Machining and Assembling the Down Feed

by R.G. Sparber

08/11/2008

Here we have the down feed almost done. The round bar sticking up, the disk, and the rectangular part with the slot in it make up the slide and was described in an earlier article. In this article I will describe the machining of the L shaped casting, fitting of the slide clamps, and fitting of the previously turned drive screw.

Here is the rough casting after the gates and flash have been removed with a bandsaw and disk sander. This is one of my last castings with my old Petrobond. It looks rather sad but a bit of machining will remove most of the defects.

One thing that machining will not improve is the space between the two raised blocks. By the time I had this space nice and clean, it was about 1/8” wider than expected. “Lemons into Lemon aid” - I just added a second strip of brass as you will see.

The first step is to identify my reference surface. This part is nice in that these surfaces are easy to reach. Once these surfaces have been cut flat, they will provide alignment for all other cuts. If I had needed a third reference surface, it would be the outside vertical surface on the left side of the casting.

A word about swarf and accuracy. You will see in the following pictures lots of swarf laying around. If any of this gets between a reference surface and a support or knee, the casting will be cut with an error equal to the diameter of the largest piece of swarf that is in the way.

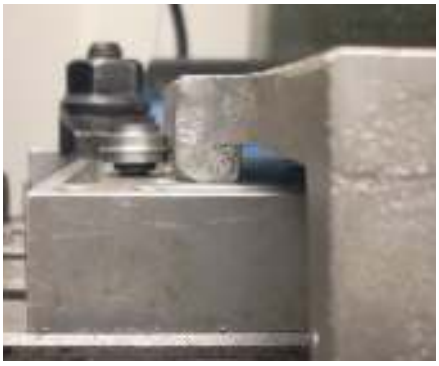
To avoid this problem, I spray WD-40 on all surfaces about to be in contact and then wipe them off with a few sheets of toilet paper[1]. A close inspection with a bright light is performed to verify all is clean. Without this attention to cleanliness, no amount of precision figuring is going to give decent results.

1 WD-40 is flammable and the toilet paper can easily burn. After wiping down surfaces, the paper goes into my OSHA approved fireproof can with lid. It is emptied just before the garbage goes out.

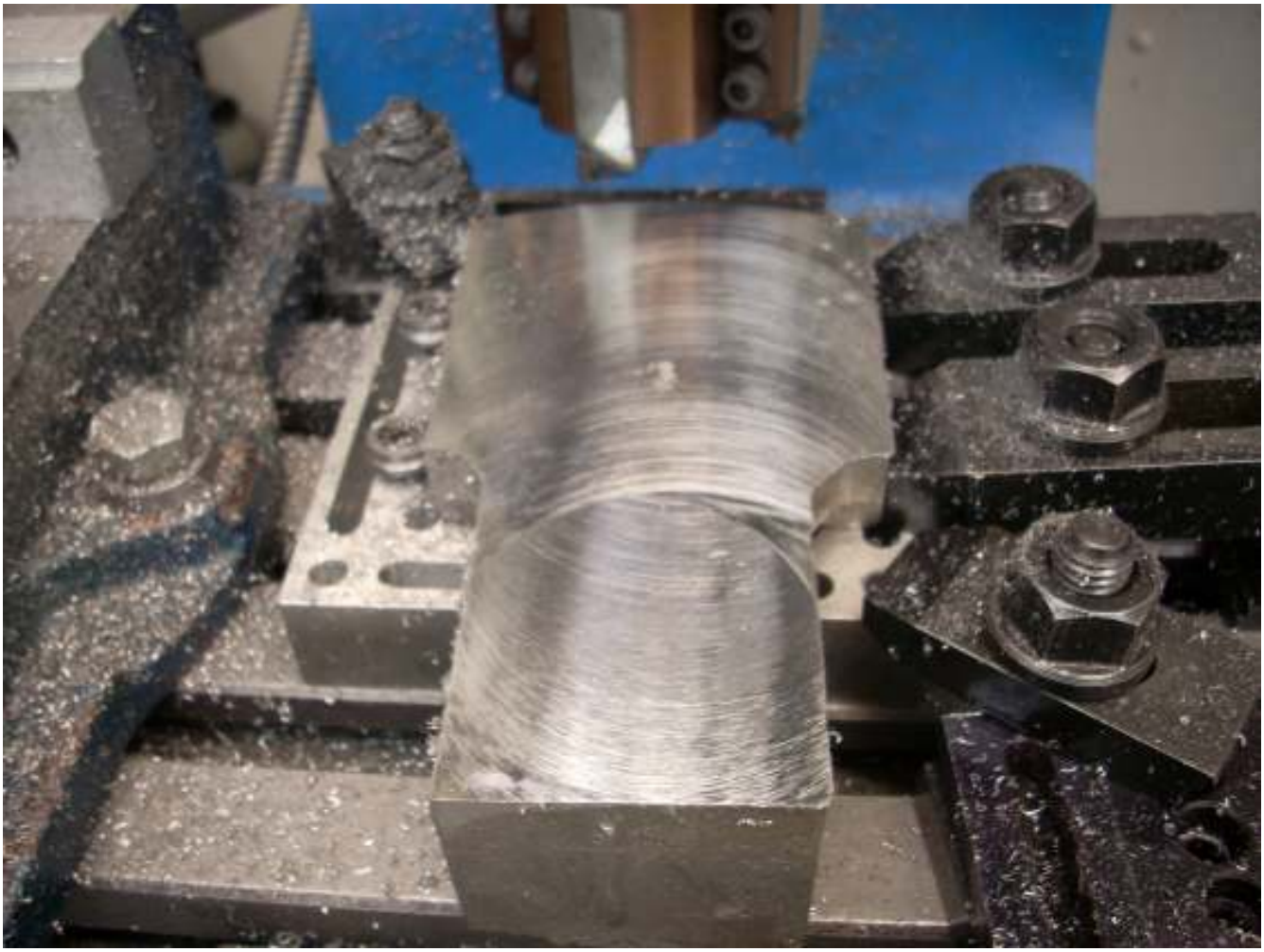
Before I can cut my “Reference 1”, I chose to roughly support the casting and cut “Reference 1 prime”, the tops of the two pads. They will give me a solid surface to support the casting as I cut Reference 1. Not visible here is the jack that is under the hold down clamp.

My mill table is true and I have placed a support plate down that is of uniform thickness. As long as Reference 1 prime is firmly against the support plate, Reference 1 will be parallel to it.

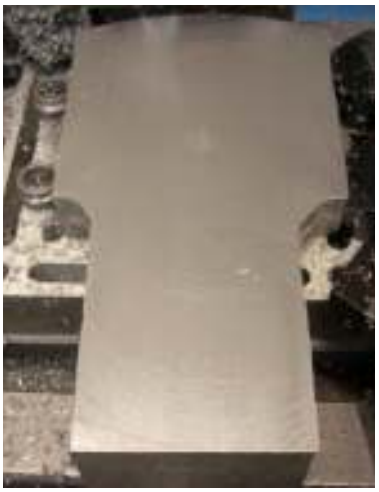
Note the two screws on the left side of the casting. They are eccentric hold down screws[2]. See the close up below. On the right side are two hold down clamps that are raised slightly as you will also see below. The eccentric screws are first turned so the narrow part is facing the casting. Then the casting is pressed against these screws. Next the two hold down clamps are pressed against the casting. A quarter turn on the screws and the casting is pushed towards the clamps and down onto the support plate.



2 See http://rick.sparber.org/Articles/tc.pdf



With all clamping done on the edges, it was easy to run my shell mill across the Reference 1 surface. This shell mill is the one that came “free” with my mill/drill and is almost 20 years old. Many people think it is a piece of junk but just this year I learned how to use it correctly. I run the tool at 2500 RPM[3]. The surface is flooded with WD-40. I know this finish looks terrible but it really is not so bad. You can see the effects of my mill head not being perfectly trammed. The back side of the cutter runs slightly deeper than the front. That is why you see an arc half way down the casting.



See what a few passes with a 3M pad do to the surface.

After machining Reference 1, I mic'd the height of Reference 2 with respect to Reference 1. Not good. My guess is that the hold down clamp side rose up about 0.005”. If this was a more critical dimension, I should have put eccentric clamps on both sides. That would have uniformly pulled the Reference 1 prime surface down to the support block. What is really important is that my Reference 1 surface is smooth and flat. Not to worry. I will be re-cutting the Reference 1 prime blocks soon enough.

