The Cross Slide and Cross Feed Assembly

By R. G. Sparber

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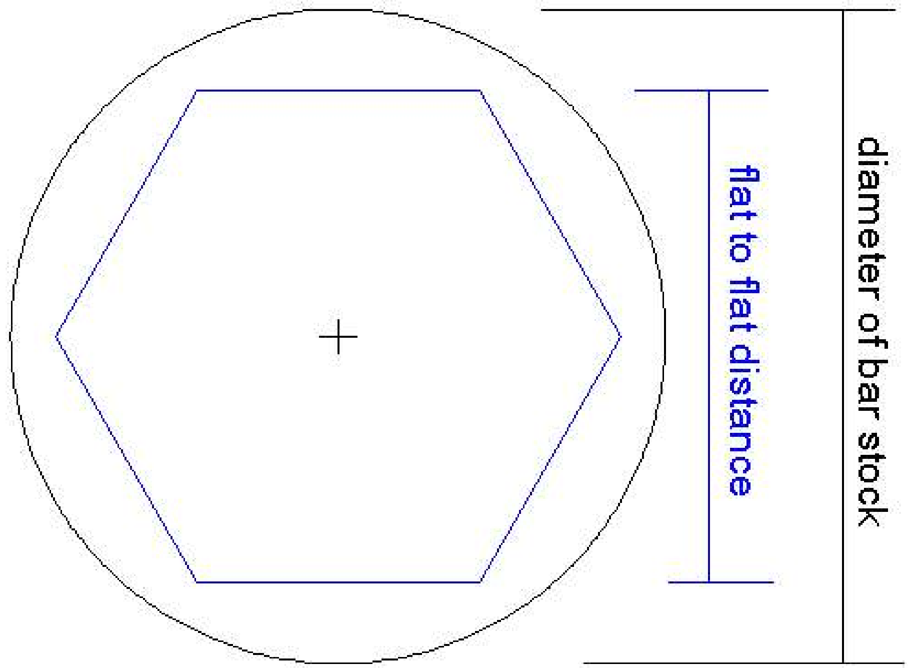
Gingery suggests we build and install the cross feed assembly (pages 104 through 106) and then install the cross slide. Given all of the changes I've made to the thickness of the associated parts, I decided to do a dry fit before drilling holes. For that reason I have merged the building of the cross slide with the cross feed assembly.

The Cross Feed Screw and Nut

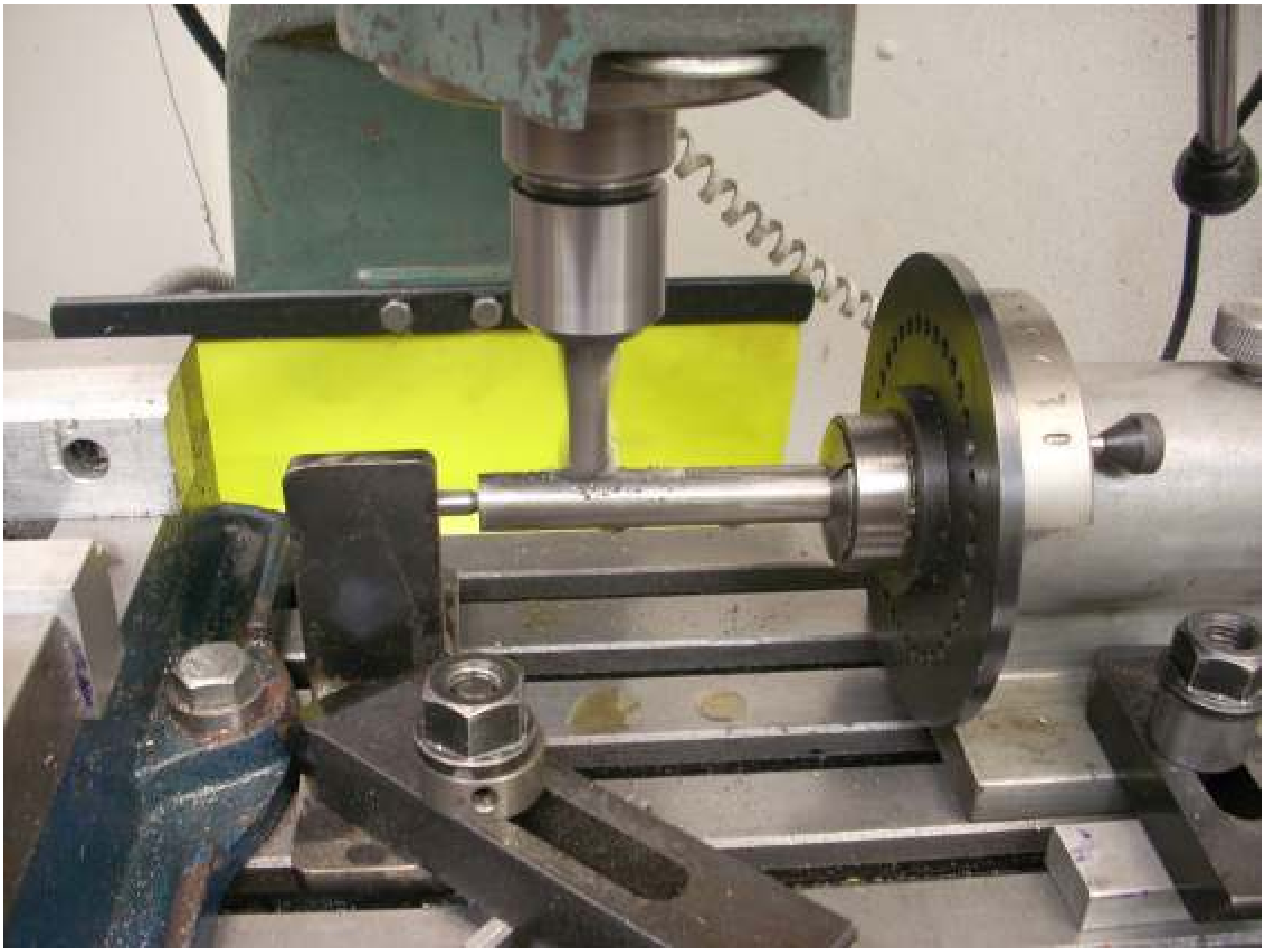
I mostly followed the book on this part. The one exception was that I made the coupler nuts from bar stock. It took less time than running off to the hardware store and was certainly more fun. These couplers and the nut were cut from 12L14 steel.

