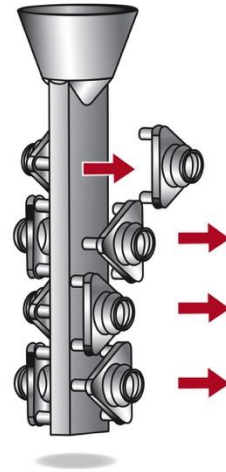


6. SHELL KNOCK OFF

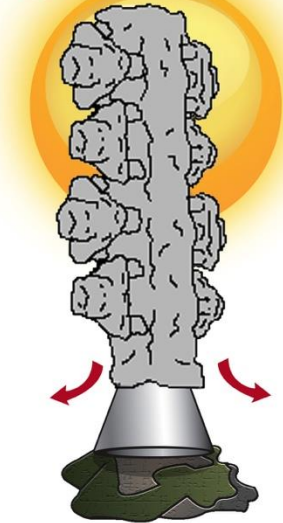
3. Shell Building



7. CUT-OFF



4. Dewax / Burnout



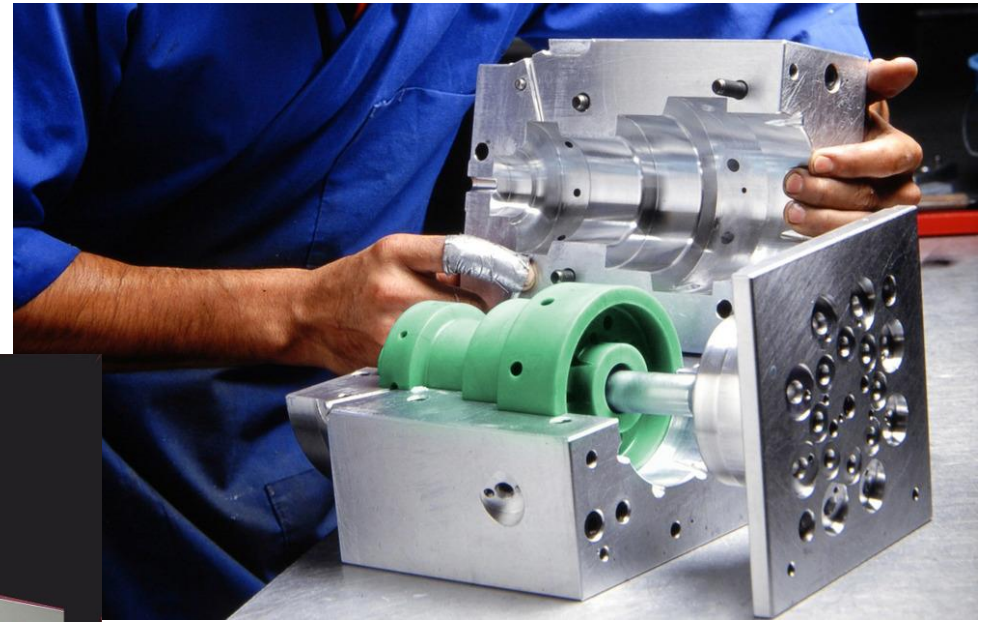
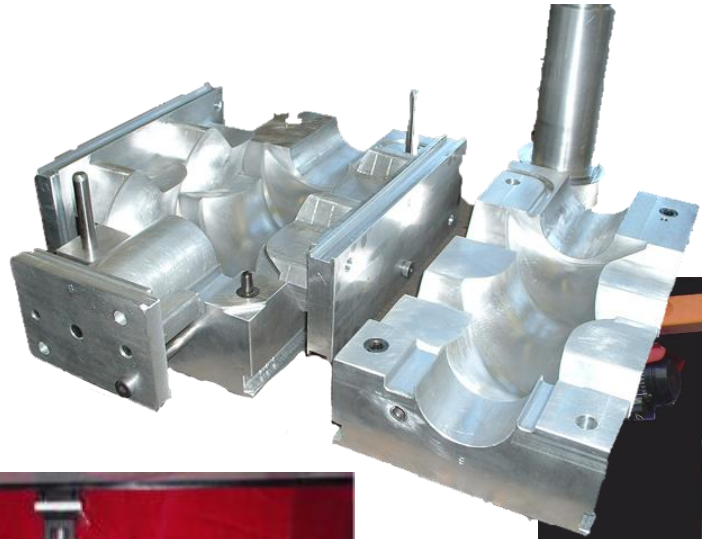
8. INDIVIDUAL CASTINGS



