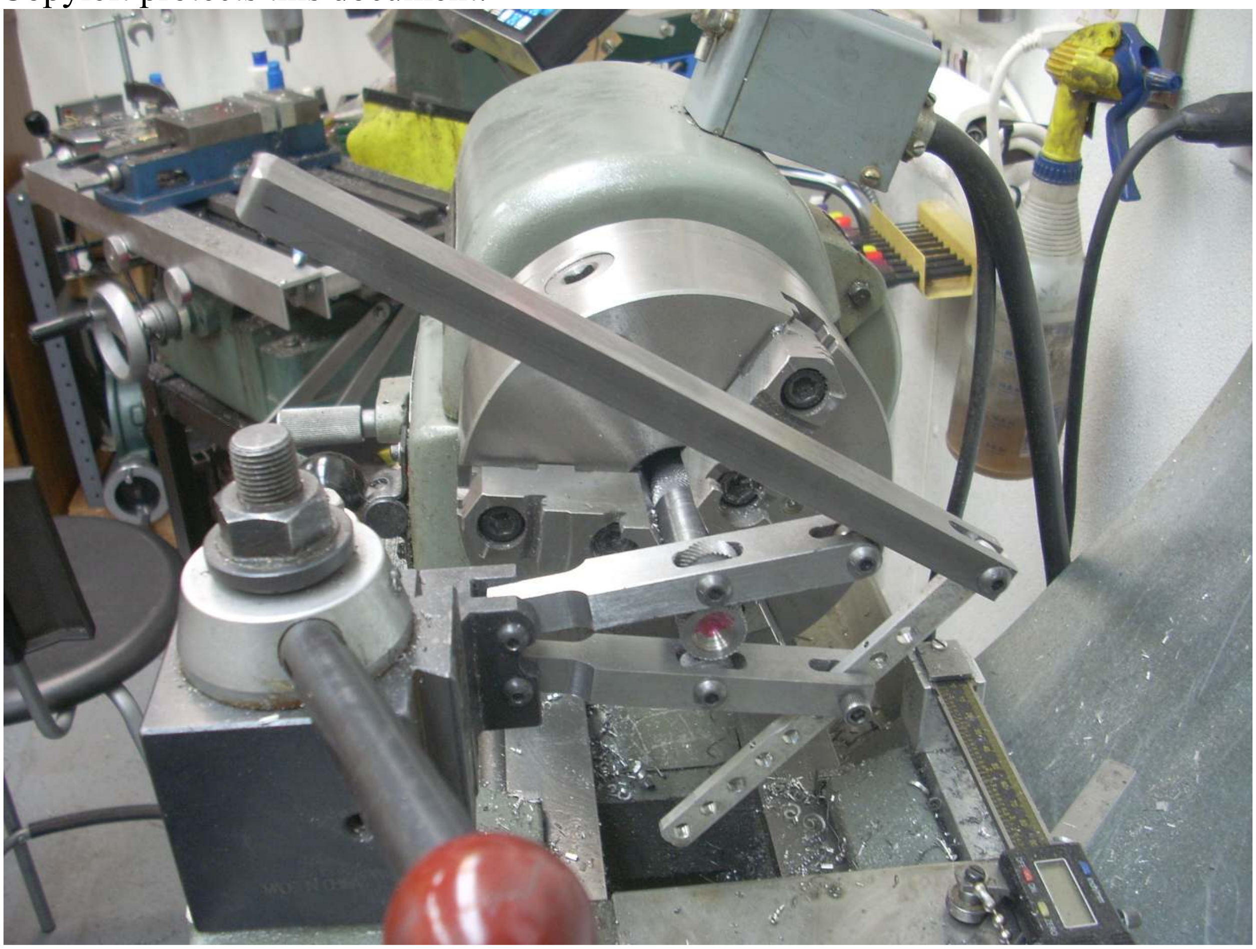
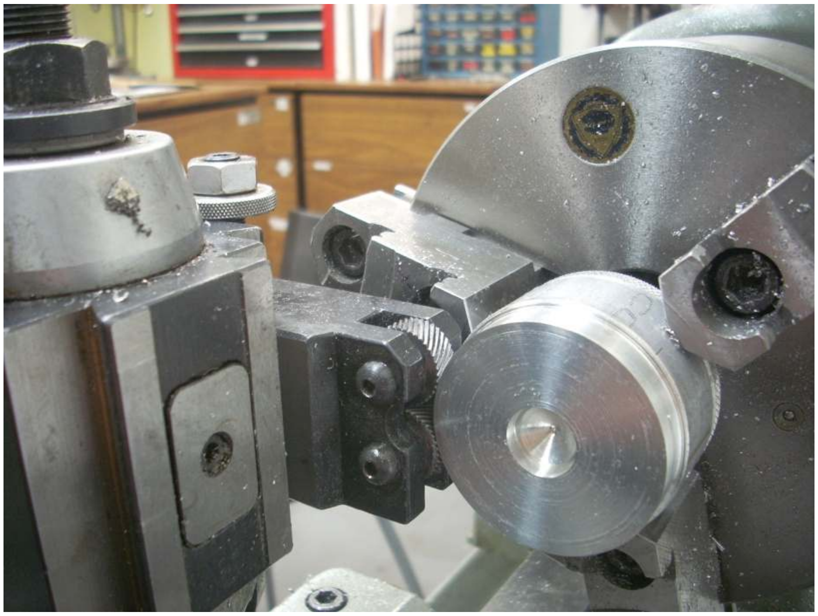
A Modified Knurling Tool, Version 1

By R. G. Sparber





I started with a knurling tool that came with my Phase II Quick Change Tool Post.

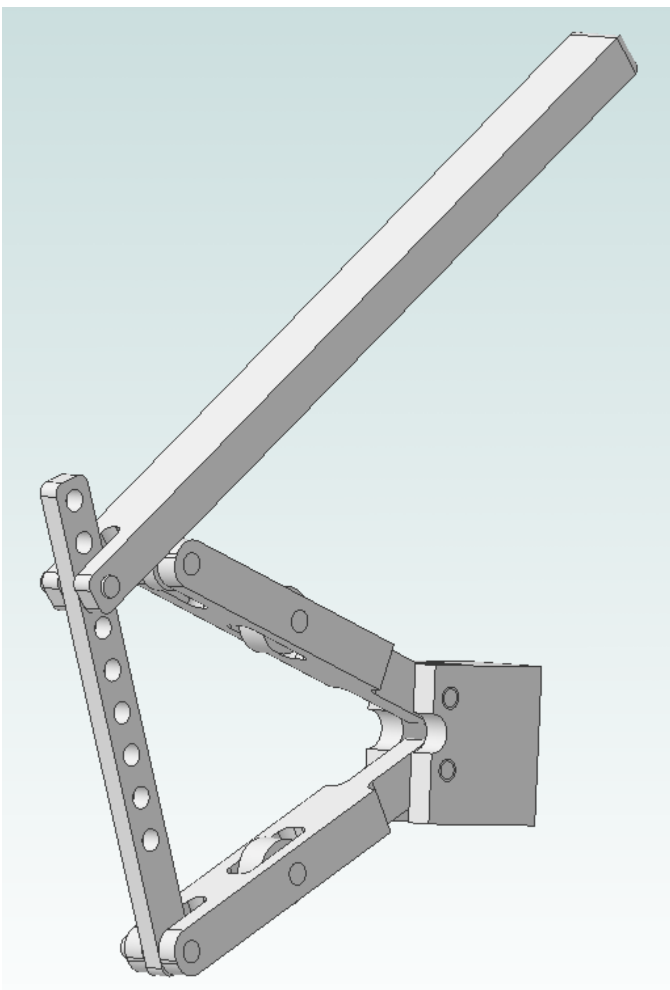
It has at least two design flaws. The first is that all force is applied from one side. This puts a lot of stress on the lathe’s apron and could cause damage. Second, it is very hard to get the two wheels to apply the exact same force on the work piece. The tool must be exactly on center. If it is a little off center, one wheel will dig into the work piece while the other just grazes it. The wheel with the deeper imprint will lock into that pattern and reinforce it. The other wheel sometimes forms multiple imprints and jump between them.

“Doc”, from the metal_shapers Yahoo group, described his knurling tool which “has never failed him”. It took about 10 minutes to rig up a test of his idea.

My proof of concept machine used the existing knurling wheels and the body of the QCTP knurling support. I added a few bits from my scrap bin and screws. My first attempt at knurling was on 5/8” diameter 12L14 and it worked perfectly. I then tried it on some 2 ¼” 12L14 and got the same great result.

So what does this arrangement have that is good? First of all, there is very little stress on the apron of the lathe. As I pull down on that wide, thin plate at the top, it squeezes the knurling wheels together in a scissor action[2]. The QCTP and apron must withstand my downward force but that is a lot less than the infeed of the wheels with the old arrangement. Second, the knurling wheels are close to being on opposite sides of the work piece. The downward force from the top wheel matches the upward force of the bottom wheel. There is no possibility of misalignment.

What didn't work so well? The bars were a very loose fit to the QCTP tool holder so the horizontal arms did twist from the knurling force. The design corrected this problem.



Here is a rendering of my finished design. I set the width of the knurling arms at the QCTP tool holder to be a close fit.

The top pin that joins the lever arm to the vertical bar is easily removable. That is how I adjust the tool for different diameters of work pieces.

If the horizontal arms bind on the work piece, I can back the QCTP away from the part. The knurling wheels will then be off of the diameter which is not idea. But it is still much better than having them both pushing on the same side.