The first step in making the couplers is to measure the OD of my round stock and the flat to flat distance of a 3/8”-16 nut.



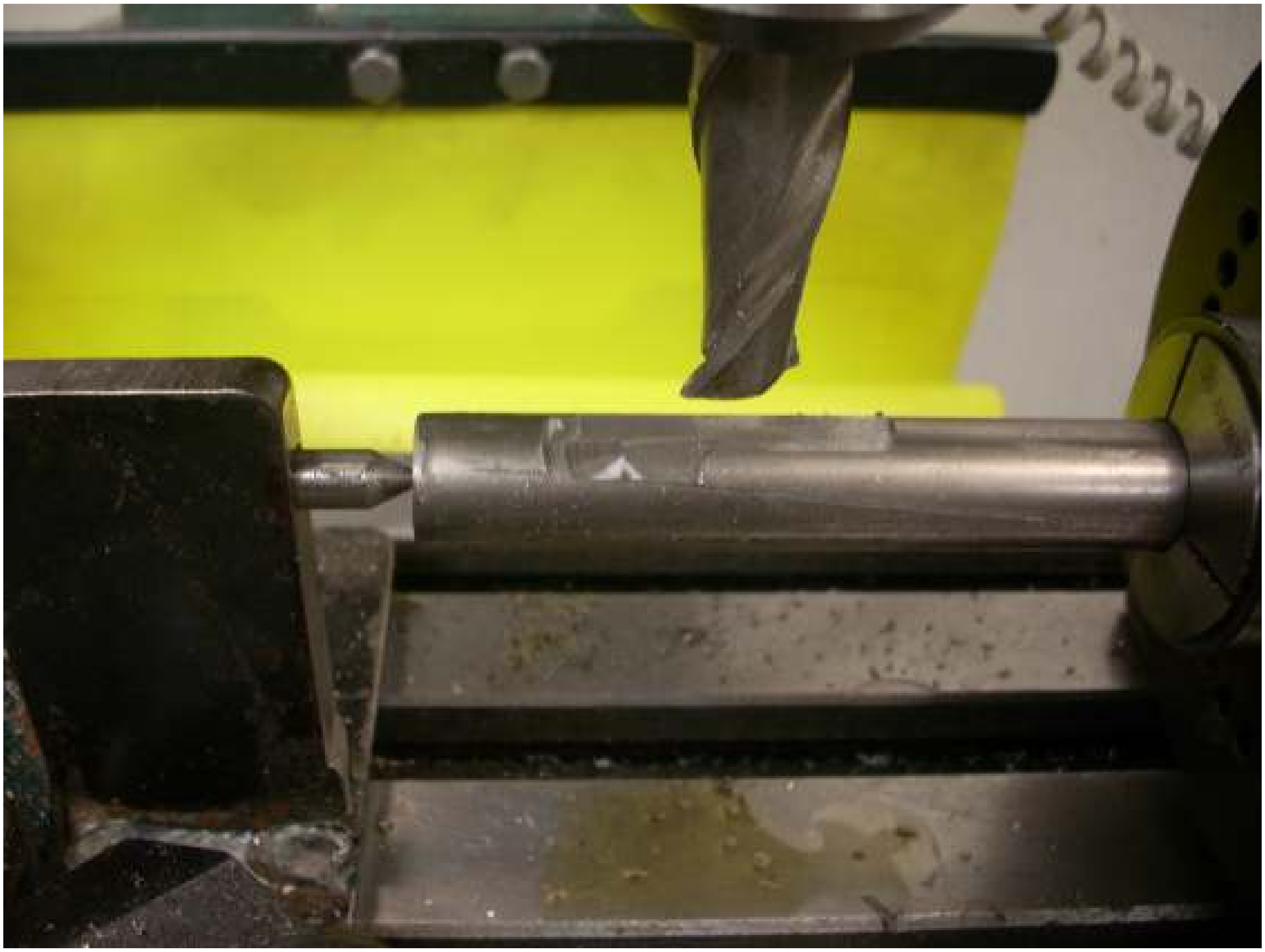
By taking half of the difference between the diameter and the flat to flat distance we know how far down to feed the end mill to cut the flats. In my case it was 0.032”.

The end of the bar stock is first squared up on my lathe and a center hole drilled. Then it is off to the mill.