Creating a Wax Pattern

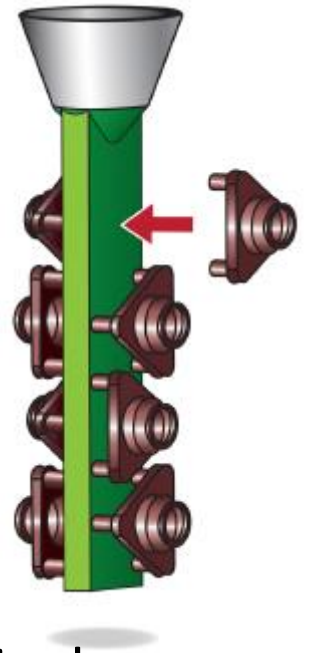


- In today's manufacturing world, wax patterns are typically made by injecting wax into a metal tool or "die"
 - With the evolution of Additive Manufacturing, patterns can be printed
- In the art community, one of a kind pieces are carved by the artist from wax blocks
 - For multiple castings, a silicon tool is usually made from the artist's sculpture and wax is injected or poured into the resulting cavity



Wax Tree Assembly

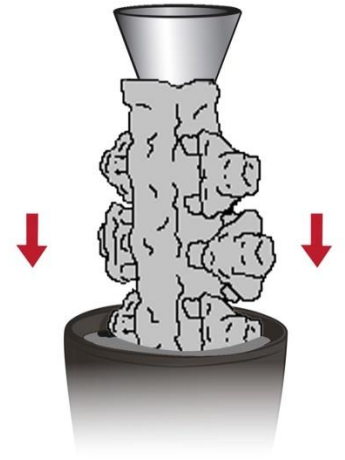
- It is typically uneconomical to make small parts one at a time, so wax patterns are typically attached to a wax “sprue”
- The sprue serves two purposes
 1. Provides a mounting surface to assemble multiple patterns into a single mold, which will be later filled with alloy
 2. Provides a flow path for the molten alloy into the void created by the wax pattern(s)
- The wax between the pattern(s) and the sprue are called “Gates”, because they throttle the direction and flow of the alloy into the void made by the pattern





Shell Building

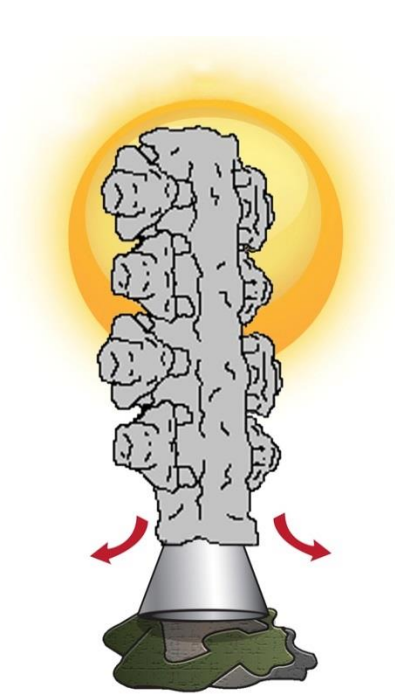
- The next step in the process is to build a ceramic shell around the wax tree
- This shell will eventually become the mold that metal is poured into
- To build the shell, the tree is dipped into a ceramic bath or “slurry”
- After dipping, fine sand or “stucco” is applied to the wet surface
- The mold is allowed to dry, and the process is repeated a number of times until a layered (or laminated) ceramic mold, capable to undergo the stresses of the casting process, has been built





Dewax / Burnout

- Before pouring metal into the mold, the wax is removed
- This is typically done using a steam-dewax autoclave, which is like a large, industrial pressure cooker
- Another method is the use of a flash fire oven, which melts and burns off the wax
- Many foundries use both methods in concert
 - Autoclave removes the majority of the wax, which can be reconditioned and reused
 - Flash fire burns off residual wax and cures the shell, readying it for casting