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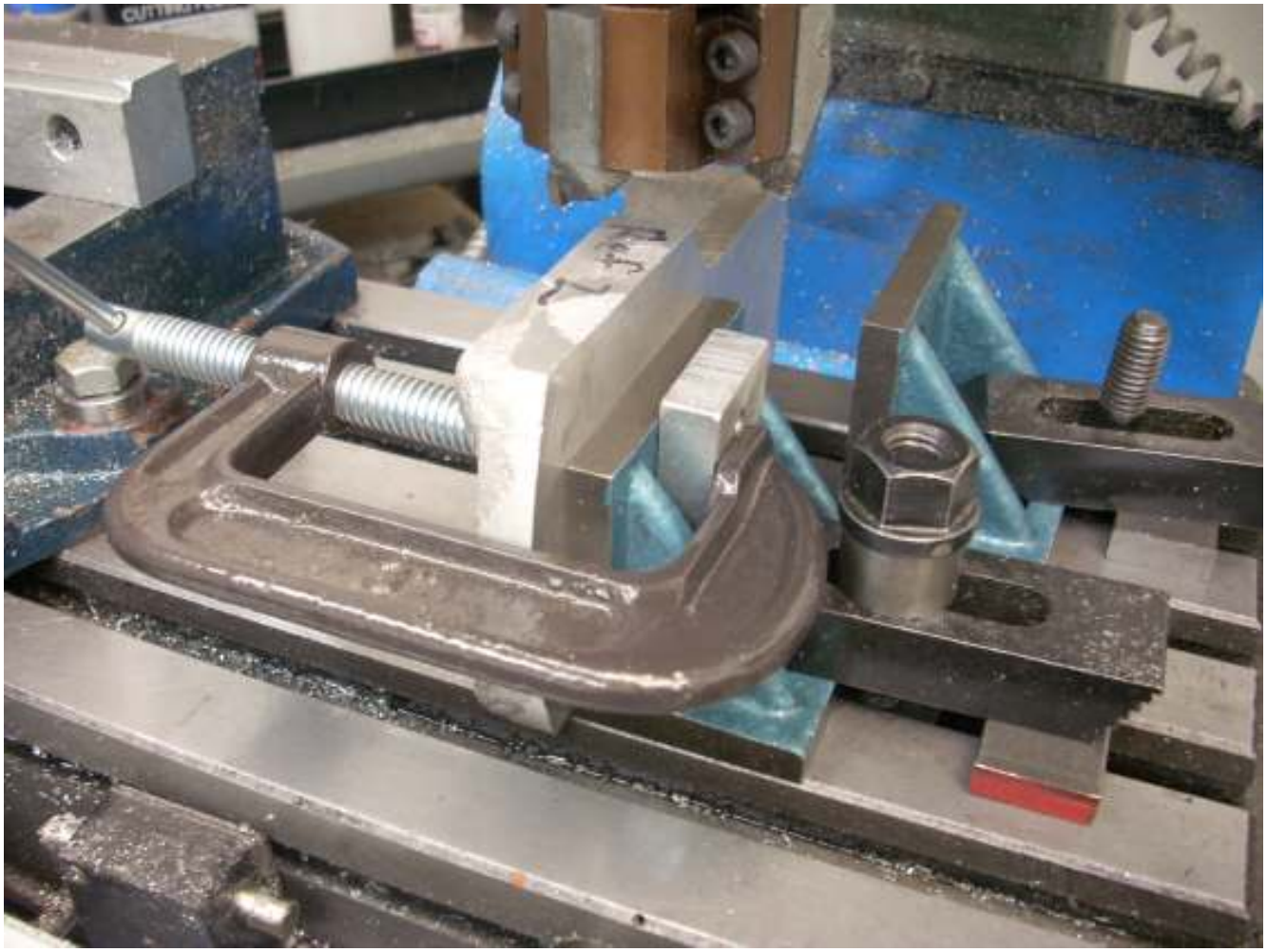
3 because that is my mill's highest speed

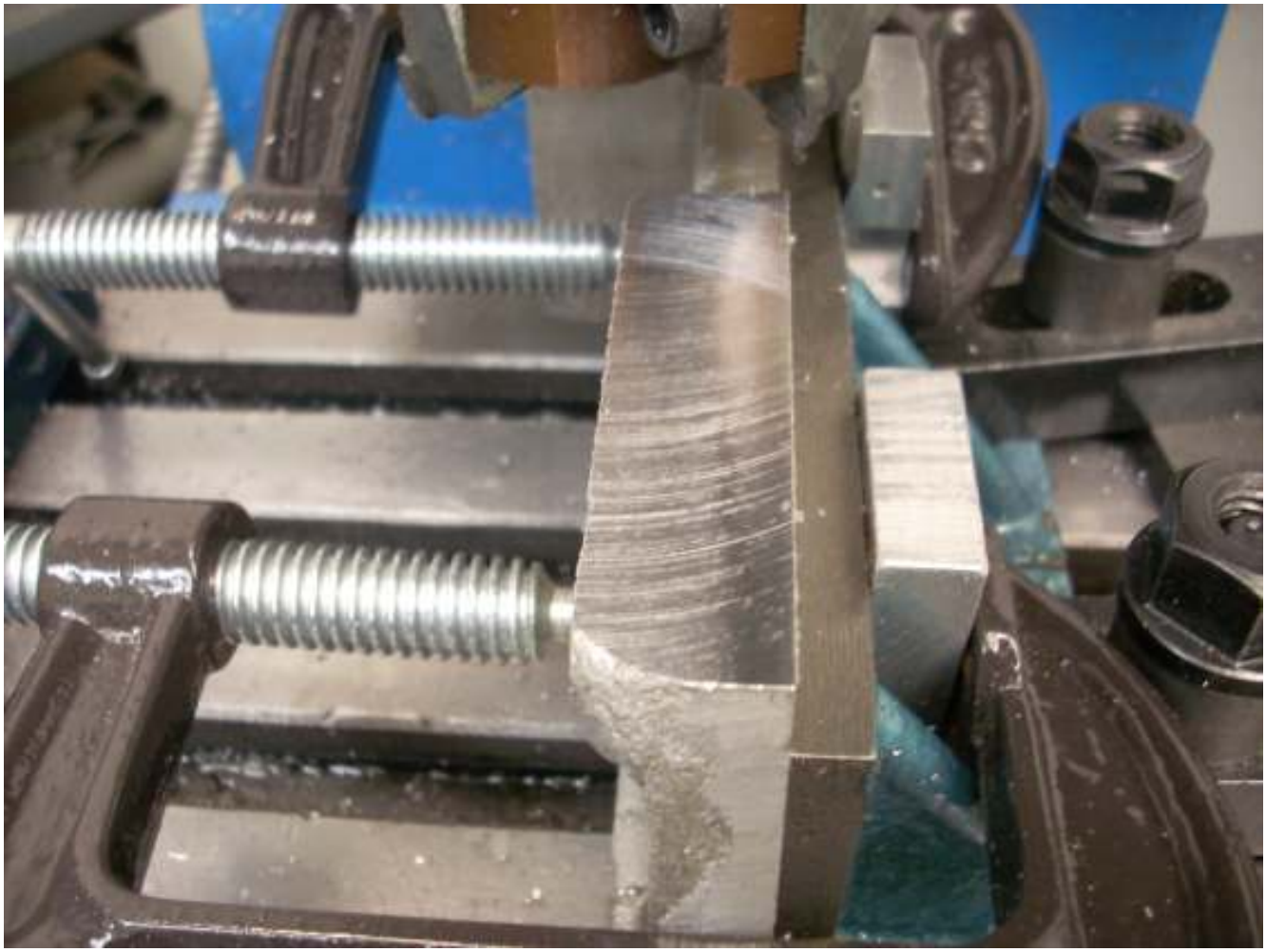


Reference 2 is now cut. A knee (angle plate) has been secured to the mill table. The casting is then set up by eye so Reference 2 is about parallel to the mill table and the C-clamp tightened.

Note the second knee in the background. It will be clamped to the casting's Reference 1 plane and to the mill table next. This sequence is important because I don't want to put stress on the casting by trying to bend it across two knees that are not perfectly aligned. The first knee plus casting define the proper location of the second knee. Only then is the second knee secured.

It is important to have two bolts holding the casting. A single bolt might permit rotation which would spoil the part and might even spoil my day if things started flying.