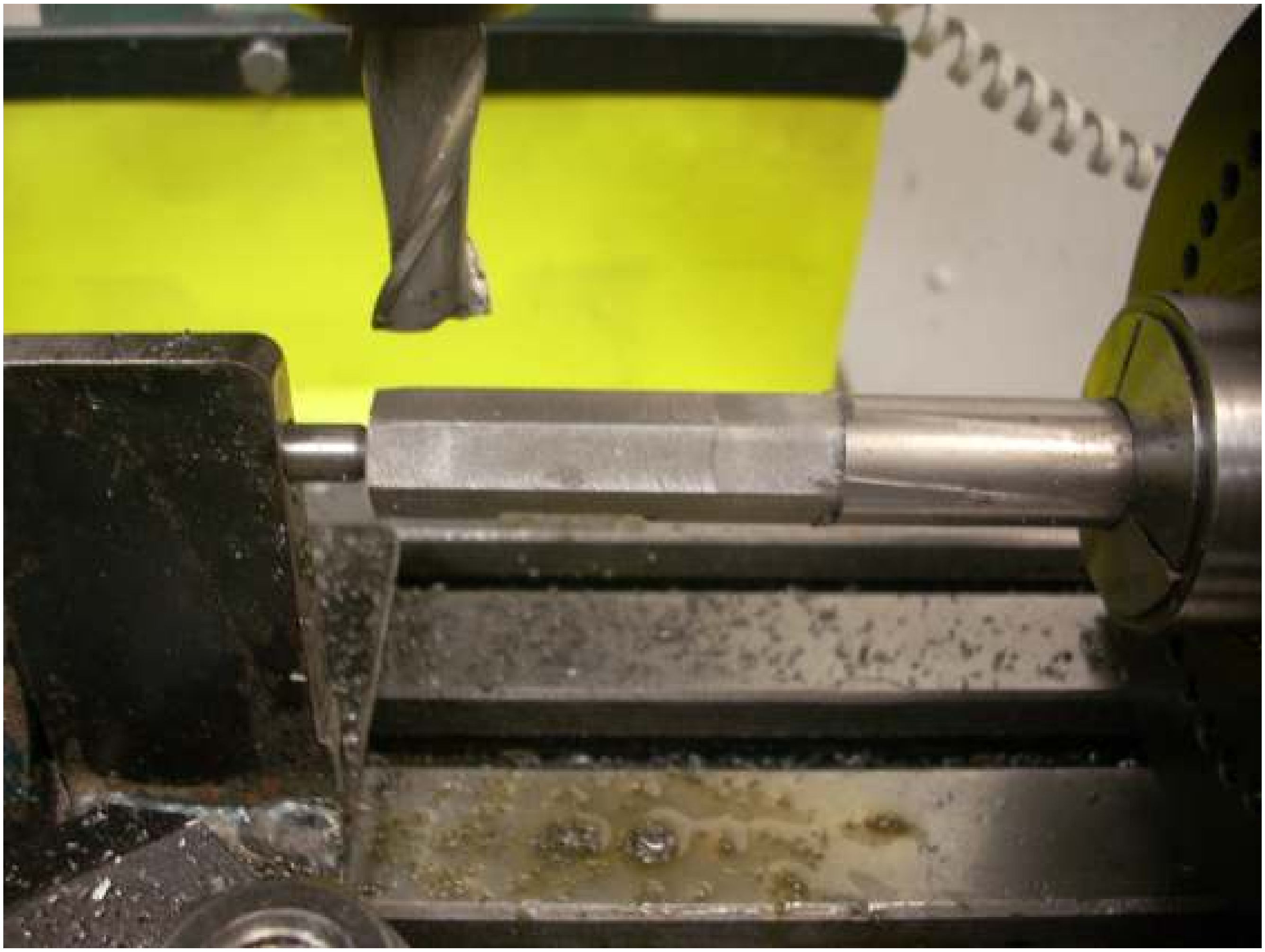


The bar stock is held in a collet and placed in my spin collet. A home made dead center supports the end. The spin collet is set to 0 degrees. The end mill is fed down until it rests on the top surface of the bar. The Z axis readout is zeroed.

This set up is not all that solid so I started by taking two 0.016” deep cuts. This worked fine but got a bit tedious after the first few flats.



I decided to feed down the full 0.032” and go for a single pass on each flat. Didn't get away with it. The cutter grabbed the bar and rotated it about 45 degrees. You can see the main flat in the picture and the “my luck ran out” flat on the left side. I have already repositioned the bar to put the main flat back on top. It won't look good but the resulting coupler will be functional. Back to making 0.016” deep cuts!



The remainder of the flats came out fine.

Not pretty.

It is back to the lathe to drill, tap, and part off the two coupler nuts.

The tap hole is drilled about 2” deep.

With the chuck locked, I tapped in about 1”. This is enough for my first coupler and as far in as the tap can reach. I then touched a file to the end to slightly round it. The parting tool is positioned to cut a ¾” piece. Before cutting through, the file is touched to the groove to slightly round the end about to be cut off. Using a file on a running lathe is not the safest operation. At the very least, be sure you have a rounded handle attached so you are not impaled on the tang if it kicks back.

After parting off, the tap is run in as far as it can go. The end is rounded, the parting tool set at ¾”, and the second coupler is cut off.

They sure would have looked nicer if I had stuck with light cuts. Oh well... not worth it to me to make new ones.

