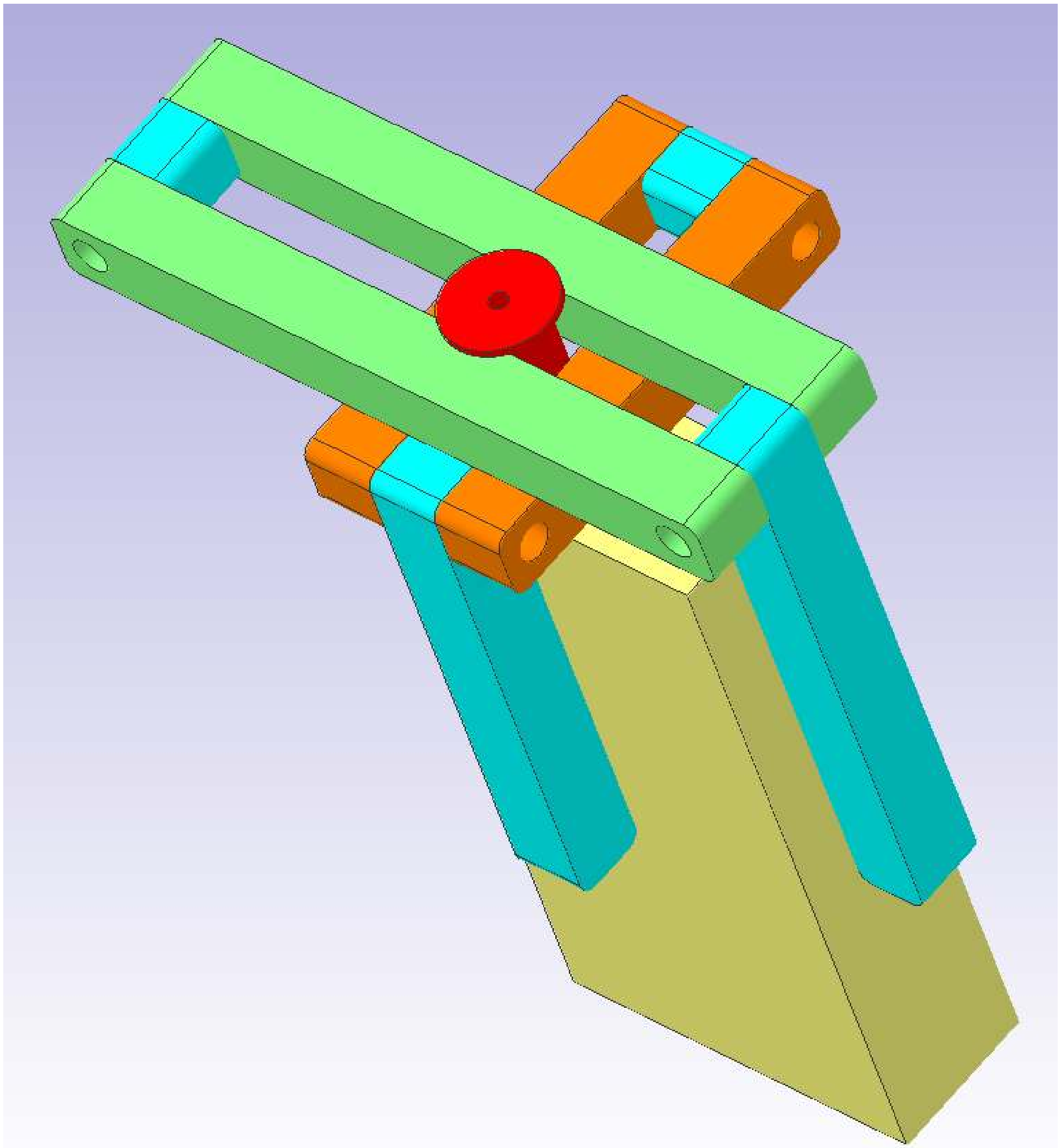
An End Drilling Guide, version 1

By R. G. Sparber

My drill press and mill/drill are too small to end drill a long rectangular piece of metal. It ends up in my vise where I try to use a hand drill and a lot of luck. This drill guide is my first attempt and finding a better way.

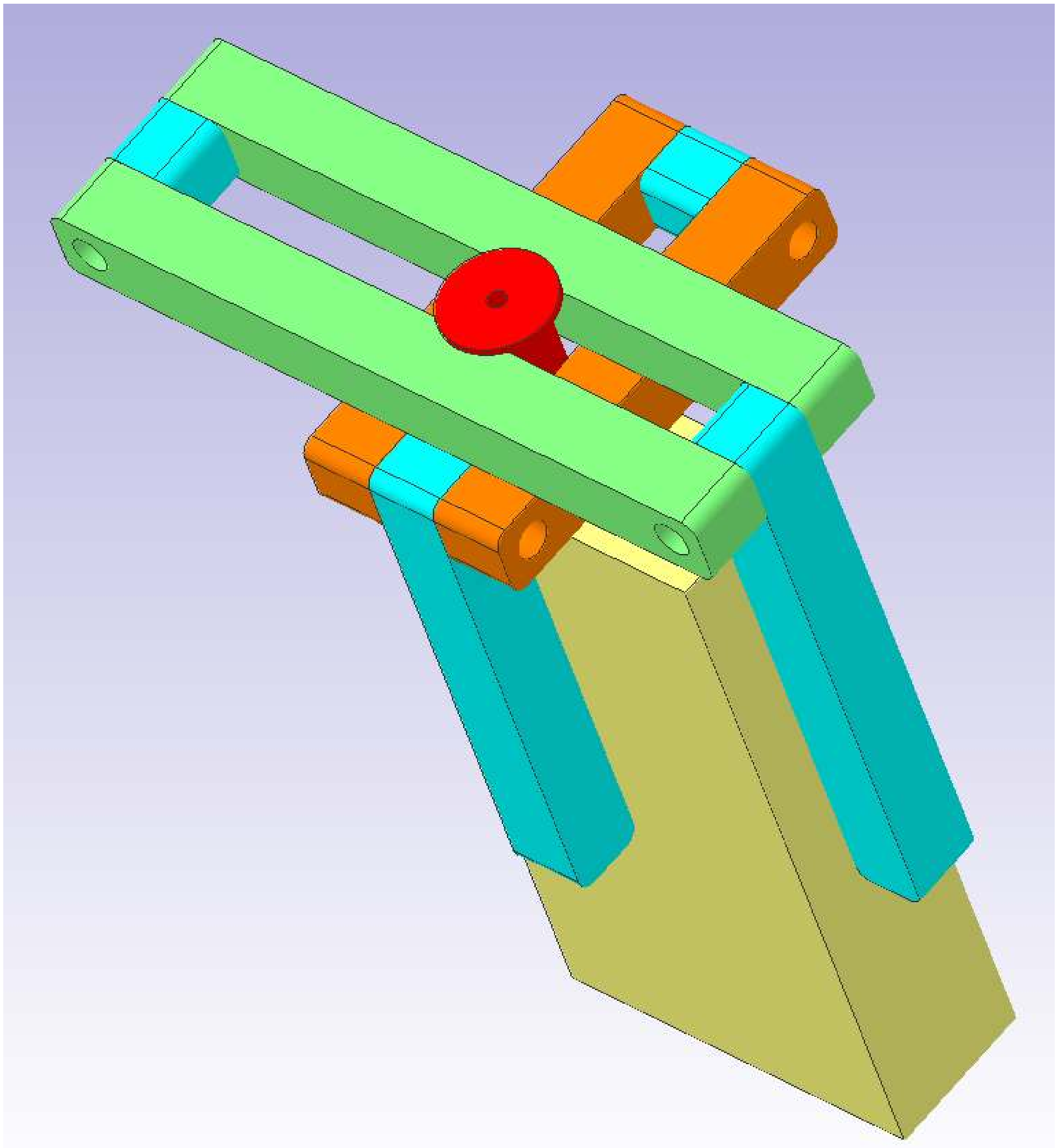
The guide clamps to the flank of the work piece and has a floating bushing which guides the drill bit. The resulting 1/8" diameter hole provides a pilot for further hand held drilling.



This rendering lets me explain the operation of the guide plus how to best make it. The guide requires that the end of the work piece be perpendicular to its major axis. Those two orange bars contact this reference surface plus permit the bushing to slide between them. Similarly, the two green bars contact the tops of the orange bars plus permit the bushing to slide between them.

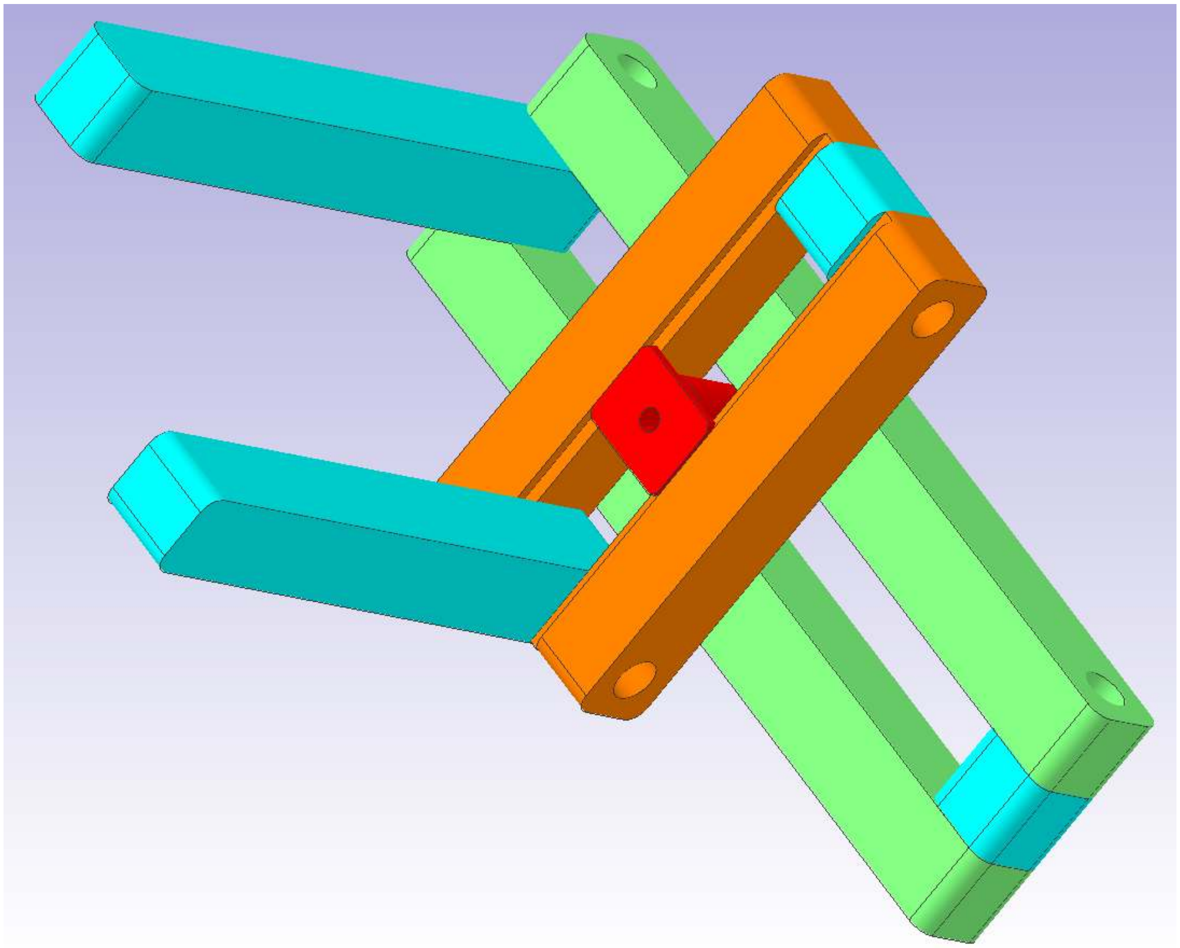
C-clamps are used to lock the blue bars to the flanks of the work piece. The result is that the bushing is locked into the desired position.

Note that these blue bars can pivot as necessary if the flanks are not perpendicular to the reference plane. Since the bushing is round, the green and orange guides do not have to be perpendicular. This means that the flanks of the work piece don't have to be perpendicular either.



The accuracy of this guide depends on having a close sliding fit between the two slots and the bushing. The trick is to machine the width of all blue bars at the same time. The actual thickness is not important, just that they are all the same. After assembly, the width of the slots are measured and used to define the diameter of the bushing.

All surfaces that contact other surfaces should be lightly cut to insure they are true.

