Making a Foundry

The Design:

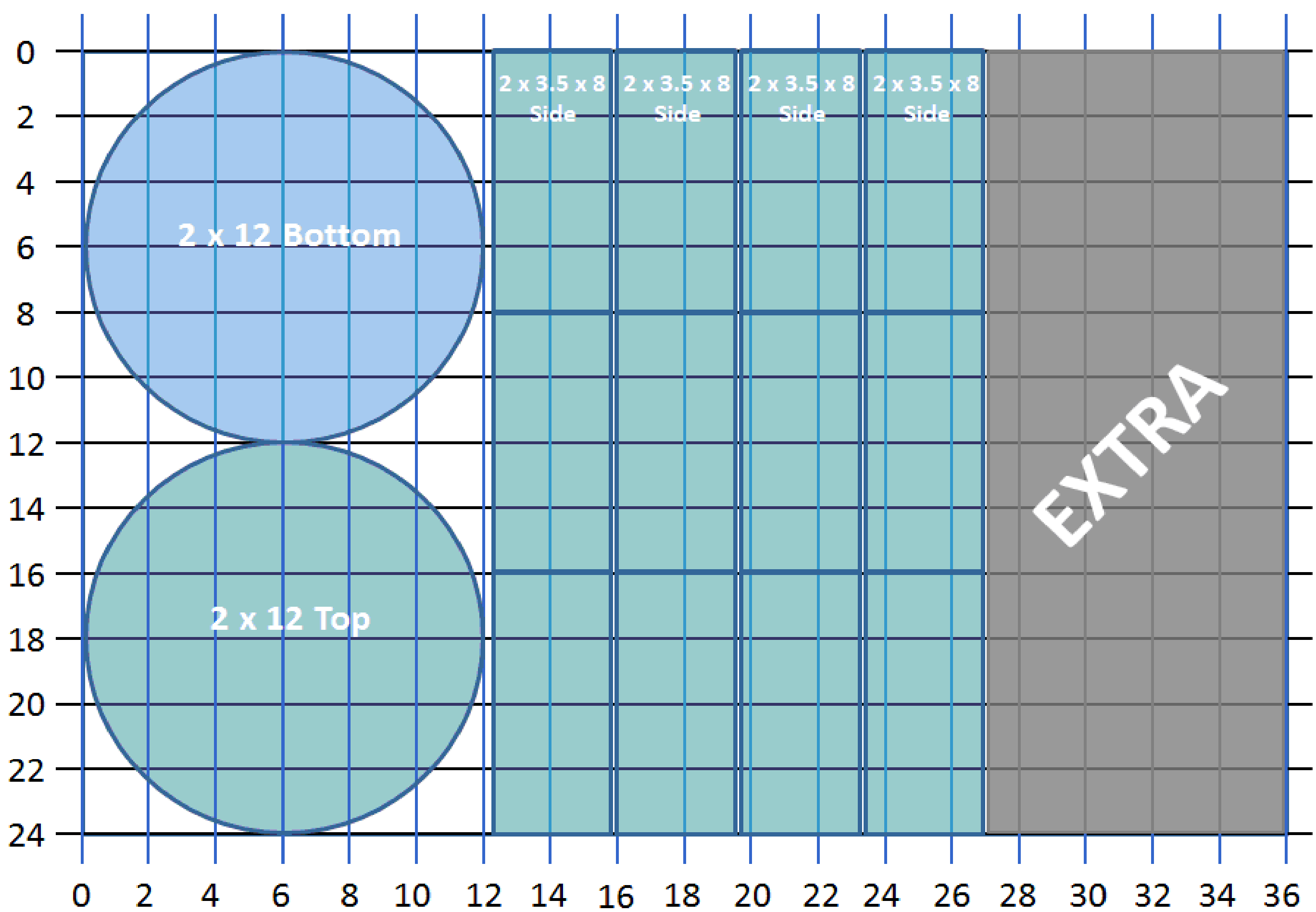
Yes, that's right, I'm making a foundry for melting aluminum, copper, etc. It had nothing to do with knives or knife-making! Having never gotten into casting metal, I thought it might be fun to experiment. Since I started playing with my 3-D printer, I realized that some of the pieces that I designed and printed might be of greater use if they were made of metal. When I discovered that I could 3-D print using wax (you know, the stuff used in investment casting), I had to try. So, our first step was making a foundry.