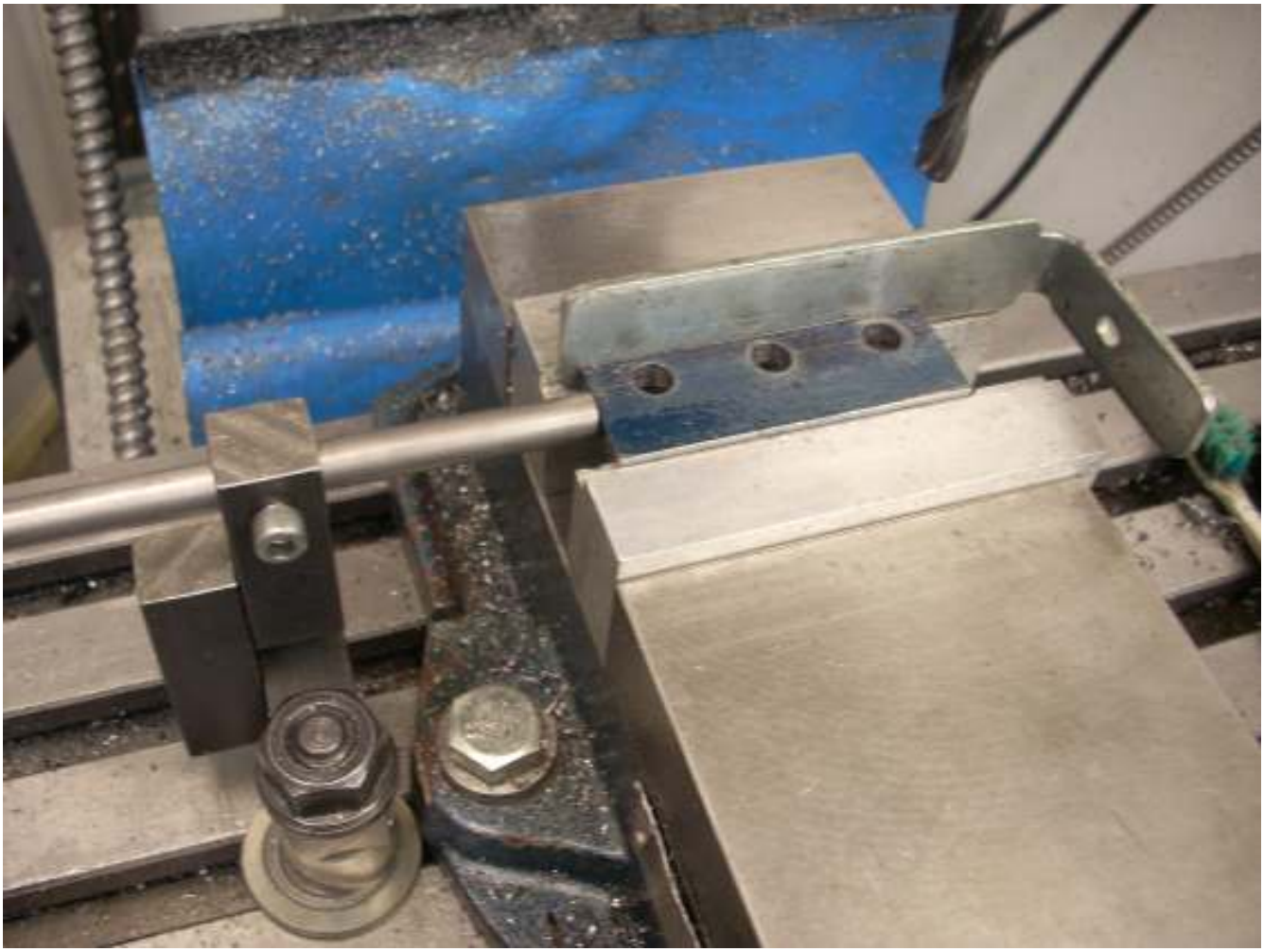
I'm now ready to shell mill Reference 2 which should be perpendicular to Reference 1.



Reference 2 has now been cut.

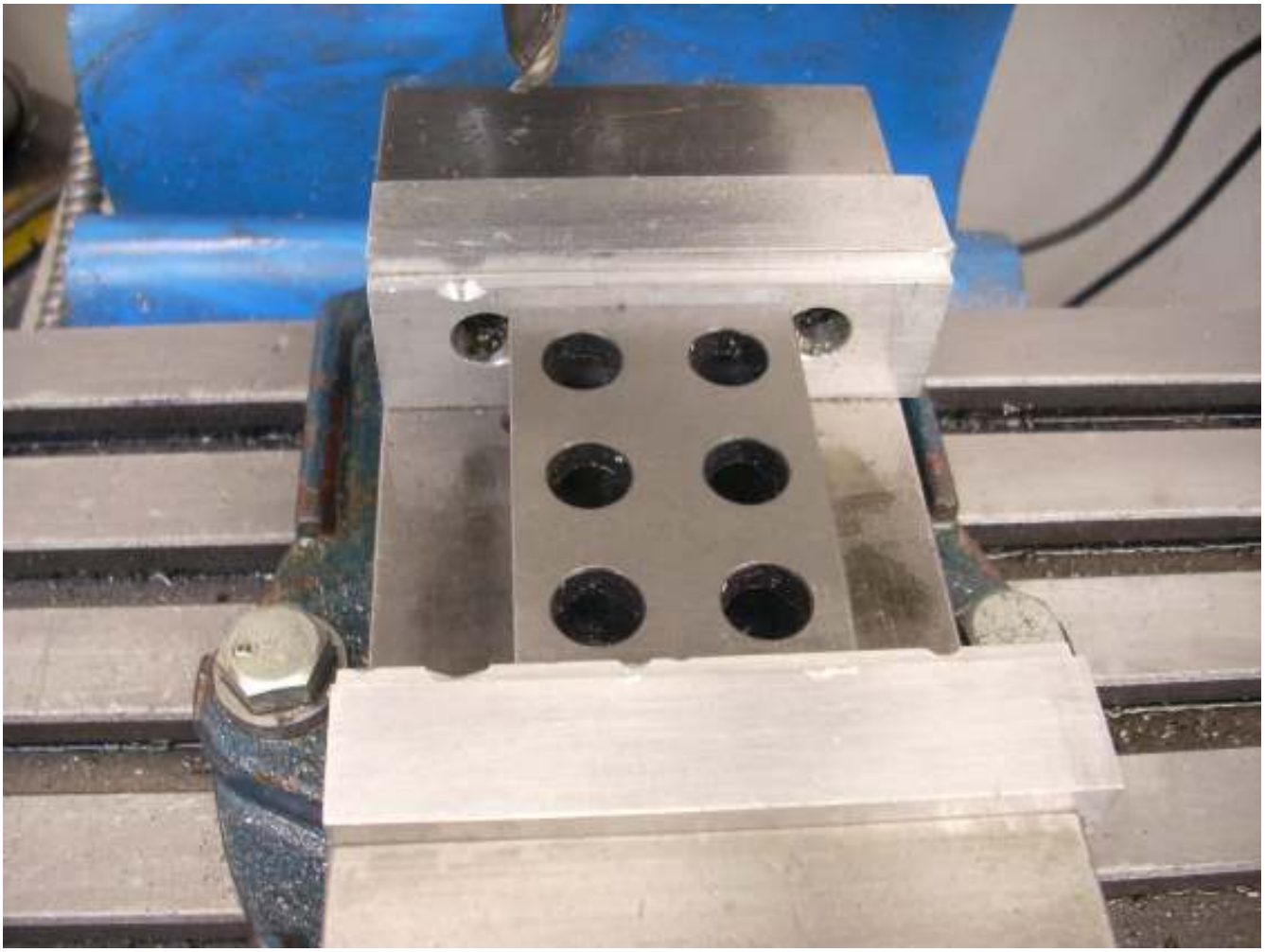
The casting is put aside as I make the hold down clamps. They will be needed during the time that the casting is set up for all top machining. I would not want to remove the casting, make the clamps, and then refit the casting. How did I catch this one? By writing out my procedures before I started.

I needed some 1/4” x 1” x 3” CRS but only had a slab of 1/4” x 3” CRS. After rough sawing off a strip 1.1” wide, I milled it to width. Well, almost. I was using my digital caliper to tell me how much more to remove in order to get to 1” but somehow set it to 0.746”. Not a big deal, but annoying that I ended up with high precision and no accuracy. Fortunately, this dimension is really not that critical. During final assembly I discovered that if I had cut the clamps 1” wide, they would have hit the slider. Talk about dumb luck!



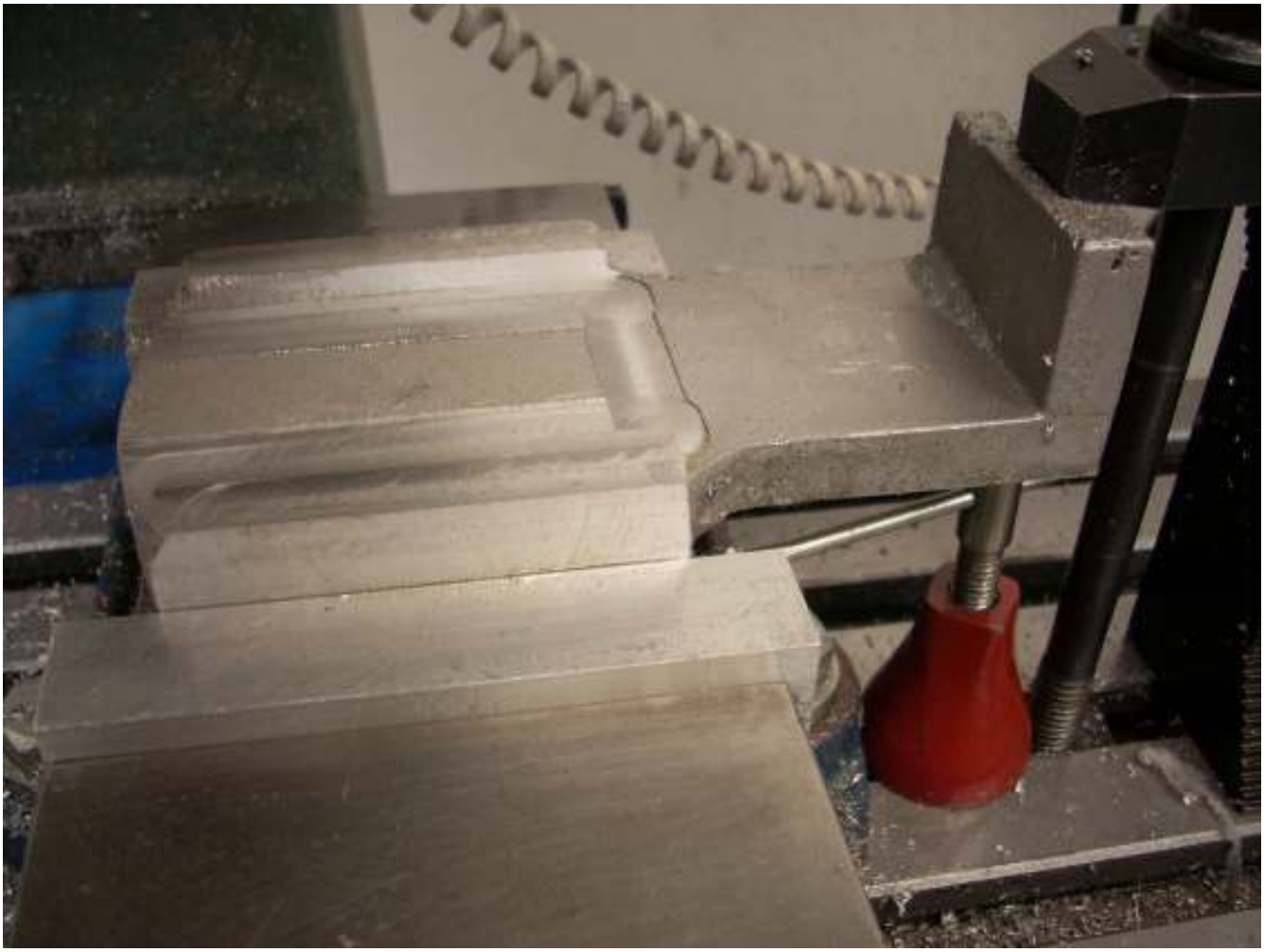
The first clamp has 3 holes drilled in it. They are clearance holes and I will use my clearance drill to cut a cone in the casting that will accept my pilot hole. By using the end stop, I was able to drill the second clamp without having to re-set up my reference. The backing behind the clamp prevents the fixed soft jaw from being hit by the drill.

