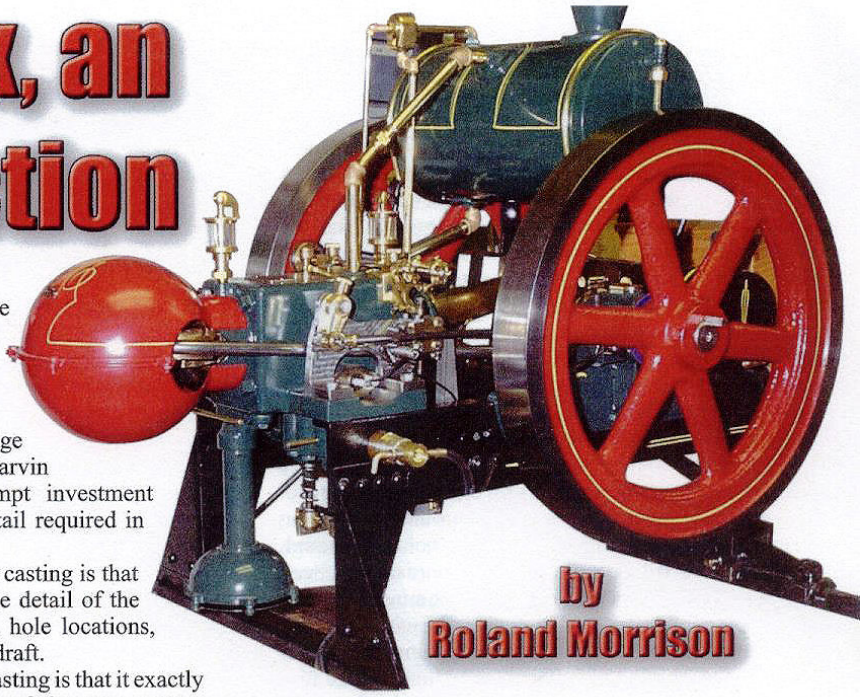
Lost Wax, an Introduction



by Roland Morrison

Beyond Sand Casting

Some really amazing things have been sand cast. However, to capture fine detail investment (lost wax) casting has been used for centuries.

Having exhausted our knowledge and ability with sand casting, Marvin Hedbergt and I decided to attempt investment casting to capture the exquisite detail required in our scale replica engines.

The great thing about investment casting is that it exactly replicates in metal, all the detail of the wax pattern, like intricate designs, hole locations, undercuts plus there is no need for draft.

The bad thing about investment casting is that it exactly replicates in metal, all the defects of the wax pattern, including bubbles, scratches and even fingerprints. Plus, investment casting brings a whole new set of problems like uneven fill, double shrinkage, knit lines, mold temperature, wax pressure, and venting.

Investment casting, greatly simplified, is a wax pattern, made by molding or carving, which is coated with a ceramic paste. The wax is melted out (lost) and metal poured into the cavity. When the ceramic is broken away the metal part is an exact copy of the wax. Note however, the wax shrinks when it cools and then the metal also shrinks.

Marvin Hedberg and I have had a steep learning curve trying to utilize this process. We decided early on, mainly because we didn't have a clue what we were doing, to make our own wax patterns. This turned out to be an excellent decision as most of our molds are so complex no foundry would want to deal with them.

Our current project is a Quarter Scale Replica of a 10 Horsepower 'Lightning Balanced Engine' made by the Kansas City Haypress Company in 1903.

This engine was 'Balanced' so it would not move while belted to their Haypress. The balancing was accomplished by opposing pistons in a single cylinder thereby counteracting the reciprocating inertia. This made for a complex, expensive engine which probably explains its rarity.

The valves and igniter are located in the center of the cylinder where the pistons meet. This makes scale replicating much more challenging than a simple cylinder head with valves.

Many areas that were cored in full size quickly exceed our ability in quarter scale. One example is the water jacket in the cylinder. A common solution is to cast the cylinder with recesses inside and then fit a sleeve for the piston. This 'wet sleeve' works well and is used in our engines.

The mold to make the wax pattern for the Lightning Balanced Engine cylinder was machined from 6061 aluminum. The cores are made from aluminum, brass and steel depending on the durability required.

Marvin master-minded the cavity and the collapsing core. All together, not counting the fasteners, the mold has 29 pieces. It takes almost an hour to make one wax cylinder pattern. Because the wax pattern is 'lost' when melted out of the ceramic mold, a wax pattern is needed for every casting wanted – plus a few for the castings that don't turn out.