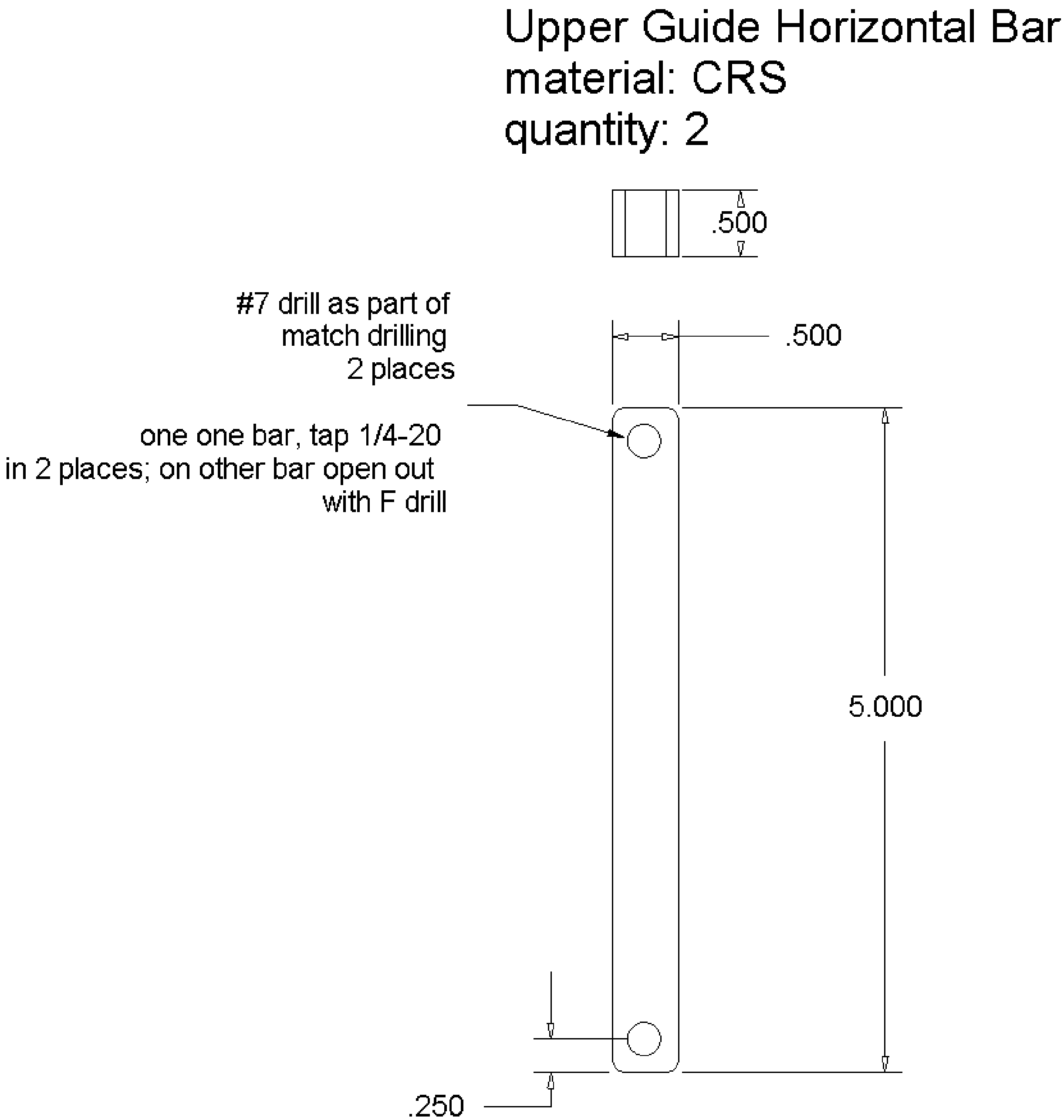


The underside of the guide reveals a bit more complexity. Shallow steps have been milled into the orange bars to accept a rectangular feature at the end of the bushing. This arrangement prevents the bushing from spinning as it guides the drill bit.

I will first present the shop drawings and then go through some of the fabrication steps.

The green bars are called the upper horizontal guide bars. The orange bars are called the lower horizontal guide bars. The blue bar associated with upper guide bars is called the upper vertical bar. The other blue bar is called the lower vertical bar.

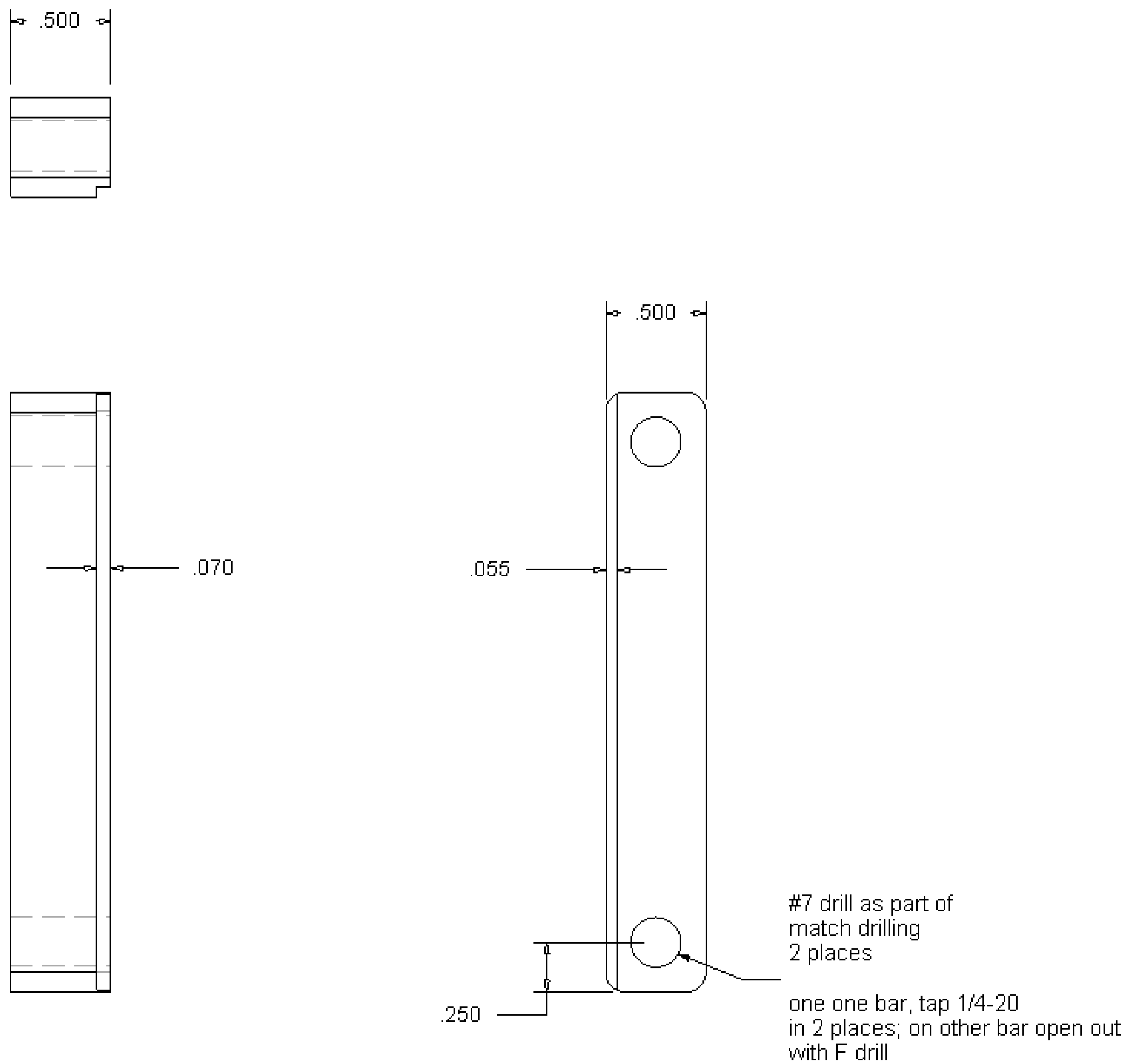
The shop drawings are presented in the order than I used them.



Neither of the 0.500” dimensions are critical. If you start with ½” x ½” CRS and take a light truing cut on all contact surfaces, you will end up with a thinner and narrower bar.

Each bar has two faces to be machined true. One face contacts the bushing and one contacts the top of the lower guide bars.

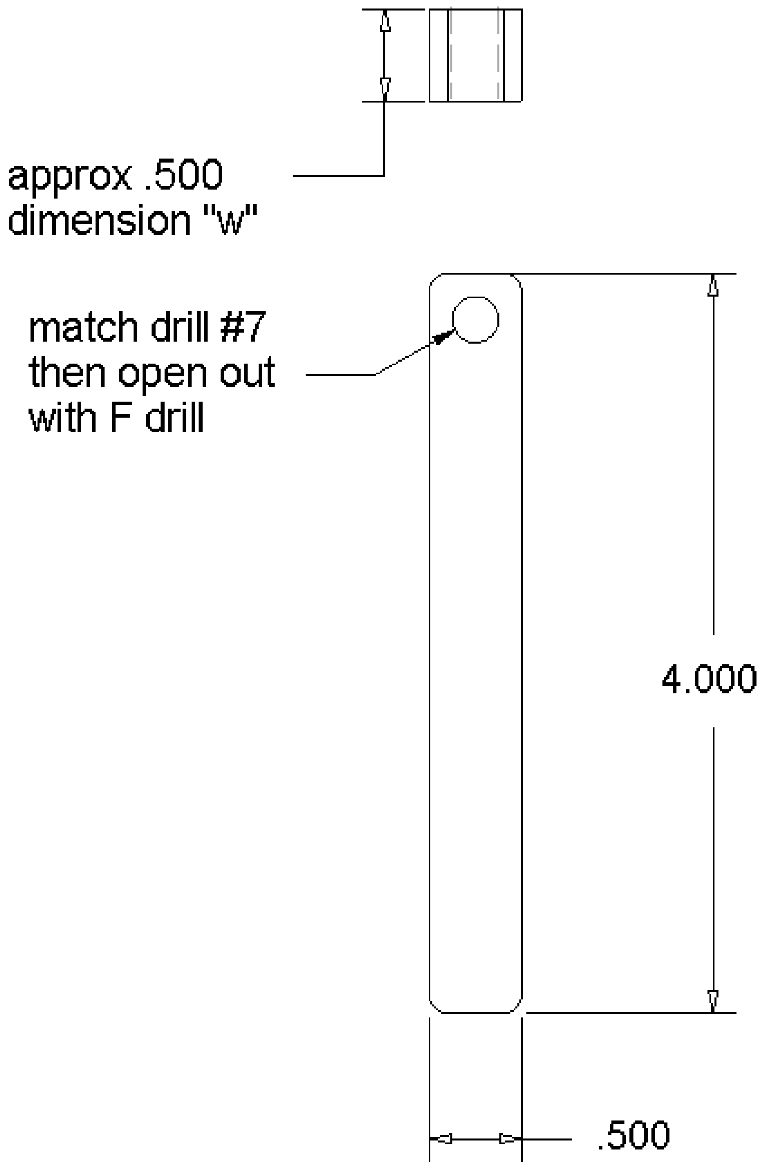
Lower Guide Horizontal Bar
material: CRS
quantity: 2



Neither of the 0.500” dimensions are critical. If you start with ½” x ½” CRS and take a light truing cut on all contact surfaces, you will end up with a thinner and narrower bar.

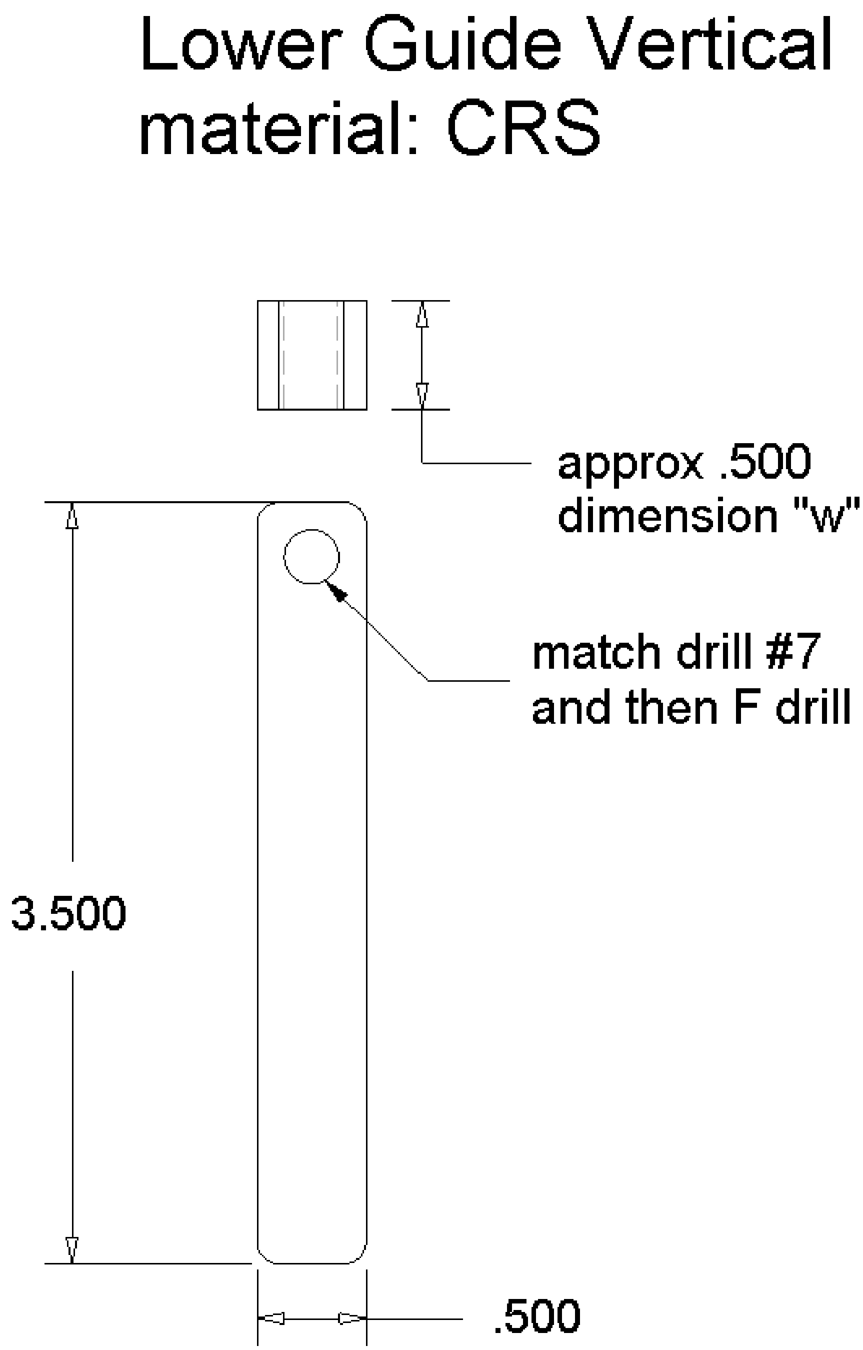
Each bar has three faces to be machined true. One face contacts the bushing, one contacts the bottom of the upper guide bars, and one contacts the reference surface of the work piece.