I am using a Shumatech DRO but still scribe layout lines. Those lines help me avoid making *BIG* mistakes. The DRO helps me avoid making *tiny* mistakes. On more than one occasion I have placed a hole exactly 1.000" from where I wanted it by using just my DRO.

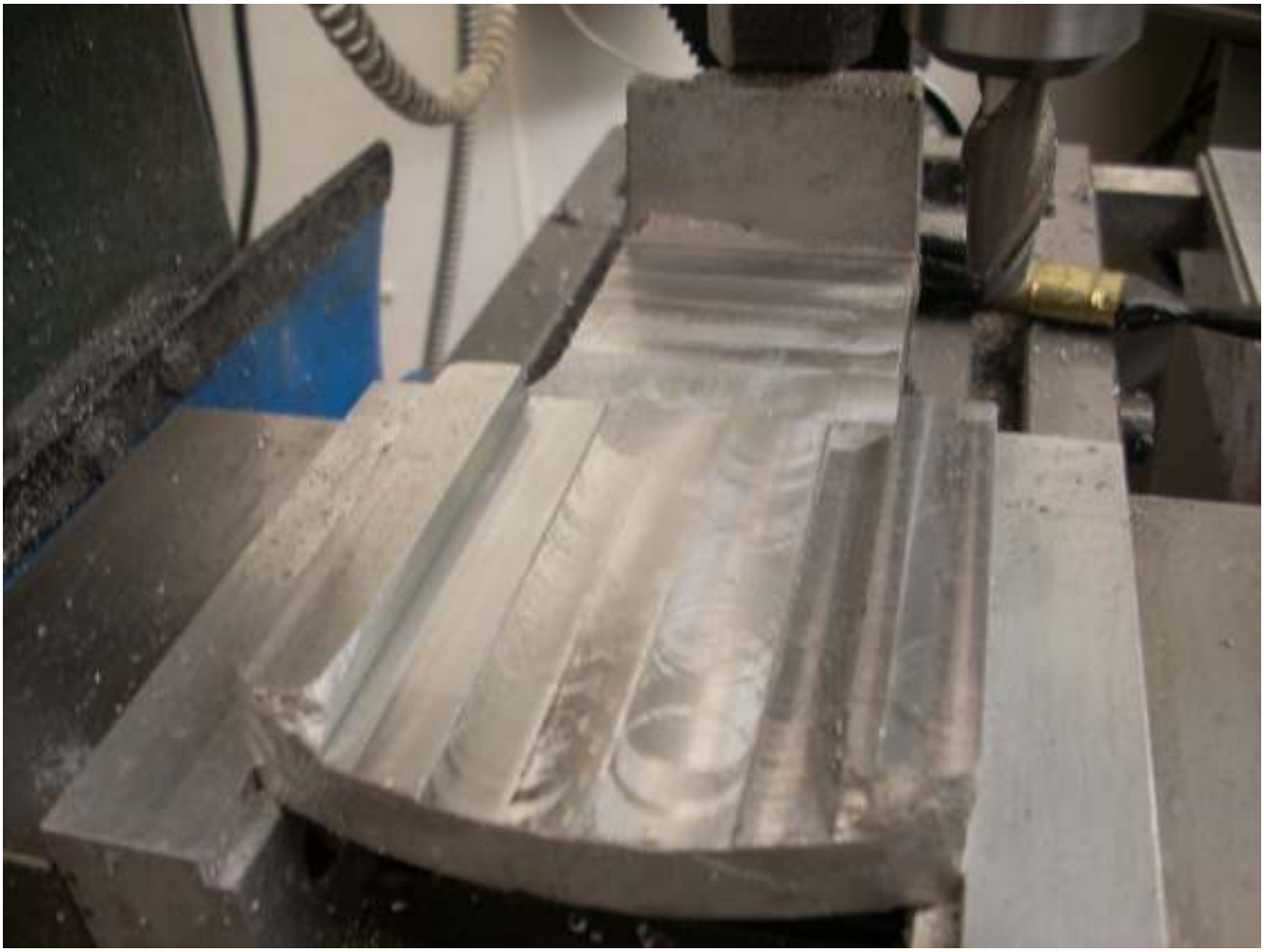


I am now preparing to machine the casting again and this time I want maximum accuracy. My soft jaws are set to approximately the spacing that will exist when the casting is clamped. With the vise tight, I machine a fresh surface on the step of the fixed and movable soft jaws. This guarantees that my soft jaws are perfectly true at this spacing.

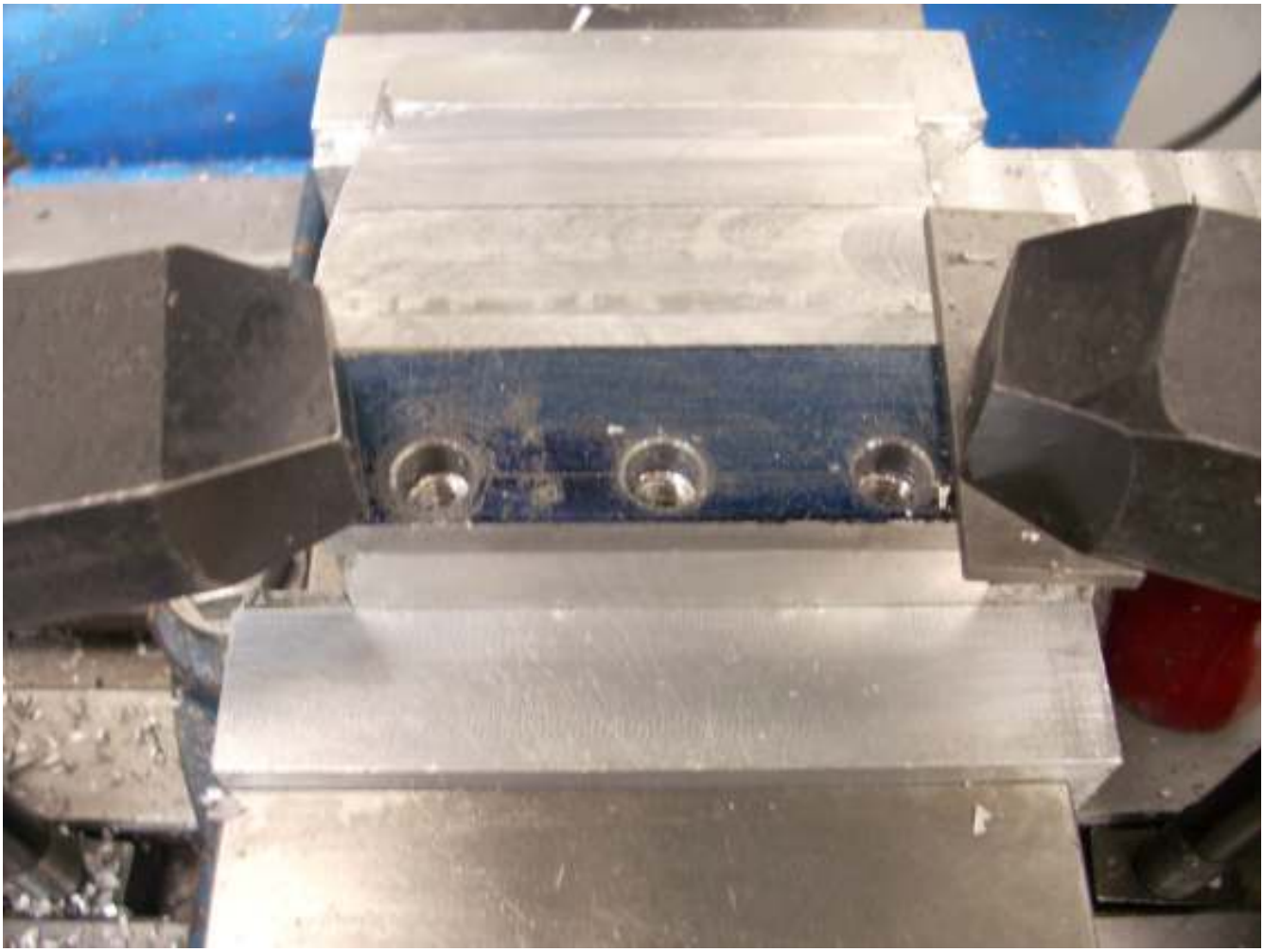
The casting is now securely held by my soft jaws on Reference 2 and 2 prime. Reference 1 is parallel to the mill table.