We quickly discovered the thicker center section had more shrinkage than the water jacket areas. We solved this by making a wax insert, called a 'chill', to fill out the center

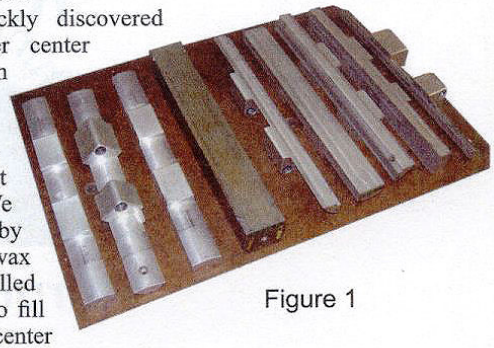


Figure 1

Figure 2

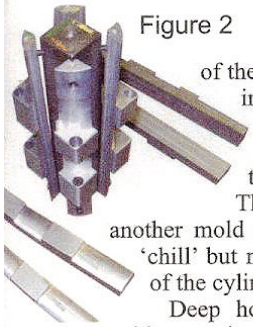
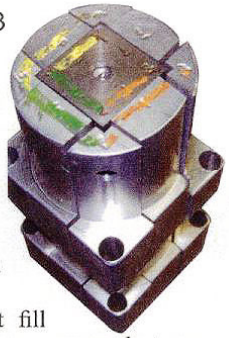


Figure 3



of the core so the injected wax was all the same thickness. This required another mold to make the 'chill' but now the sides of the cylinder are flat.

Deep holes will not fill with ceramic so all the cores were made to go completely through to the cylinder bore. This puts the ports in the cylinder casting. These ports are intentionally undersized so they can be reamed to fit the attaching parts.

Figure 4

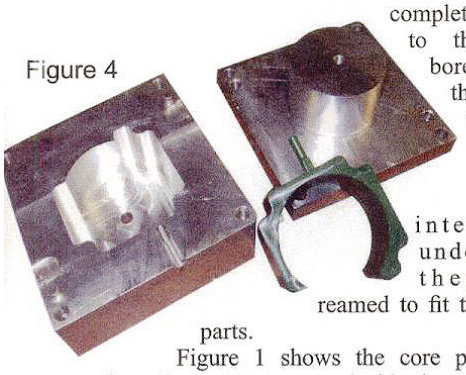


Figure 1 shows the core pieces which form the water passages inside the cylinder. The ends and the center section are a shrink fit on the cylinder sleeve so the cooling water is contained in the two square areas with holes for water passage in the corners. The core was made to collapse after the wax cooled by tapering the center square section so it could be removed. The corner pieces screw onto that (Figure 2) and dovetails hold the flat sections. (Figure 3)

Figure 5

Figure 4 shows the 'chill' mold and wax. Figure 5 shows the 'chill' in place on the core. Figure 6 and 7 detail the cores for valve and ignitor ports showing how they fit against the main core. Figure 8 shows pins which lock the core in place and form the cooling water holes.

Figure 6

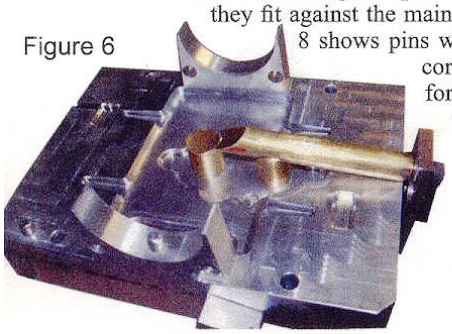
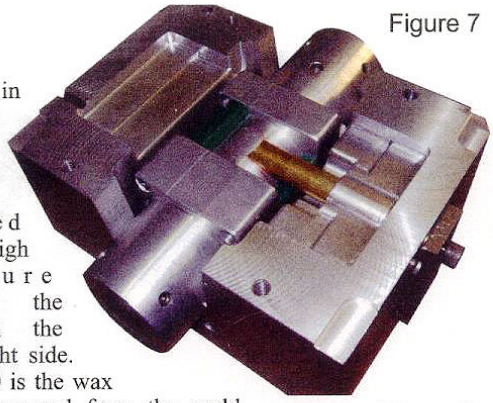


Figure 7

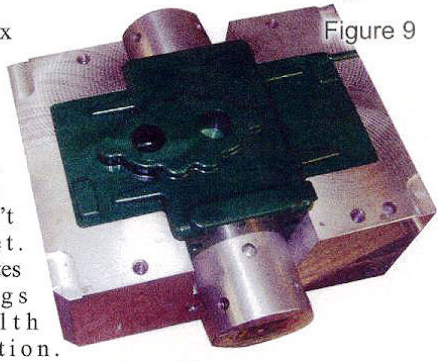


Note in Figure 9 the wax has been injected under high pressure through the gate on the upper right side. Figure 10 is the wax pattern removed from the mold showing the main core position. Disassembly of the core starts with removal of the tapered center (Figure 11) which then allows dovetail pieces (Figure 12) to be removed. The happy ending is shown in Figure 14 where a grade 30 cast iron cylinder is being machined for a shrink fit on the sleeve.