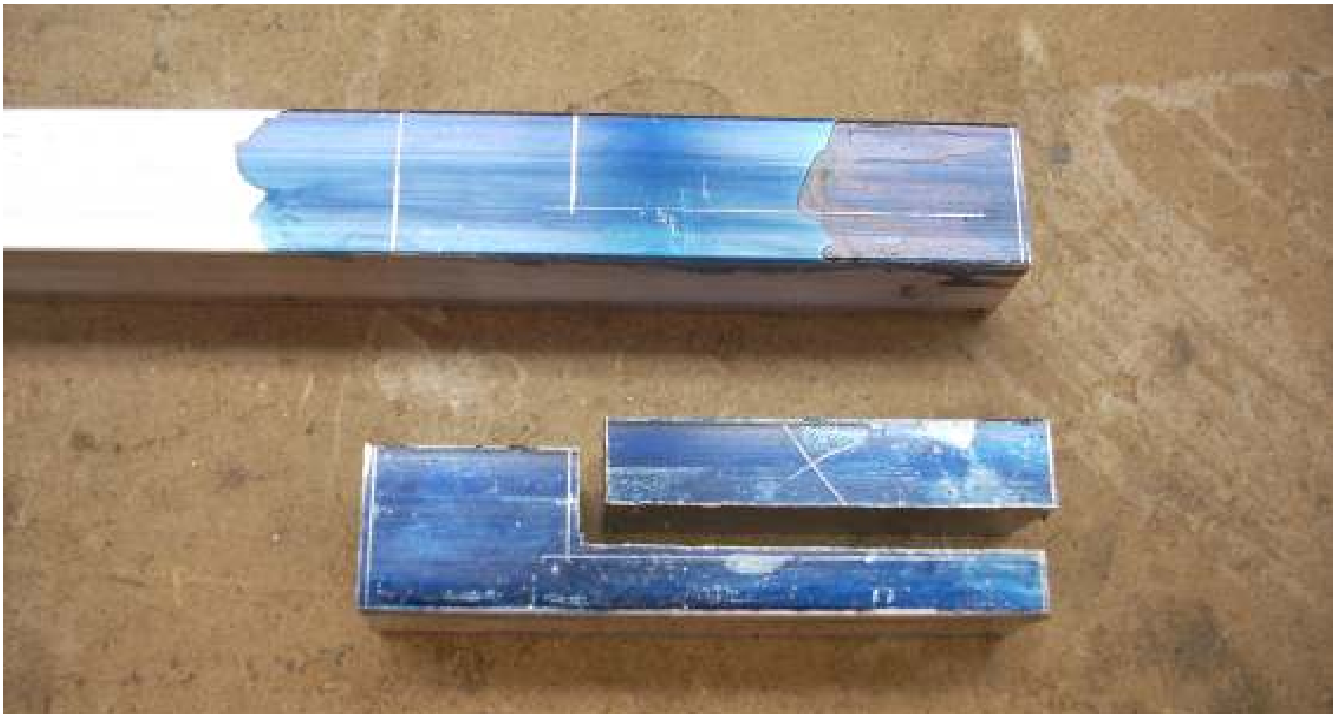
The end pieces are 3/8” CRS. I turned down the first 0.5” of them to the minimum OD for a 3/8”-16 thread. This made running the die a lot easier. The ends were cut square.

The ends of the threaded rod were also cut square. Note the use of 3/8”-16 nuts with a cut in them to hold the rod in the chuck without damaging the threads. This arrangement has limited holding power so light cuts are made. Given that all ends are square, they should seat squarely as they meet inside the couplers.

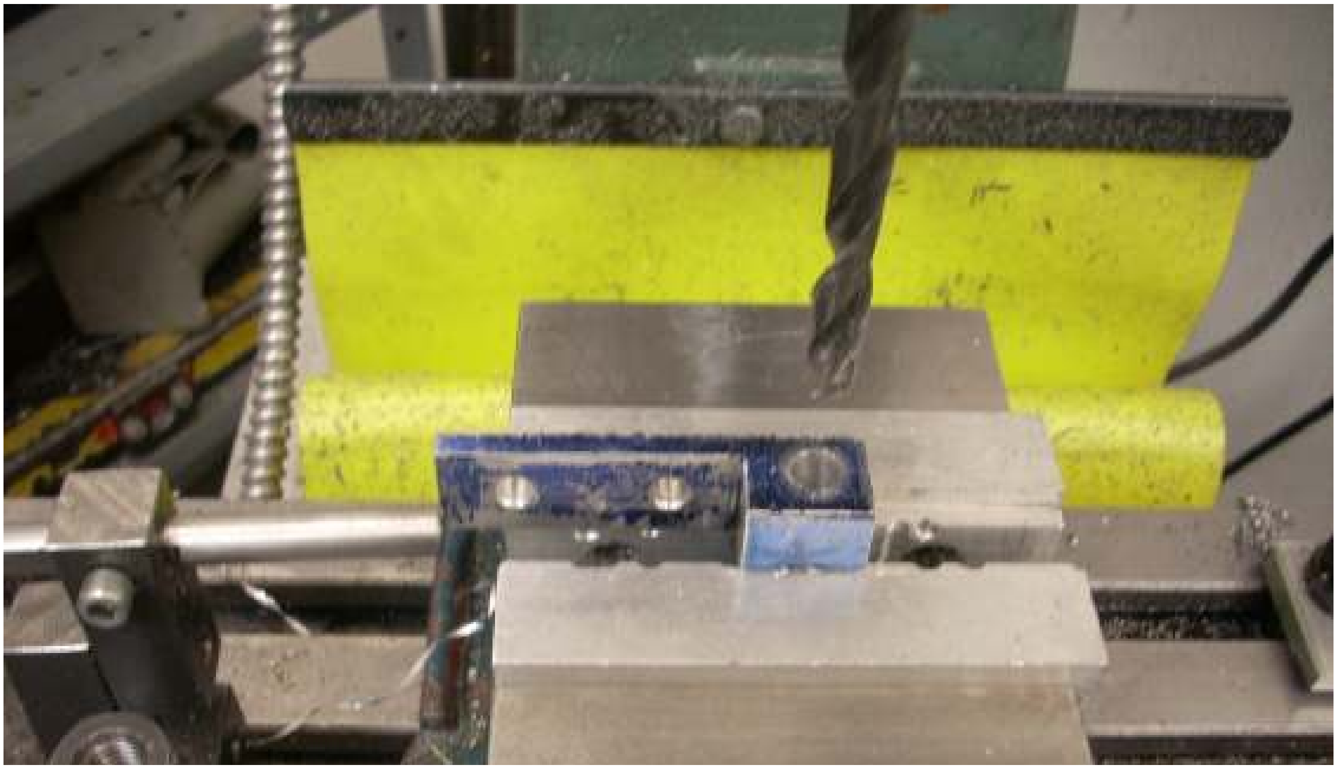
Not much to say about the nut. I first drilled and tapped the 3/8”-16 hole. Then drilled the ¼”-20 tap hole until it broke into the 3/8” hole. A 1/4”-20 tap was then run down being careful not to hit the 3/8”-16 threads. The 3/8”-16 was was run a second time to clean up the mess made by the ¼”-20 tap.