A jack is snugly placed under the end of the casting and a hold down clamp added. You can barely see the slide pads that have just been cut with an end mill. This is my zero reference for my Z axis. I then raised the cutter 0.240” and cut the clamp support blocks. That will leave me about 0.010” for shims so I can accurately adjust the distance from the underside of the clamps and the top side of the slider.



The end mill was then set to be 0.02” below the wear pads and the remainder of the surface cut.



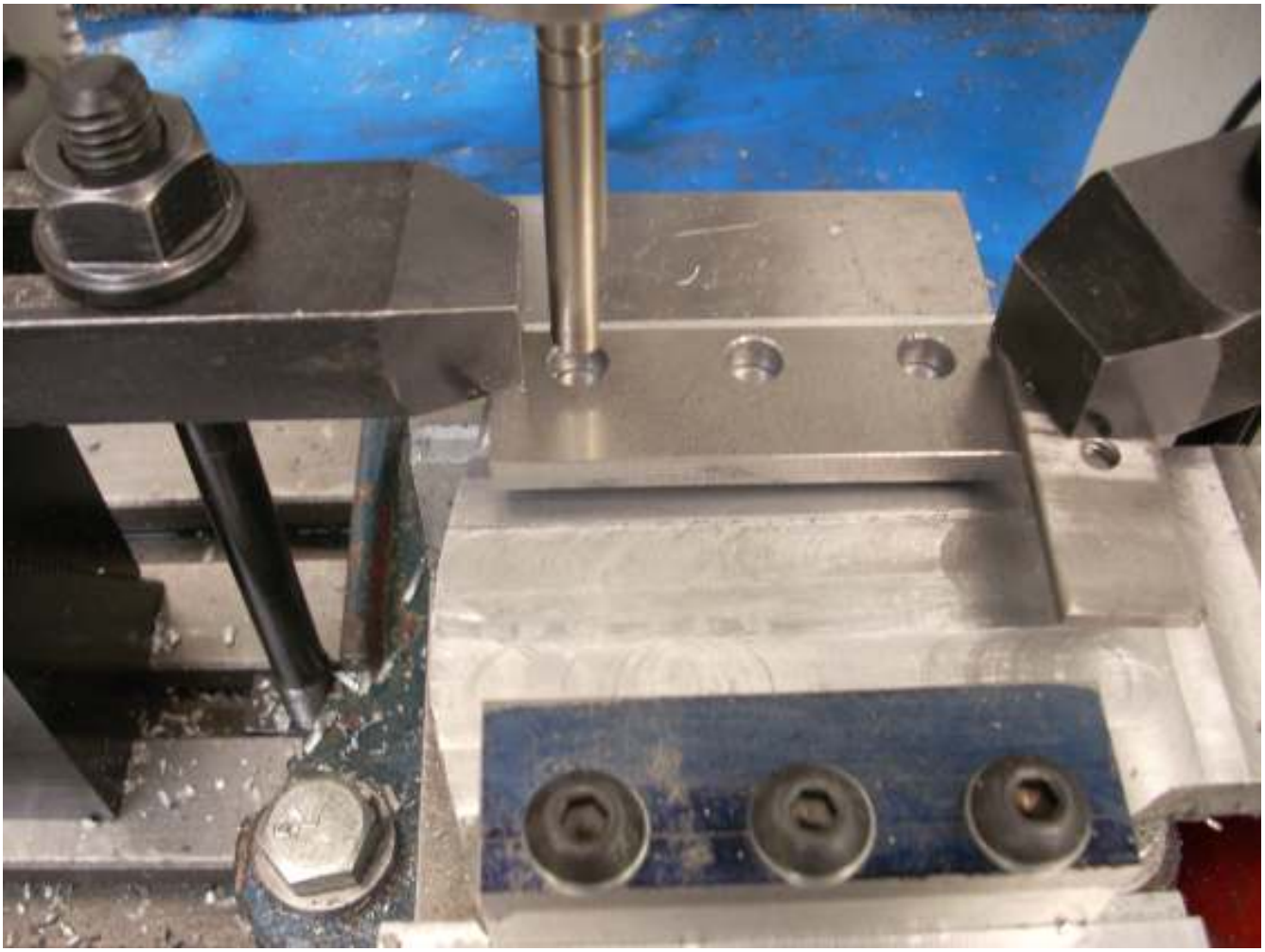
Without moving the casting, the first clamp is placed down and secured with a pair of hold down clamps. A 1-2-3 block was used to insure that the edge of the clamp is on the same plane as Reference 2. Since the clamp was machined so the edges are parallel, this alignment insures that the edge facing away from us is also parallel to Reference 2. Later I will transfer this alignment to the second clamp.

I chose to drill all the way through to make tapping easier and reduce the risk of the tap bottoming and breaking off.

Since all is secure, I was able to pilot drill and tap all 3 holes before adding screws. In general I would not do this if there was any chance of things slipping.

This is a match drill operation so the DRO is not used. The goal is to get each tapped hole perfectly centered in the clearance hole, not to perfectly locate each hole relative to the casting. I could have drilled the clearance holes after clamping the steel but didn't think of it until later. That would have guaranteed that each set of holes is aligned.

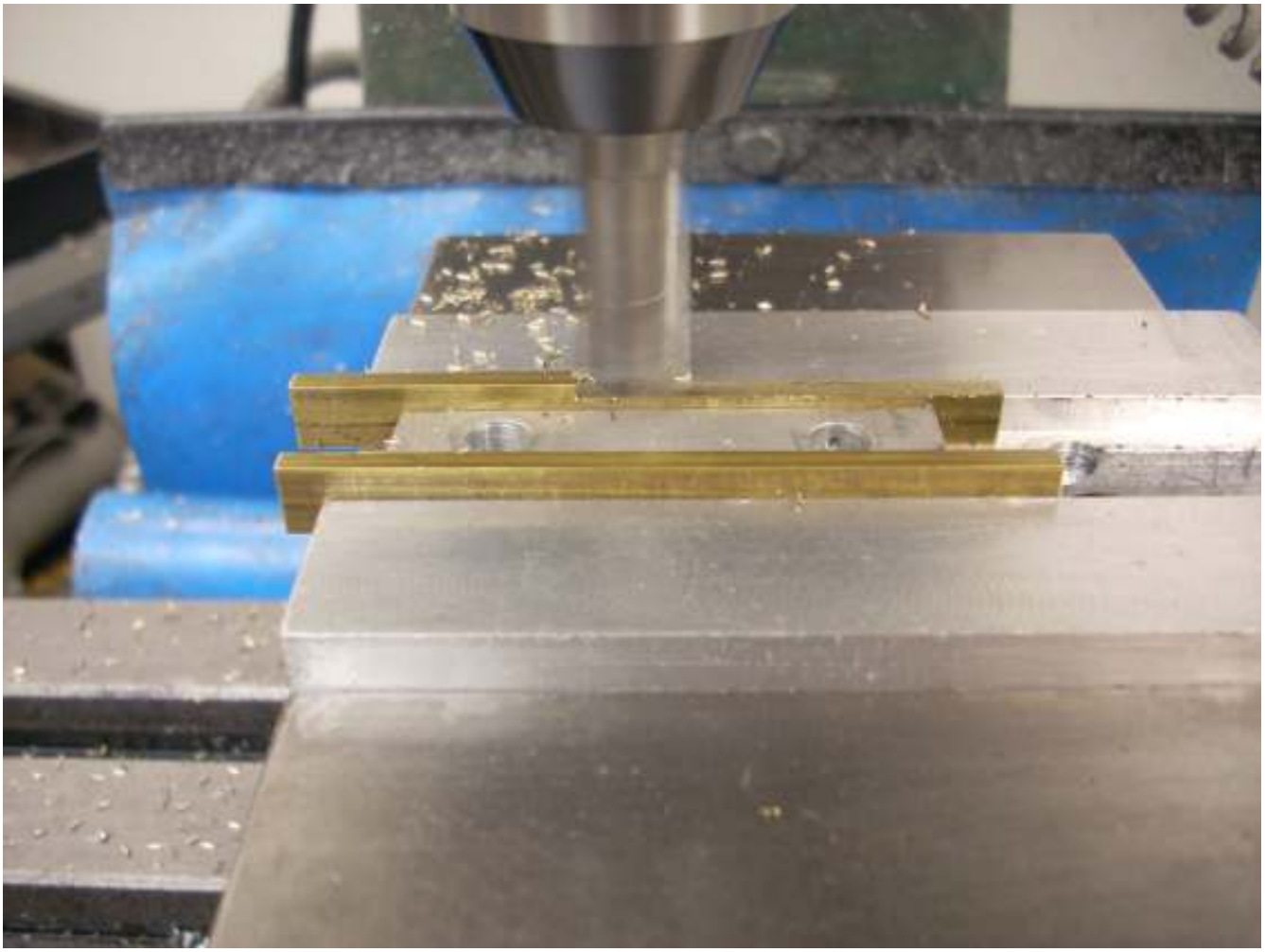
I used a spiral point tap held in the drill chuck. The mill was brought up to speed and then power cut. When the spindle's RPM seemed about right, I drove the tap into the hole. In all cases it went in more than half way but not all the way through. That is better than having it go all the way through and then either rip out the cut thread or yank the casting out of the vise. A tap handle was then fit and the remainder of the threads cut. Since I'm using a spiral point tap, there is no need to turn in a bit and then reverse the tap to break the chip. I can just gently turn in with lots of WD-40 as my cutting fluid.