Figure 8

We never found a suitable book on investment casting. Either they were very technical and for high production far beyond our capabilities, or about jewelry and art casting.

Figure 9



Injection wax is available in all colors, hardness, melting points, and density. Which one is best? We haven't found it yet. Supplier websites and catalogs are a wealth of information. Try www.kindt-collins.com or www.freemanwax.com

This cylinder mold is just one of many molds required to make the Lightning Balanced Engine.

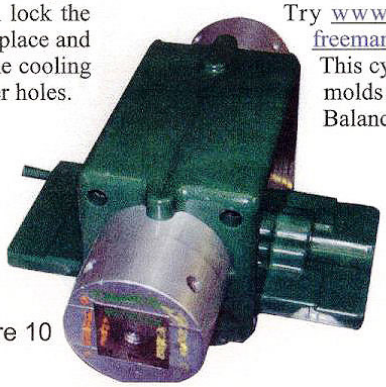


Figure 10

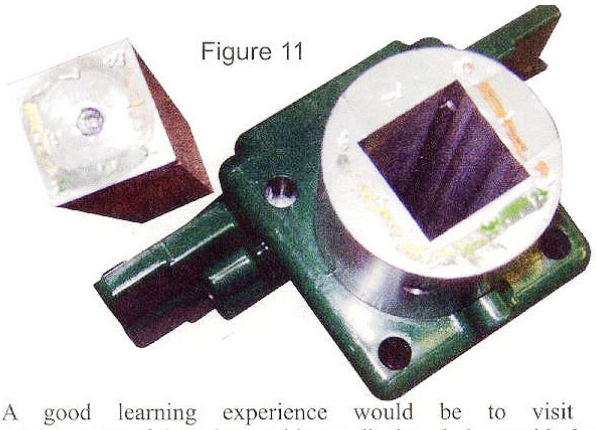


Figure 11

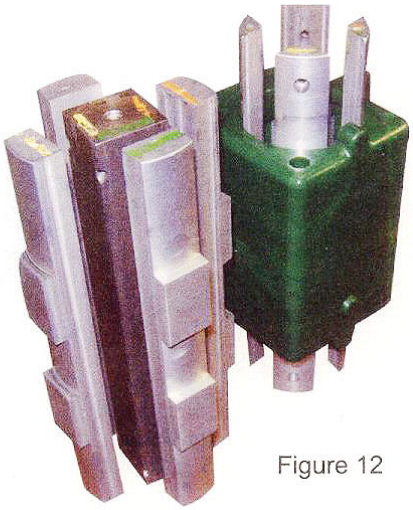


Figure 12

A good learning experience would be to visit our website where many of the other molds are displayed along with the metal casting produced from the wax pattern www.morrisonandmarvin.com/lightning_molds.htm

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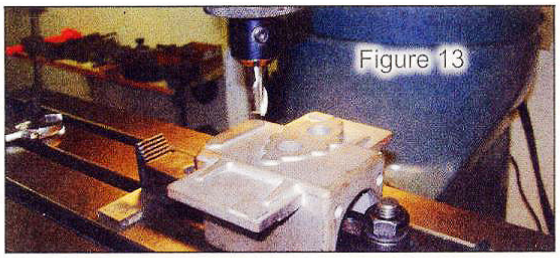

Figure 13

Lost Wax Casting of Nameplate

THE END

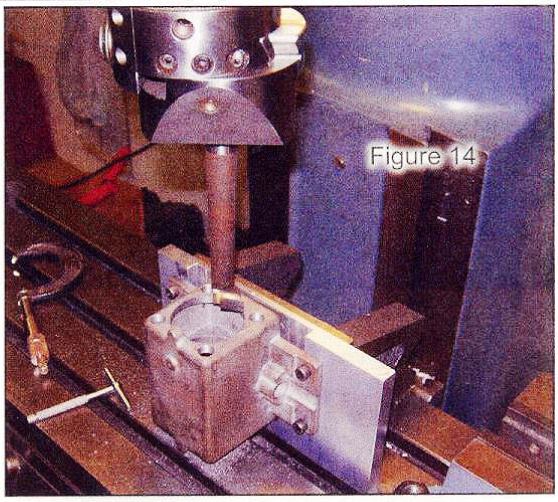

Figure 14

More to come from Roland on lost wax casting