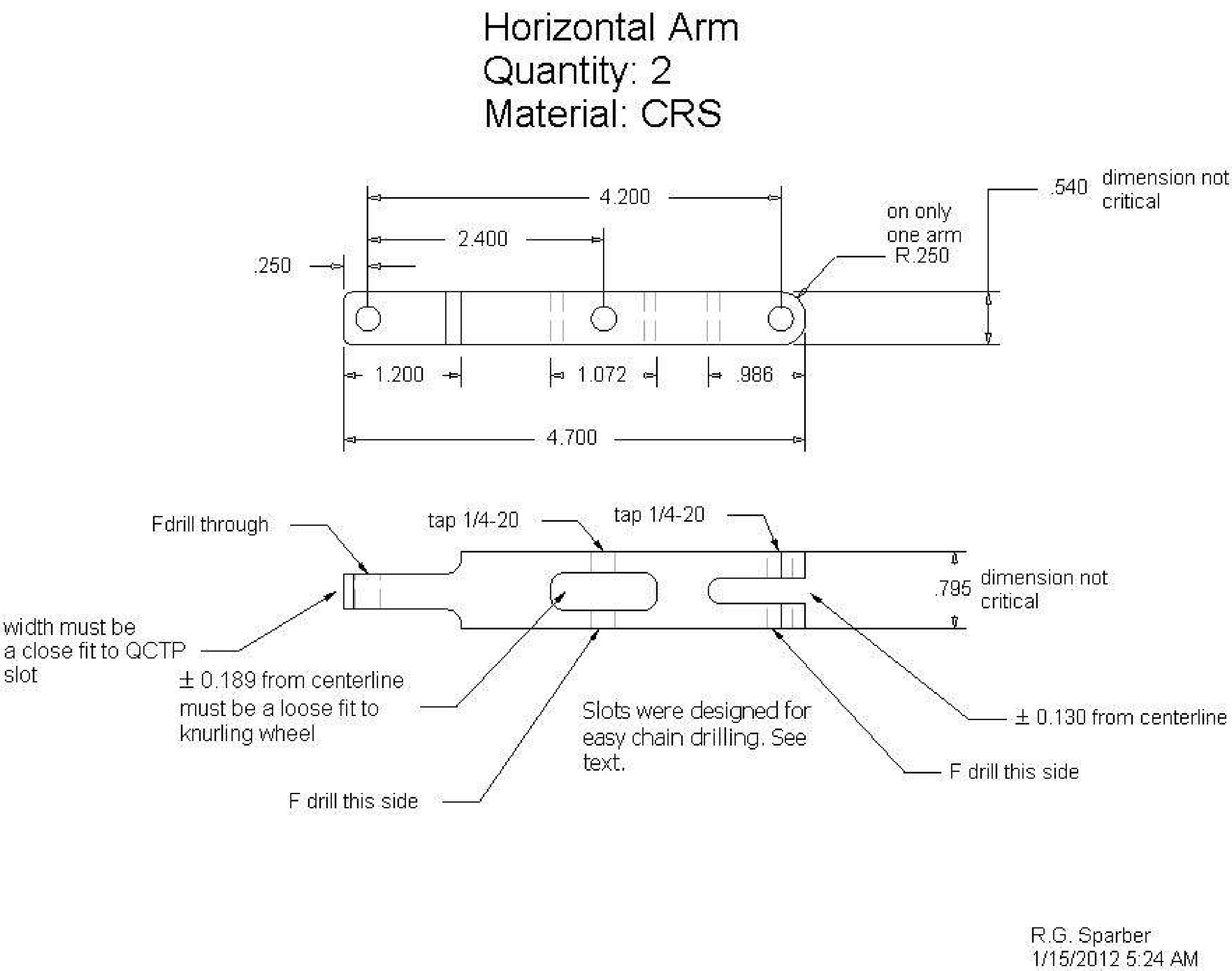
I have only used this tool to knurl at a fixed place. Moving it along the work piece does cause the QCTP to rotate. An additional support on the arms may be necessary.

[2] There is nothing new here. Plenty of good knurling tools use this arrangement of knurling wheels.

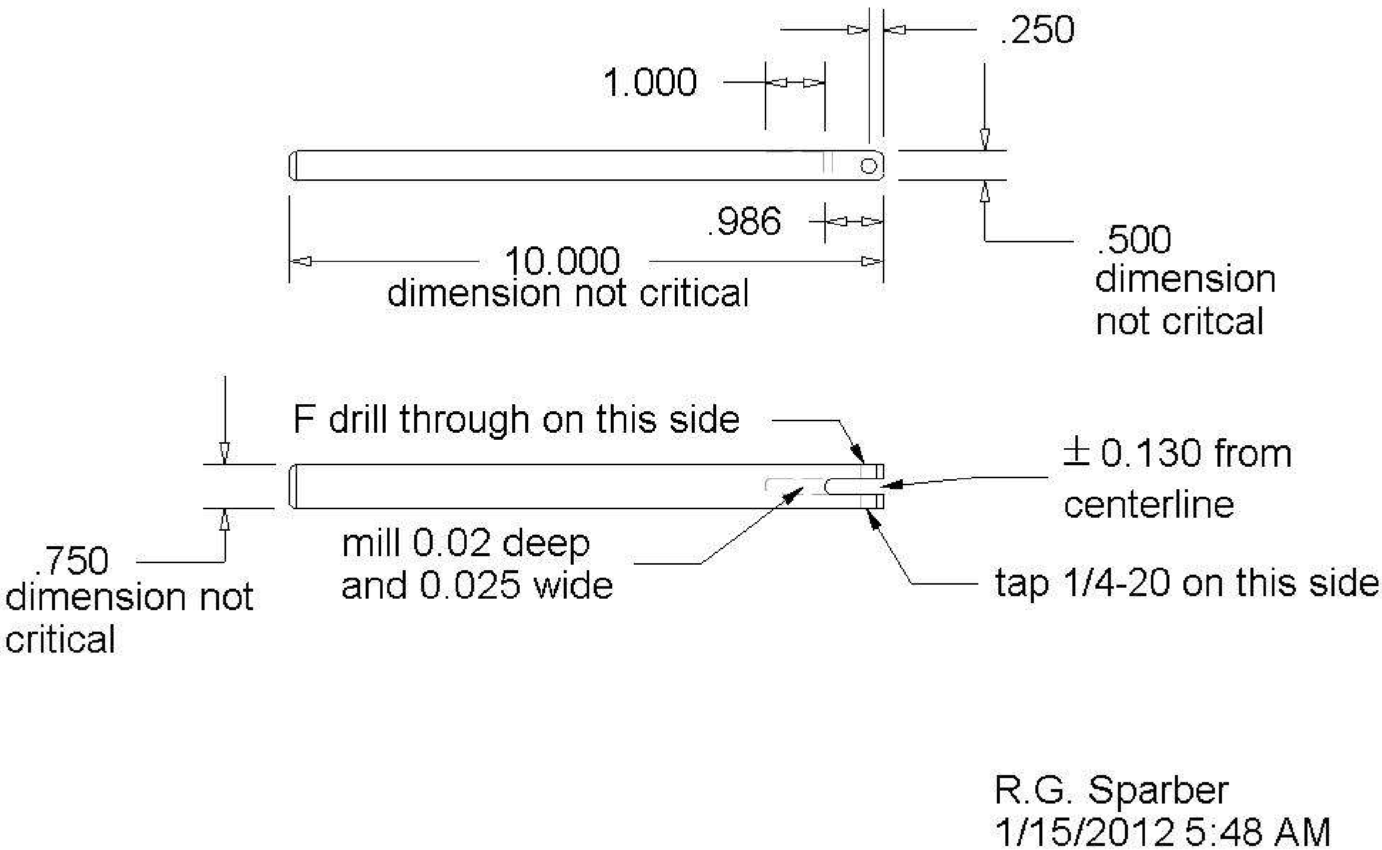
Shop Drawings

All slots have been sized for easy chain drilling.

Details of the end slot can be found in http://rick.sparber.org/dms.pdf. The center slot is the same idea except that a $\frac{23}{64}$" drill is used.