The Cross Feed Screw Bearings

I love to do casting but this part just does not justify the effort. I milled it out of ¾" square aluminum bar stock instead.



After layout, I used my bandsaw to remove most of the excess. I then milled down to the marked surface. This thickness is not critical but I did take care to make both supports identical.



The stop on the left side plus the steps in the soft jaws enabled me to put both 3/8” holes in the same place. I knocked a hole with a 23/64” drill and then followed with a 0.375” reamer.

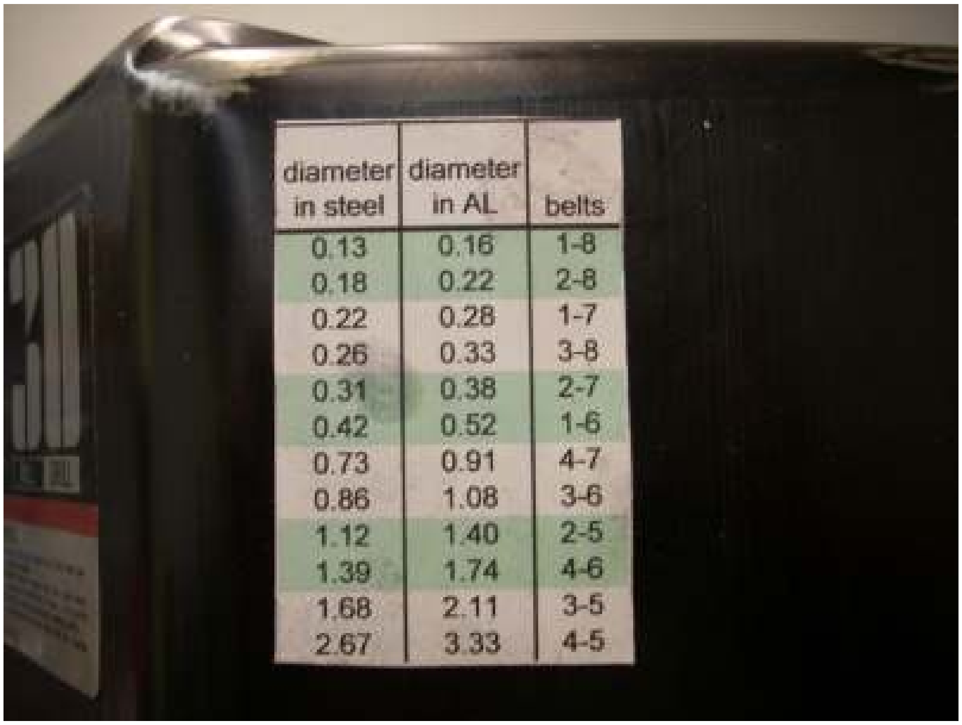
Contrary to Gingery's suggestion to next mount the bearings on the cross slide support casting, I put the assembly aside until the cross slide was done.

The Cross Slide

This is the second casting done with my new Petrobond. Nice crisp corners.

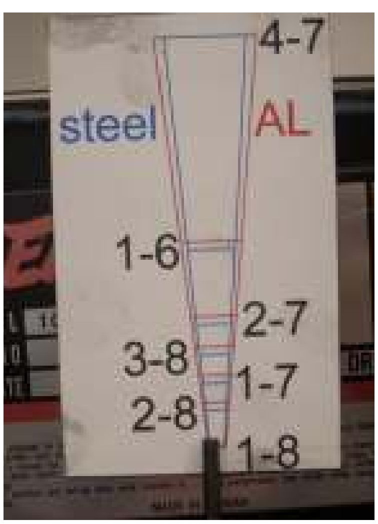
A few minutes with my bandsaw and belt sander and the transformation begins.

I will first make the clamps and then machine the casting. But first, a little side trip.



diameter in steel	diameter in AL	belts
0.13	0.16	1-8
0.18	0.22	2-8
0.22	0.28	1-7
0.26	0.33	3-8
0.31	0.38	2-7
0.42	0.52	1-6
0.73	0.91	4-7
0.86	1.08	3-6
1.12	1.40	2-5
1.39	1.74	4-6
1.68	2.11	3-5
2.67	3.33	4-5