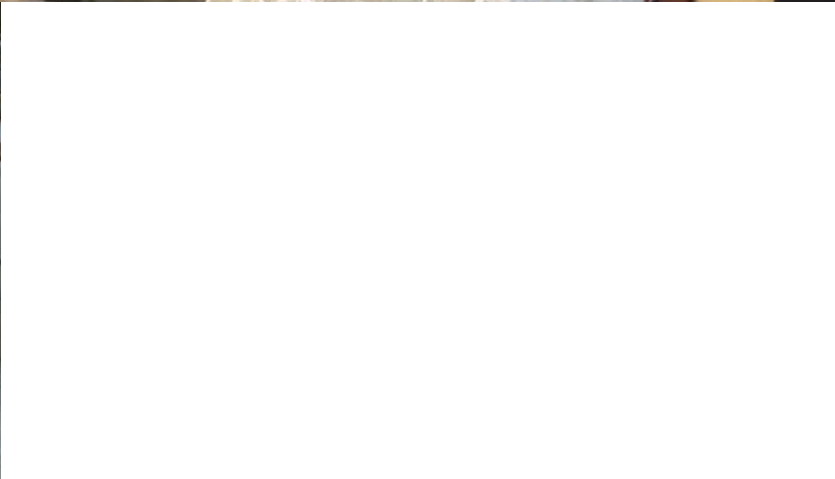




Metal Pouring

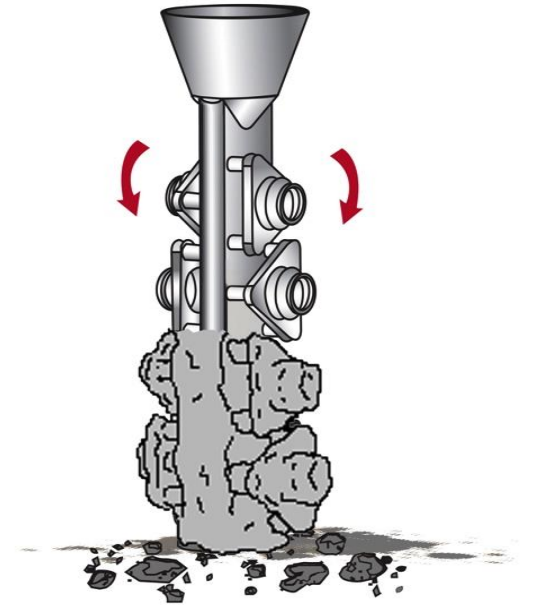
- Before the metal is poured into the ceramic mold or “shell”, the mold is preheated to a specific temperature to prevent the molten alloy from solidifying or “freezing off” before the entire mold is filled
- Alloy is melted in a ceramic cup (called a crucible) using a process known as induction melting
 - A high frequency electric current creates a magnetic field around the alloy, generating electric fields inside the metal (eddy currents)
 - The eddy currents heat the alloy due to the material’s electrical resistance
- When the alloy reaches its specified temperature, it is poured into the mold, and the mold is allowed to cool