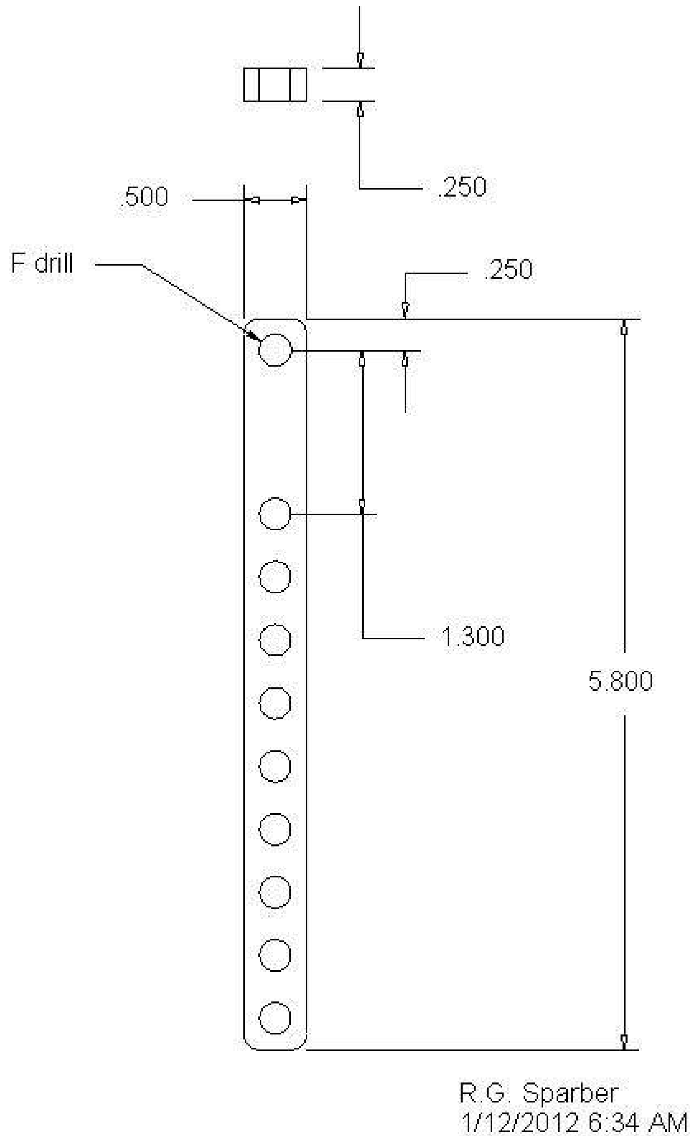


Lever Arm

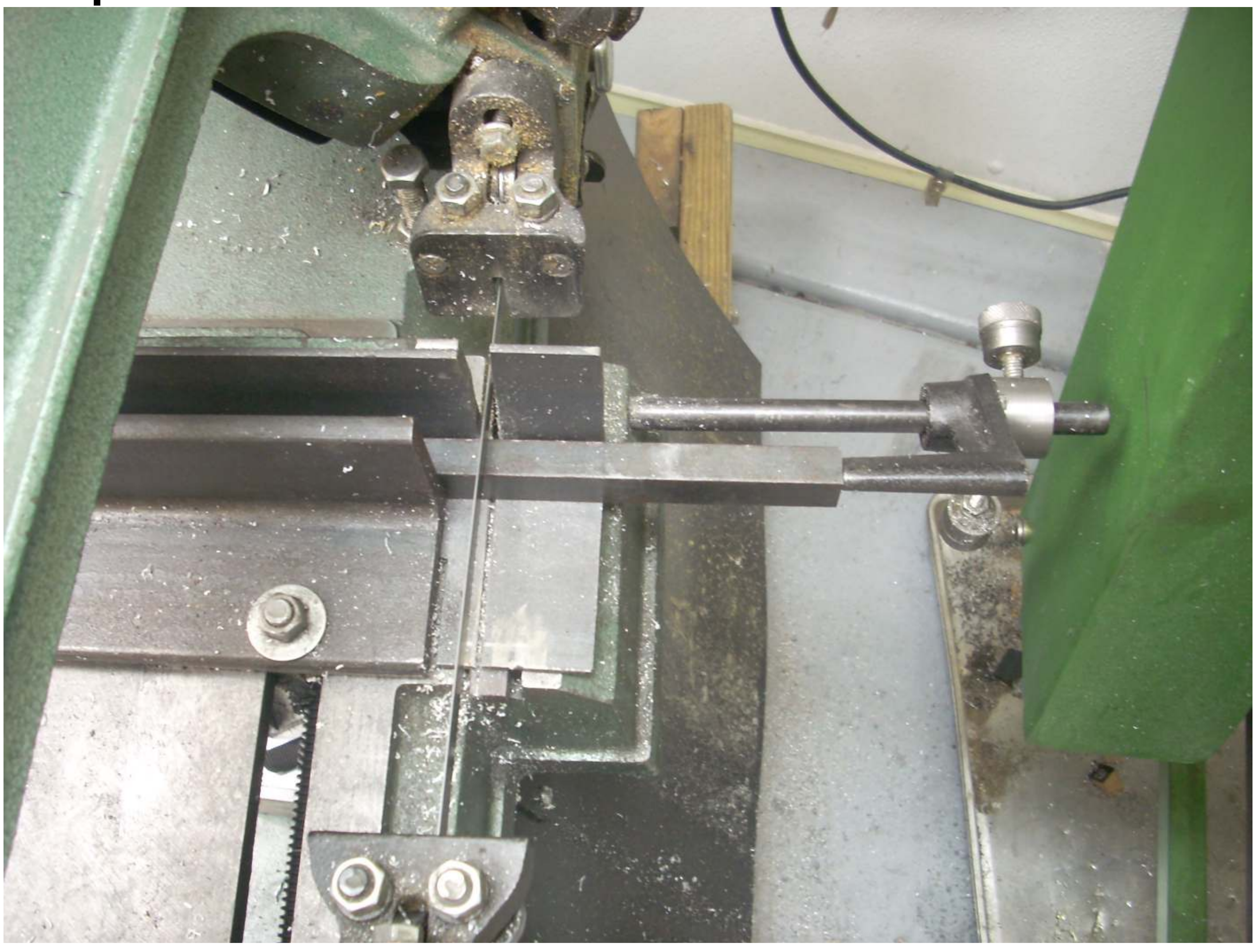


The non-slot end is rounded for safety. The shallow slot engages with the top arm's ball bearing to guide the lever arm.

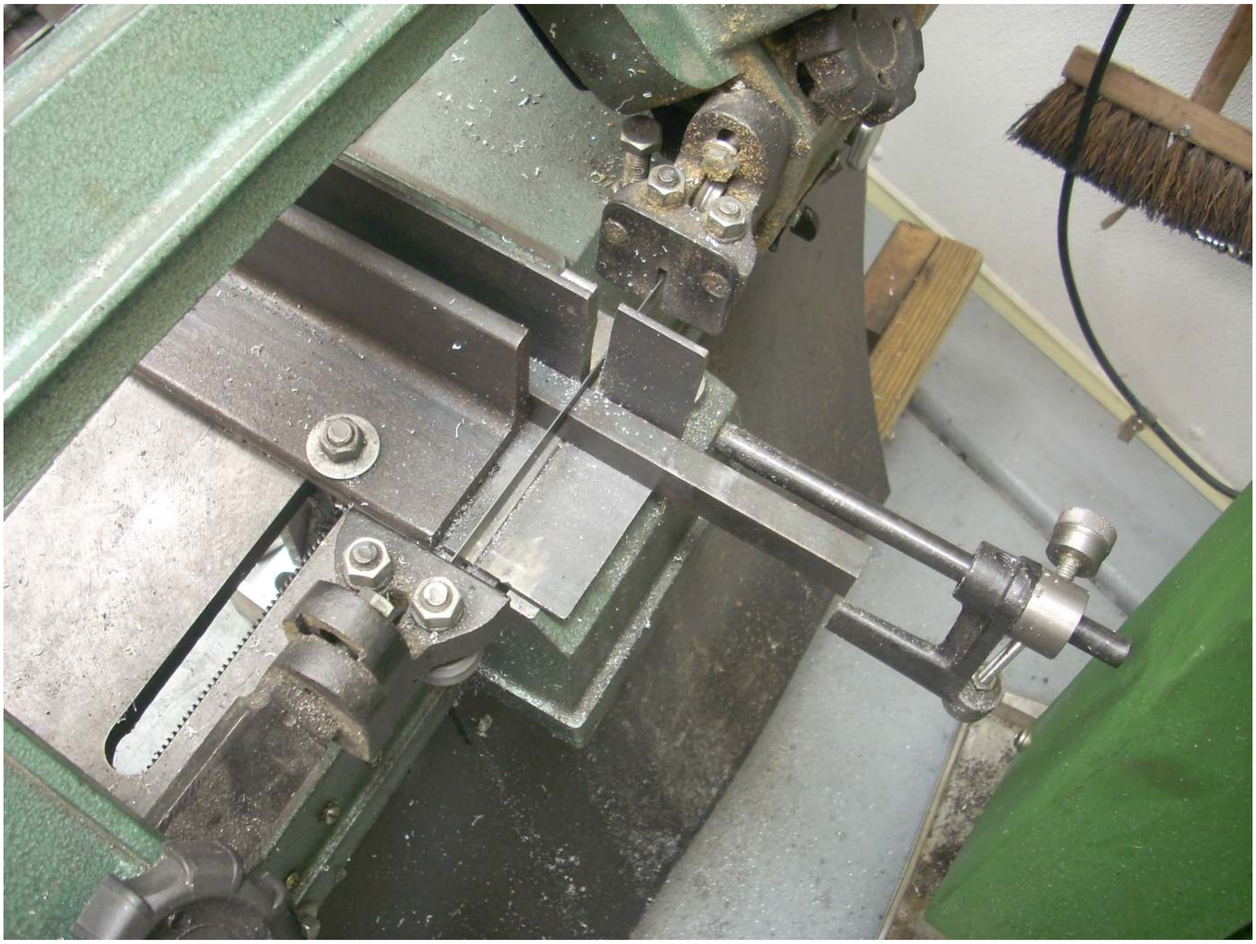
Vertical Linkage
Material: CRS



Shop Work



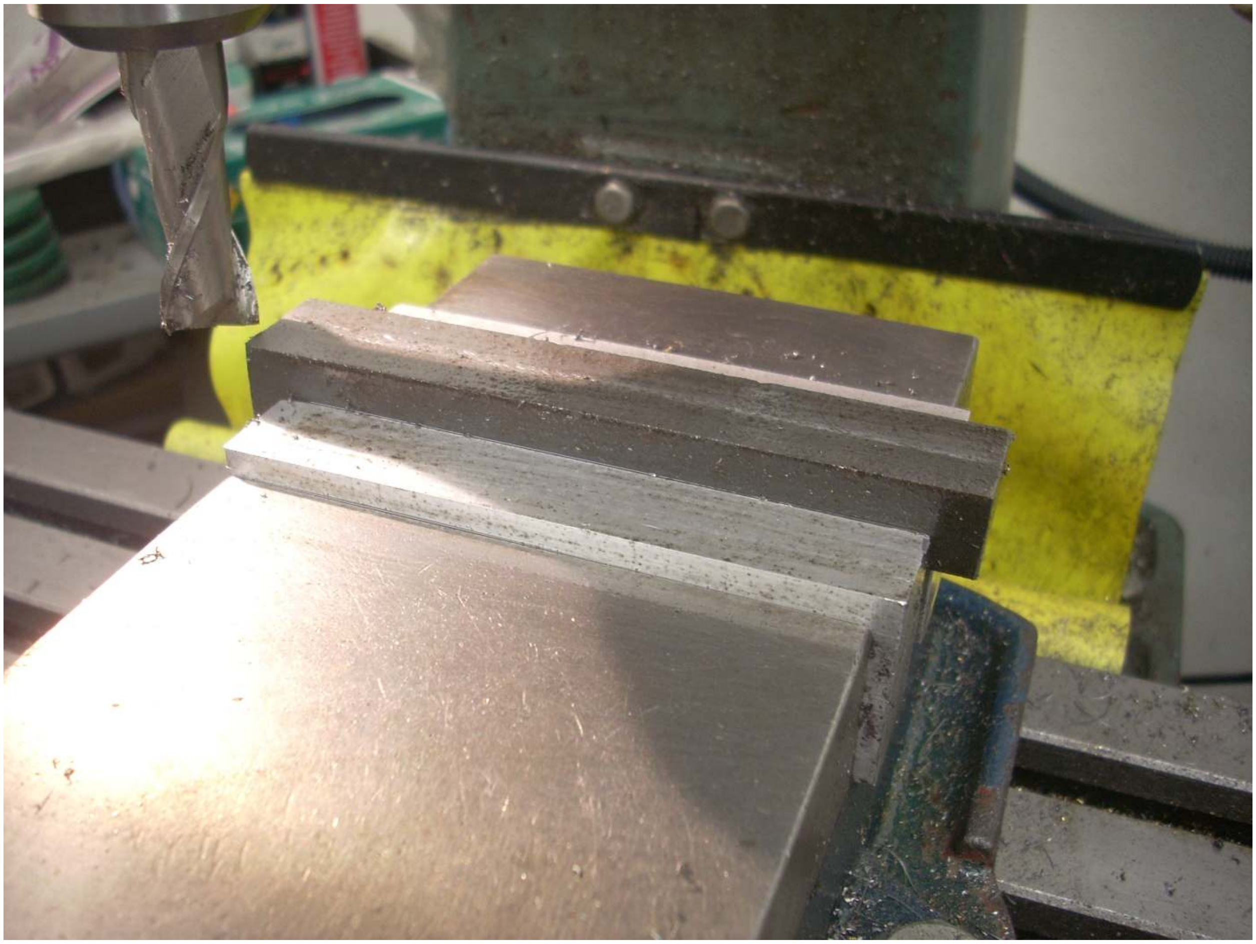
I started by sawing the bar stock for the horizontal arms. For the first bar, I measured from the blade to the end of the bar. Then I set my stop which can be seen on the right.