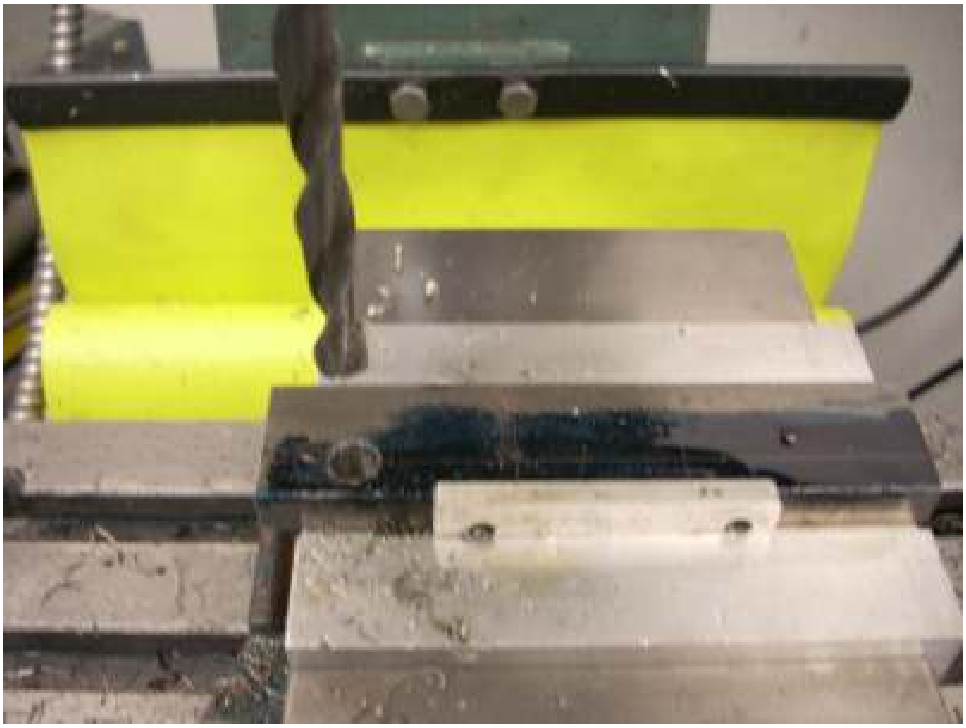
In the past, I have taken the drill diameter and used it to calculate the required RPM. The RPM was then used to pick which set of belt positions comes closest to that RPM. Then today it dawned on me that there is an easier way. I took each possible RPM for my mill and worked backwards to find the drill diameter that matches it. For steel I use 80 SFPM and 100 for aluminum. The result is the table above. For example, a 3/8" drill is between 0.31" and 0.42" so for steel I should use belts 2-7 to go a little faster than ideal or 1-6 to go a bit slower. After making this table, I realized I could make the task a little easier.



No need for a list of diameters, just draw them in. So now I hold the drill (or end mill) up to this figure to find the nearest set of belts. I also made 2 more copies and cut out the V for steel on one and aluminum on the other. Slide the V onto the shank and read off the belts.

I realize this is no great advancement in the art, but it saves me a minor tedious step that I have done every time I pick up a drill or end mill.

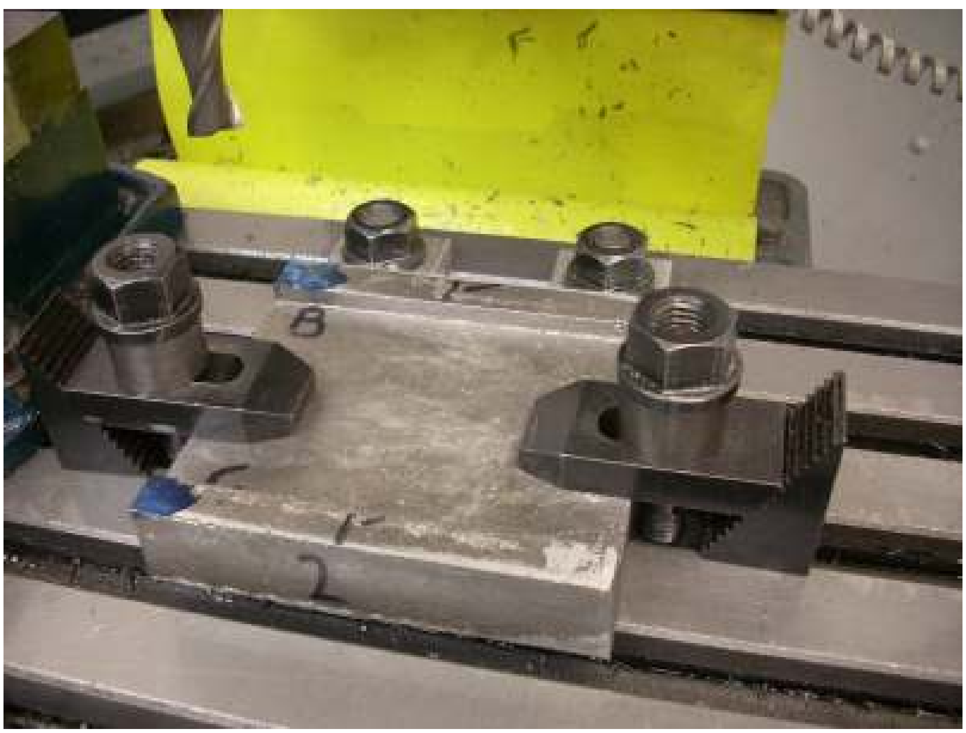
OK, back to making the clamps.



