Casting Tree Design and Investment Technique for Induction Platinum Casting

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ABSTRACT

This paper explores the result of breaking out of the old paradigm considered the conventional wisdom of platinum casting - breaking all the rules around flask size, type and configuration, investment mixtures and de-watering, sprue size and configuration, as well as how tall the tree can be and how many pieces can be cast on a tree.

Using actual examples and photographs, you will learn techniques that have proven to work better than the old ways. These techniques will include "crooked tree" spruing, a spruing technique where the rotation of the casting machine is taken into consideration to get maximum fill.

The result is less investment cracks and resulting finer detail, less casting defects, easier de-vesting and higher yield at lower cost. This paper will help you to improve your platinum casting ability, as well as your productivity.

KEYWORDS

Platinum casting, spruing, investment, tall trees, sprue size, crooked tree, maximum fill, de-vesting, technique.

INTRODUCTION

When Michael Epstein first approached me and talked about tall tree casting I was very skeptical. He showed me a cast tree of platinum eternity rings weighing about 350 grams. The one striking feature of the tree was the thin center sprue. It was only 4.5mm in diameter, yet it was over six inches tall and supported well over 40 rings. During the next few month, I visited his shop and spent some time with him to expand and further experiment. Ultimately, casting trees weighing 550 grams and holding close to 85 rings were possible. Many casting experiments lead to a whole new understanding of platinum casting, and brought about a procedure that is absolutely amazing.

In this paper I will discuss some of the findings and conclusions that have been the outcome of these ongoing casting experiments.

THE EQUIPMENT

The casting was done with a Galloni Modular 6 induction casting machine. This machine develops 5KV induction power and was using a standard coil and 350 gram capacity crucible.

In later experiments we replaced the standard induction coil with a larger one (the largest one to fit this model casting machine) and used a crucible capable of holding 600 grams of platinum.

THE CASTING EXPERIMENTS

Series 1

In the initial casting series, we used a variety of investments, to see if there are any major advantages or disadvantages to them. I felt that the more available an investment was, the easier the casting method can be applied to the industry.

The various investments used were Platinum Plus from Ranson & Randolph, Opticast from Kerr, J Formula from Romanoff and West Cast Platinum QC from Rio Grande.

In all cases, the investment properties were changed by reducing the percentage of the acid that was used to mix the solution needed to make the investment by 45% and replaced the missing portion with distilled water. That mix was then blended with the proper proportions of distilled water to create the binding liquid.

Leaning the acid content created a somewhat more porous investment, which seemed to have the benefit of being more flexible, and allowing gases to escape, without sacrificing strength.

In previous experiments, it was discovered that most investments are already showing signs of cracking during the jell state. This has been totally eliminated by the acid modification.

The kiln was at room temperature in some experiments, and at 200°F in others, with no significant differences.

Burn-out was done in a computerized electric kiln. The alloy cast was Pt950/Iridium.

PREPARING THE FLASK

In these experiments, we used a 3" x 8" perforated flask.

The flask was wrapped with 12 layers of "Bounty" brand paper towels. In previous trials, it was found to have the best absorption. Using masking tape, the paper towels were secured around the flask. The perforation of the flask will allow for lateral absorption of the water, which, as you all know, need to be removed from the flask. This use of a perforated flask is very unique for centrifugal casting.

THE WAX TREE

Through many experiments we determined that the ideal diameter of the center sprue was to be 4.5mm. In order to make a tall tree, able of supporting 40 or more (in later experiments as many as 100) rings, this center sprue needed to be supported. The best solution for this was a metal core in the center sprue, which would then be removed before the actual casting. Using a 1.5 mm copper wire dipped it into the wax in the wax pot such a sprue was created. In later experiments, this copper wire was replaced with silver, as there was a minor problem with the oxidation of the wire during the burn-out.

The center sprue was then waxed to a wax dome and the wax patterns were attached at a 45 degree angle to the stem. This is the conventional method used by many casting houses. The sprue size of the rings was 1 x 2.5mm and was attached to the side of the eternity rings. These rings were made to support 2-3mm diamonds. They were ajoured, and drilled.

We were casting four flasks. Tree #1 contained 40 rings. The center sprue however was 5mm square and hollow with a 1mm-wall thickness. This was done to see if a hollow spruing system was feasible and economical.

Tree #2 was waxed up with 40 eternity rings, sprued at the before mentioned 45 degrees.

Tree #3 contained a wide variety of small parts, pieces and for a line bracelet and parts of several rings. The unique thing about this tree is the fact that the wax pieces were actually distributed over three sprues, coming from the same cone.

Tree # 4 was simply a way to create some blanks for casting and consisted of three wax rods, 8mm in diameter. The resulted cast wire was then rolled and used for die striking other parts in an unrelated manufacturing sequence.

BURN-OUT

The following schedule was employed for burn-out.

After pouring the investment into the wrapped flask and additional vacuuming to remove the air bubbles, the flask remained on the bench for one hour.

The flask was then set into the kiln and the kiln was brought to 200°F within 30 minutes and held at that temperature for two hours.

After two hours at 200°F the temperature was brought to 350°F with a 1/2 hour ramp.