Before I started to saw, the stop was swung away from the bar. This prevents binding as the blade cuts through and the bar tends to tilt.

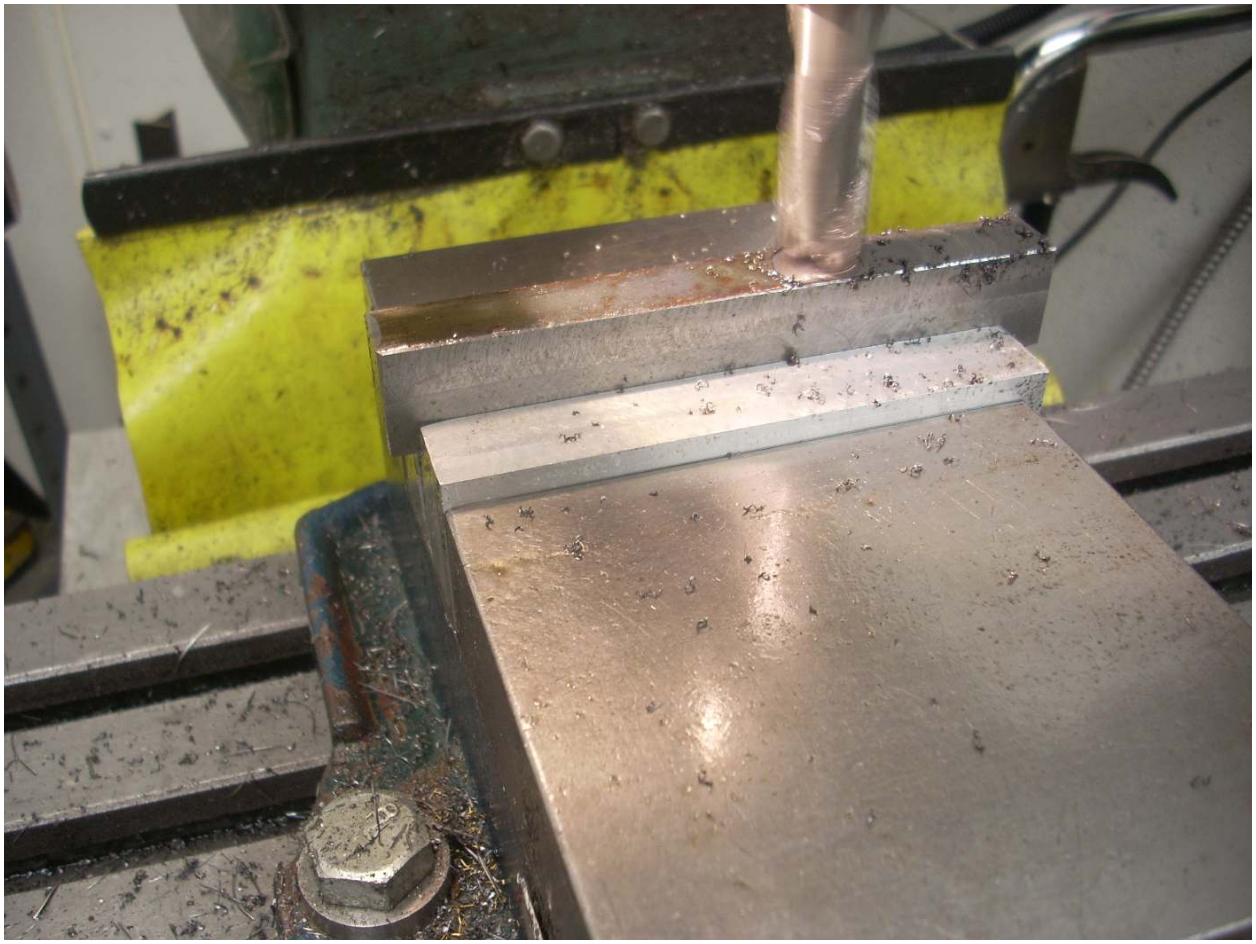
It is off to the mill to square up the ends and cut the bars to the correct overall length.

I have a Digital Read-Out (DRO) which makes this job easy. After cutting the right end, I set zero. Then I move to the other end of the bar and first rough cut to about 0.01” over. My finish cut was at 4.700”. It is not that this dimension is critical for the operation of the tool but rather than it lets me fixture the two arms easily.

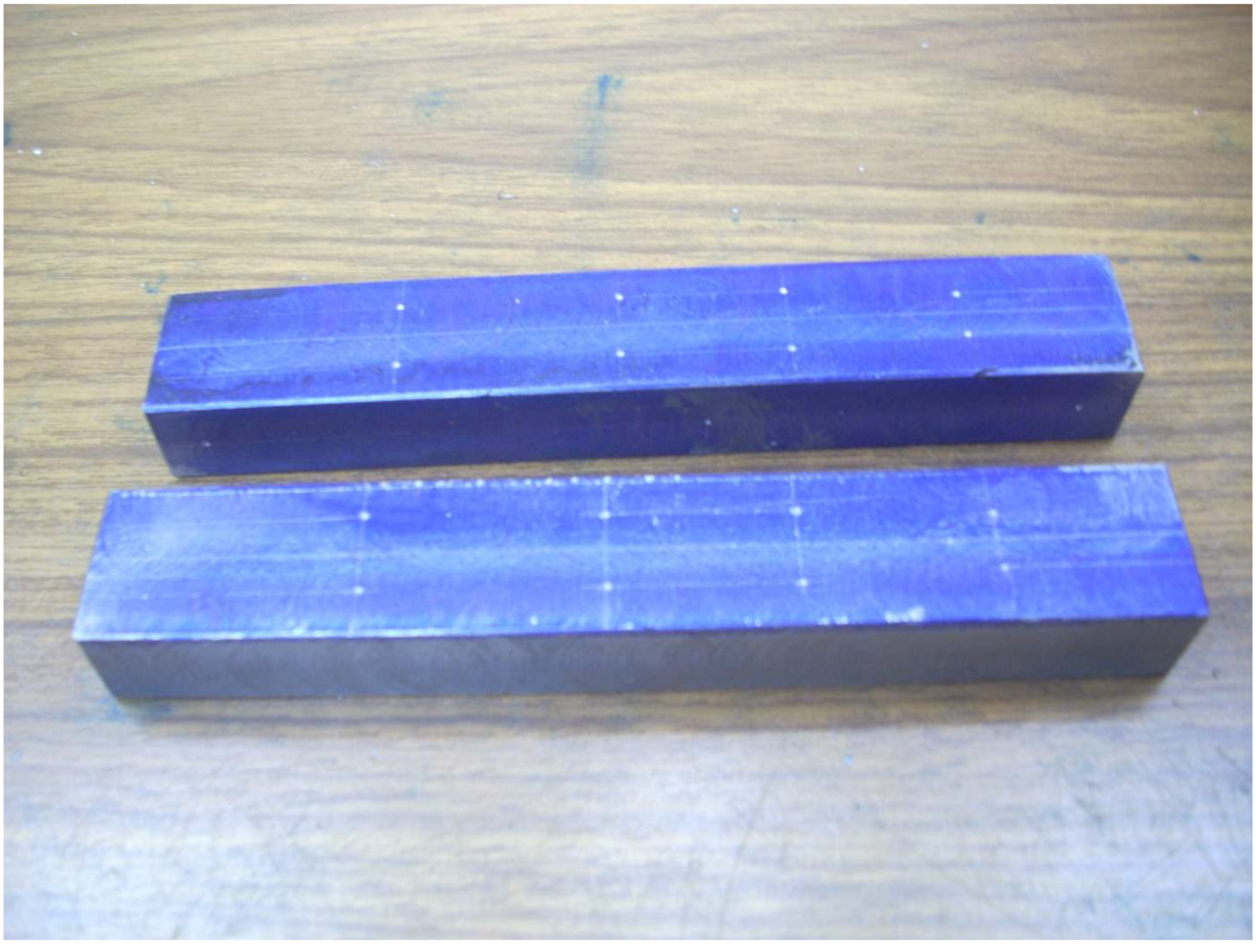


I next faced the top of the bar to insure it is perpendicular to the ends. This bar stock was found on the side of the road and was rather beat up. Some dings were too deep to mill out without sacrificing too much metal.

The edges were beveled on my belt sander to remove all burrs.

