Xander Janssen 16-04-2023 English-V1

Casting embossed name shields in a sand mold.

This document describes the special case of casting metal in a sand mold for the production of $2^{1/2}$D products i.e. 3D products that have a relatively small 3th dimension and that have a flat backside.

Example of a 1.5” x 1.5” x 1/6” crank case cover casted in tin. The letters are raised 0.02” above the surface and have a line width of 0.027”. The original part was a 3D printed PLA template.

Supplies:
- Original part or 3D print
- Oil-bound casting sand
- Double casting box e.g. MDF trays or PVC tube with dimensions at least 2x the part
- Pure talcum powder, not mixed with corn starch
- Small spoon e.g. melon spoon
- Hammer or piece of round bar material
- Flat surface e.g. piece of tile/granite/marble
- Optional a (hydraulic) press
- Kitchen sieve
- Scalpel or sharp but especially thin knife
- Steel ruler
- 3mm steel wire
- 6mm steel tube
- Kitchen scales
- Small gas burner
- PPE such as welding gloves, safety goggles, sturdy shoes and long trousers
- Kitchen rack/coaster
- Saw and file set

Procedure:
Step 1/17: Place the casting box on the flat surface. In this case a piece of Ø80 mm PVC rain drainage pipe. A bottom less box out of MDF is also possible.

Step 2/17: Push the sand through the sieve until there is a generous (> 1”) layer on the bottom of the casting box and then tamp this layer well with a piece of round bar material or hammer handle.


Note: at this step, the original part (sprinkled with talcum powder) can already be placed on the flat plate and thus become embedded in the sand. This works very well according to many YouTube videos. However for this particular case with very small letters that rise only 0.02” above the surface, this does not work very well. In my opinion, this is because the sand is compacted insufficiently homogeneous between the letters as tamping is a relatively uncontrolled process. If the part is pulled out of the sand, sand remains between the letters and the mold is unusable. In contrast, this technique works fine for more coarse parts such as fly/train wheels. This is because the sand needs a certain minimum volume to be self-supporting. Too small details crumble easily, unless pressed very hard.

Step 3/17: Carefully turn the cast box over and inspect the surface. This should be completely smooth and without holes/breaks/contamination. If the surface is not completely smooth, start over.

Step 4/17: When the surface is smooth, turn the casting box over again and fill it further. This can even be done with chunks of casting sand. This is much faster than pressing through the sieve, but make sure to press each new layer very well layer and compact it so that there are certainly no cavities.

Allow a good "hill" of sand to rise above the edge of the mold. Hammer, or as in my case press, this very well. The more the sand is compacted, the better the result.

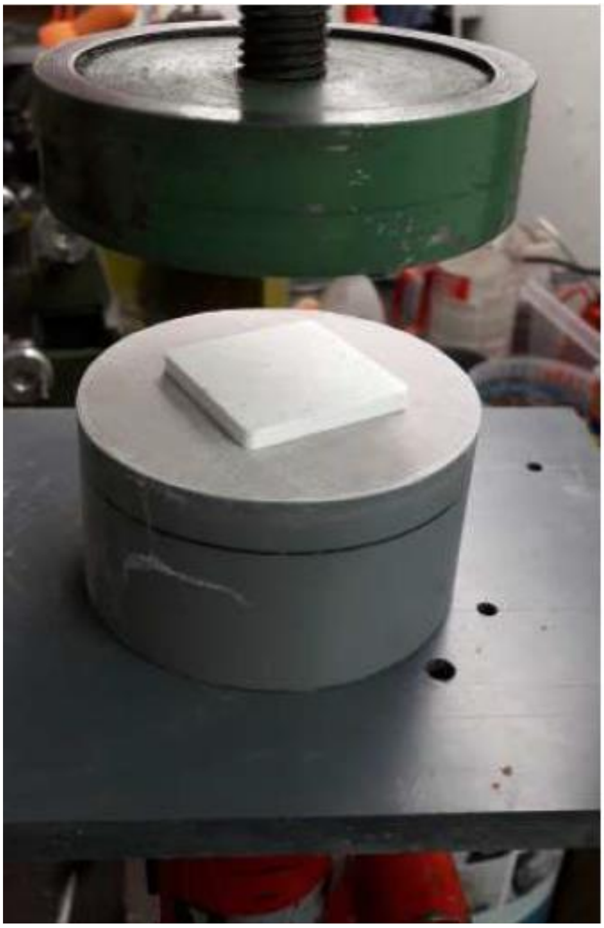
Note: I have marked the bottom of the mold that always remained on the flat surface with a black line. This is to avoid swapping the top/bottom during the process. This side is the most important to stay nice and smooth.