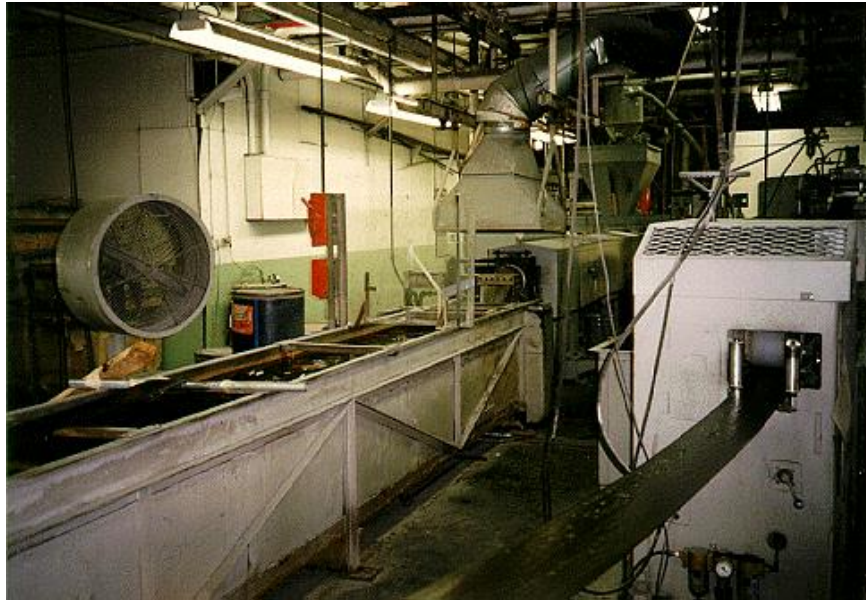
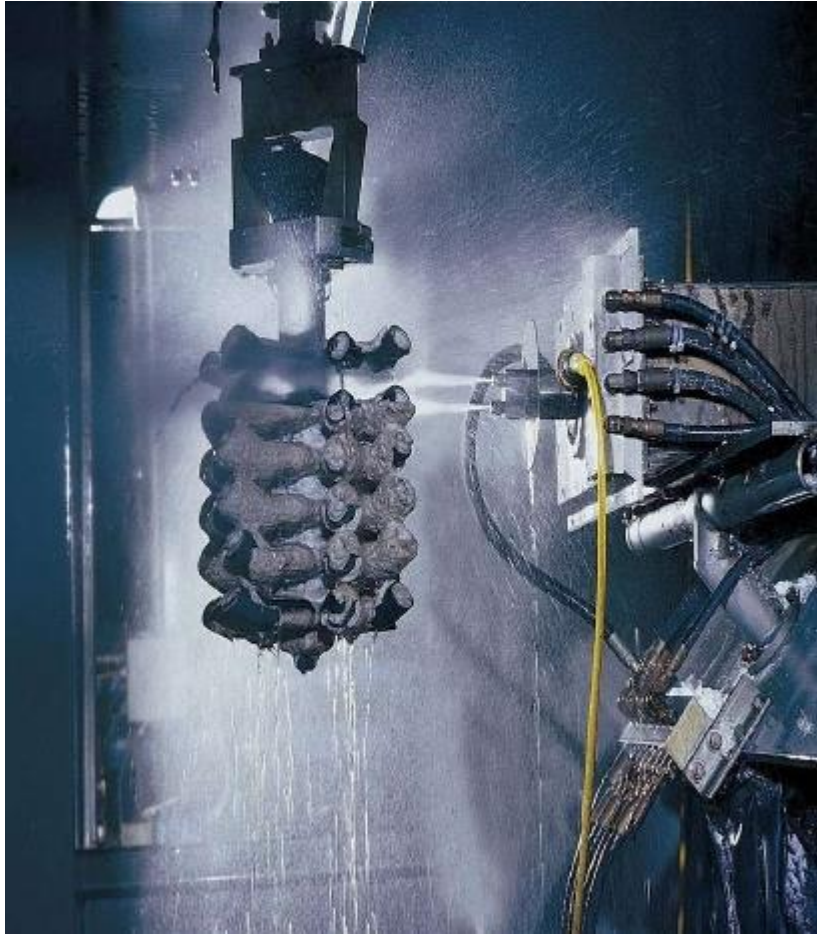




Shell Knock Off

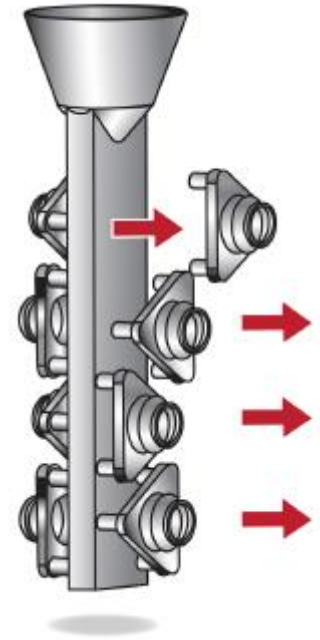
- Once cool, the shell material is removed from the metal
- This is typically done via mechanical means
 - Hammer
 - High Pressure Water Blast
 - Vibratory Table
- Shell removal can also be accomplished chemically, using a heated caustic solution of either potassium hydroxide or sodium hydroxide, but this approach is being phased out due to environmental and health concerns





Cut Off

- Once the shell material has been removed, the parts are cut off the sprue and the gates are ground off
- Part cut off can be done manually
 - Chop saw
 - Torch
 - Laser (limited applications)
- Parts can also be cut off using automation, that is, the mold can be secured using a fixture on a programmable cut off saw