It remained there for one hour. Then the kiln was opened, the paper and the copper wires were removed from the flask and the flask was placed back into the kiln. The temperature was then ramped up to 1700°F in a 3 1/2 hour ramp.

CASTING

For the casting of these flasks, the RPM of the machine was slowed down to the 200-300 range. One assumes that when casting platinum a higher speed would bring better results. This is not true. At high speed the metal enters the flask with lots of turbulence. Any sudden change in direction, any gas obstruction will shorten the distance the liquid platinum can flow. By reducing the speed of the machine, the metal enters in a smooth even flow, has the ability to push any gas from inside the flask away and fill the cavity with amazing, clean and porous free castings.

For large pieces the recommended speed of the arm was 200 RPM, for most rings the best results were obtained at 250 RPM and for a triple tree casting with many small parts, 300RPM worked best.

Flask temperature for this experiment was at 1700°F. The metal temperature was set to 1980°C, 200°C super heat. The Pt alloy was Pt950/Ir.

RPM for flask #1 and #2 was at 250, for flask #3, 300 and for flask #4 at 200.

RESULT

All four flasks filled to the top. The average weight of each flask was 350 grams. The investment was removed in a solution of Caustic Potash 45%.

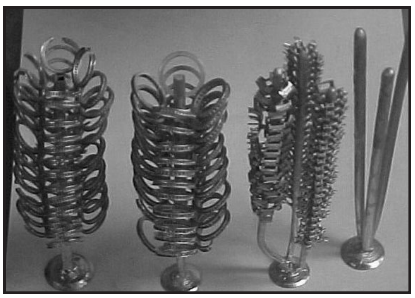
Tree #1

There were a significant number of no-fills on the tree. But, if one considers that the center sprue was a hollow one, with a wall thickness of about 1mm, then it is amazing that the entire tree filled at all. We abandoned further experiments with hollow core center sprues. This may be subject of additional research in the future. Just proving the feasibility was the goal here.

Tree #2

There were two no fills at random position on the leading side of the rotation direction. This brought about new testing in the next casting run, experimenting with sprue placement and angle.

Tree #3 was filled and again, it showed some casting flaws on the leading edge in the direction of the flask rotation.



Tree #4 was a complete fill.

All three rods were solid, with almost no internal porosity.

SERIES 2

After several more casting runs using the technique as described before and observing casting defects, and random no-fills, Michael continued to modify the procedure. The first change was the fact that better results were achieved by spruing the waxes at 90 degrees to the center sprue. Reducing the casting temperature to 1400°F was another improvement. (Actually, some stone-in-place casting using this tree method was done successfully at 500°-600°F-flask temp.)

Experiments with larger items, some weighing as much as one ounce, as well as multi-piece and multi-sprue flasks was being done.

In this casting series the parameters have been changed to include larger crucible size, the coil on the machine has been replaced to accompany this change and the average casting tree weighs 550 grams.

The burn-out cycle has been significantly shortened.

PREPARING THE FLASK

The flasks were again wrapped with paper towels and taped. The flask sizes were 3" x 8" and 4" x 6".

WAXING THE TREE

Flask #1

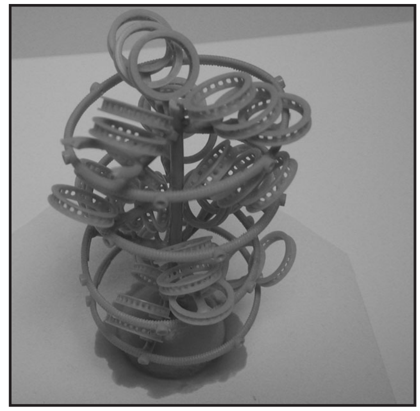
To prove that larger objects can be cast in the same way, a number of frog design pins were being waxed. Cast, each frog will weigh one ounce.

Flask #2

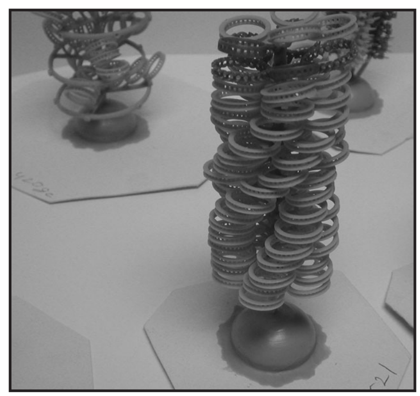
Another concept was a tree with several bangle bracelets. It has been said that objects of this size are hard to cast. The interesting part on the bracelet tree is the fact that the wax sprues that are making the bracelets are also utilized as sprues for several rings on the same tree.

Flask #3

80 eternity rings are on this particular tree, weighing over 521 grams once cast.