The back clamp was positioned by using a close fitting rod. At this point I had finished drilling the front left hole and moved the Y axis to the back clamp. This insures that the clamp bolts line up. It is not critical but would look sloppy if they were off by a lot.

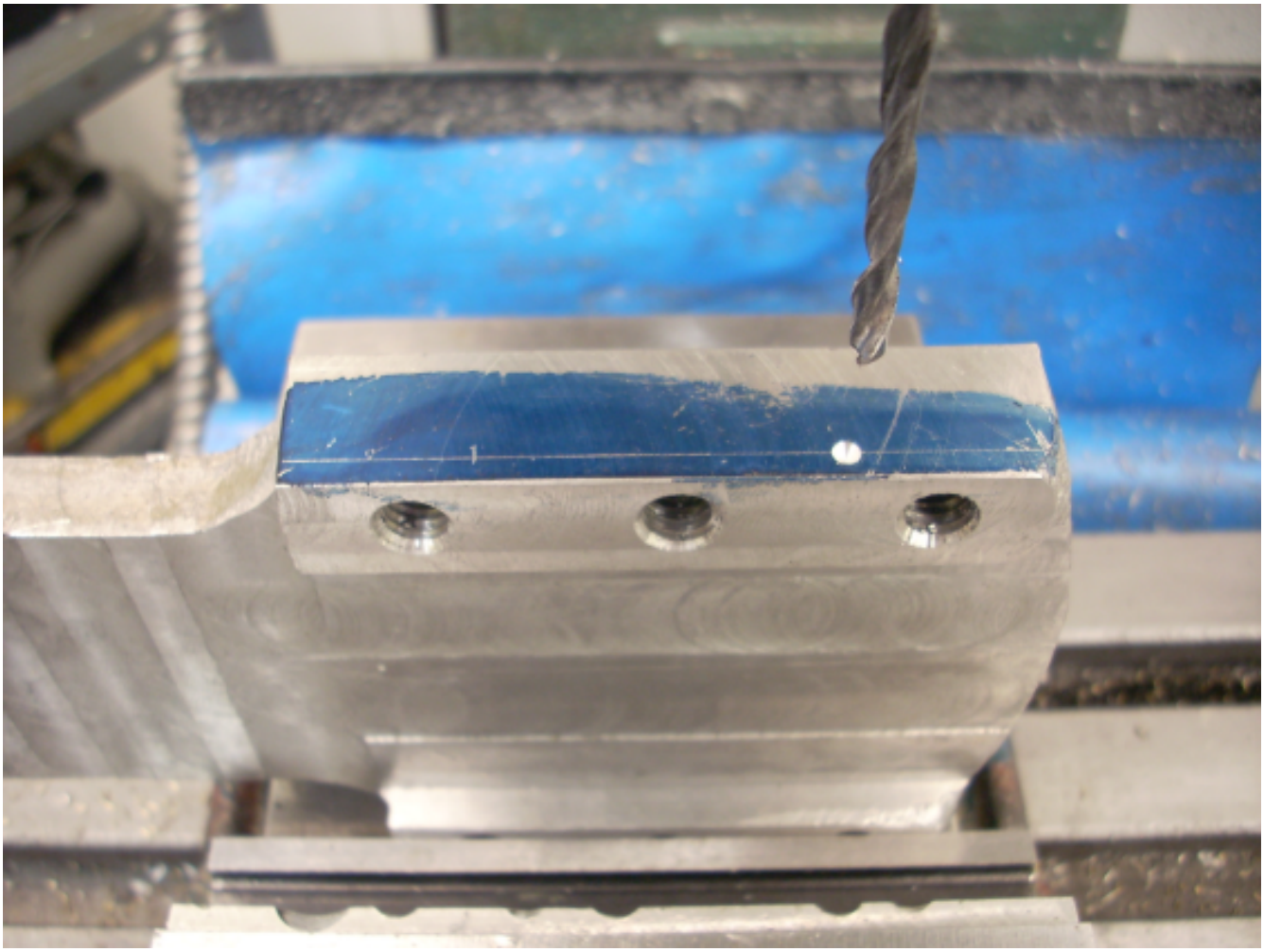
After drilling and tapping the first hole, I added a screw. Then packing was added to insure that this back clamp is parallel to the front clamp. Again, it is not that critical but would look sloppy.

The remaining 2 holes are drilled, tapped, and secured with screws, one at a time. All top machining is now complete and the casting can be safely removed from the soft jaws.

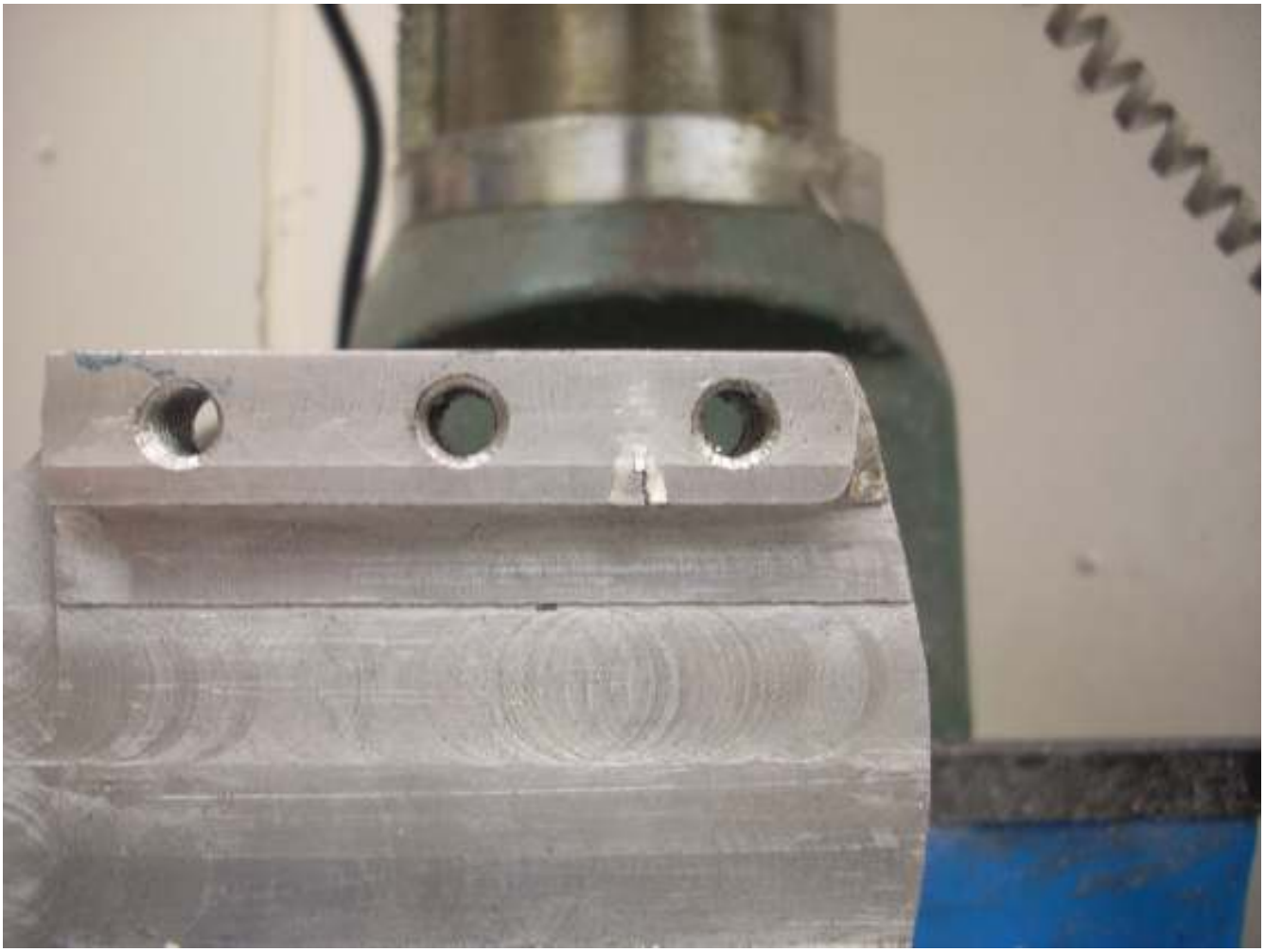


When I was cleaning up the casting, I did not think about the spacing between clamp supports. I just wanted to remove the mess. When I trial fit the slide, it became obvious that I lucked out. An 1/8” strip of brass on each side would nicely fill the gap. Here I am machining the height of the brass strips to 0.240” to match the height of the clamp supports. One strip will be the gib while the other will be Loctite®'d in place.