Upper Guide Vertical Bar
material: CRS



The thickness, “w”, of this bar must be identical to that of the other vertical bar and of the two spacer blocks.

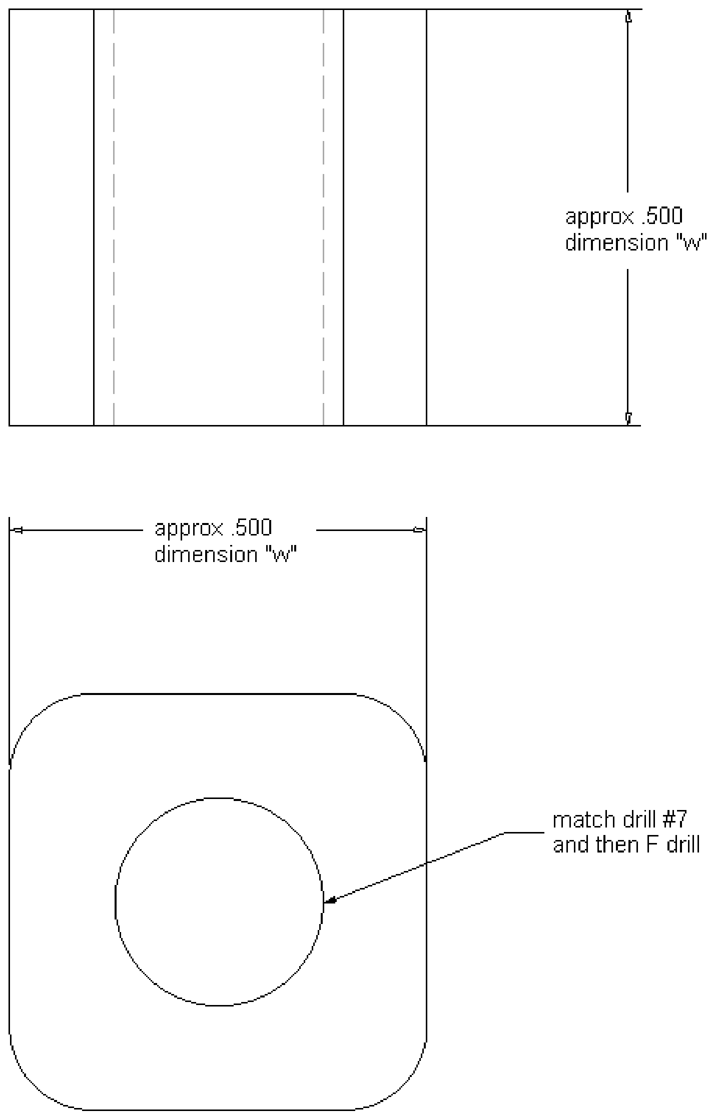
The length and width are not critical.



The thickness, “w”, of this bar must be identical to that of the other vertical bar and of the two spacer blocks.

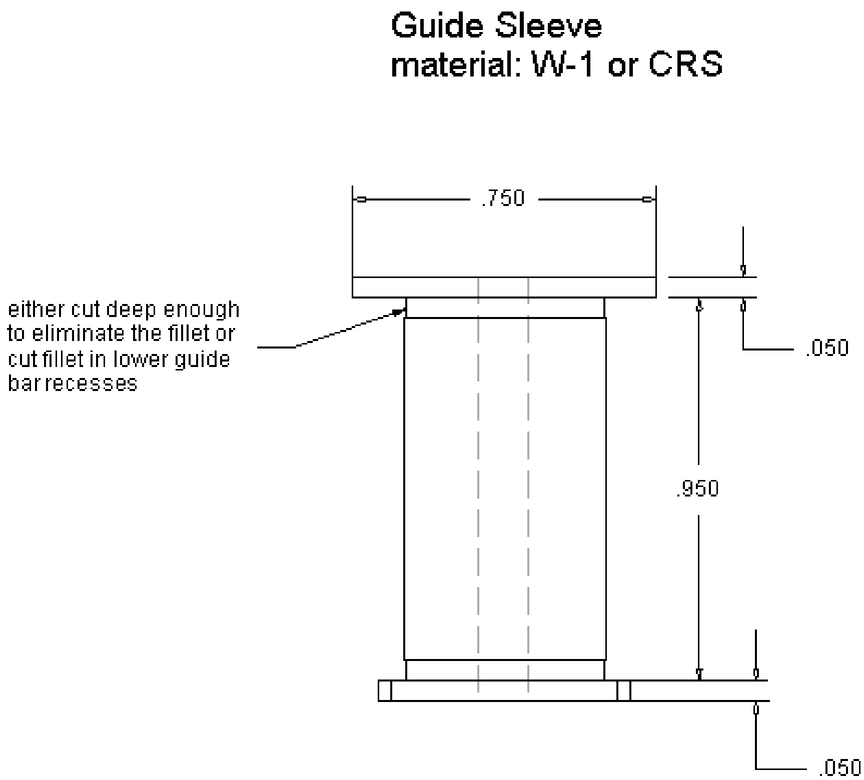
The length and width are not critical.

Spacer Block
material: CRS
quantity: 2

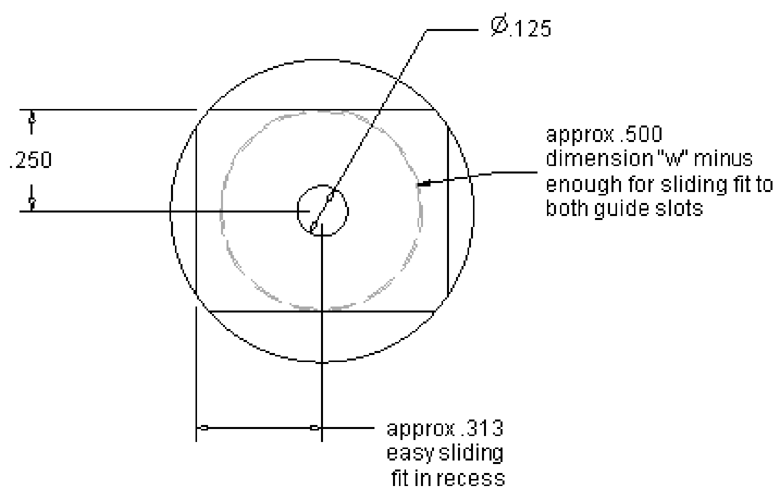


The thickness, “w”, of these blocks must be identical to that of the vertical bars.

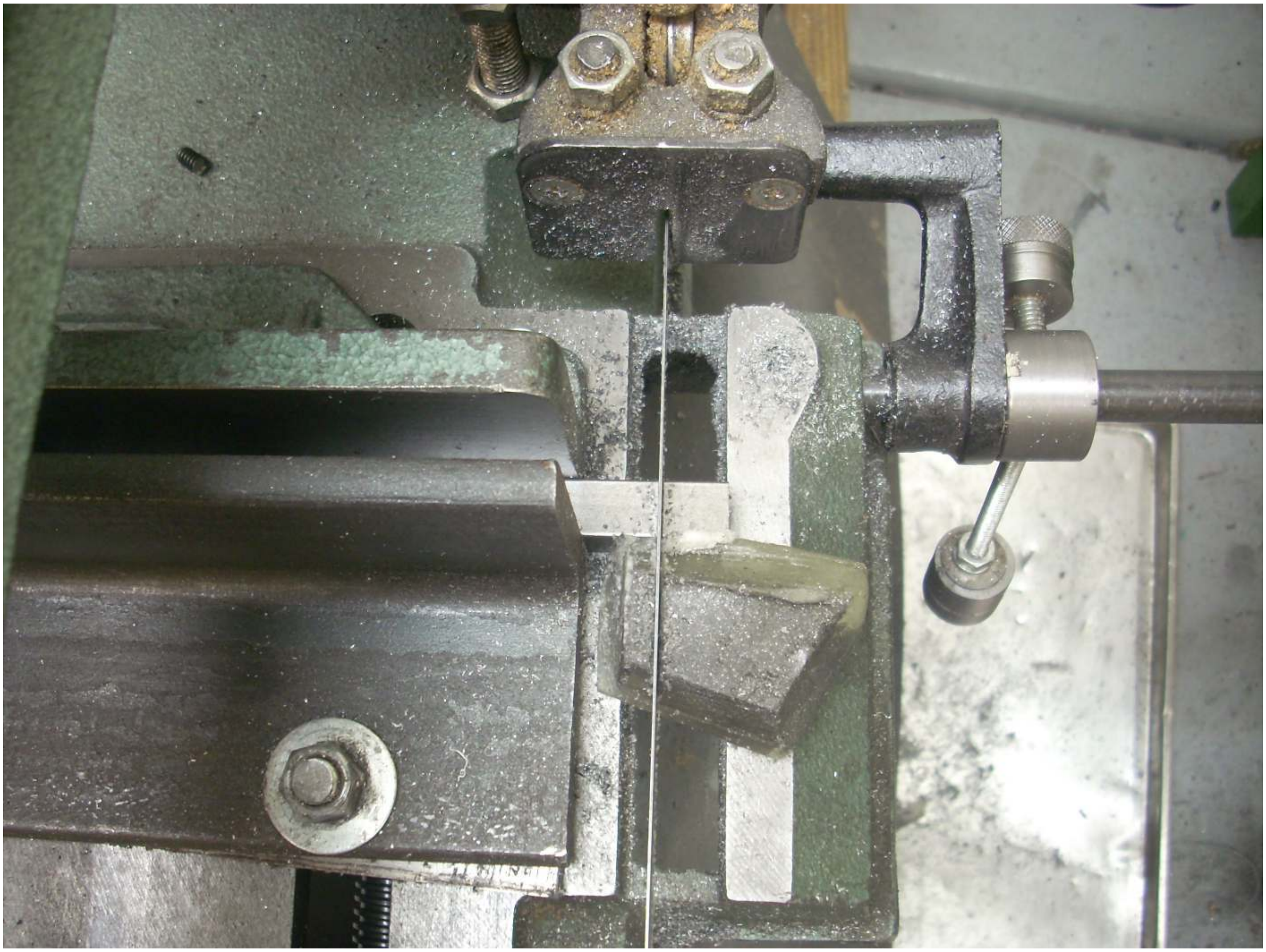
The length is not critical.



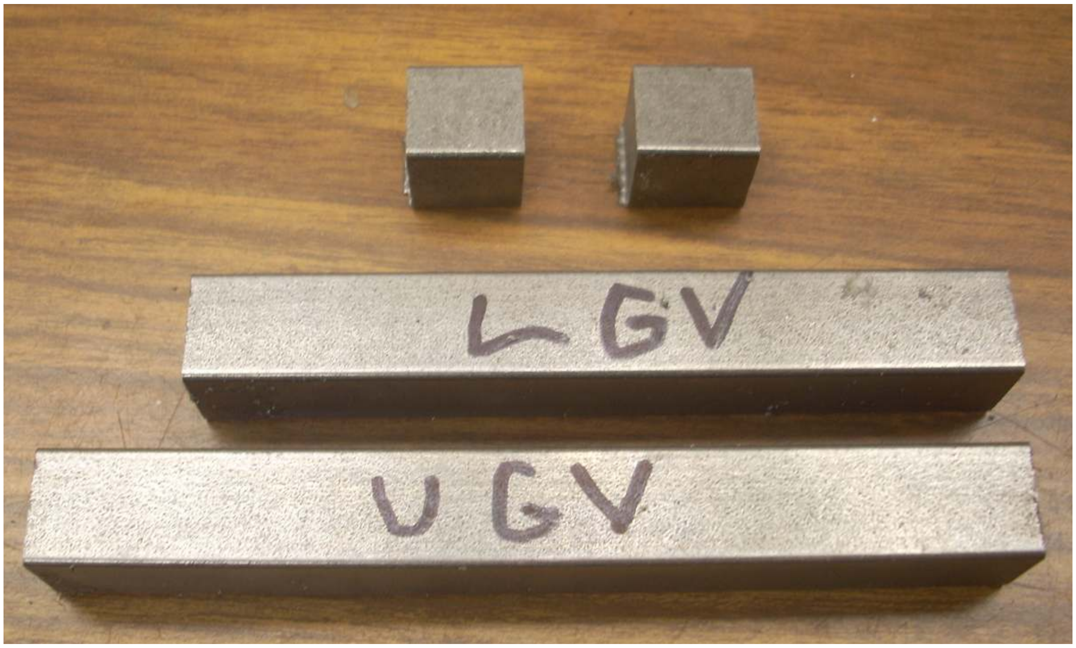
This should be the last part made. It is cut to fit the rest of the guide.