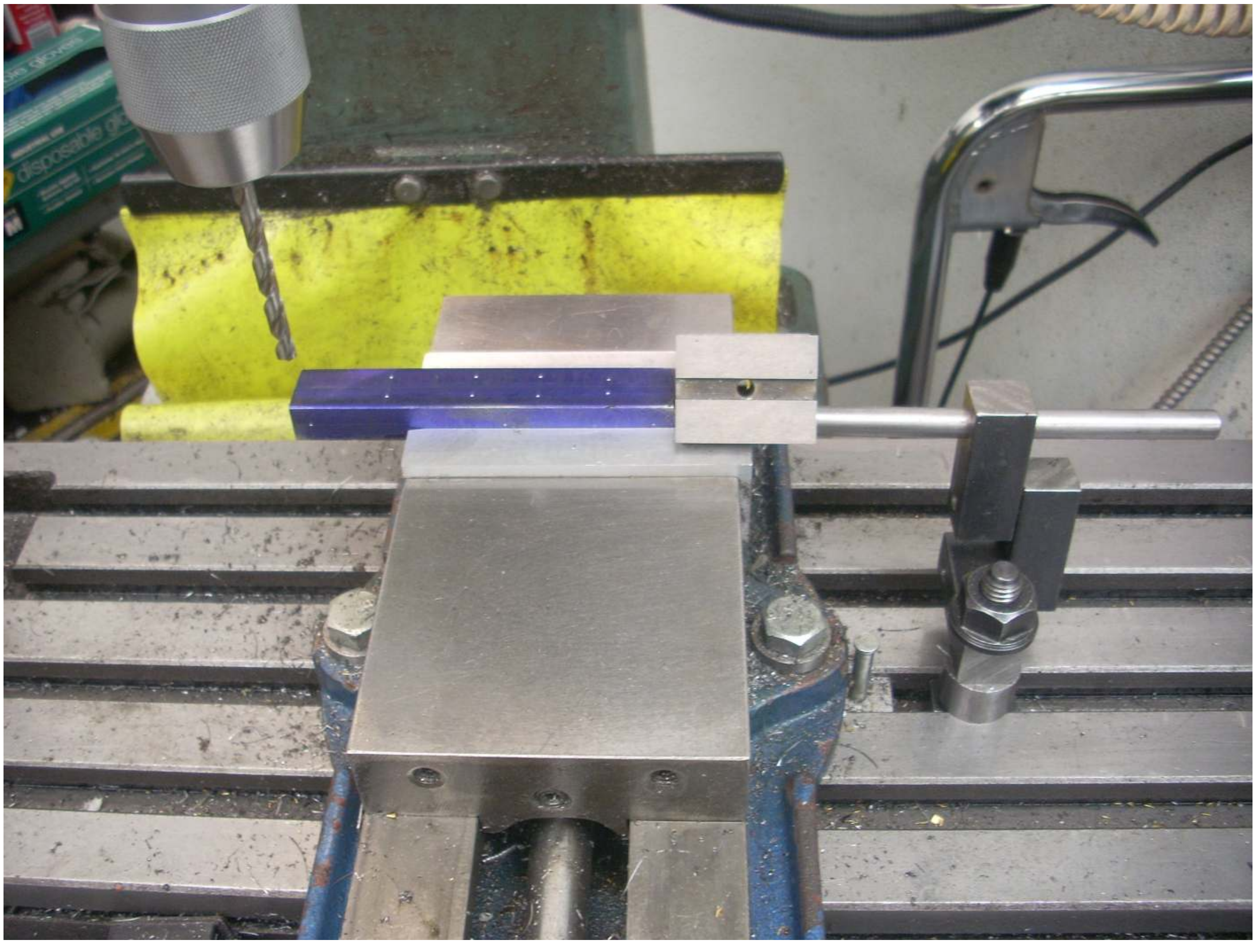


I then milled the first edge. You may be able to see that the part is in my softjaws. I did this for convenience, not accuracy. With softjaws there is no fumbling with parallels.

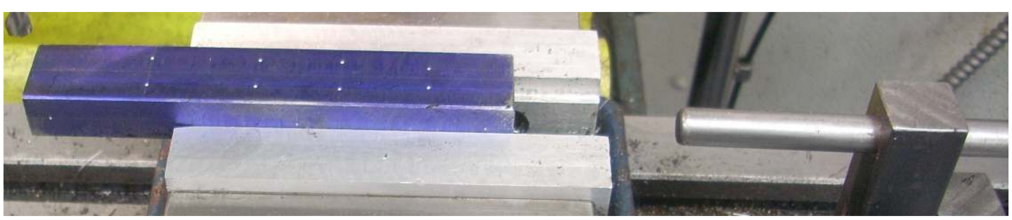


With the bars squared up, I coated them with layout fluid. Then I scribed the features to mill. At each intersection I made a shallow punch mark. The scribe lines will be hard to see but the punches will still be visible.

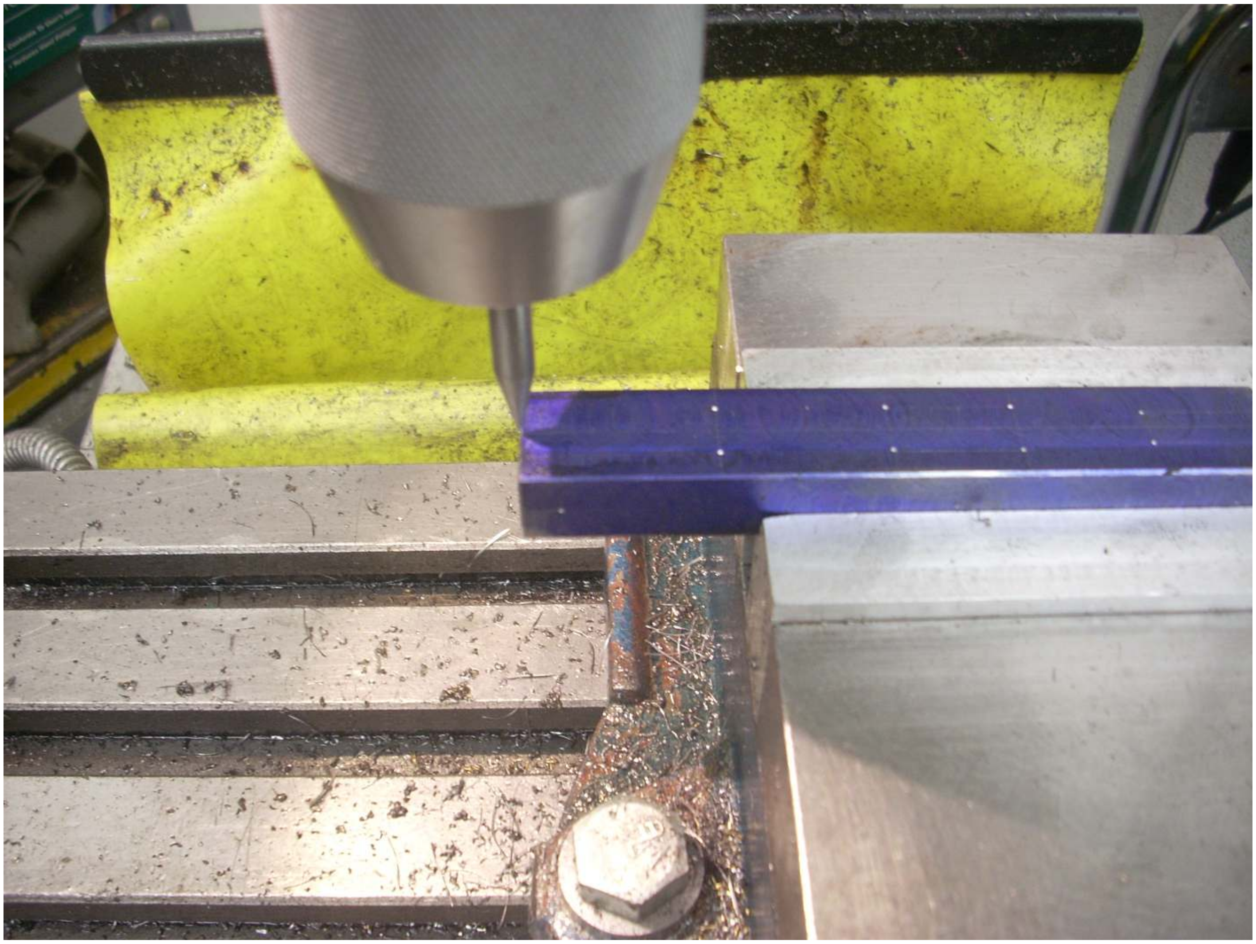
These layout lines keep me from making precise and large errors. I've been known to make a cut that is exactly 0.1" off. A quick glance at my layout lines before milling tends to reduce the number of such errors.



When making more than one of something, it is usually worth the time to set up a few machining stops. In this case I want to set the right end of the bar at a specific point. The challenge is that I will be milling a slot in this end and don't want to hit my stop. So I use a V block between bar and stop to set the position.

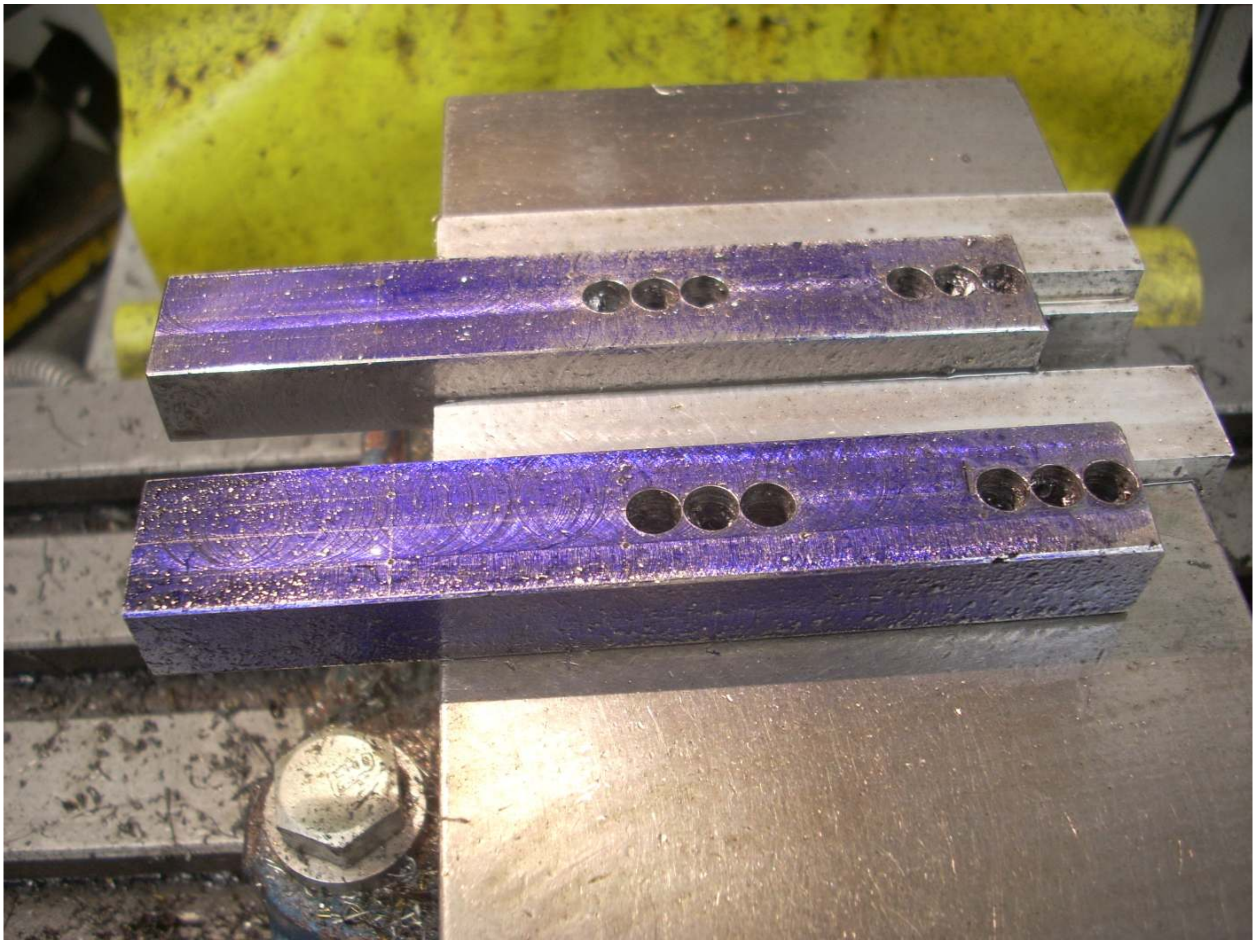


Before machining starts, I remove the V block.