The spacer is used because I want the brass strips supported by the steps of the soft jaws but the step is wider than the brass is thick. I tried putting both strips on one step and the spacer on the other soft jaw. That would enable me to cut both strips with a single pass of the cutter. This did not work because one of the strips inched up a little. So I ended up having to make two passes but both strips stayed firmly bedded.

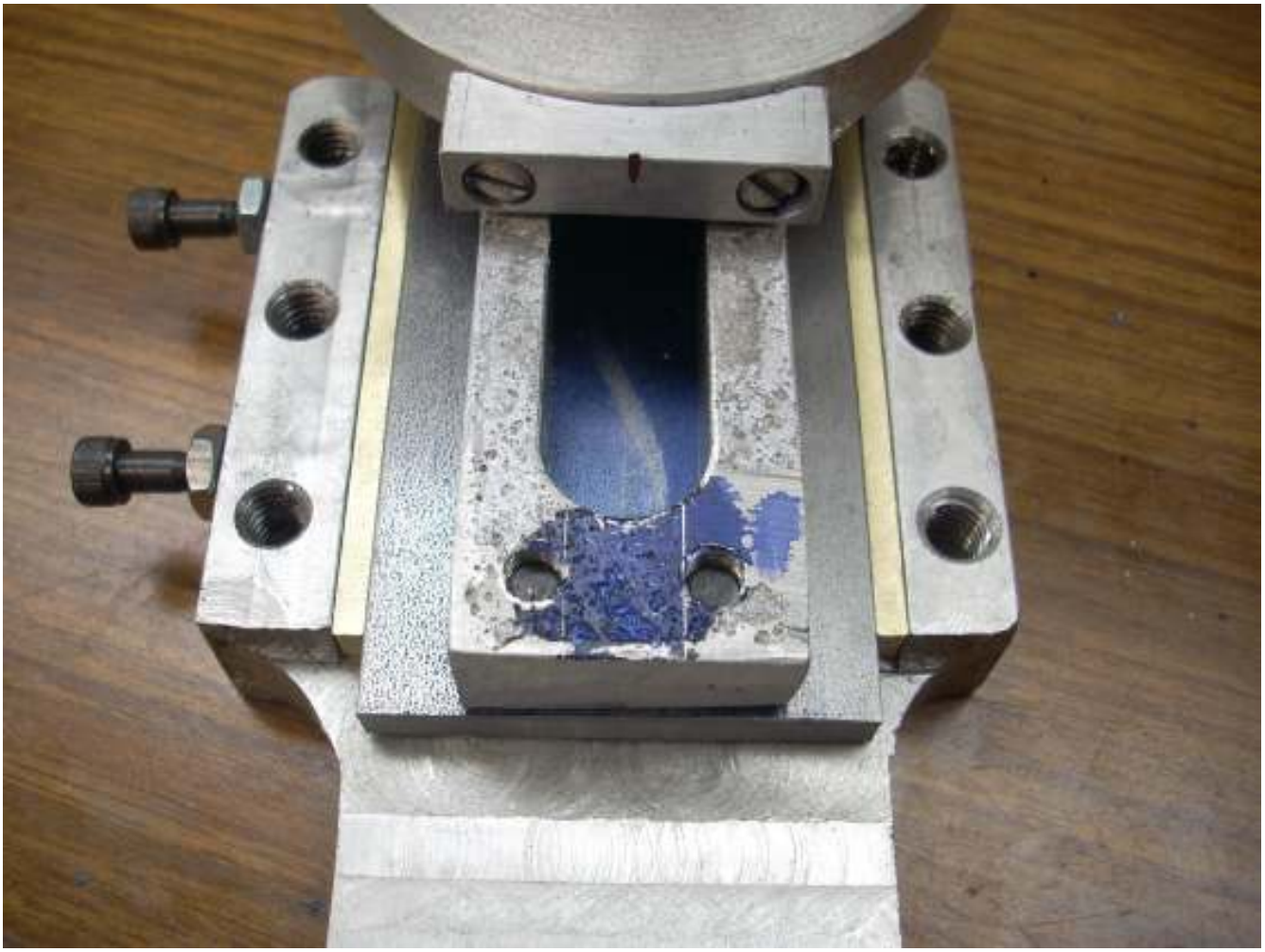


The casting has been set up in the vise and the gib screws are being set. There is not much metal between the wall of the hole and the top of the clamp support block. I chose to put the gib screws 0.120” from the edge so the force on the gib would be centered. The problem with doing this is that I'm very close to breaking through.

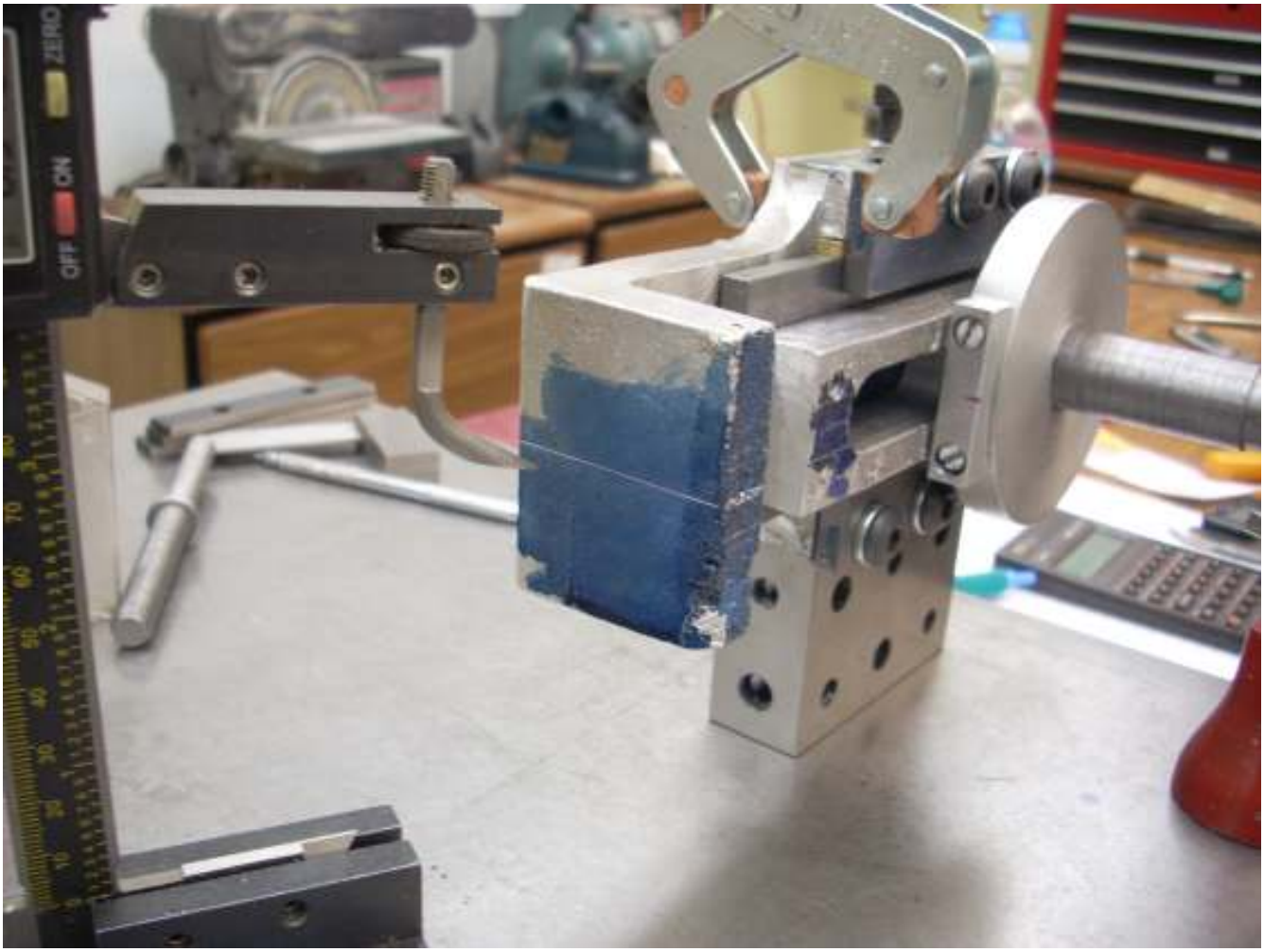


Like I said, not much room. In hindsight, it would have been better to set the clamp plate with the 3 screws in place. It would have backed up the thin aluminum area and prevented the breakout.

This looks bad but is not a big deal. I just filed the damaged area flat so it does not interfere with the clamp. Yes, I know it is there but, given the countless little screw-ups I've done on this project, may not even remember this one.



