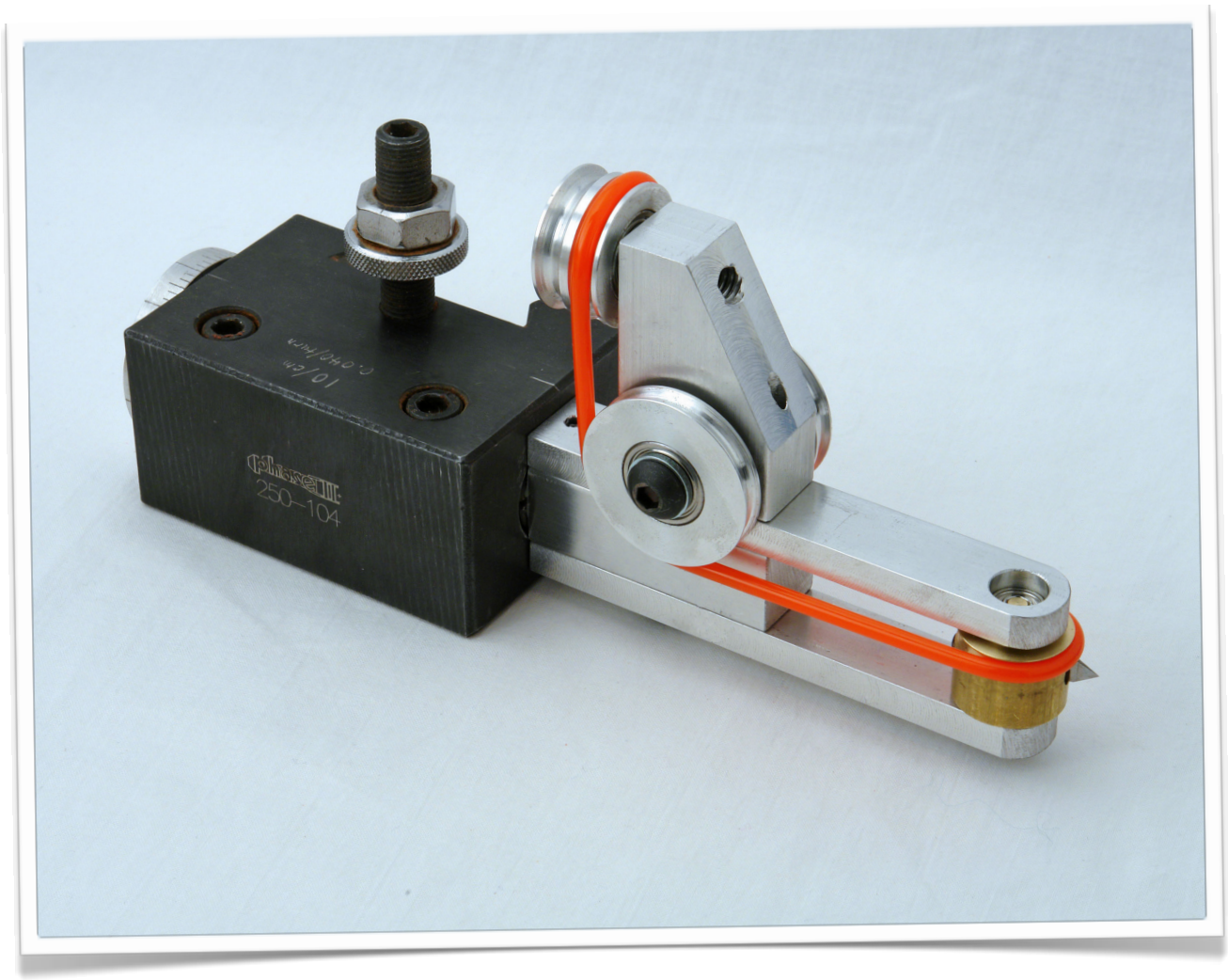
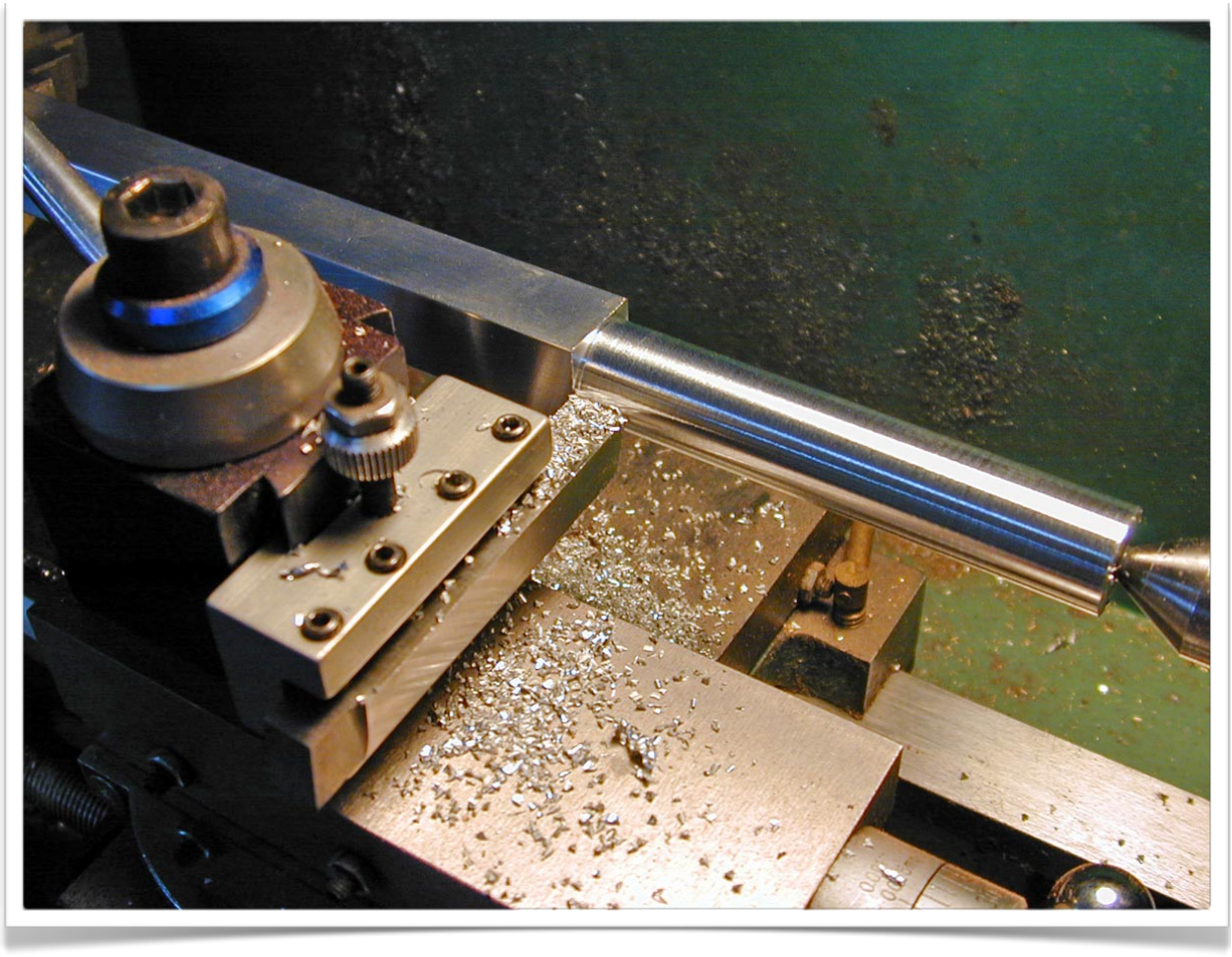
Universal Cutting Frame