Shop Work

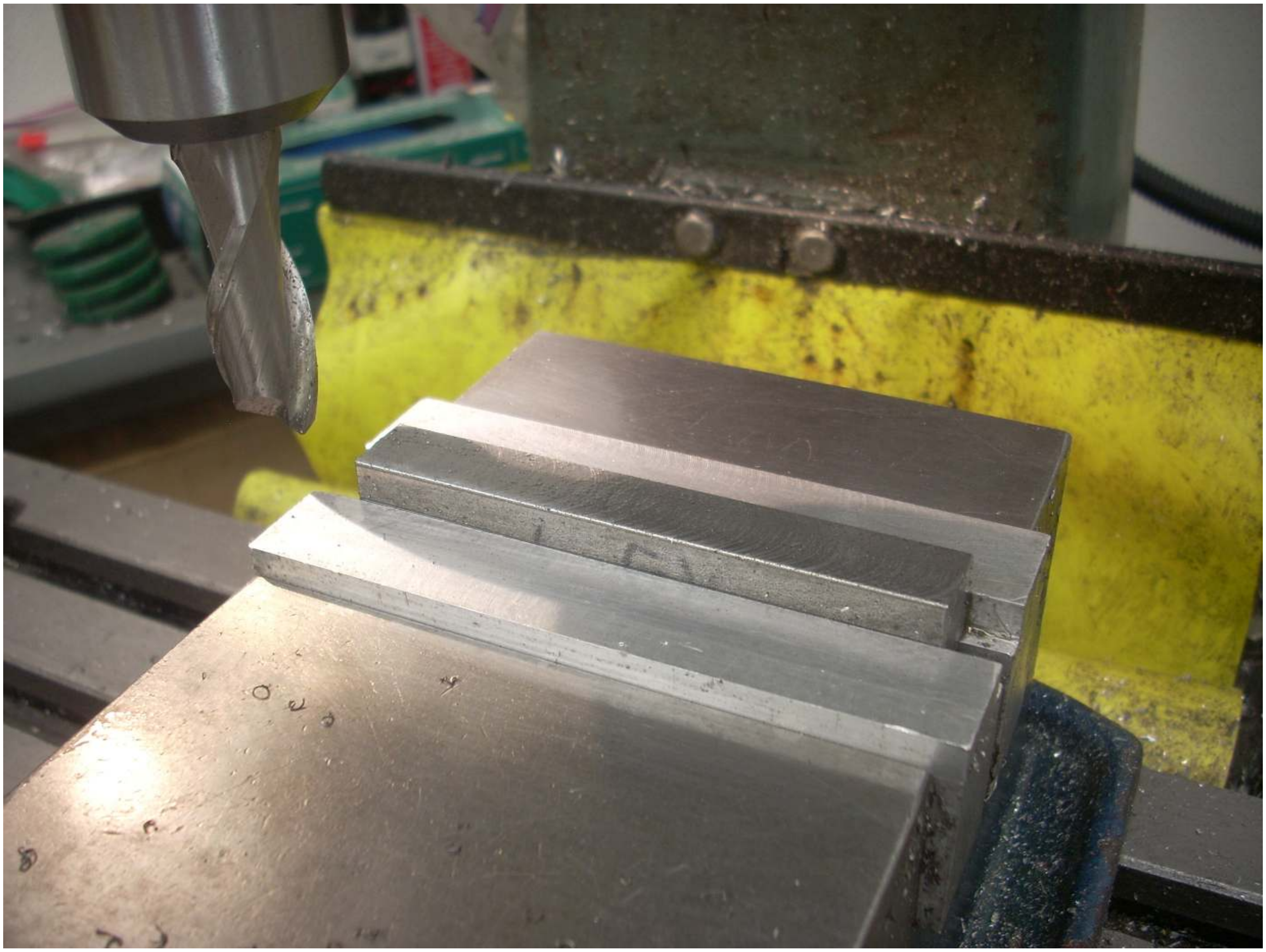


I started with 3 pieces of ½” x ½” x 12” CRS. All bars were cut about 0.05” longer than the finished dimension. Here I’m cutting one of the spacer blocks. My cutting “fluid” is a recycled block of paraffin wax. I collect the cut bits, melt them down in the sun, and cast them into a block again.



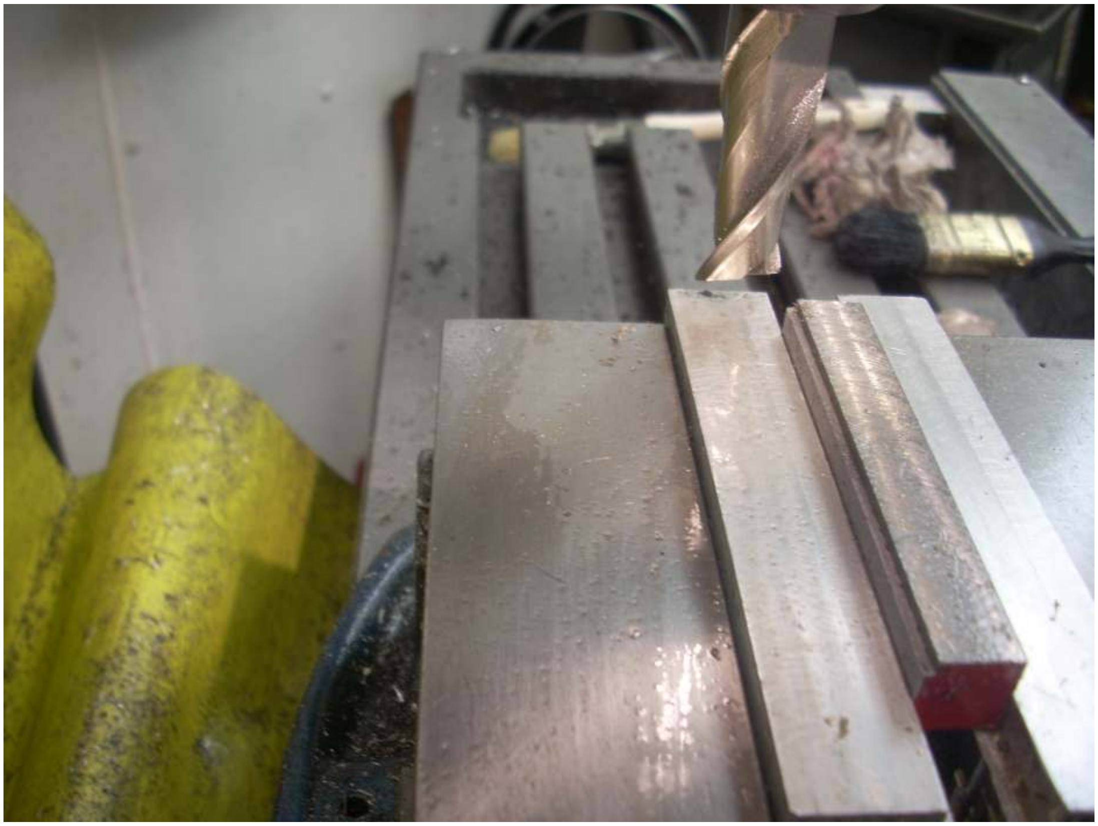
All bars that will set the width of the slots have been cut.

Each piece is carefully deburred and then cleaned with alcohol.

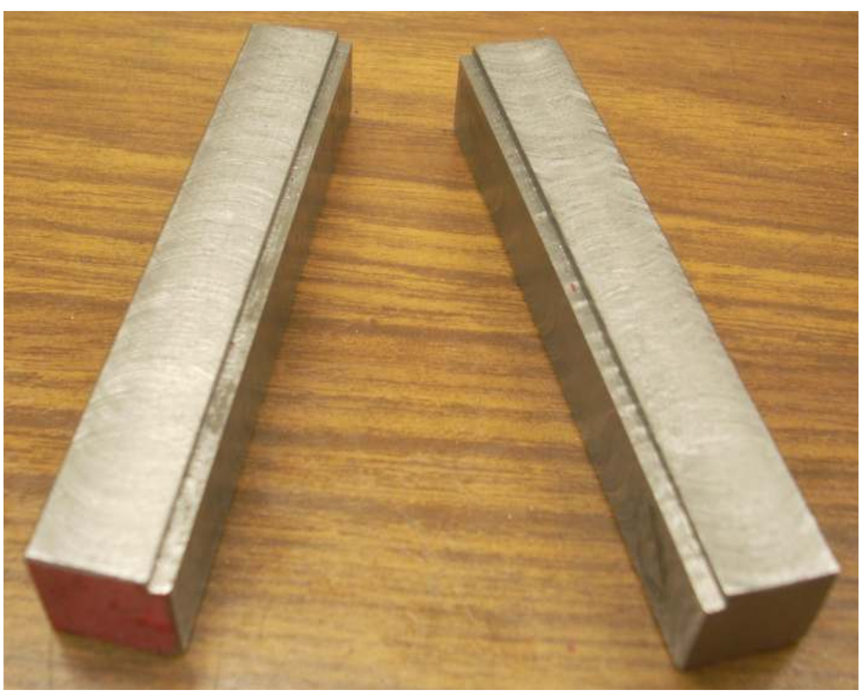


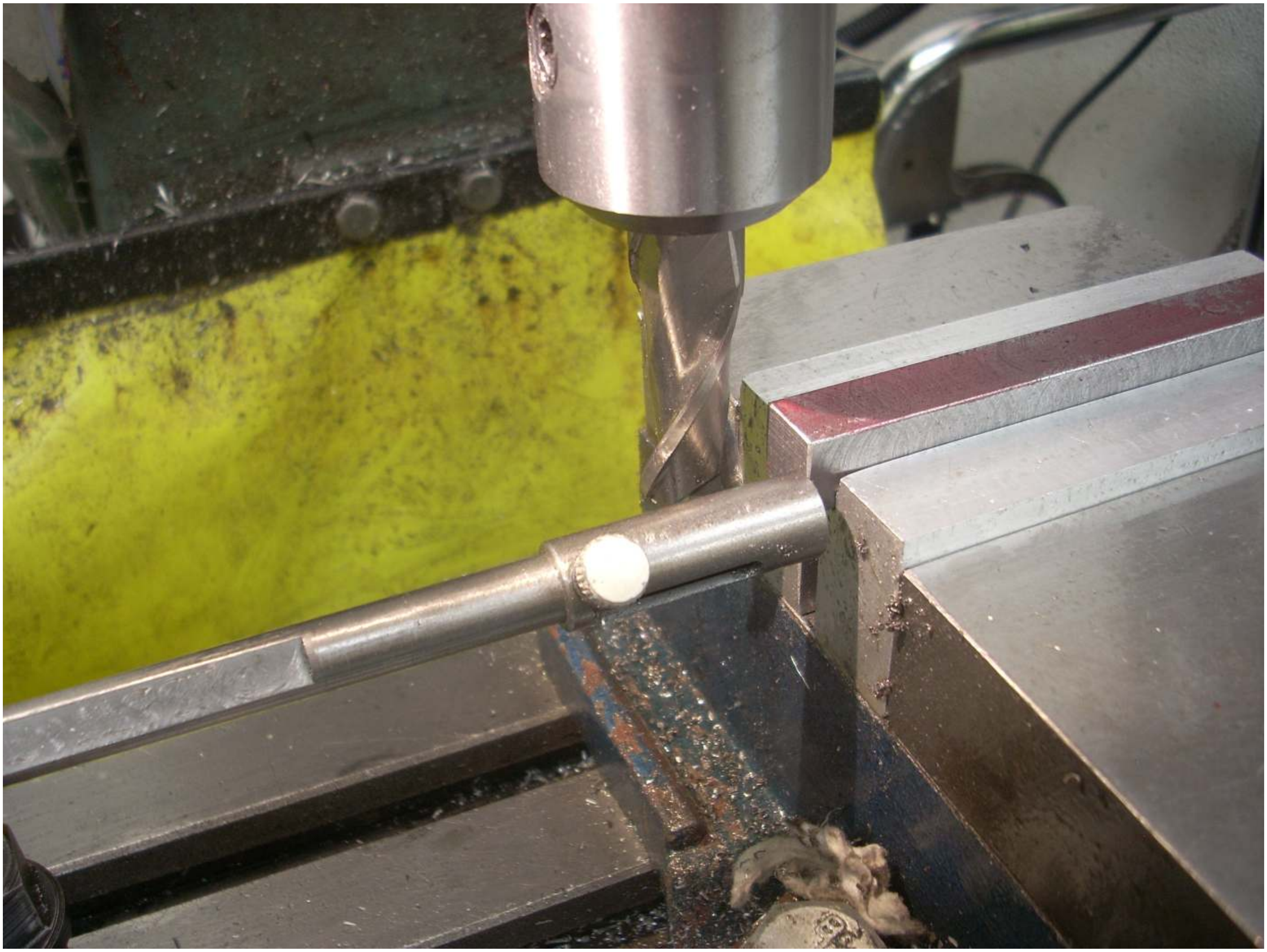
The vise is cleaned with alcohol and inspected to be sure no swarf is left on the contact surfaces of my soft jaws. I then pressed the first bar down and tightened the vise. The 5/8” end mill was then touched down on the surface, zeroed, moved to the left, and lowered about 0.004”. The quill was then locked.