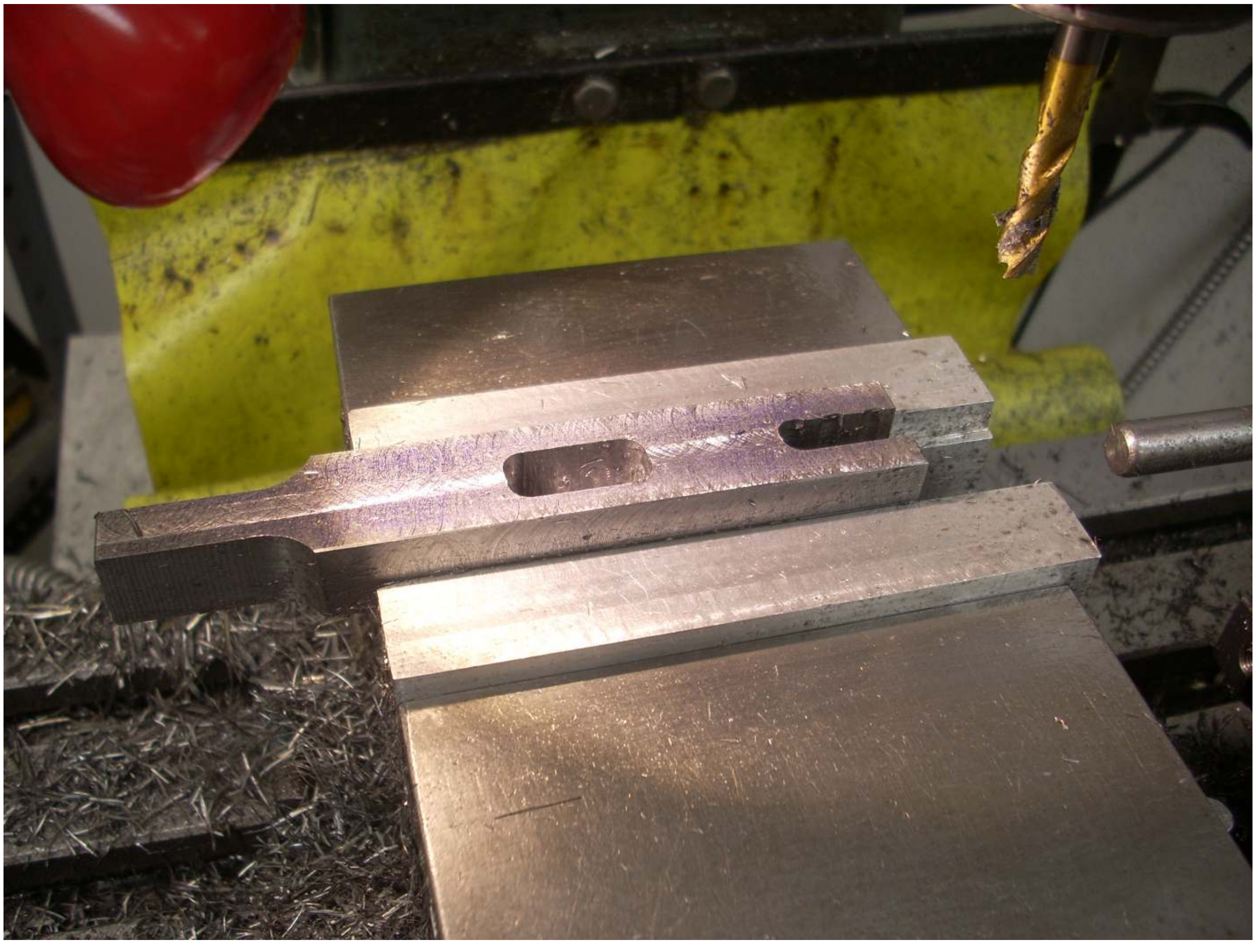
I’m using a “spud” to locate the end of the bar because I was lazy. It all came out OK but would have gotten nicer looking results if I had used my Electronic Edge Finder that zeros my DRO.

With the spud, my X = 0 point was off maybe 0.005”. However, all features relative to this reference point were accurate to the limits of my DRO.



Here I have chain drilled the end and center slots. You will notice that I redesigned the arm slightly to make this task more efficient. I also made the center clot wider to give more room for the knurling wheels.

It is not obvious here, but my eye ball alignment with the spud was off about 0.01” on the Y axis. Not pretty but did not affect functionality.

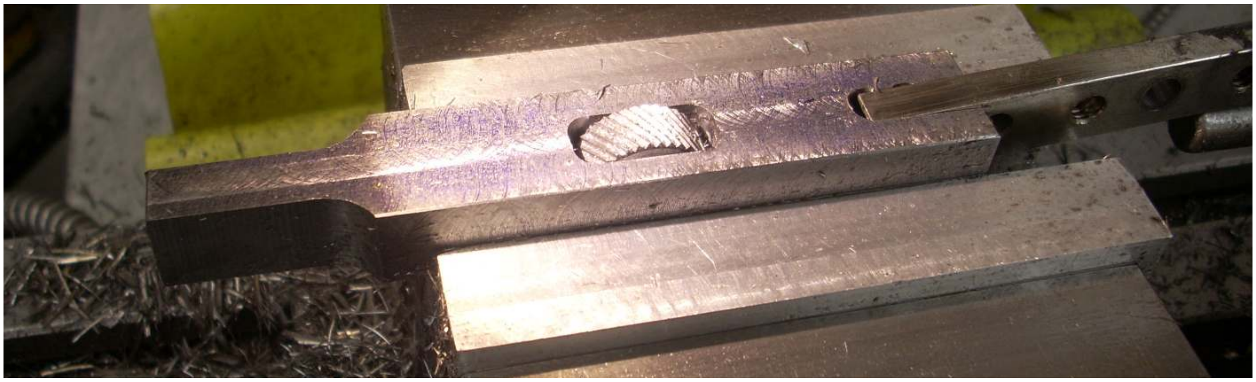


I just finished milling the end and center slots plus end tongue.

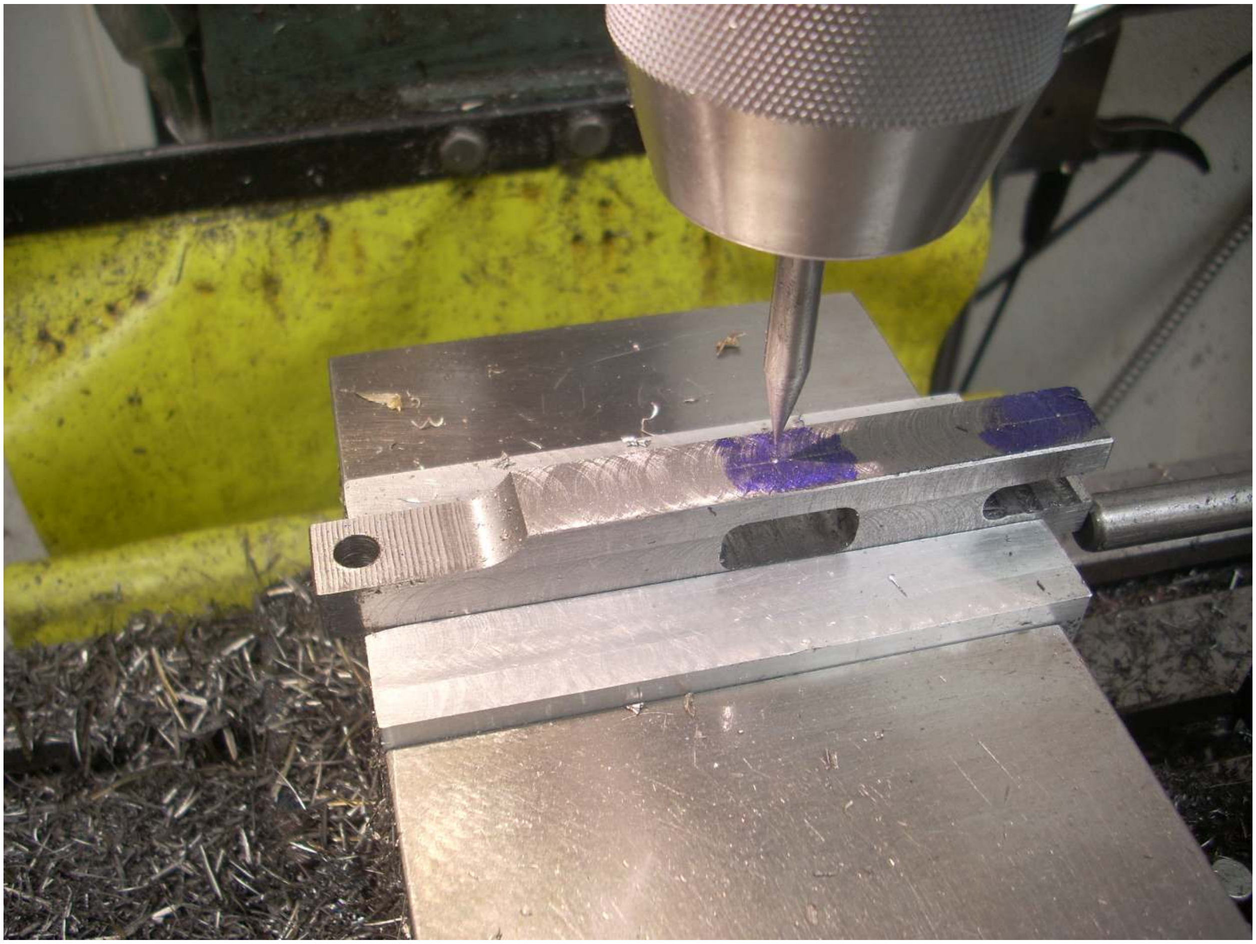
My first machining operation was to use my 5/8" end mill to cut the tongue. The roughing cut was at full depth and 0.01" from the finish line. It put a lot of force on my mill but came out fine, or so I thought. I then made my finish cut.

When hogging metal like this, it is important to up-mill. This means that the cutter is turning so the table feed is pushing against the cutting force. If you down-mill, the cutter will pull the table into itself and cause problems. The table can shift back and forth in the backlash of the leadscrew and the cutter can take a big enough bite to knock the head out of alignment.