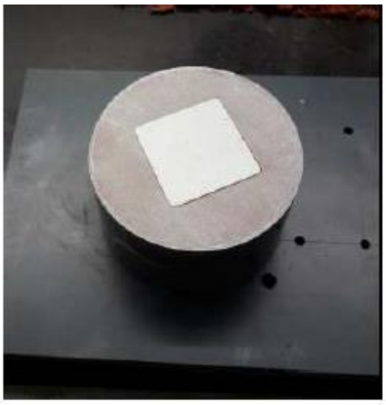

Step 5/17: Using a steel ruler or straight piece of sheet metal, scrape the top of the mold smooth. This does not have to be perfect, but no large pieces should be pulled out of the mold. Hence also marking the important side.

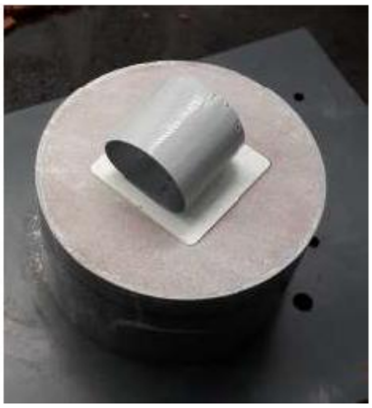

Step 6/17: Now generously coat the top of the mold with talcum powder. This too is a balance between on the one hand too little so that the object does not come out of the mold and on the other hand too much so that detail of the object is lost. Finding the right amount took me 3 times making a new mold.

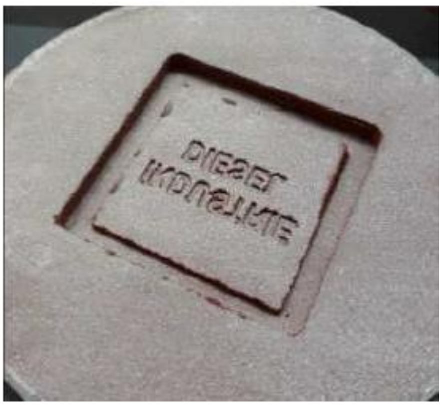

Step 7/17: Press the object into the mold. For this I use the press again because it takes a lot of force. It can also be hammered into (with a block between object and hammer), but then there is more chance of lateral shift. Be careful with fragile or hollow templates not to crush them!!!



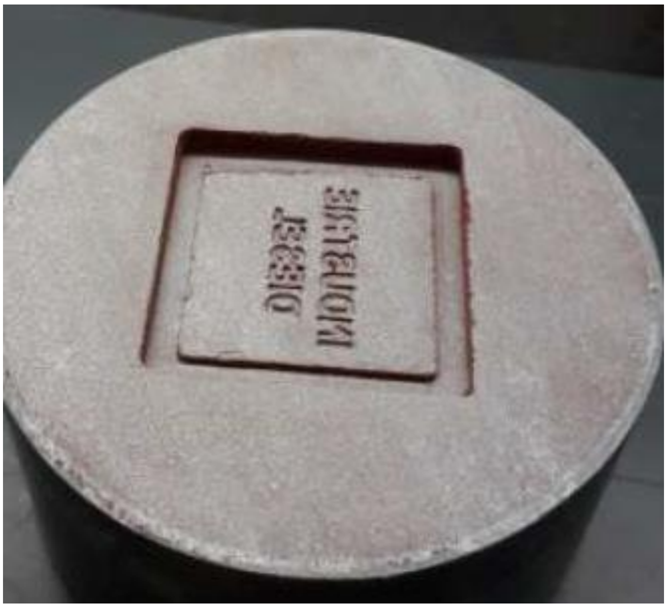
Step 8/17: Pull the object out of the mold as vertically as possible. I do this with a piece of duct tape. Some damage can occur on sharp vertical edges. This in itself is not bad and is correctable but it must be kept within limits. A mold that is self-releasing i.e. with all vertical planes at least 5 degrees drafted is even better.