Searching YouTube for foundry ideas, I found some good approaches and some really terrible ones. Most of them, even the good ideas, were bulky, heavy and thermally inefficient, like foundry cement, which I initially considered. Upon further research I learned that it is not a good heat insulator. This meant that it would take longer to heat metal and heavy. Some designs used a galvanized bucket for the container, with the foundry cement. I considered this approach to be a non-starter due to the potential for toxic zinc fumes if the bucket temperature reached 292° F. I really didn't know if it would, but I didn't want to find out either.

Some of the better approaches used fire-brick—good insulation. Since I have found fire-brick to be too damn brittle and prone to cracking, I didn't consider it—personal prejudice. Other reasonably good ideas that I saw, used ceramic wool insolation. This led me to the approach that I used for making the electric furnace: Ceramic board! With that in mind, I set out to design a foundry based on ceramic board.

I already had a container to use for the project, an old stainless steel pot. It measured 10.5" high and 12" in diameter, perfect for my purpose. The dimensions of the container determined the required size of ceramic board for top, bottom and sides. Based on its dimensions I determined that one piece of ceramic board measuring 24" x 36" x 2" would do the trick. The board layout is shown below.

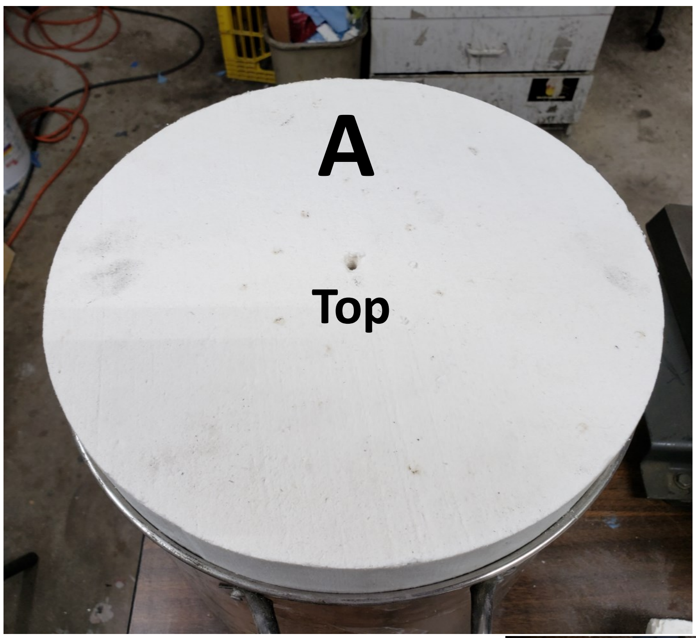
2" Ceramic Board—24" x 36"

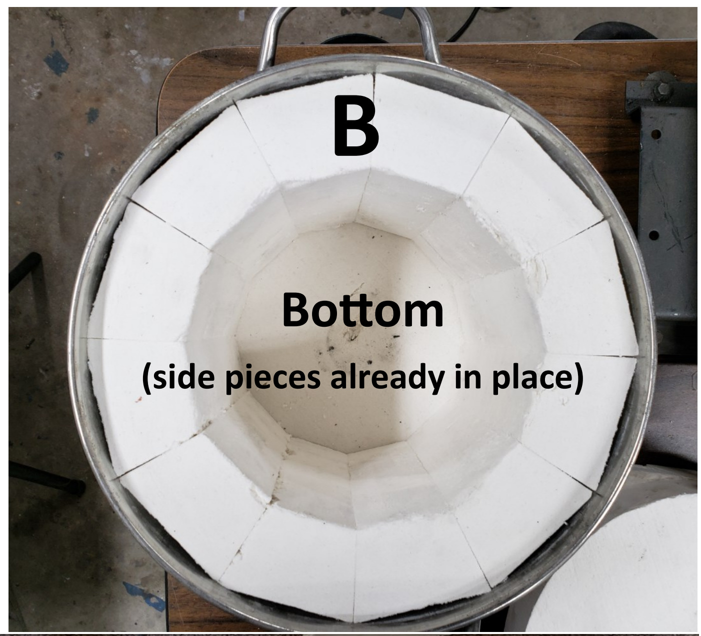


Implementing the Design:

Using the bread knife that I "borrowed" from my wife when I made the furnace, I cut a 12" x 24"section, then cut it into two 12" squares. Using my band saw, I cut two 12" diameter pieces: one for the top (A) and one for the bottom (B). My design required twelve (12) side pieces, each piece would have 15° angles on both sides. I cut the 12" diameter disc for the top and bottom (Figs. A and B), first.