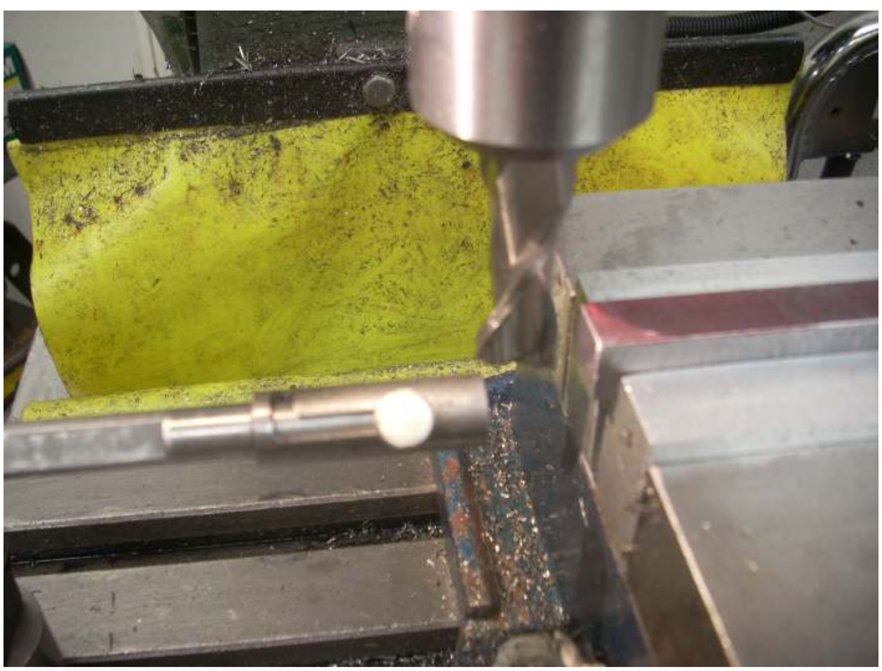
After all 4 of the parts have been cut on two adjacent faces, I unlocked the quill, lowered the cutter about 0.004” and locked it again. All remaining surfaces needing truing were then cut. In this way I was assured that space between all guide bars were identical as possible.



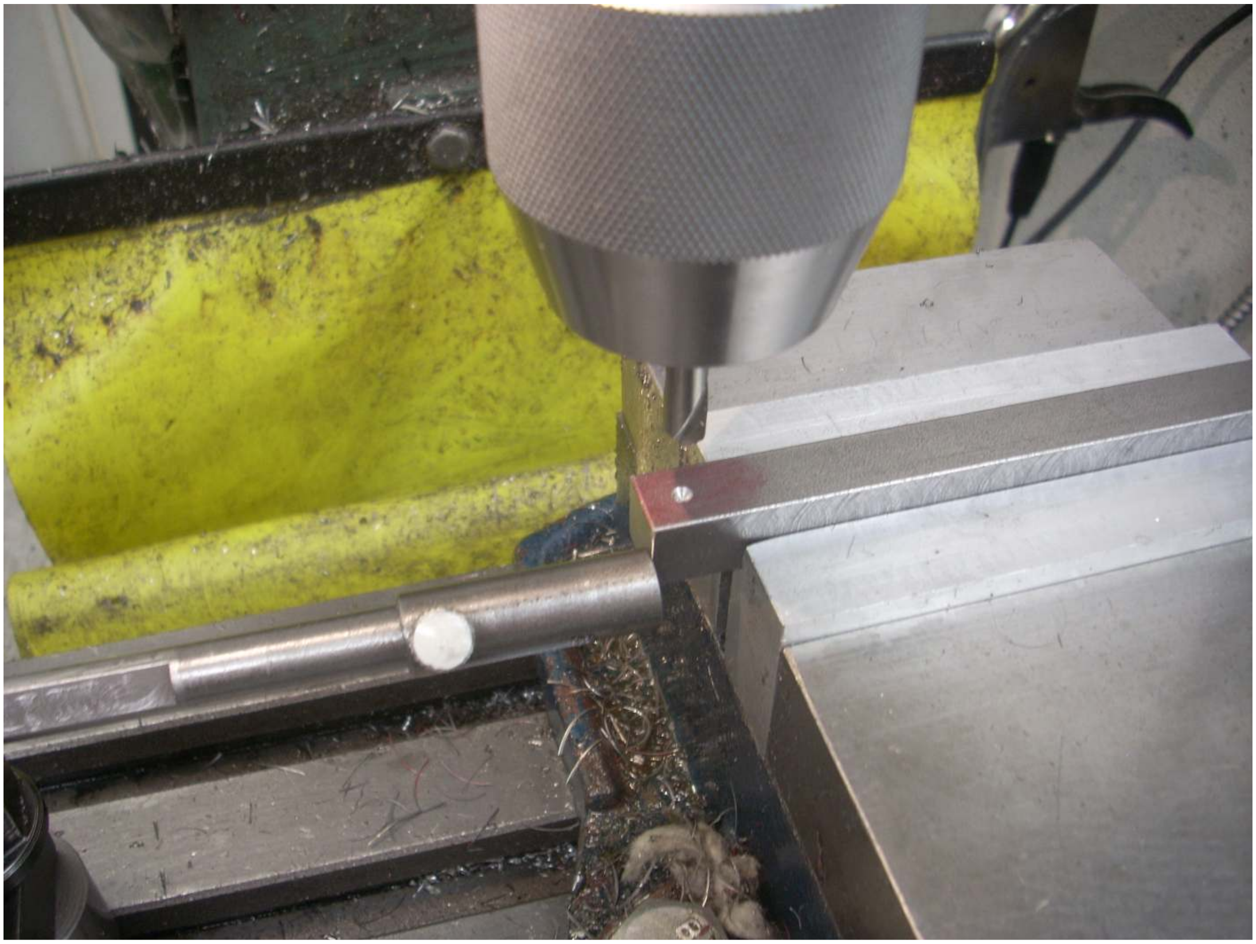
Here I'm milling in the steps into the lower horizontal guide bars. Once the cutter's position had been locked, I milled one bar, carefully cleaned the vise with alcohol, and then milled the second bar.







Time to side mill the ends of all bars. They were sawed fairly squarely so I can use a front face stop to position the end for milling. The stop is retracted and locked in position before the mill is powered up.



All bars ***should*** have been side milled on both ends but I only did one end. This worked well for the spacer blocks but could have been trouble for the horizontal guide bars.

You can see here that I am drilling my holes with respect to the end. If two mating bars were different lengths, the holes would not be in the same place. This is one place I lucked out.

Note that the plans call for match drilling. I actually chose to drill all holes separately because my set up is rather accurate. If in doubt, go with match drilling since it will guarantee that all holes line up perfectly.

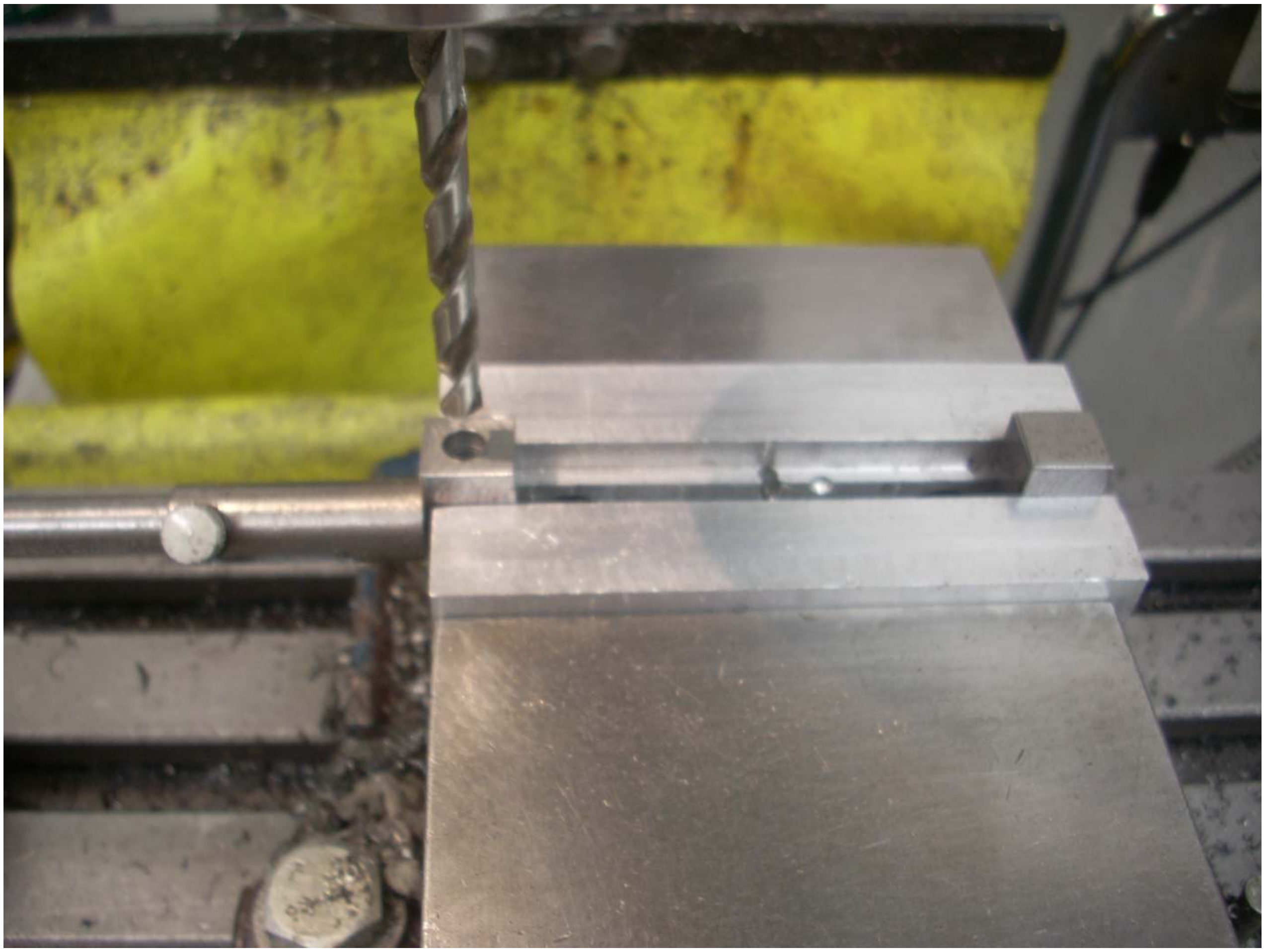
After using my spotting drill, I ran my #7 drill in preparation for tapping. I then chucked up a spiral point ¼-20 tap. Then I squirted in some cutting oil.

The mill was brought up to full speed, power cut, and the tap quickly fed down into the hole.

Do not try this with a hand tap. It will likely snap off.

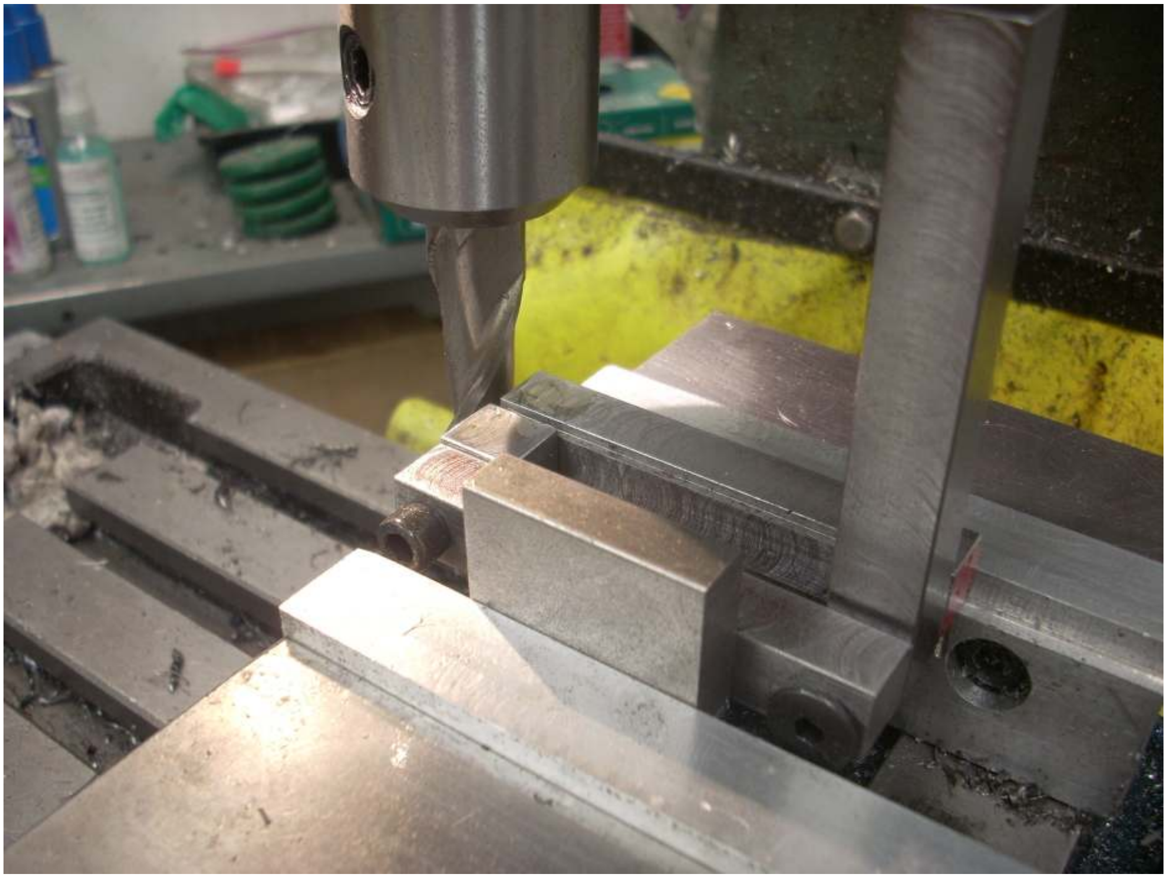
The spindle coasted to a stop and left the tap part way in the hole.

