THE INVESTMENT PROCESS

WHERE IT STARTED

The Egyptians and Chinese used the process in their early history to make statues and jewelry. The investment casting method was largely ignored as an industrial process for the fabrication of parts until the demand for rapidly finished parts during World War II created the need for near net-shape components that could readily be put into their final form. Then new inorganic high temperature ceramic mold binders were developed to industrialize the process applications to include high strength and corrosion resistant materials such as low to high carbon alloy steel, tool steel, stainless steel, and nickel and cobalt base alloys. Aluminum and brass alloys are available also. It is a process capable of producing intricate shapes weighing from a small fraction of an ounce up to forty pounds or more.

HOW IT WORKS

A injection molded wax pattern is used for each part produced which is then encased in multiple layers of ceramic material. The wax pattern is then removed from the ceramic shell mold. The mold is fired in an oven and then molten metal is poured into the cavities left by the evacuated wax pattern. Upon cooling, the resulting precision castings are cleaned and subjected to further processing such as heat treatment. At this point, many parts are in their final form and are ready for use while others may require a small amount of further processing such as machining before reaching their final form.

The word investment, in INVESTMENT CASTING, denotes the mechanical manner of making a mold rather than the material used. This process employs a three-dimensional pattern – using all three dimensions – to produce a one time destructible mold into which molten metal will be poured. A very simple example would be to pour wax into and egg shell, let it cool, then crack away the shell. People, not especially versed in casting terms, on occasion associate this process with financial matters.

Some examples of usage would be: dental appliances, jewelry, components for the automotive industry, military weaponry, jet engines, aircraft structural parts, machinery components, and many others.

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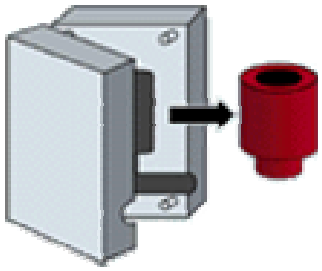
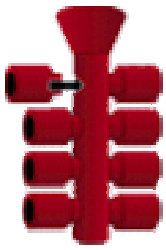
THE PROCESS



PATTERN PRODUCTION

The process begins with the production of an expendable pattern. This pattern is made by injecting wax into an aluminum die (pattern tool).



MOUNTING/CLUSTER ASSEMBLY

Patterns are fastened by the gates to one or more runners. The runners are attached to the pouring cup. Both are usually made of wax. Patterns, runners and pouring cup comprise the cluster or tree, which is needed to produce the ceramic mold.

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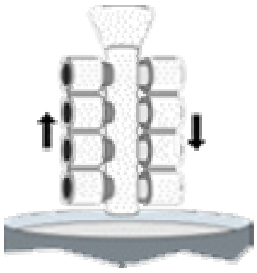
THE PROCESS CONT.



SHELL MOLDING (INVESTING)

STEP ONE

The cluster (tree) is rinsed in a pattern wash/etching solution. This removes any mold release residue from the pattern. The cluster (tree) is then dipped into a primary slurry/binder. The cluster (Tree) is manipulated so that the patterns receive a complete and even coat of binder.

STEP TWO

The cluster (tree) is then stuccoed with a primary refractory grain, this gives us our face coat. After drying, this primary coating process is repeated as necessary. The primary coats determine detail and surface finish.

STEP THREE

After completion of the primary coats the cluster (tree) is ready for the secondary or back up coats. This is done in the same manner as the primary coats except the binder composition and viscosity is different and the stucco grain size is coarser. The secondary/back up coating process is repeated as necessary until the shell is strong enough to hold molten metal. After completing the back up coats the cluster (tree) is then given a seal coat by dipping it back into the slurry. The shell, after drying, is now ready for dewaxing.

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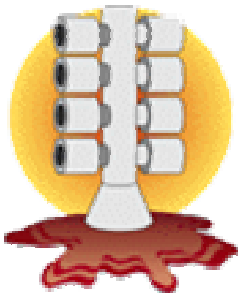

CERAMIC SHELL DEWAXING

The coated cluster (tree) is placed in a high temperature furnace or steam autoclave. This melts out the patterns, gates, runners and pouring cup - creating a ceramic shell containing cavities of the casting shape desired with passages leading to them.

CERAMIC SHELL FIRING (BURN-OUT)

The shells (molds) must be fired to burn out the last traces of pattern material, remove any moisture, bring shell to fired strength, proper temperature, and aid in fluidity for thin sections. Shells are fired to temperature designated by part design and alloy selection.

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THE PROCESS CONT.

CASTING

Molten metal is poured into the fired shell at temperatures between 1300°F - 2950°F depending on the type of alloy selected, and the casting/part configuration. Pouring temperatures are maintained as cool as possible.

SHELL MOLD/INVESTMENT REMOVAL (KNOCK-OUT)

After the poured (molten) metal has cooled, the shell (mold) material is removed from the casting cluster (tree) using high pressure water, vibratory or shot blast methods.

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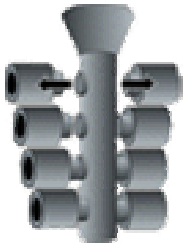

CASTING CUT OFF AND CLEAN-UP

The individual castings are removed (cut-off) from the cluster (tree). Remaining protrusions left by gates or runners, are removed by grinding. Generally the castings are shot, sand or bead blasted for a smoother finish.