The assembly so far is looking good.



It is now time to transfer the exact center of the slide to the front face of the casting. I know that my slot is 0.625” wide. Using my digital height gage, I set zero at the lower face of the slot and then came up by 0.3125”. This height was then marked on the casting.

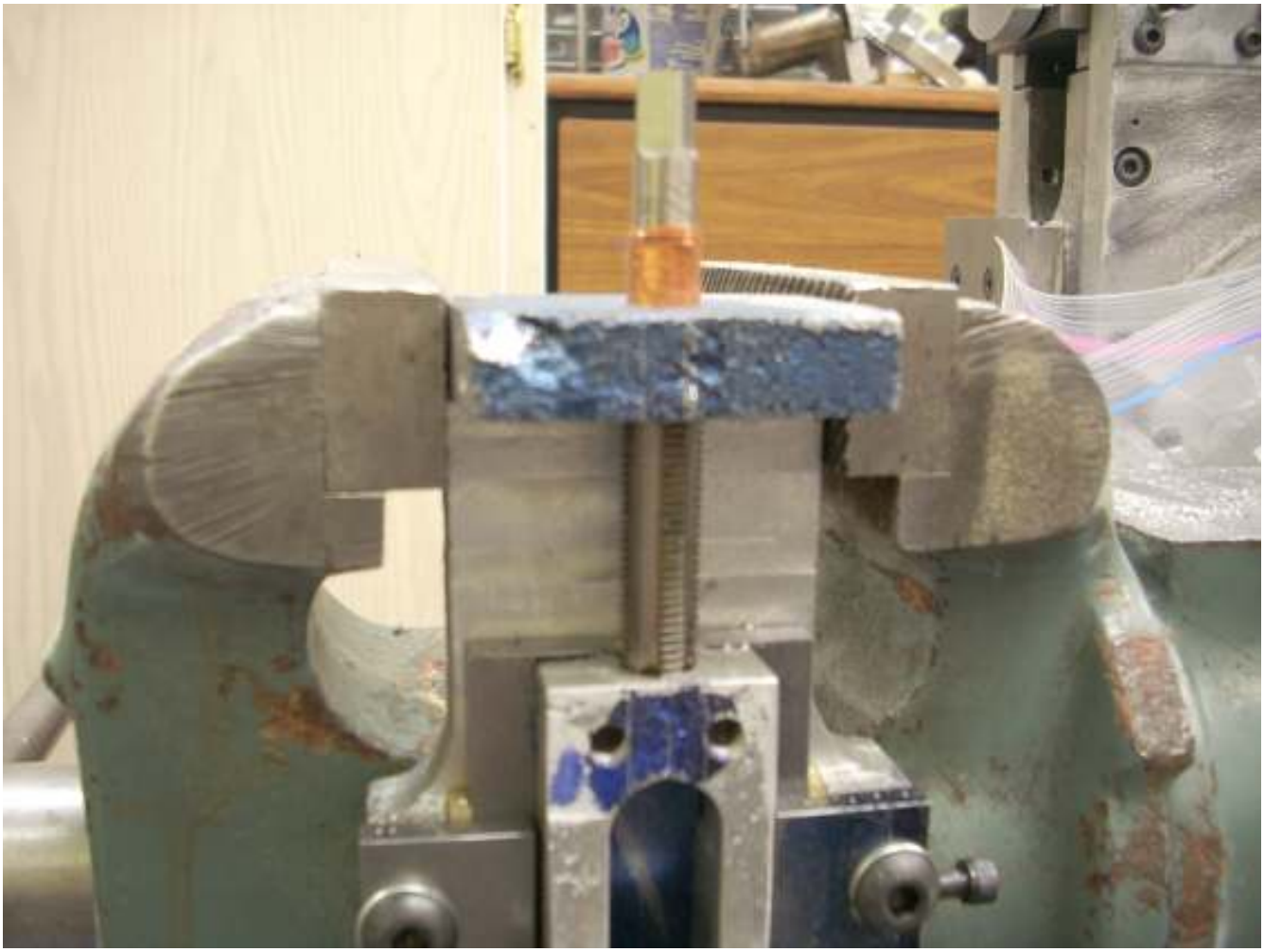
I then placed Reference 1 down on the surface plate and zeroed my height gage at the top of the slide plate. I then touched down on the top of the casting area that holds the slot. Dividing this number in half gives me the center of the slot in the vertical dimension. I then scribed a horizontal line on the front face of the casting. The center of the slot has now been transferred to the front of the casting.

The casting is now back on my mill. Reference 1 is clamped to one knee. Reference 2 is pressed up against a second knee. I then used a spud to get the center of the spindle aligned with my scribe marks.

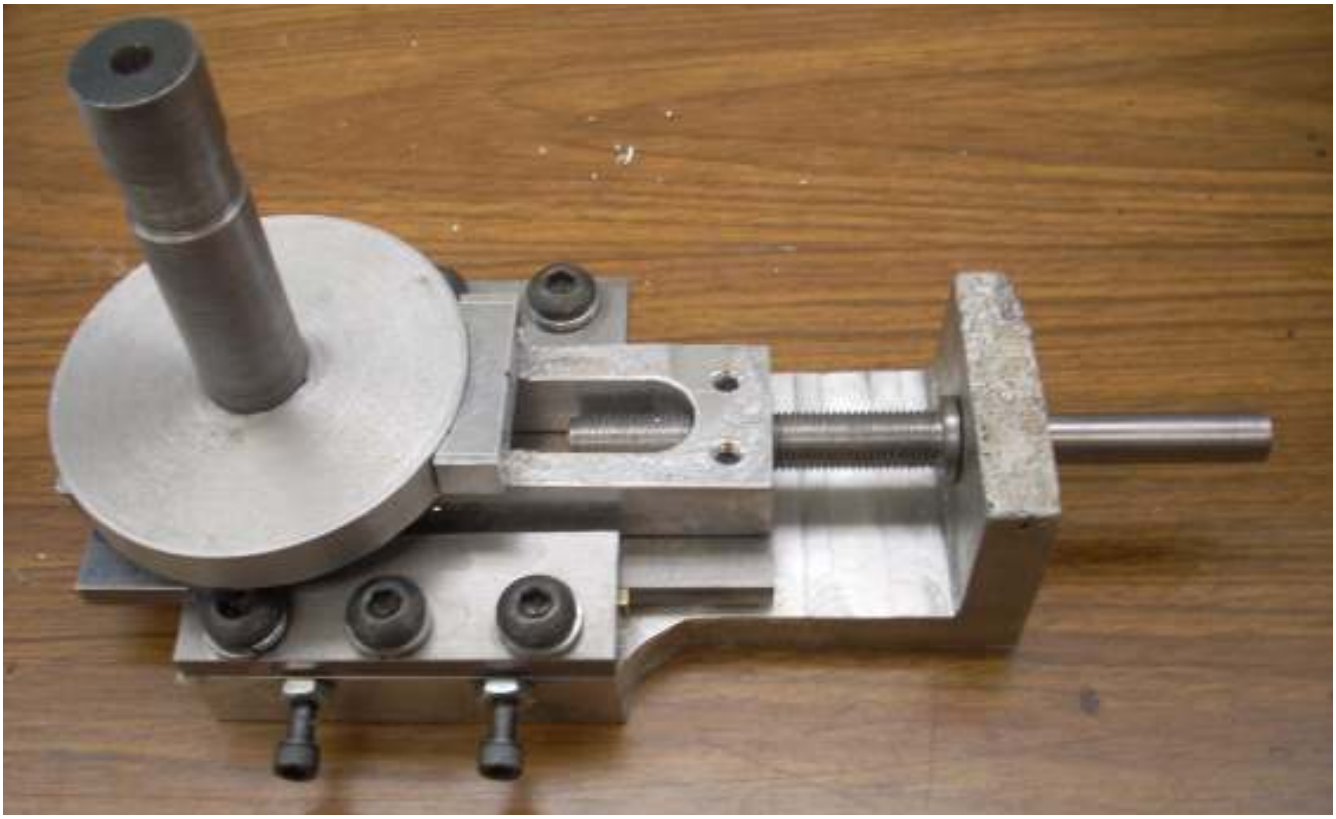
Note that I keep my vise as far to the left as possible on my mill table. That gives me room for setting up a clamp system directly on the table without having to disturb the vise.

Another view of the set up. Reference 2 is in contact with the knee on the left.

With the casting aligned and secured was then a simple matter to step drill through both the down slide and slide castings. I started with a 1/8” drill and ended with a 25/64” drill which is the tap drill for a 7/16”-20 thread.



The casting was moved to my bench vise. A 7/16”-20 tap was placed in the slide's hole. The shank of the tap was fit up into the down feed's hole. A strip of copper sheet was wrapped around the shank to keep it close to centered. In no time the hole was tapped.



For all of my minor screw-ups, the resulting part looks good to me. My guess is that a typical machinist makes many minor mistakes when making a one-off part. If they are making a second identical part, they get a second change to get it all right. The procedure would be modified so future parts would not suffer from these mistakes.

I did forget one step. The outside of the feed screw support must be cut flat so it can accept the feed dial pointer. I'll leave this for another day.

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