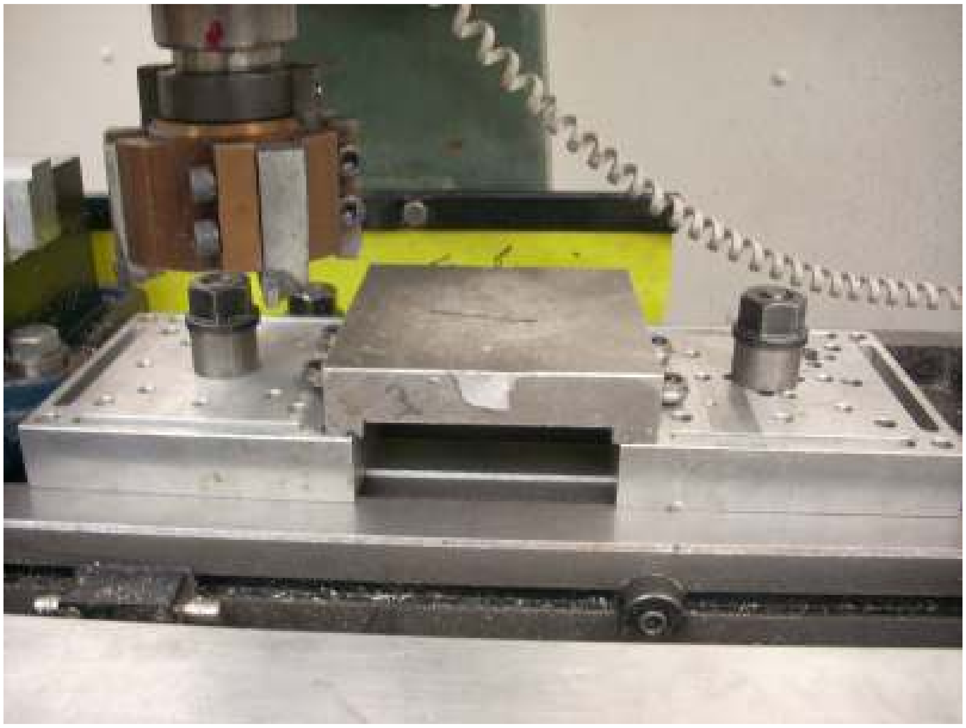
The clamps are drilled with my clearance drill. The packing in the front puts the movable jaw back enough to not hit the drill.

The clamps are ready to go so the next step is to machine the cross slide casting. I have labeled the wide clamp support “B” and the narrow one “C” just in case I have a senior moment. I have also marked the primary reference plane 1, not shown, and secondary reference plane 1 marked 1'.

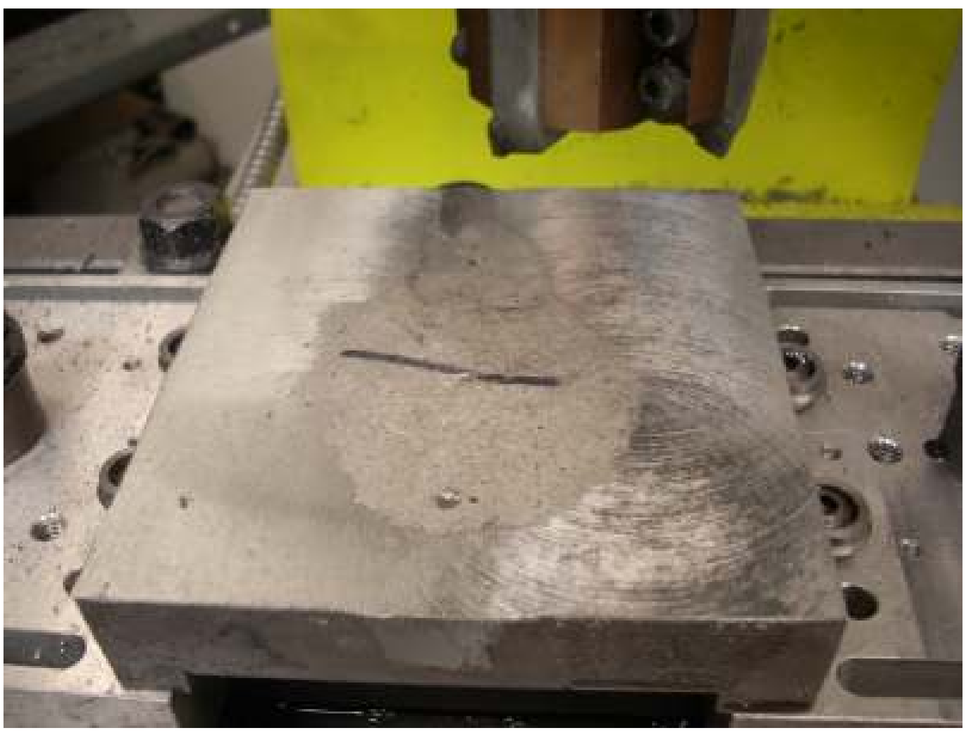
My soft pads are clamped to the mill table and a light cut is made with the end mill. I now have precision X axis stops.



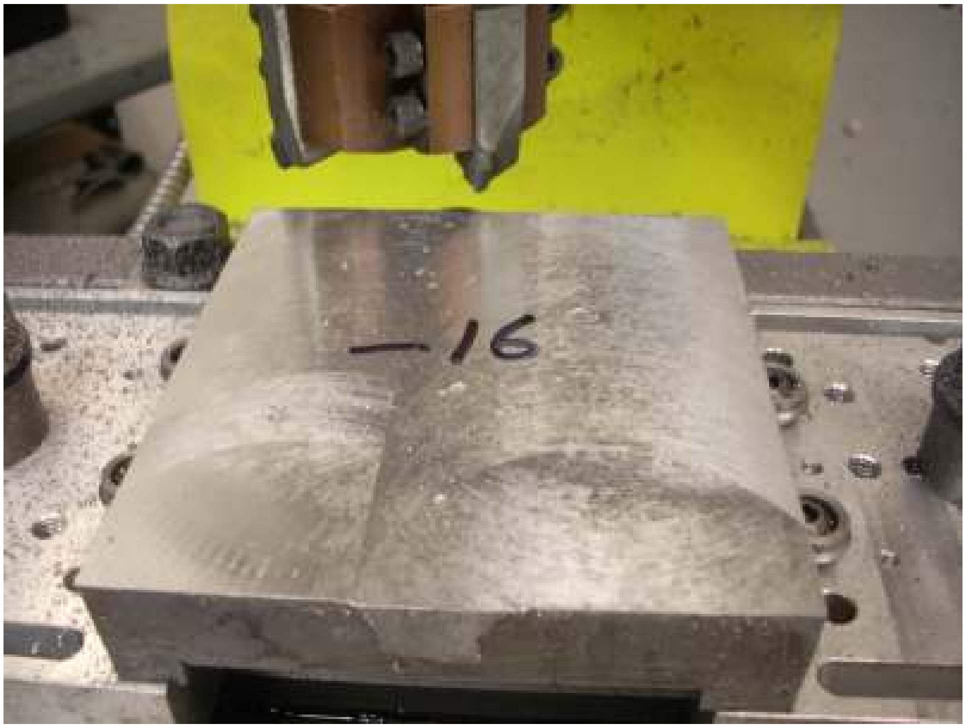
My primary reference plane 1 is down on the table and I'm ready to take a light cut on the secondary reference plane 1. The X axis pads are not needed for this cut.