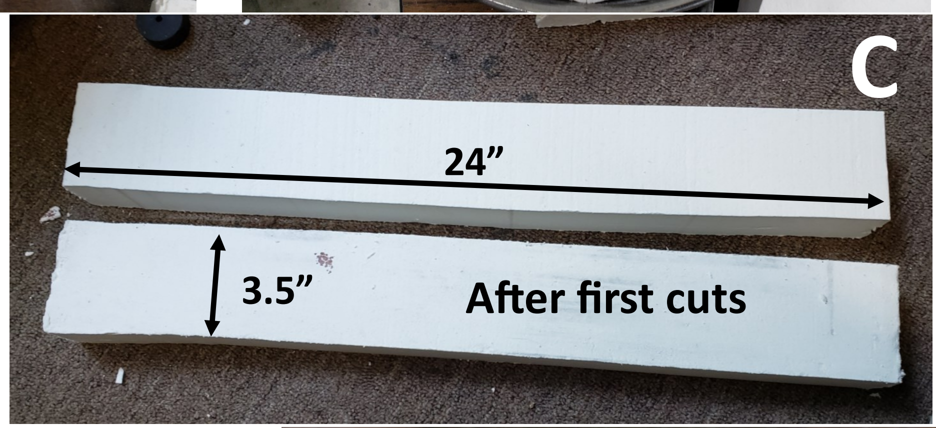
Next, I pressed the bottom piece into the pot and started working on the side pieces. First, I cut them into 3.5" x 24" lengths (Fig. C), then I cut each of them into three (3) 8" lengths. A little trigonometry provided the inner and outer dimensions (Fig. D and E) for each 8" piece. I next set up the band saw at a 15° angle and cut each side of the 8" sections.

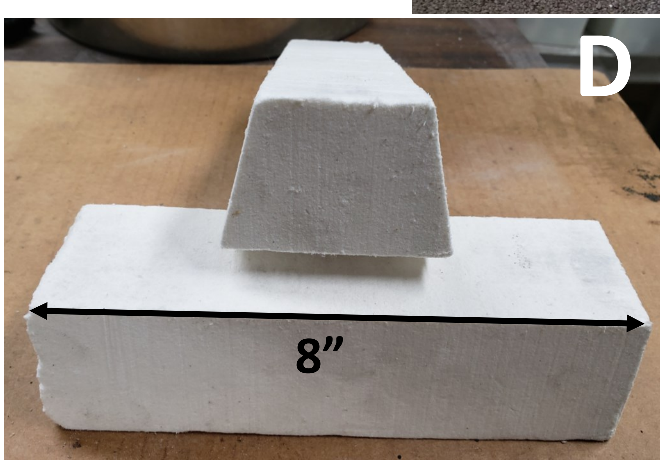


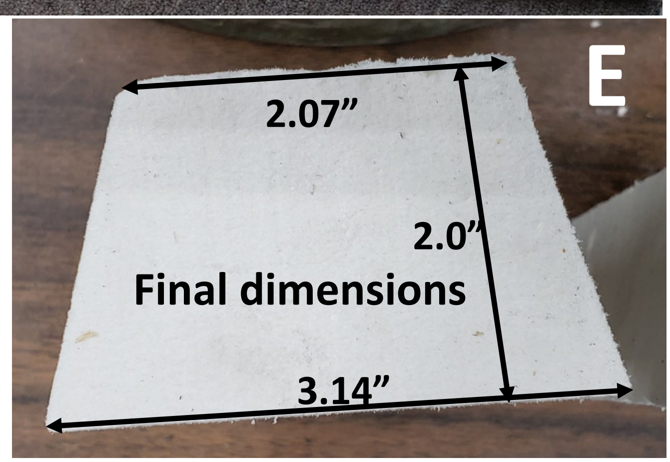


Figures:

A. Top piece resting on side pieces
B. Bottom piece, pressed into place
C. Rectangular pieces before final cuts.
D. Front and side of pieces after final cuts.
E. Close-up of piece, showing final dimensions.







Assembling and Rigidizing the Pieces:

As previously mentioned, the bottom was pressed into place, first. The twelve 8" long sections came next. I actually made fifteen sections, just in case! When I pressed the last section into place, it was snug so I got a bit ham-fisted and crushed the piece. Remember, it's not brittle like ceramic brick, but it's soft. That's when I was pleased to have the extra pieces. The next one went into position without issue, as you can see below.