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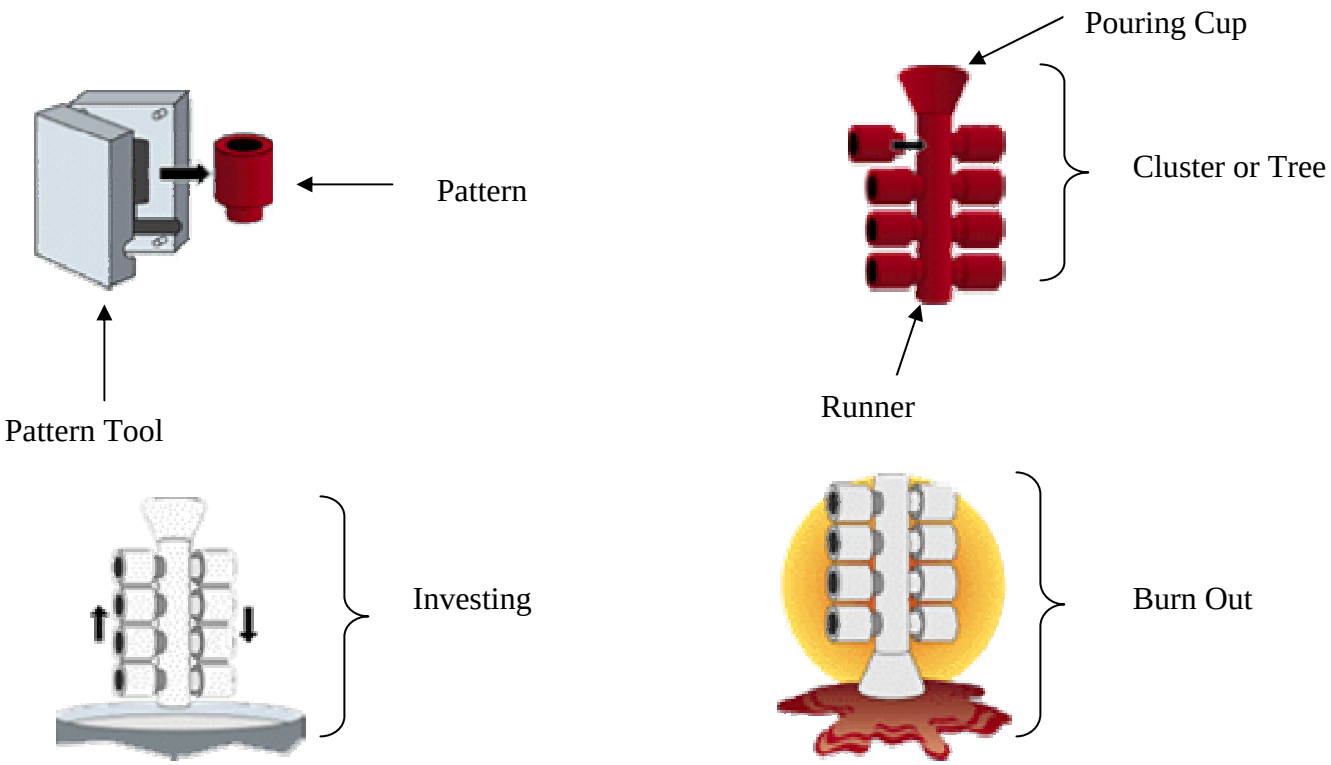
INVESTMENT CASTING



DEFINITIONS

1. **PATTERN TOOL**: An aluminum die that is used to produce an exact replica of the finished part in wax.
2. **PATTERN**: An expendable wax replica around which molding material is placed to produce a finished casting.
3. **POURING CUP**: Where the molten metal is poured.
4. **CLUSTER OR TREE**: A group of expendable patterns on runners for casting purposes.
5. **RUNNER**: The portion of the tree assembly that connects with the casting ingate.
6. **INVESTING**: The coating of an expendable pattern with a ceramic material so that it forms the surface of the mold that contacts the molten metal when the pattern is removed and the mold is poured.
7. **BURN-OUT**: Firing a mold at high temperature to remove pattern material residue.

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INVESTMENT CASTING BENEFITS

Alloy Flexibility

All alloys both ferrous & non ferrous

Superior Surface Finishes

60 to 90 RMS

Thin Walls

As thin as .060”

Tight Tolerances

+/- .005” to 3”

Near Net Shape

On average, investment castings offer 90% or more of the requirements of the finished part in an as-cast state. Investment casting can incorporate complex undercuts, slots, holes, lettering, and bevels into the design.

Design Freedom

Investment casting offers the fewest design restriction of any metal working process.

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MECHANICAL PROPERTY LIMITS FOR COMMONLY USED CASTING ALLOYS

Alloy	Temper	Ultimate (ksi)	Yield (ksi)	% Elongation	Hardness
		1000 PSI	.2% offset		Brinell
A 365	T6	34	24	3.5	70 - 105
410	F	95	75	8	94 - 100
304	F	65	30	30	- -
D - 2	F	23	13	1.5	55 - 85
85-5-5-5	F	37	17	30	60

Note: The above properties are believed to be correct, but are not warranted in any way by McCann Sales, Inc. “F” as cast condition

GENERAL DESIGN DATA

SIZE RANGE: Up to 250 lbs.

METALS: All

TOLERANCES: +/- .005” for 3” then add +/- .003 inches/inch

PARTING LINE SHIFT: N/A

AVERAGE TOOLING COST: $ 2,000 to $ 9,000

TYPICAL ORDER QUANTITY: All

AVERAGE TOOLING LEADTIME: 6 to 8 weeks

SURFACE FINISH: 60 to 90 RMS

MINIMUM SECTION THICKNESS: .060” premium / .080” average

MINIMUM DRAFT REQUIRED: Zero

Note: The above information is meant to be a basic guideline for comparison purposes only.

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