This article describes the construction of a Universal Cutting Frame (UCF) for ornamental turning. A mini metal lathe and a mini milling machine are required to make this project. Most of the steps in making this cutting frame are the same as making the Horizontal Cutting Frame, with some difference in dimensions, the ability to rotate the cutting frame in the tool holder, and the additional pulleys. Please review the construction plans for the HCF and the photos, as only the differences or additional steps will be discussed here.

I started with the main frame, using 6061 Aluminum (5/8” x 5/8” bar and 1/4” x 3/4” bar). Cut the top and bottom arms to length and mill to 5/8” wide. In the case of the 5/8” x 5/8” center bar, leave it the full length of the arms (total of 7.125”) so that it can provide support when drilling and reaming the bearing holes. Turn the shank to 0.625” diameter for a length of 5.125” in a metal lathe. This permits the cutting frame to rotate in the tool holder. Cut the top cap from a piece of 5/8” x 1.25” bar and mill to 5/8” x 1.125” x 1.75”. You can also mill an angle as shown in the drawing (or leave it square if you prefer). The 4 frame pieces are held together with two 1/8” spring pins (to assure an accurate alignment) and a 1/4-20 x 1.5” screw.



Drill the holes for the spring pins and screw as describe in the HCF construction notes. Then drill and ream the hole at the end of the arms for the bearings as described in the HCF notes, and make the two pulleys that will mount on the sides of the frame.