When I started this project I decided to use propane, instead of electricity, since we still had the burner that we used on the original forge* when we started making our own knives. So I drilled a one inch hole in the side of the pot and through the ceramic board to accommodate the burner.

Now I was ready to coat the ceramic board sections of the foundry with a "Rigidizer". Its purpose is to strengthen and seal the ceramic and make it less susceptible to flaking and erosion. Notice the pretty pink color of the rigidizer. Fortunately, it dries white!

Once it was dry, a couple days later, I cut a hole into the top piece and coated it with the rigidizer as well. The next step was to coat it with reflective putty.

*If you read my paper on gas vs. electric for hardening throwing knives, you may recall the problems that we had due to using a propane forge.

The Reflective Putty:

I had planned to use a trowel to apply the putty, but I found that using a pair of nitrile gloves and wetting them before working the putty allowed for more uniform application. I initially applied ~3/8" thick layer to the bottom and let it set up over several days. I next applied a thinner layer to the sides and top and a thin coat to the center hole of the lid. The hard shell of the dry putty made the foundry appear to be one piece.

I picked up some stainless steel handles (McMaster-Carr) and attached them by drilling small holes through the top and then partially drilling four 1" diameter holes ~ 3/4" deep. The handles had 8-32 threaded holes, so I placed 1"wide #8 washers inside the bottom of the lid (black circles) and on top. After aligning the handles with the holes, I tightened the screws into the handles. Once that was done, I sealed the holes with the putty.

The completed foundry weighs 14.25 lbs. The top weighs in at 3 lbs. I consider that to be **LIGHT-WEIGHT** for a foundry! That is especially true after seeing some of the monster DIY foundries on YouTube.

The Crucible Tongues and Pouring Ring:

While the putty was drying, I set about to finalize my design and make my crucible tongues. Unfortunately, the steel strap I required for my original design was out of stock at Home Depot. I could have ordered the steel online, but when I saw a section of 1/2" square tubing that they *did* have I got the idea for a completely different design. So, I redesigned the tongues based on the piece of 1/2" square tubing. I definitely prefer this design over my original. This design eliminates the need for separate lifting and pouring tongues.

As you can see, the tongues have a hinge at the top (leftover steel from quench tower baffle project) and two pins at the bottom for holding the crucible. I welded them on after heating and shaping the tubing on a home-made mandrel. The hinge placement allows for one-handed placing and lifting of a crucible. I added an adjustable stop screw to allow for free movement of the crucible for pouring and using one hand to hold tightly to the crucible without damaging it.

I originally drilled holes into the crucible to accept the lift pins on each side. The bar with a ring attached is used for pouring while using the same tongues. Later, I added a bigger ring at the opposite end for larger crucibles. The pictures below and on the next page illustrate how they work.

The Crucible Tongues and Pouring Ring (continued):

When I ordered a larger crucible (4-6 Kg), I decided to modify my lifting approach. The crucible was ~5” in diameter. Given that my foundry had an interior diameter of slightly less than 7”, my pin-lifting technique for smaller crucibles barely had enough room to maneuver. So, I designed a steel support, with holes for the lift pins, that would fit around the crucible .

The lift brackets were recessed, providing an extra inch of clearance with the crucible walls. This allowed not only for the use of the larger crucible, but also provided support to hold the ring in place when in the foundry. The pressure of the tongs also provides a secure hold on the crucible for lifting and pouring.

I shaped the open lift ring by wrapping, clamping and heating another leftover piece of steel from the quench tower baffles project. The lift brackets were heated and pounded into shape before drilling the lift holes. After welding the brackets to the lift ring, I welded a larger ring to the other end of the pouring handle to accommodate the larger crucible. The end result is shown below.