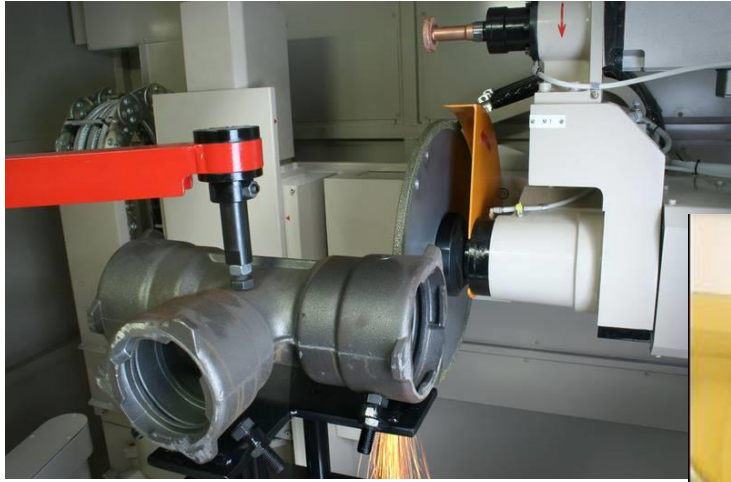




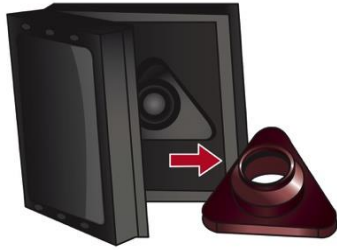


Individual Castings

- Once the parts are removed from the sprue, and the gates removed, the surface can be finished via a number of means
 - Vibratory/Media finishing
 - Belting or hand grinding
 - Polishing
- Finishing can be done by hand, but in many cases it is automated
- Parts are then inspected, marked (if required), packaged and shipped
- Depending on the application, the parts can be used in their “net shape” or undergo machining for precision mating surfaces

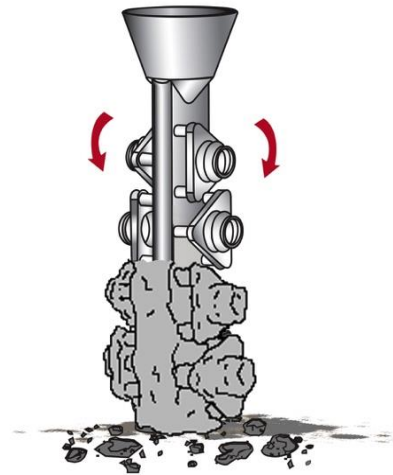
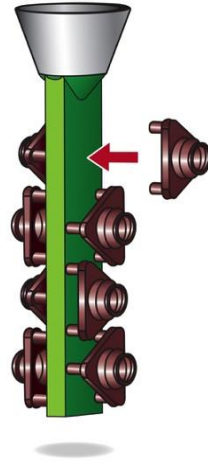


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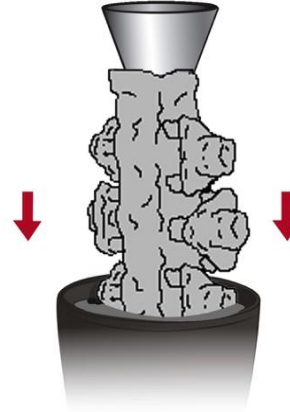
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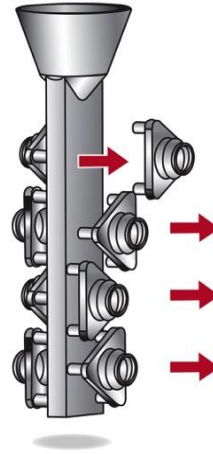


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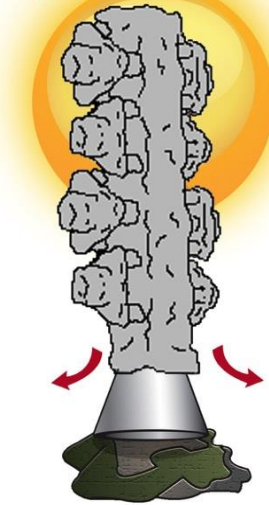
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8. INDIVIDUAL CASTINGS



Summary

- From Egypt and China to modern day manufacturing, investment casting has evolved from an art to a high technology enabler
- In our everyday lives, investment castings can be found all around us



Questions?

Call the Investment Casting Institute
at 201-573-9770.