In a similar fashion, make the double pulley from a piece of 1" round Aluminum 6061 with a hole just a bit over 0.625" for the bearings. Secure a bearing in both sides of the double pulley with Loctite 638.

Turn the cutter head on the metal lathe from a piece of 360 brass rod (0.75" diameter) as described in the HCF notes. The dimensions and tolerances are critical. When drilling the 3/16" hole, be sure to center it as closely as possible. If you don't, then when you rotate the cutting frame you will have to re-adjust the height of the cutting frame in your tool holder to make sure that the center of the cutter is aligned with the center of your work. (Note: You could also drill the 3/16" hole and set screw prior to turning the piece).

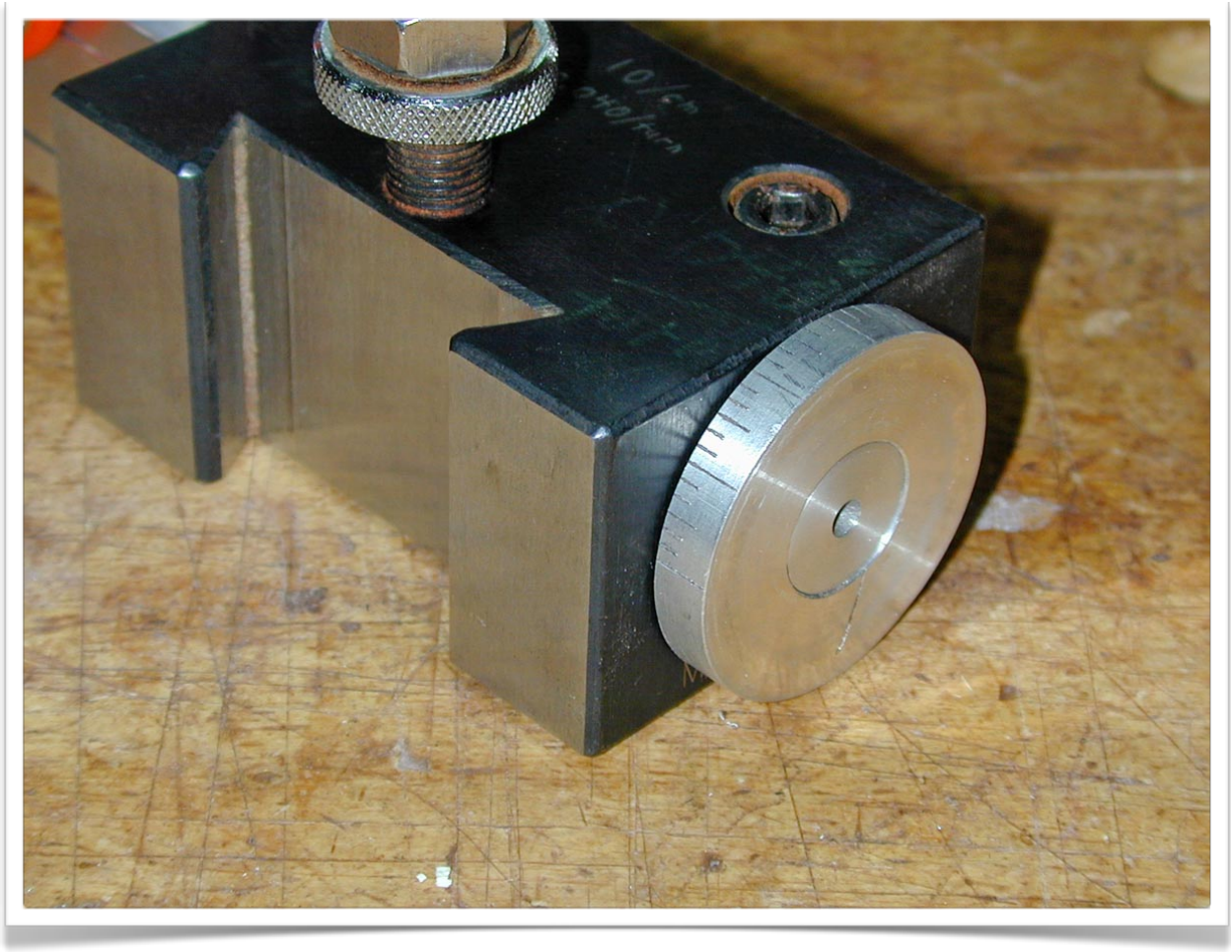
Check the fit between the arms of the frame. Without any shims, the cutter head spins very free. I added shims until I noticed a slight difference in how free the head spins. This is also a good time to check the balance of your cutter head. I bought several different lengths of set screw and used the one that gave the best balance.