I then used a tap handle to finish the job.

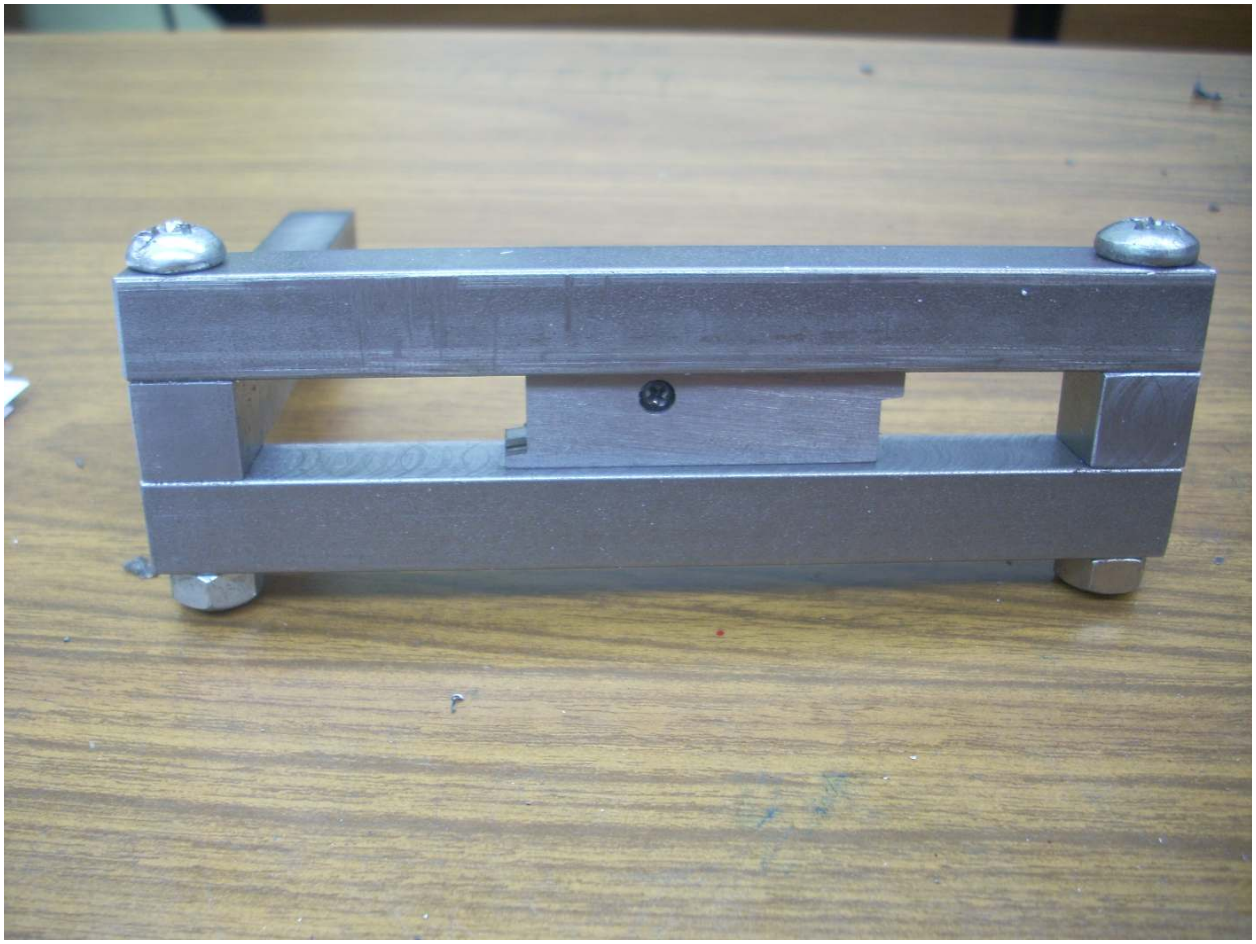


Drilling the spacer blocks required some packing material on the right end of the vise jaws to insure that the movable jaw made square contact with the block being drilled. After finishing the block on the left, I swapped the two blocks and processed the second spacer block.

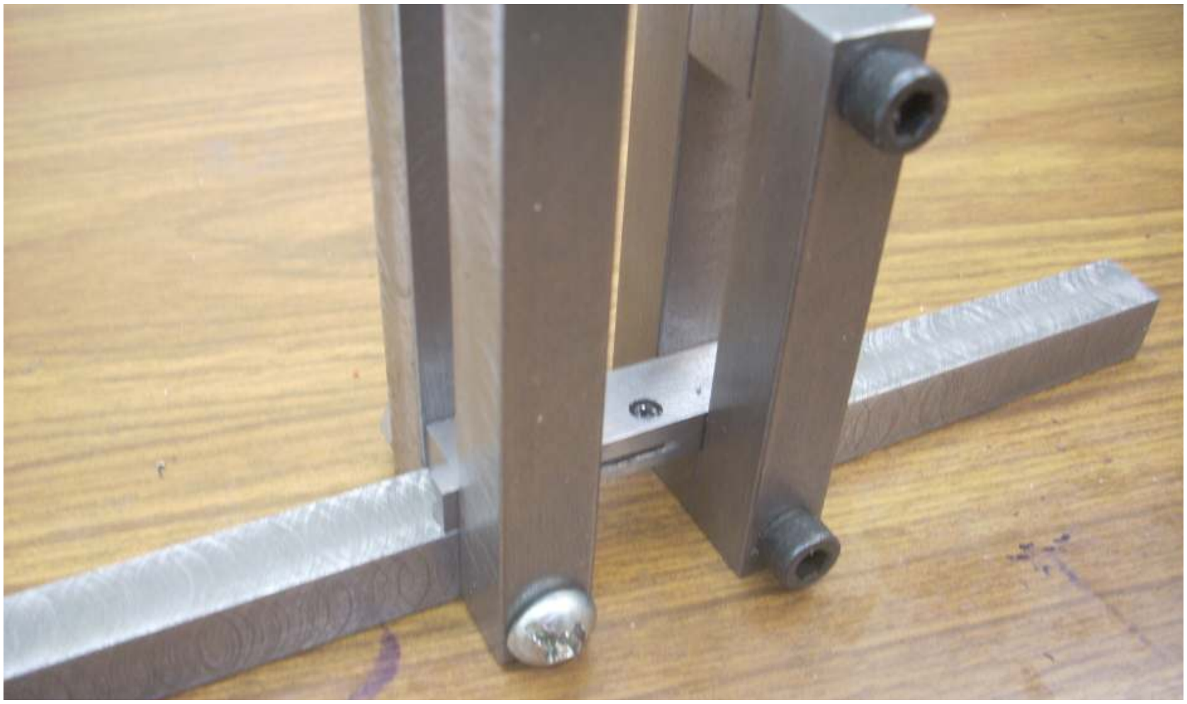
I did made a dumb mistake here. One of the blocks was drilled through an un-machined surface. This screwed up my oh-so-grand plan of having all bars that set the gap be the same width. In hindsight, I should have just gone ahead and drilled a second hole in that block through the correct faces. Instead, I had to artfully use my belt sander to bring it down about 0.004”. Not the best choice.



Here is why I thought I didn't want to side mill both ends of each bar. I figured I would assemble each guide and then mill it true on the end just for looks.



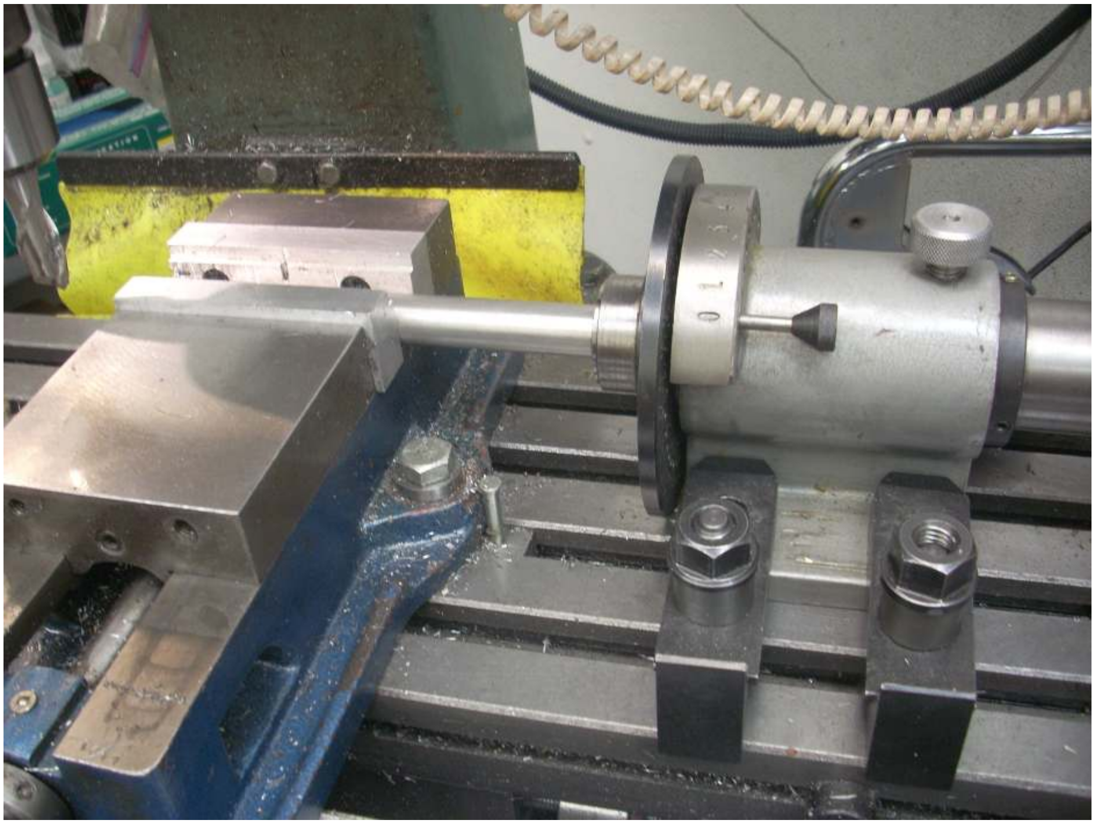
I used an expanding parallel to measure the space between guide bars. This assembly has the spacer block that was drilled correctly. The parallel slides nicely along the entire slot.



Next I checked that the gap was the same between guides at the vertical bars. All is well. It was only when I checked at the lower guide spacer block did I find my mistake.

With the upper and lower guides done, it was time to make the bushing. I decided to use some ¾" 12L14 for this prototype. I may later change to W-1 and harden it.

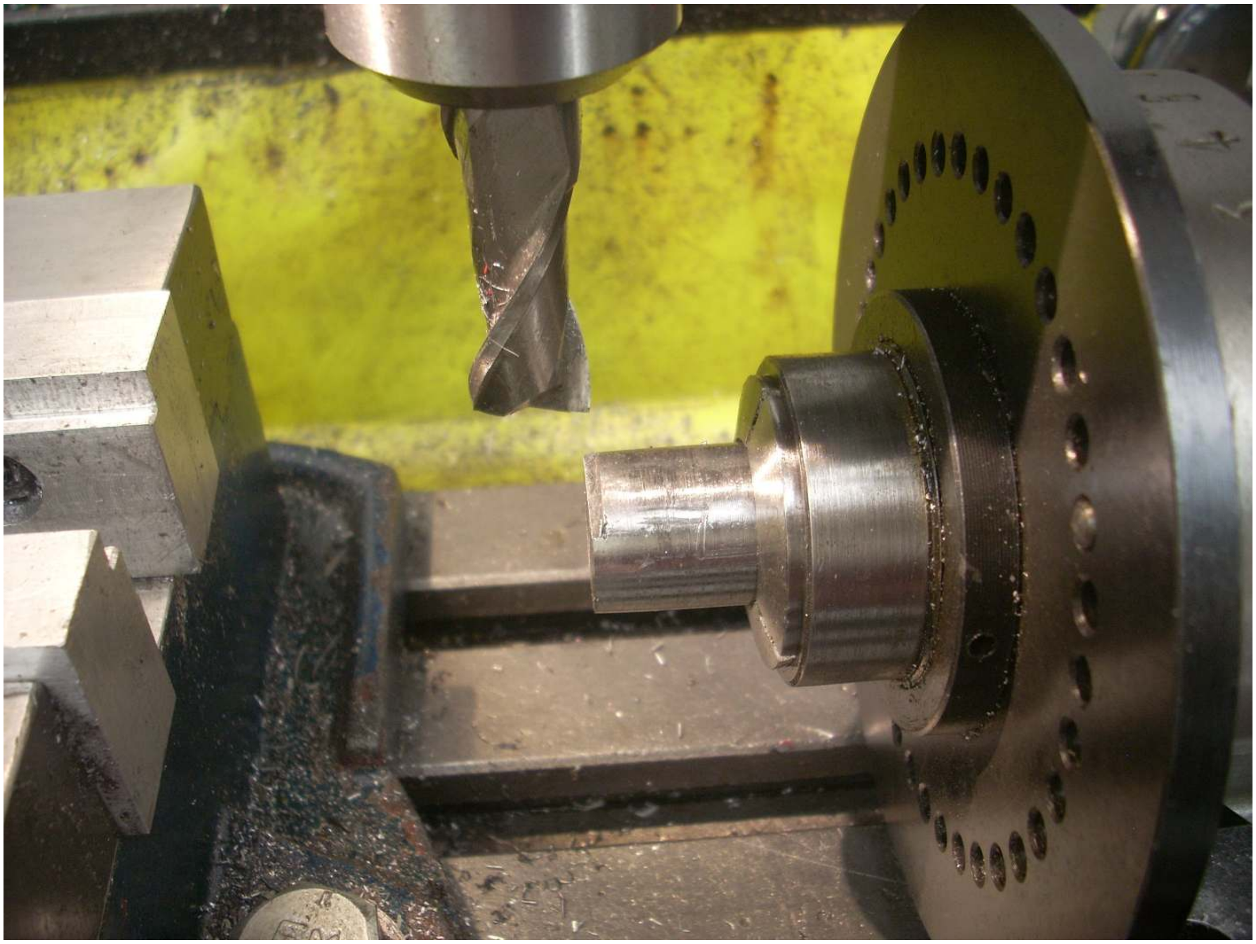
The first step was to square the end of the round stock on my lathe.