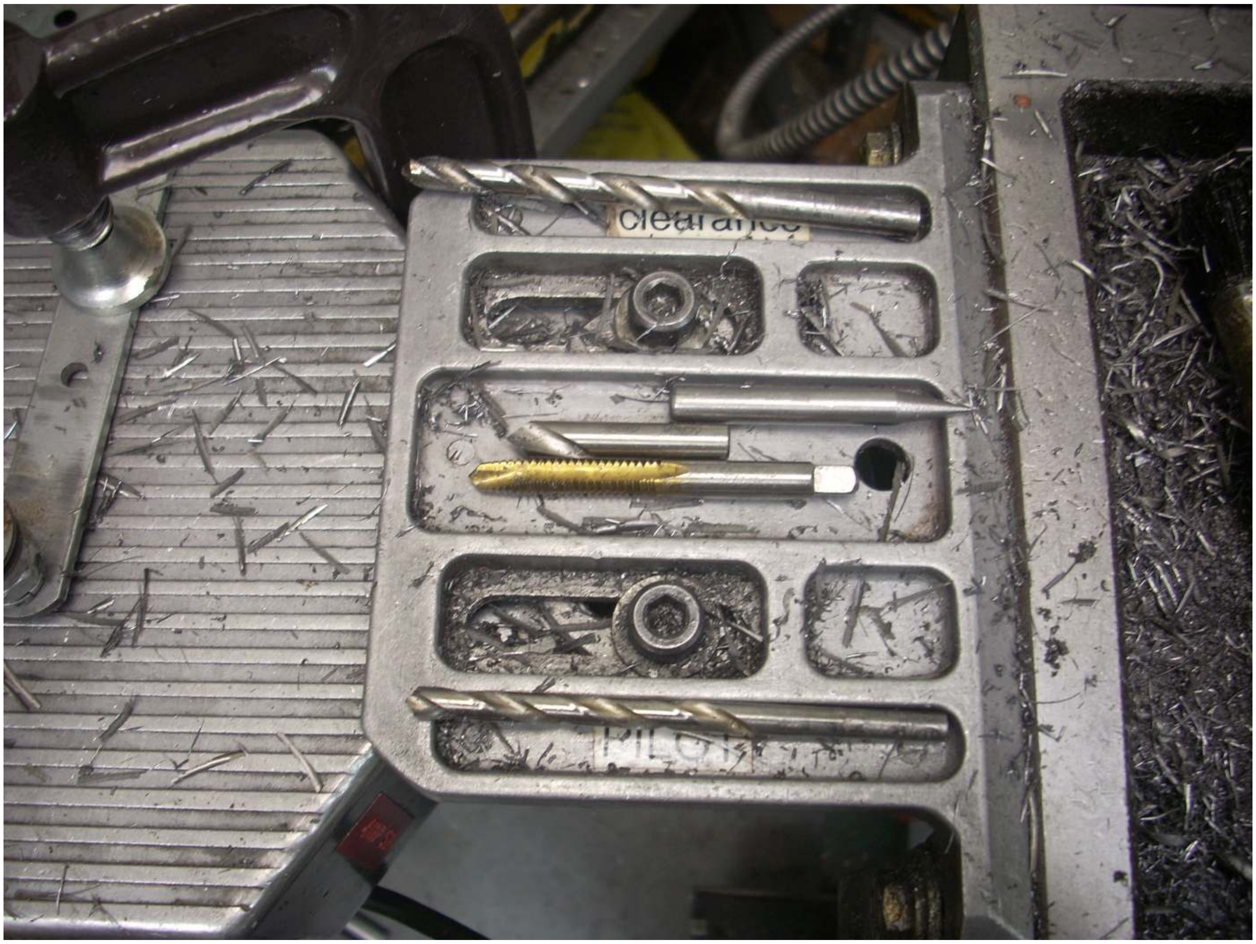
Now, that is not to say that up-milling doesn't also hold the risk of having the head go out of alignment. In fact, that is what happened here. The head rotated on my round column just a tiny bit. I didn't notice until I finished milling the end slot. Look close and you will see that on the far wall are round cut outs from my chain drilling. The head moved about 0.008". It is functional but, again, not pretty.



Before I removed the bar from the vise, I trial fit the knurling wheel, and a ¼" bar. I also trial fit my QCTP tool holder. Now is the time to make those small adjustments.

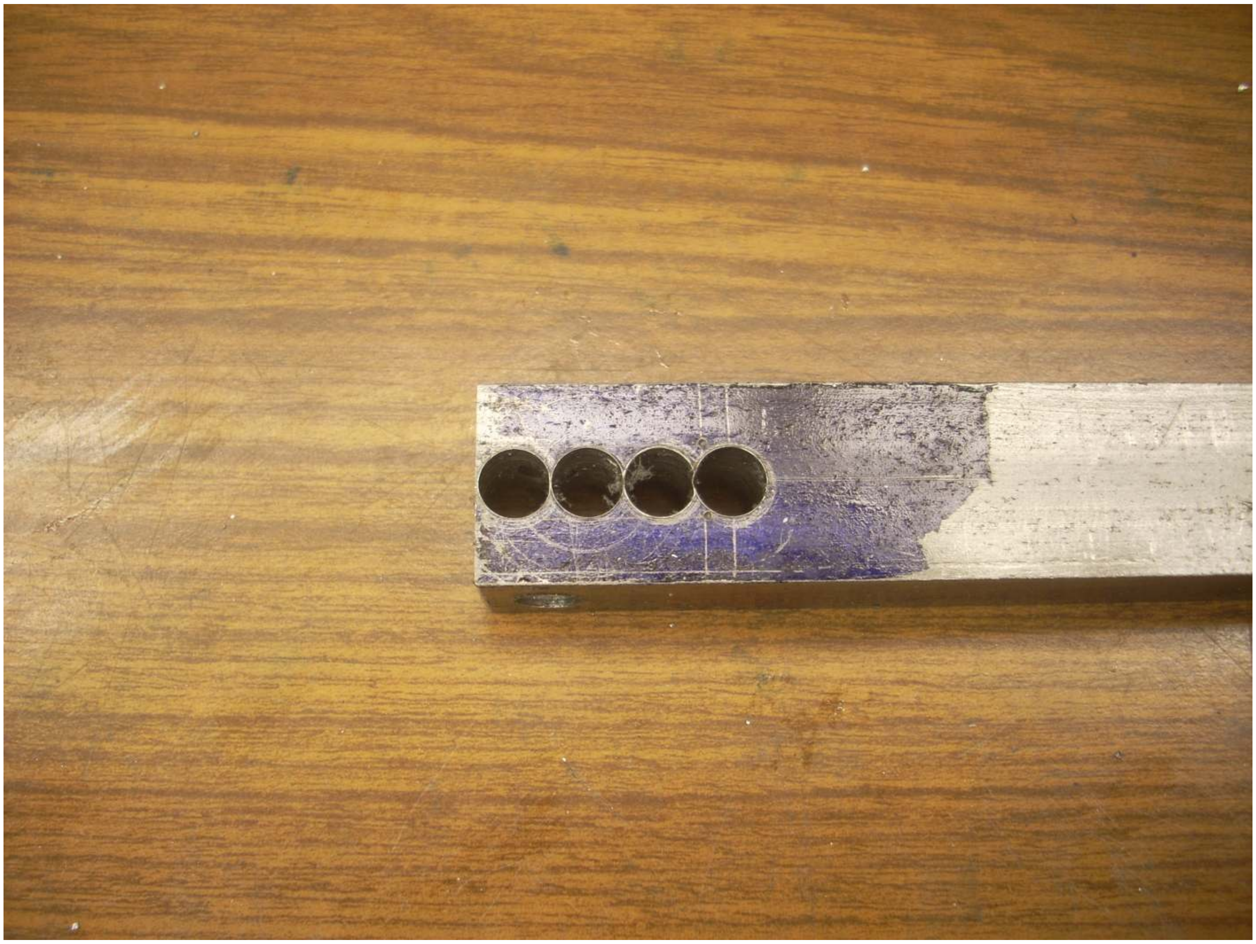


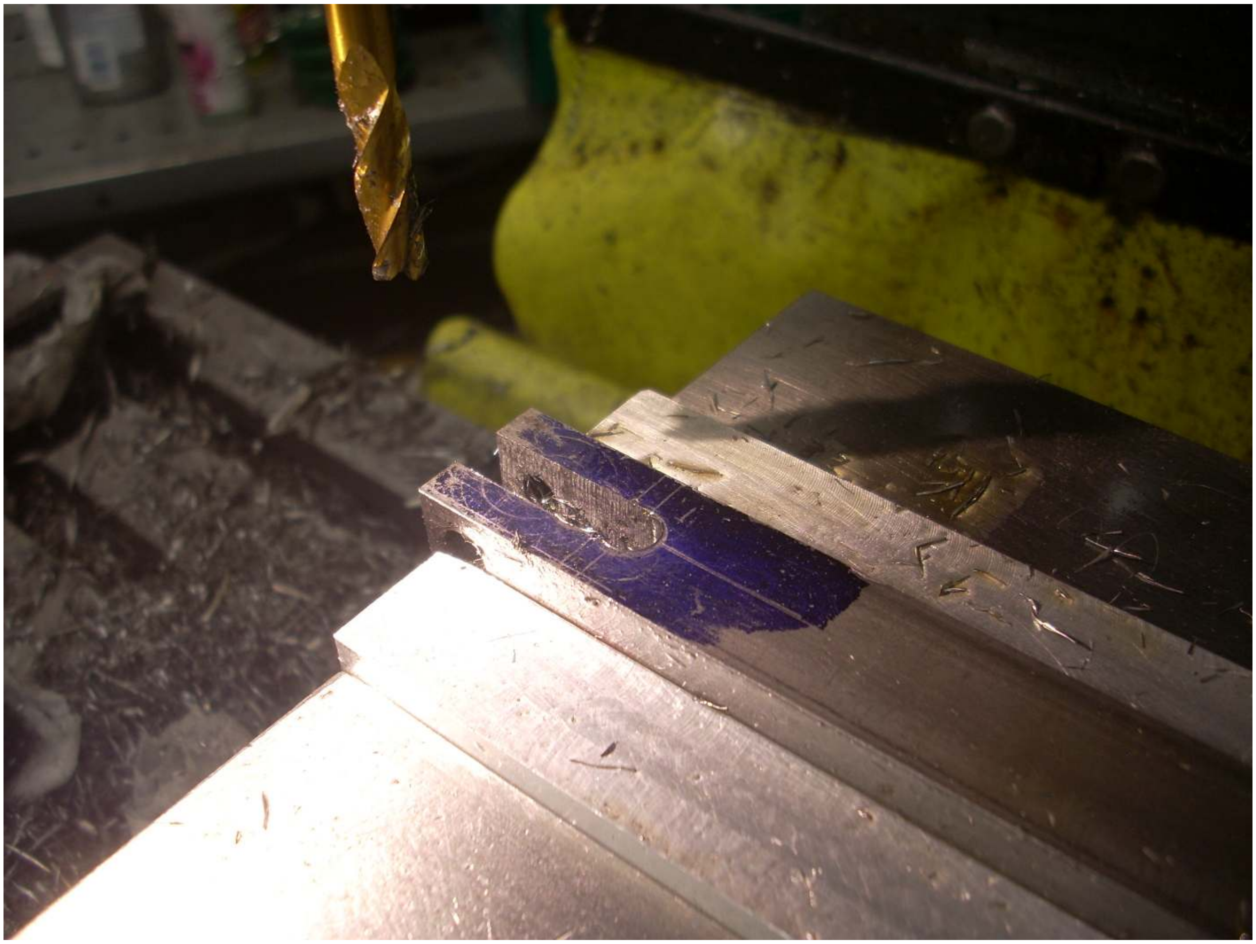
I am drill and tapping my side holes. The hole in the tongue is ¼” to match the exiting knurl axle. The center slot and end slot holes are first drilled through with a #7 drill in preparation for tapping. I then drill through the top part with an F drill. The final step is to run the tap through.