Now, it's time to mount the pulleys. Put a 1/4" washer on each side of each pulley. The washers should be small enough so that they only contact the center of the bearing. (I actually used metric washers which were smaller outside diameter). The screw for the double pulley is adjusted to give a slight preload on the two bearings. Tighten the screw only enough to cause a slight notice it the pulley spinning freely. The bolt is secured by using regular blue (i.e. non-permanent) Loctite for bolts.

The placement of the side pulleys is marked so that the belt from the cutter head to the pulley is parallel with the arms and vertical to the double pulley above. I used 1/8" urethane belting. Depending on how deep you made the groove in the pulleys, you'll need to make allowance. Mark the position of the center hole for the pulleys and drill/tap the hole. Put a 1/4" washer on each side of each pulley.

Cut a piece of 1/8" urethane belting and melt the ends together. This will take some practice. My method is to hold both ends on the edge of a flame from a propane torch until they just start to melt, and quickly press the ends together until cool. It helps to lay the belt on a flat surface being careful to keep the ends straight and aligned (and don't wiggle or move until it's cooled). It also helps to have someone else dribble some cold water on the joint to cool it more quickly. Sand off any excess squeeze-out by gently holding the joint to a disc sander while rolling the belt. This takes some practice to get a good joint, so plan on practicing with extra belt material. It also takes a bit of experimenting to get a snug belt that's not too tight.

Finally, make a dial for the end of the shank that extends beyond the end of the tool holder. Secure the dial to the rounded shank with a set screw. I marked my dial using a rotary table on my milling machine. If you don't have one, you could also scribe the dial manually using a protractor. I placed small marks every 5 degrees, a large mark every 15 degrees, and a full-width mark every 30 degrees. I made a mark on the top of the tool holder as well (not easy to see in the photo).



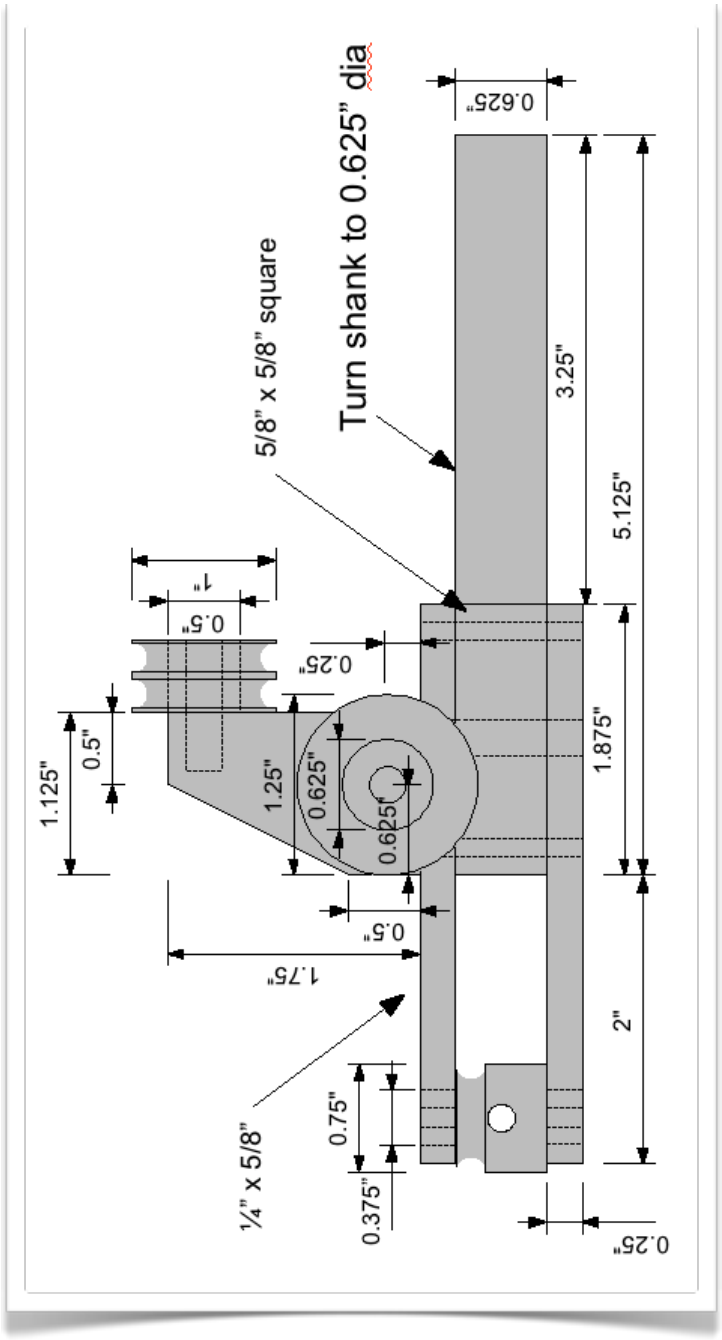
After the first few hours of use, you may want to check the fit of the cutter head between the arms again.