Moving over to my mill, I set up my 5C collet indexer. I used a piece of 5/8" bar to align the indexer to my X axis by clamping it in my vise. Then I used 3 hold down clamps to secure the indexer to the table. The third clamp in behind the indexer.

In the past I set the clamps horizontal but this time I first placed them flush on the sloped surface of the indexer's foot and then set the step blocks to support them. I figure the increased contact area will help keep the indexer from moving.

I then removed the 5/8" bar.

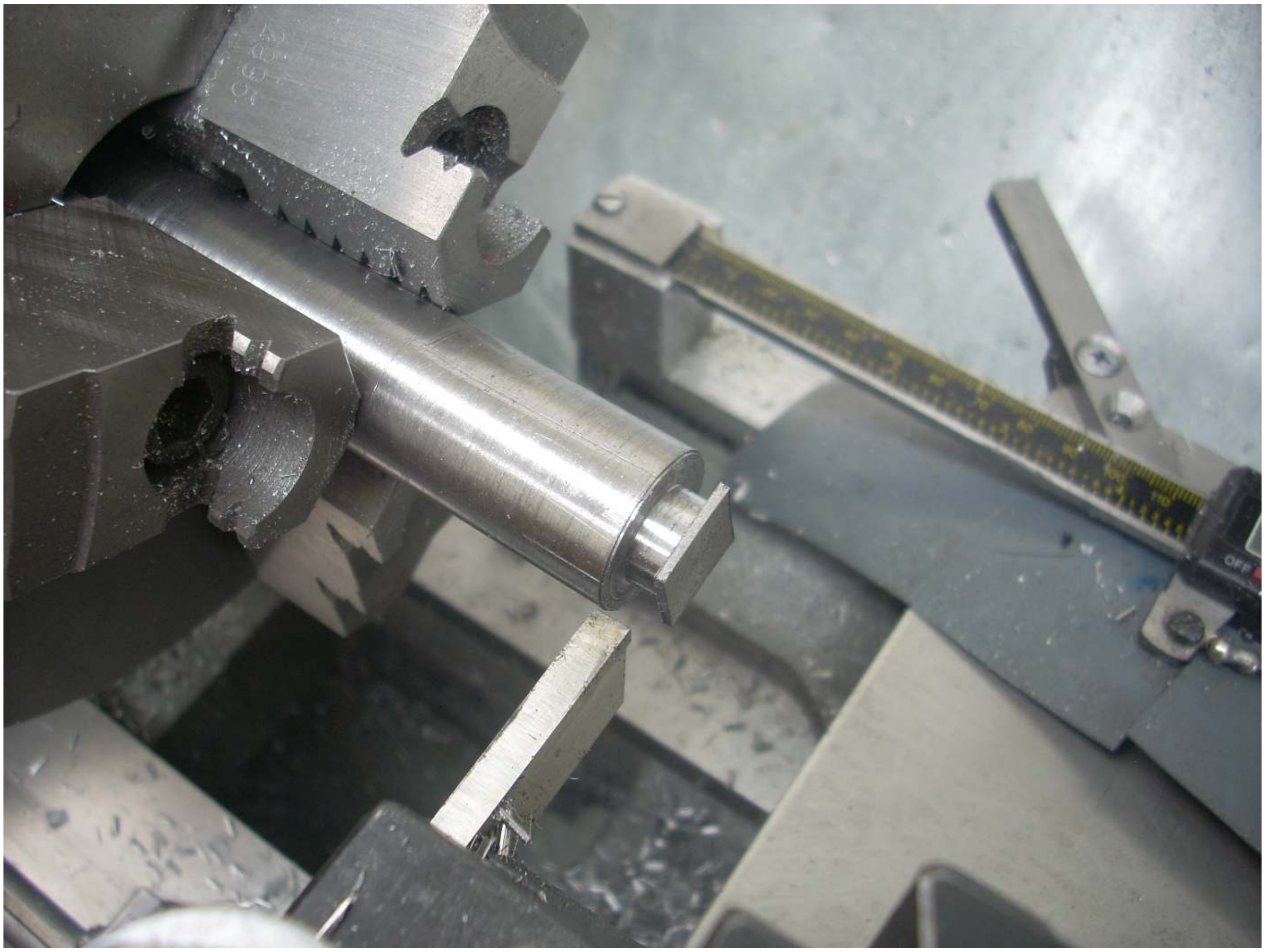


The ¾” bar is clamped in position and the indexer locked at 0°. I then touched the cutter down on the top surface of the work piece, zeroed it, moved it away from the bar, then lowered the cutter down 0.375”. I then zeroed the Z axis again. My zero point is now at the center of rotation of the rod. I then raised it up 0.250” and fed in 0.055” to set the width of the cut.

In a single pass, I cut my first edge of the rectangle. After rotating the indexer 180°, I cut my second 0.250” edge. Then I raised the cutter to 0.313” and was about to cut my third edge.

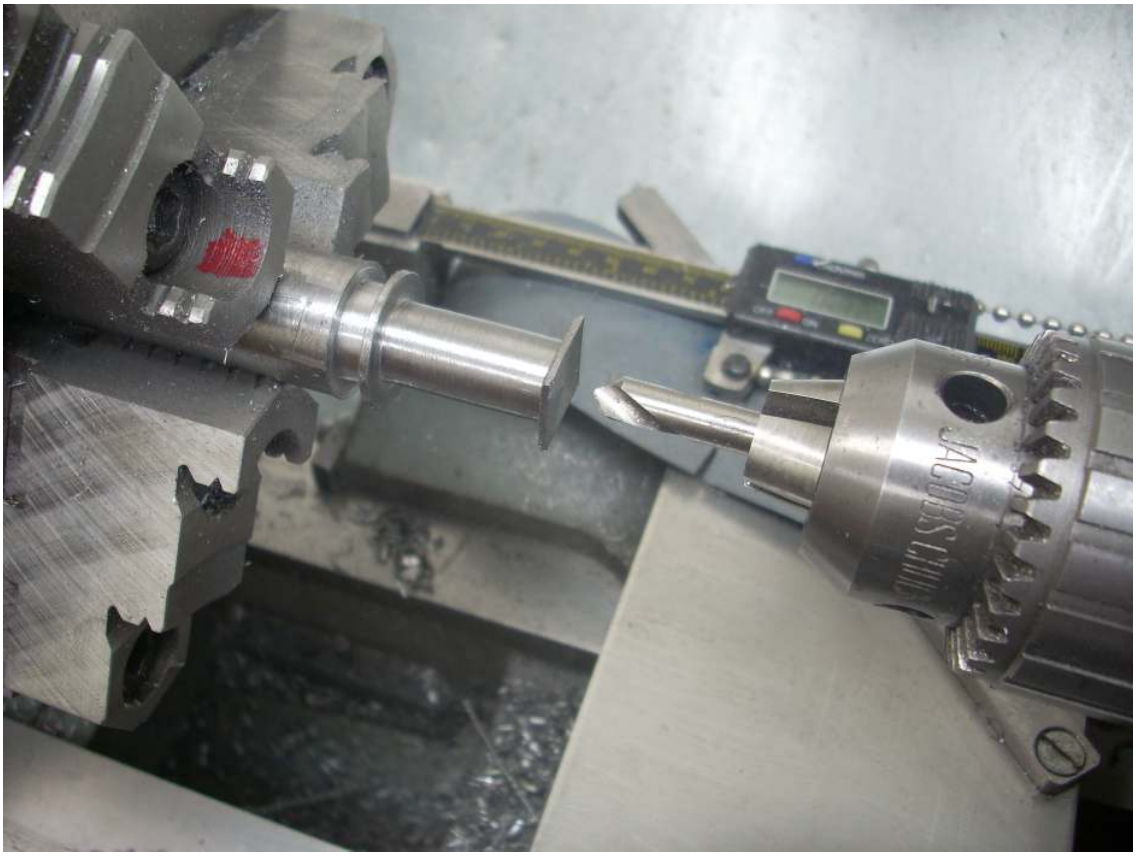
But then I realized that I could directly measure the width of the slot on the lower guide which would give me a more accurate value. It turned out to be 0.606” so I change my cutter to 0.303” and took the cut. Rotating 180°, I took my last cut.

The result is a rectangular solid 0.055” thick, 0.500” wide, and 0.606” tall. Time to return to the lathe.



I used my 3/16” wide parting tool to cut the back side of the rectangular solid. I turned the work piece diameter down to the width measured by the adjustable parallel. This is my dimension “w”.

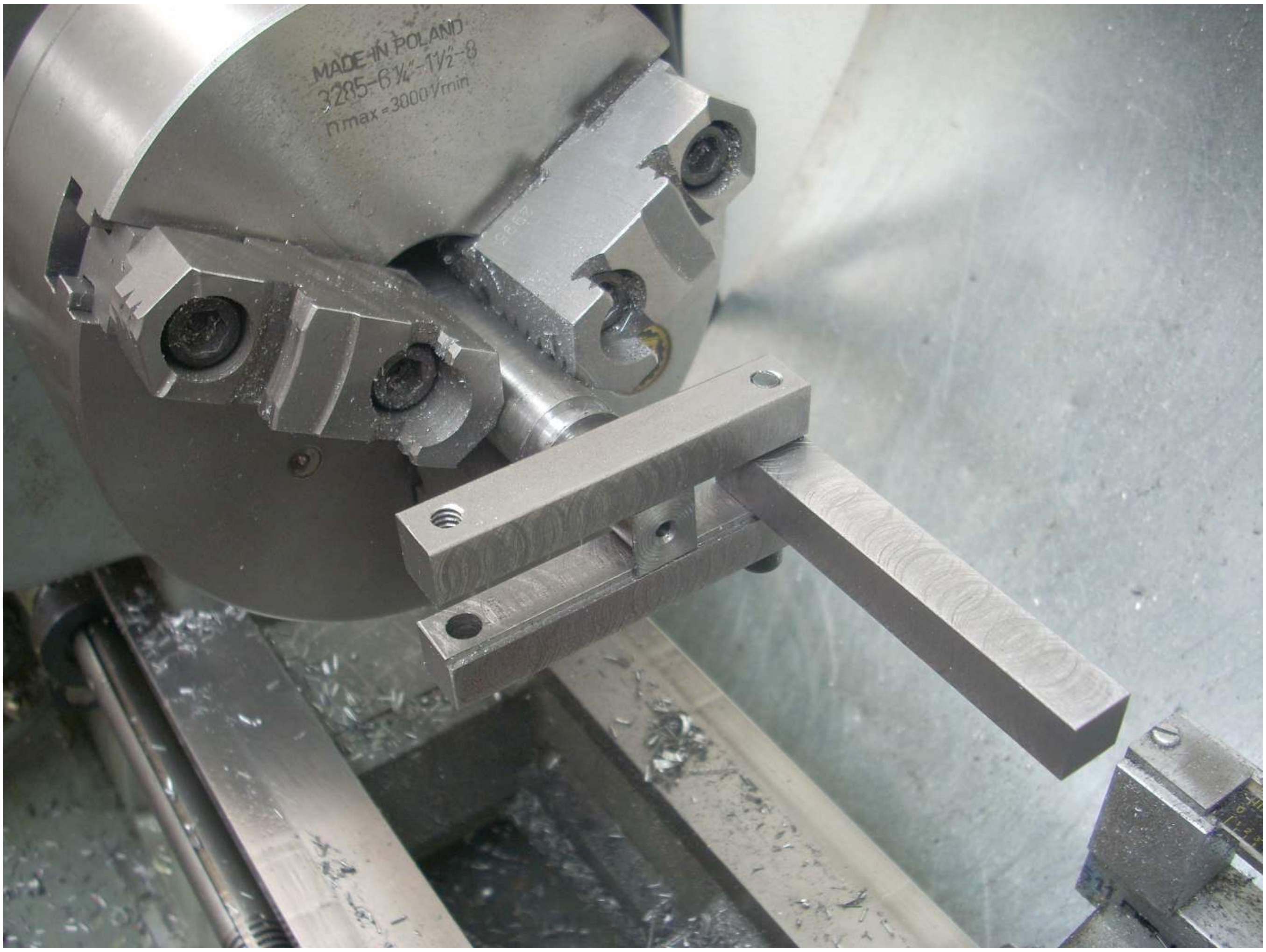
I then moved the parting tool over 0.950” + 3/16” in order to cut the underside of the second disk.