When I'm concentrating on machining, I tend to make some really dumb mistakes. One method I use to keep me out of trouble is to use the built in shelf that supports my mill table power feed. Note that the labels in the near and far pockets. I put my pilot drill and clearance drills in their correct pockets. The center pocket holds the rest of my tools. This has saved me many times.

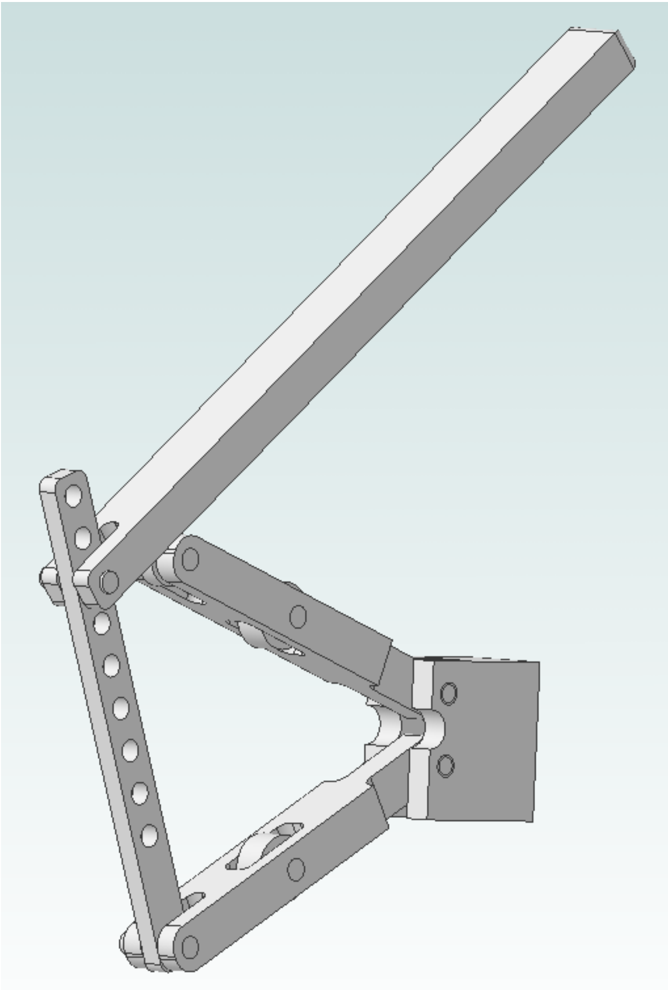
My next task was machining the lever arm. After my bad experience with the horizontal arms, I decided not to be so lazy. I'm using my EEF to set the X and Y zero points. Note, from the shop drawings, that my Y zero point is at the center line of the bar. This makes machining the slots much easier when using a DRO.


Here you see the chain drilled slot using the design shown in the shop drawings.



The ¼” end mill was first run down the centerline as a rough cut. Chain drilling had removed most of the metal so this was a nice, quiet operation with little vibration. I offset the cutter to +0.130” and ran in to the full length of the slot. Then I offset the cutter to -0.130” and came back out. All went well this time.

Final Assembly

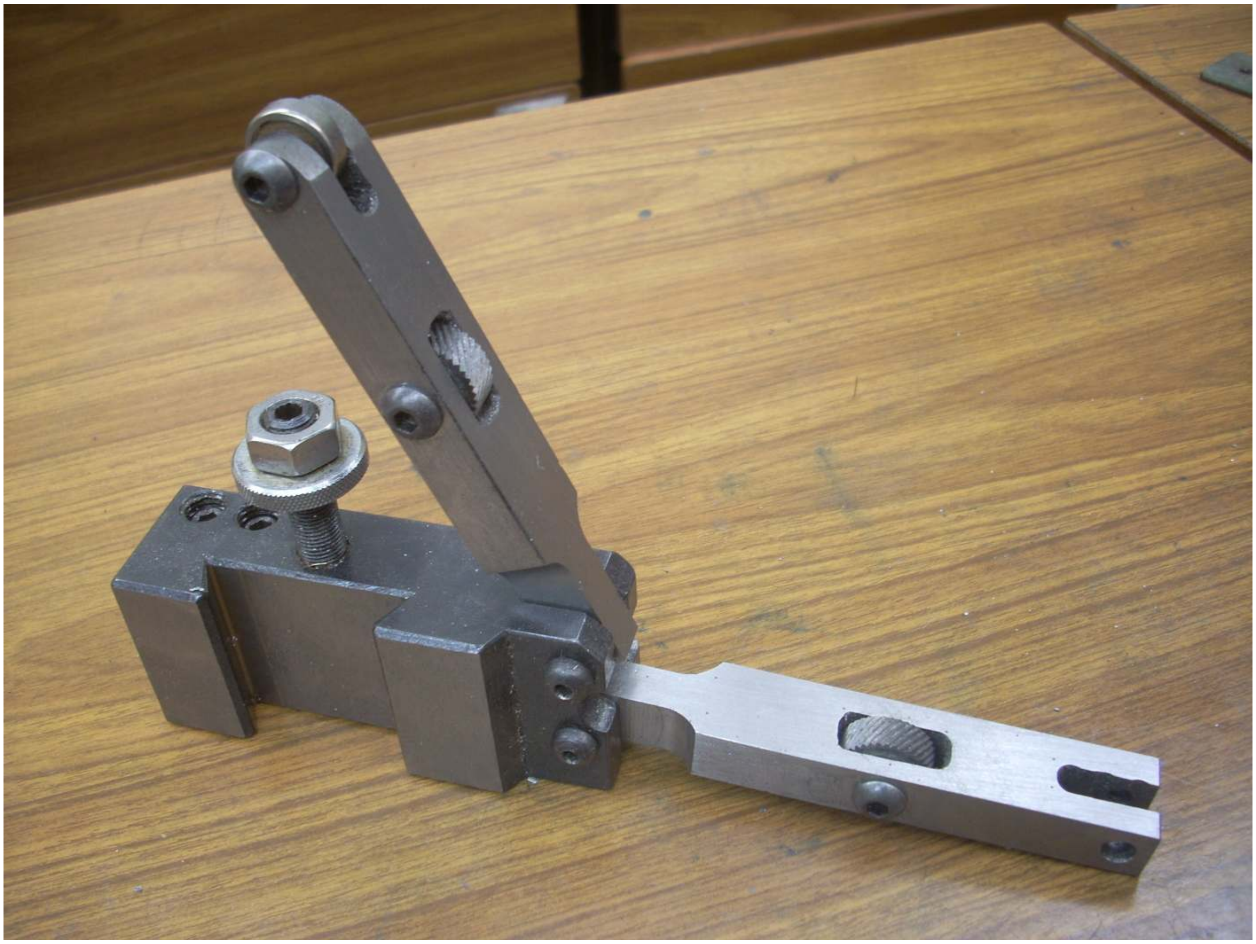


The QCTP knurling tool is taken apart. Use the knurling axles to lock the arms into the location previously occupied by the knurls.

Install the knurls in the arm slots. Use ¼-20 screws as axles. You will notice wear on the threads due to the pressure of knurling. If this becomes a concern, make new axles from ¼" round stock that is threaded on one end. Slot the other end to fit a small flat blade screw driver.

The lower arm joins with the vertical bar using a ¼-20 screw.

The upper arm joins the vertical bar with a ¼-20 screw with a head that is easy to turn with the fingers. This is the adjustment point. Excess vertical bar length comes out the top of the tool to avoid it hitting the lathe's apron.



The rounded end horizontal arm goes on top.

I am using a ball bearing that is about 5/8” in diameter and about 0.2” wide at the end of the top horizontal arm. It engages with the shallow slot in the lever arm to minimize rolling friction plus provide some stability.

You can see the shallow slot here.

My vertical bar was made from 0.2” thick aluminum rather than ¼” CRS because that is what I had on hand. Also note that the wrong end of the vertical bar is attached to the lever arm. I later flipped it around.

This knurling tool can handle round stock up to about 2.5” in diameter.

It works well for knurling one area of the work piece. But when I try to move the apron, the QCTP tends to rotate from the side force. More study will be done to solve this minor problem. I might have to add a support bar or find a procedure to minimize this rotational force.

Here are three samples of the knurl I can form. The sample on the far right was at a diameter slightly larger than what Machinery’s Handbook suggests. The middle sample was slightly smaller than what they suggest. And the sample on the far left is at a diameter that is as far from what they suggest as possible. All three look the same to me. Ah, but that is another article[3].

[3] See http://rick.sparber.org/knu.pdf

Acknowledgements

The outpouring of help on this adventure has been amazing. I need to thank "doc" from metal_shapers for many bits of essential wisdom. Neil and Gene from valleymetal provided facts that have been of great help in seeing what is important. JR Williams, Gordon Long, Alan Lapp, and Ian Newman of metal_shapers have provided many practical tips which I will use in subsequent versions of this article. Steve from metal_shapers provided a few links to huge bodies of information on knurling. I'm still working through it. Thanks to L. Garlinghouse of atlas_craftsman for his advice on lubrication.

I must also acknowledge the authors of Machinery's Handbook for a well written section on knurling.

These generous people again demonstrate that "all of us are smarter than any one of us".

I welcome your comments and questions.

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