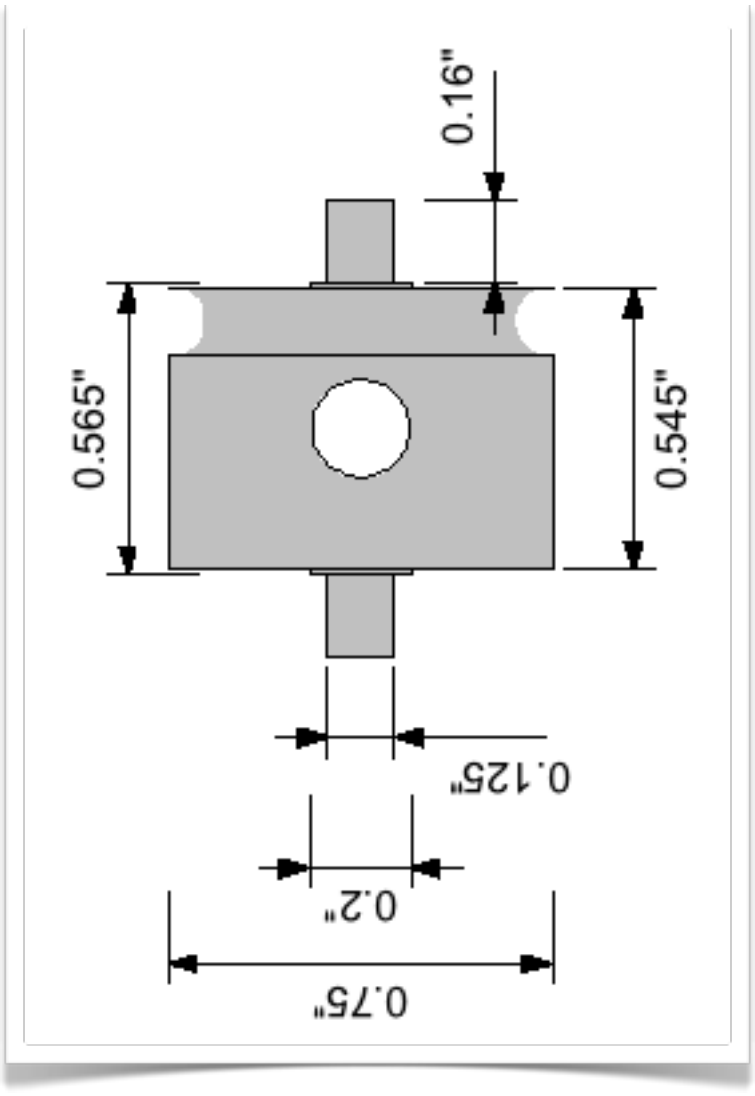
Have fun with your new cutter!

I would like to acknowledge the helpful discussions with David Lindow and Jon MaGill. Their willingness to share information helps all of us learn more about the art of Ornamental Turning.

Parts List

6061 Aluminum
5/8” x 5/8” Square
1/4” x 3/4” Bar (milled to 1/4” x 5/8”)
1.25” Rod
1” Rod
5/8” x 1.25” Bar (milled to 5/8” x 1.25” x 1.75”)
360 Brass
0.75” Rod
Bearings (McMaster-Carr part numbers)
2 ea. #57155K316 3/8” OD 1/8” ID flanged ABEC5
4 ea. #57155K377 5/8” OD 1/4” ID ABEC3
#99040A301 pkg 0.001 shims
Miscellaneous
Loctite 638
Loctite for bolts (regular blue stuff, non-permanent)
1/8” Urethane belting (#59725K702)
1/8” x 1.5” spring pin
1/8” x 1” spring pin
1/4-20 x 1.5” screw
2 ea. 1/4-20 x 1/2” screw
1/4-20 x 1” screw
6 ea. 1/4” washers
10-24 set screw


Turn shank to 0.625" dia
5/8" x 5/8" square
¼" x 5/8"
0.625"
3.25"
5.125"
1.875"
2"
0.25"
1"
0.5"
0.25"
1.125"
0.5"
1.25"
0.625"
0.625"
0.5"
1.75"
0.75"
0.375"
0.25"


0.16"
0.565"
0.545"
0.125"
0.2"
0.75"