Large crucible and lift ring


Large crucible with lift ring attached


Using tongues to lift the crucible

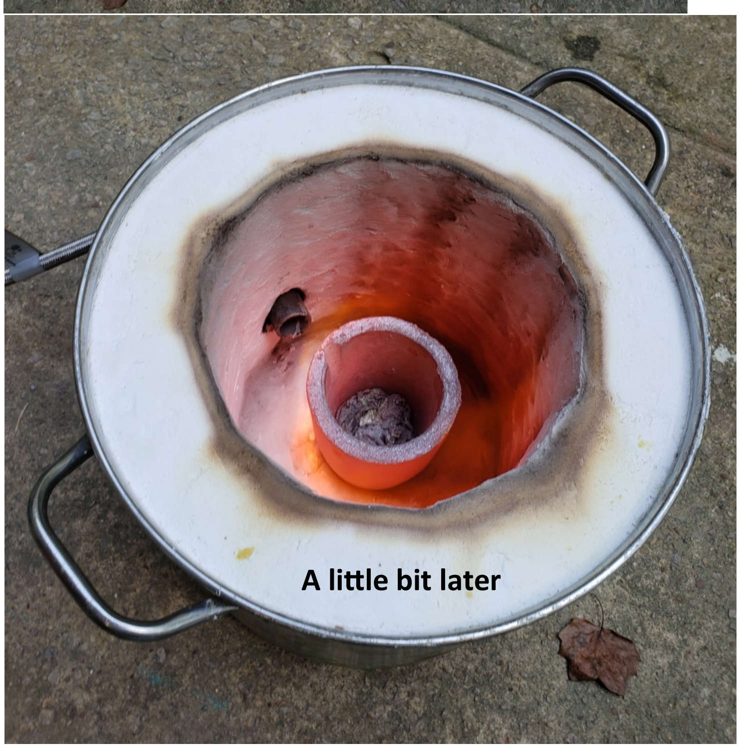

Large crucible with lift ring, tongues attached to lift ring, larger pouring ring

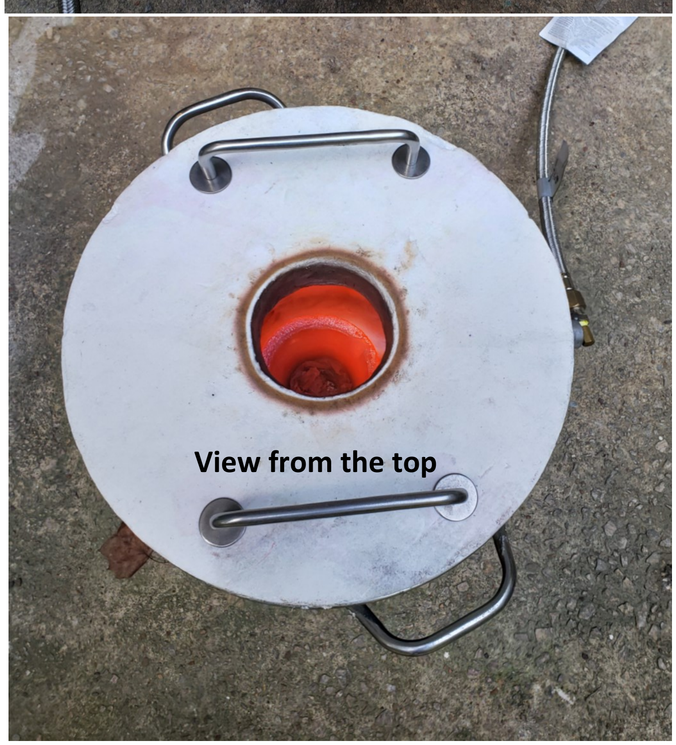
First Firing:

If you have worked with ceramic board, or you read my paper on making an electric furnace, you know that it requires a burn-out at ~1200° F. This is a smelly process that removes whatever it is that was used in manufacturing the stuff. When burnout is complete, you are left with a snow white finish and no odors. You can see that the area closest to the burner has turned white first. The opposite side needed a bit more time.

Speaking of ceramic board and heat insulation, while the crucible was glowing I could place my hand on the side of the container (SS pot) which was definitely warm, but not hot enough to burn me. In order to take the picture, I removed the top (without gloves). Handles were definitely on the hot side, but bearable. The heat blast when the lid was in place was impressive! The heat made it difficult to take a picture.

All in all, I'm pleased with the results, but the next page shows how easily it could be made. Far less work!





Addendum: A Simpler Approach

While congratulating myself on the clever design of my foundry, a thought crept into my thick skull: The same 24” x 36” x 2” section of ceramic board could have yielded six 12” diameter pieces. Besides the top and bottom, I could have cut larger center holes in the other four and stacked them in the pot. I would have a foundry of the same dimensions with far less effort.

This approach would have provided flexibility in determining my internal dimensions by just changing the size of the center holes of the four stacked sections. Sometimes, we get absorbed with a concept and don’t consider the easy approach until it’s too late! The results would have been the same, but the implementation process would have been much easier.

I’d love to see this approach implemented, but I don’t need to now! Any takers?