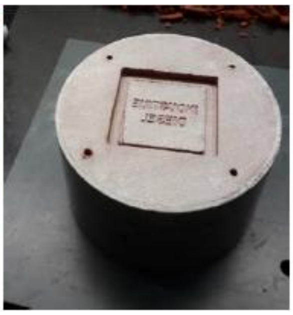
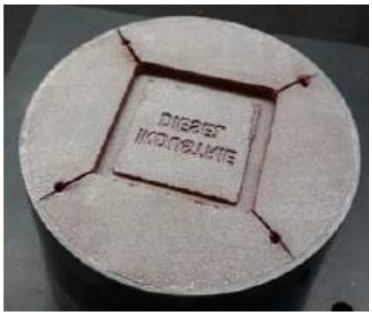




Step 9/17: If necessary, make small corrections to the mold by pushing back the loose edges with a soft brush, wooden stick or finger in latex/nitrile glove. You could already pour tin into this mold, but it is difficult to estimate how much tin should be used. In addition, the casted tin will bulge at the top because the gravity is not strong enough to overcome the surface tension. As a result, the top will always become spherical. You then have to mill / file this flat again, which takes a lot of time and is full of risk. Hence it is better to make a double mold. To do this, follow the steps below.



Step 10/17: When pouring metal in a closed mold, the air has to go out of the mold while the tin goes in. Often two vertical channels in the top half of the mold are used, 1 for the supply of the metal and a 2nd for the air to escape. In this configuration, the mold filled until liquid metal comes up in the drain. For the kind of thin products described here, it is better to vent at all corners i.e. points furthest from the supply. This way the tin can flow well into the corners. To do so, pierce holes through the entire bottom mold with a Ø1/8” steel wire. Then cut with a sharp, but especially thin, knife from the corners to these holes. Check the lower mold for contamination with loose grains of sand, chunks, etc. If necessary, carefully blow clean without removing (too much) talcum powder.

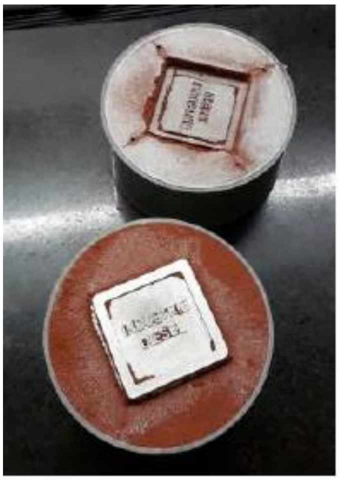
Step 11/17: Repeat steps 1 to 5 to make the top part of the mold. Pierce a supply channel of at least Ø1/4” through the mold while the bottom of the mold is pressed against the flat stone. This prevents the sand from breaking out at the bottom. Using a spoon (melon spoon), scoop the top into a funnel to make pouring easier Then blow to remove loose grains/chunks of sand from the funnel and feed channel.

Step 12/17: Slide a piece of sawn-off connecting sleeve over the bottom template. Do not use a full sleeve, because it often has a "transition" in the middle so that the molds do not come together. Check the bottom mold one last time for contamination, if necessary blow clean again and place the upper mold. The mold is now ready for use and can be stored for a longer period of time (if necessary). Take care that nothing can fall into it.

Step 13/17: Calculate the volume of the part and the supply. Add at least another 0.2 cubic inch to have enough material in the funnel. This ensures sufficient pressure on the cast during the solidification. The shrinkage that occurs in the part is supplied with liquid tin from this funnel and hence a dimensionally stable part without a “sink hole” is created. Multiply the volume by 0.11 lb./in^3 and weigh mass of tin. The picture below shows the remnants of an earlier casting. Another option is to melt plenty of tin and then not pour it all out, but I think this is a waste of energy.

Step 14/17: Work in a well-ventilated area or outdoors on a fireproof surface and with use of PPE. Place the mold on a rack so that the air can escapes through the channels at the bottom. Now melt the amount of tin in a crucible. After all the tin has melted, it is important to continue to heat for a minute (typically 60 seconds) because otherwise the tin solidifies too quickly and does not flow nicely into the mold. In this case, the tin is melted in a stainless steel ladle. Now pour the tin into the mold in one smooth motion. The sand insulates quite well and therefore let the mold cool down for a sufficient amount of time (typically half an hour).

Step 15/17: Open the mold and dig out the object along the funnel using a small spoon. Now push everything from the mold and break the sand further away. Keep the sand, it can be reused.



Step 16/17: Remove the remnants of sand with a hard (brass) brush, for example on a Dremel. Then remove the feeder and file/mill away any tin that has run between the two mold halves. Below from left to right: molded product, feeder removed, edges trimmed, painted.

Note: on the left you can clearly see how convex the tin remains due to surface tension in the absence of hydrostatic pressure. The top of tin in the funnel is quite bulging and this will always happen with a mold that is open at the top.

Step 17/17: Scrape the talcum powder and some sand from the bottom mold and throw away this residue. The rest of it sand in the mold can be used again. The talcum powder has to go because it absorbs the oil and thereby dries the sand. This prevents sticking of the mold, but if more and more talcum powder gets into the sand, the sand will age faster, no longer stick together and therefore becomes no longer useful.