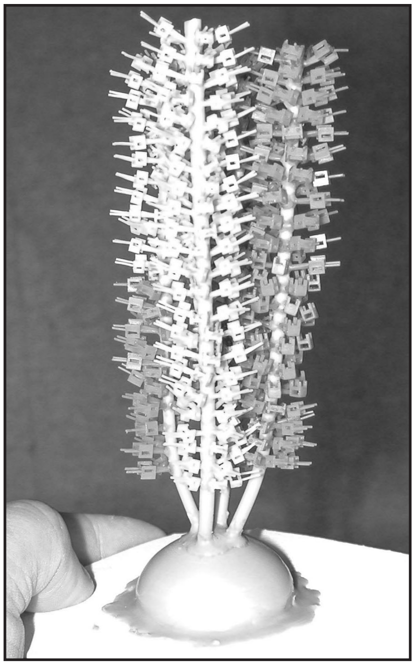
Flask #4 four line bracelet parts on four separate sprues in one flask. These parts are very small and contain the wires that will connect the bracelet.



THE BURN-OUT

For this experiment, the investment was R & R Platinum Plus. The Pt alloy was Pt950/Ir as well as Pt950/Ru.

After investing, the flasks were placed into the kiln without any bench setting time. The kiln was set to come up to 200°F in a one hour ramp. After being held at 200°F for 1:45 hour (for a 8" x 3"flask) the kiln was brought to the burn-out temp of 1400°F. This temperature was reached within a one-hour ramp. After being held at that temperature for an additional 1:45 hour,

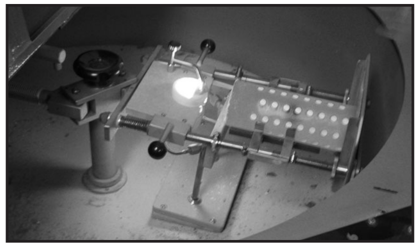


the casting was done. It is important to know that the amount of wax that is needed to burn as well as the number and size of flasks in that kiln may extend that time significantly.

CASTING

Casting was done using the same parameters as before. It is important to note that for the platinum Ruthenium alloy the temperature was increased by 20°C.

For the larger pieces the RPM was reduced to 200. The rings were cast at 250RPM and the small pieces were cast at 300RPM. The flasks were left to cool until the red was gone from the button and then doused in a bucket of water, using a hammer to tap the flask to help with the investment break-out. After most of the investment had been removed, the trees were soaked in a heated solution of Lye (in this case the brand name Red Devil) for about 30 to 45 minutes.



RESULT

Flask #1

All the frogs came out. Because of a mix-up in the flasks, there was no button on this particular casting tree. (The metal for the bangles and the metal for the frogs were mistakenly switched). While both trees filled completely, neither one had a button.) The castings were smooth with great detail inside and out.

Flask #2

The ring and bangle bracelet tree filled completely. As above, the lack of a button did not seem to matter.

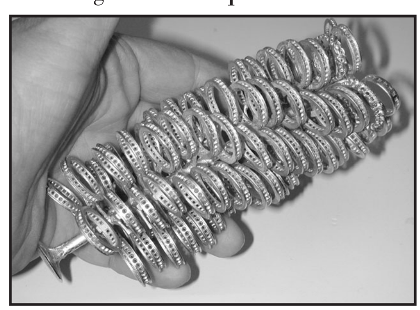
Flask #3

550 grams of eternity rings. The tree filled to the top. There were about seven rings that had filling problems along the leading edge of the rotation. These problems were addressed by further casting experiments using a crooked tree. Over all, this 550 gram tree yielded 407 grams usable product. Almost 75%.

Flask #4

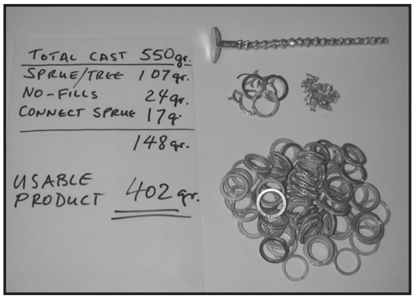
This flask too filled all the way to the top, but there was approximately 10% casting flaws on the leading edge.

This lead to experiments with crooked casting trees. By adjusting the angle of the tree in relationship to the direction of the metal flow and by spruing accordingly, another series of castings were done each resulting with a complete fill.



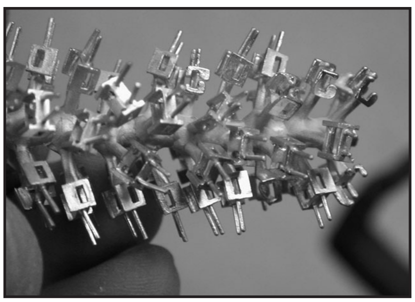
CONCLUSION

This system of casting has actually refuted many beliefs regarding platinum casting. It proves conclusively that it is possible to cast large production trees with a regular induction machine. It was learned that smaller center sprues are better than larger ones. The fact that the rotation of the casting machine need-



ed to be slowed down, rather than speeded up to get complete fill. Single, small diameter sprues on objects seem to yield better results than multiple thick sprues.

About the casting quality, I am happy to say that there was very lit-



tle porosity and that the pieces, especially the eternity rings could be used with very little finishing time. We are currently testing bend flasks, which allow for the flow of the metal and follow the natural path of the platinum within the flask. The modification of the investments as well as the spruing technique that follows the bend stem, allow for a near 100% fill every time. There will be

more testing and more refining of this technique, but the people that were asked to try this and follow this system have all reported major improvements in their casting results.

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