After feeding in to the finished diameter, “w”, I moved the parting tool over by 0.050” + 3/16” and partially parted off the work piece. I then used my file to deburr the resulting disk.

I then switched to my Diamond® cutter and removed the metal between parting tool grooves. The last few thou were removed with a file to give a nice, matched finish.

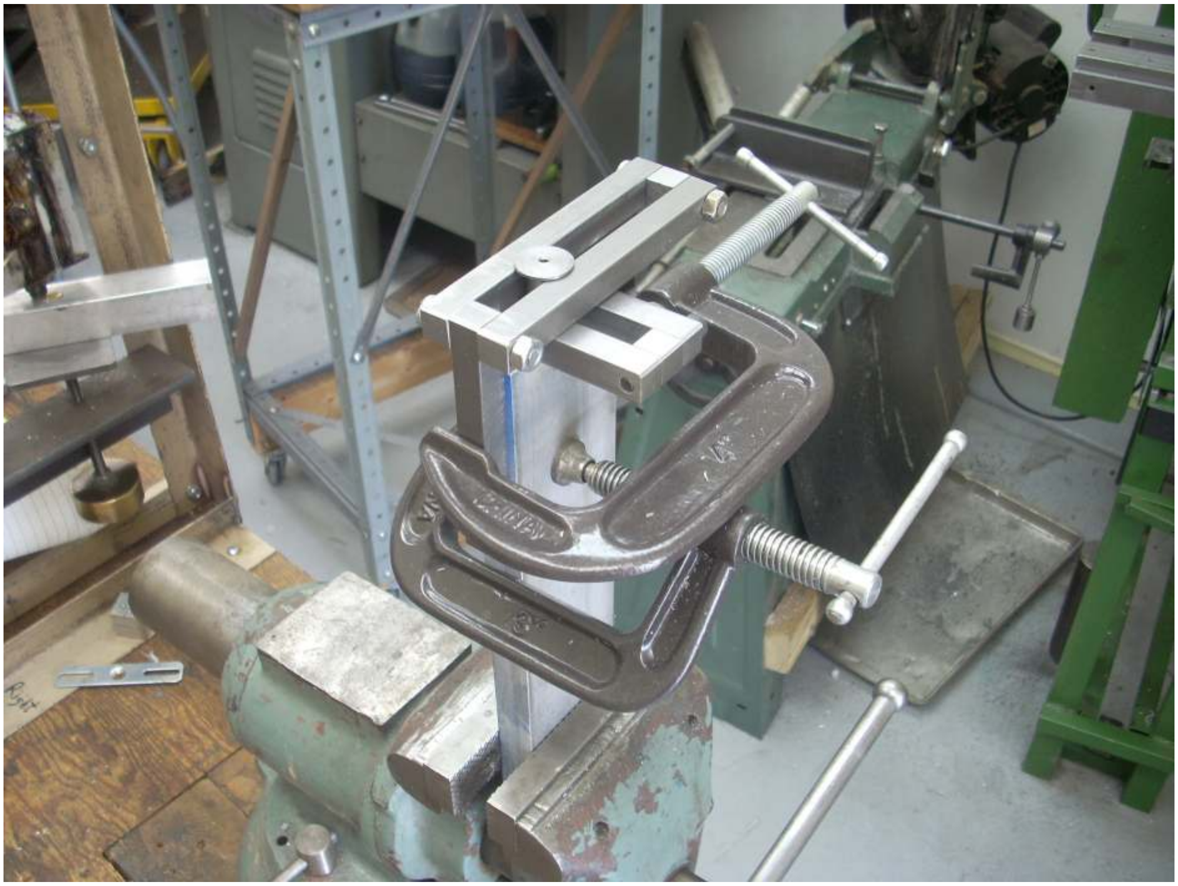
Before I forgot, I center drilled the end. This was followed by my 1/8” drill to a depth of 1.125” to be sure I completely drilled through the work piece.



I used the lower guide as my gage to be sure I had a sliding fit.

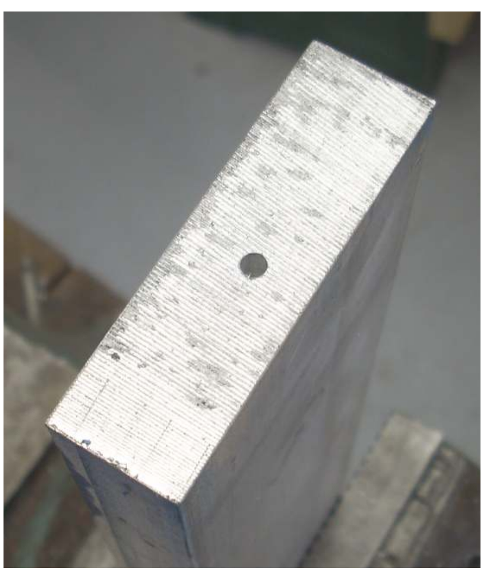
All was well so I parted off the work piece.

Final assembly provided one rude reminder. I got a bit carried away drilling clearance holes and ended up not drilling tap holes in one of the upper horizontal guides. Not a big deal, just had to use nuts to secure the two bolts.



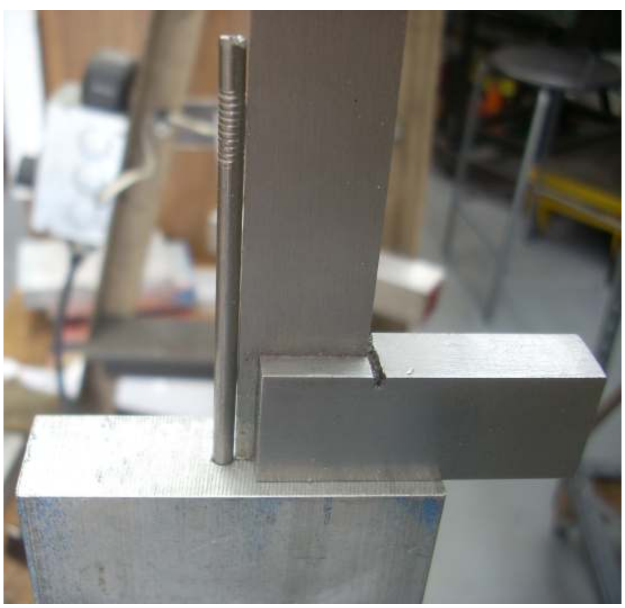
The drill guide has been clamped to a piece of 6061 bar stock held in my bench vise.

I used my hand held electric drill with an 1/8” drill. The guide was solidly in place.

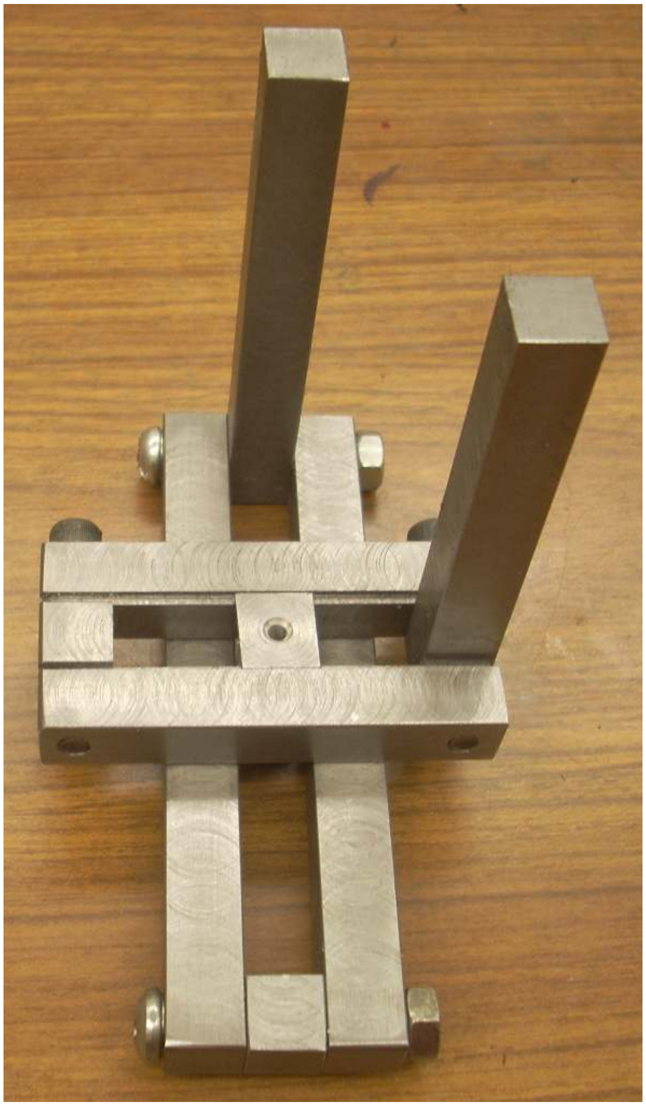


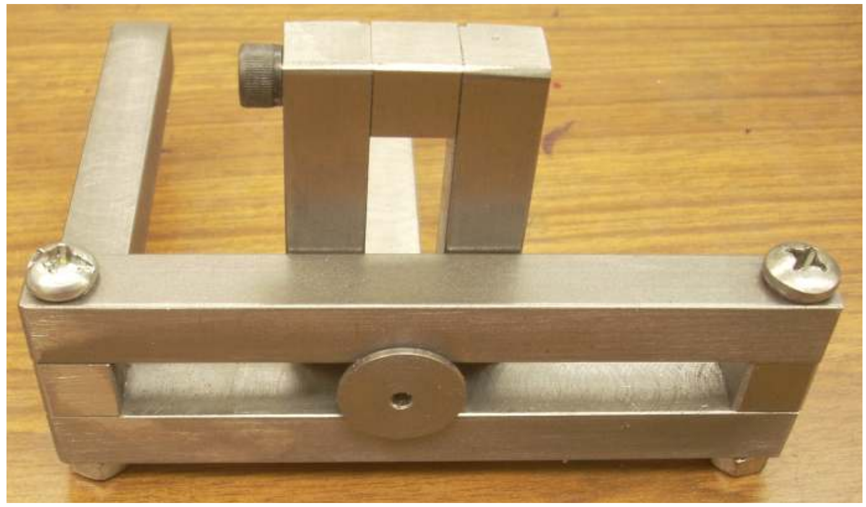
The resulting 1/8” diameter hole is about 1” deep.

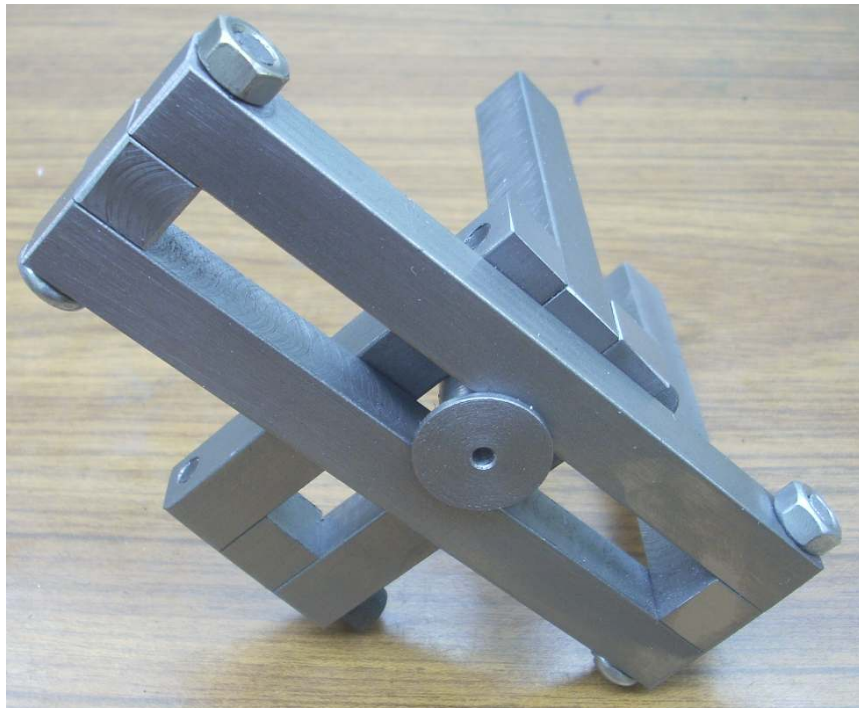
I removed the guide and drilled down another inch with just the drill. It seemed well supported.



I could not find a close fitting rod to test the alignment of the hole. Here I used a nail but it turned out to be slightly bent. So all I can say is that the hole looks fairly straight…







The fasteners were from my junk pile so don't match. But otherwise, I think the guide is usable.

I welcome your comments and questions.

Rick Sparber
Rgsparber@aol.com
Rick.Sparber.org