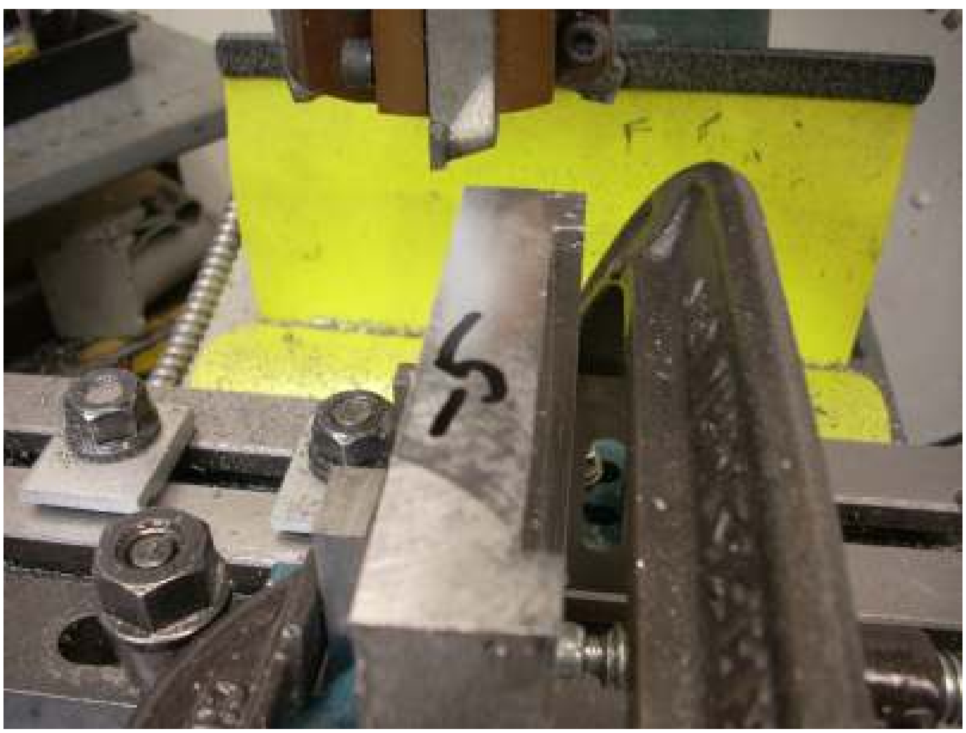
I now use my newly cut secondary reference plane 1 to support the casting. Eccentric screws are used to hold the casting down and give my shell mill full access to primary reference plane 1.



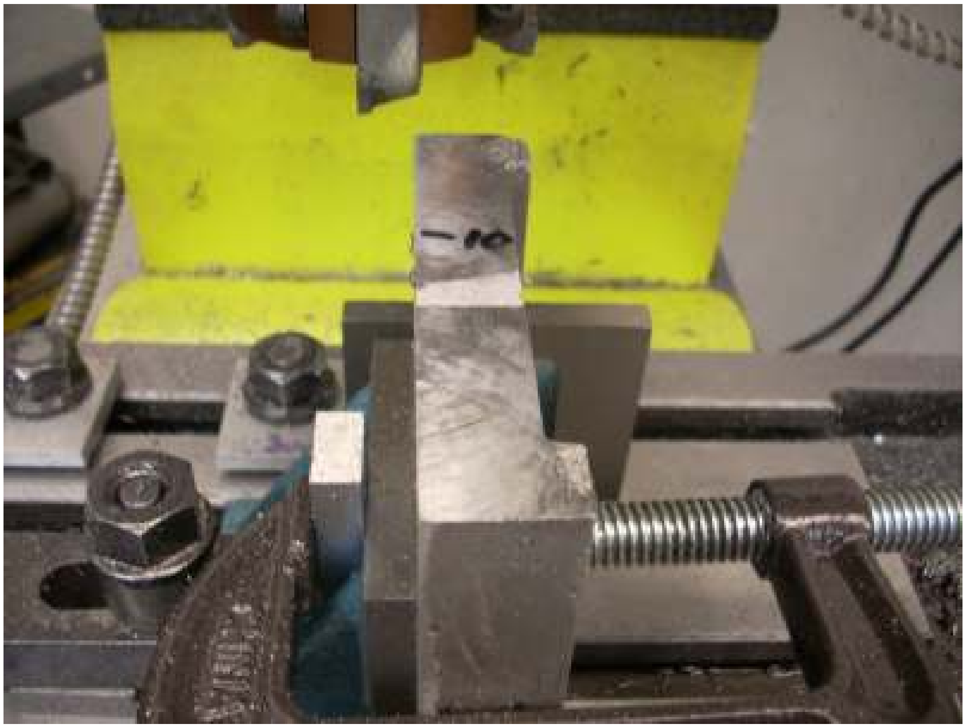
After the first pass of the shell mill, you can see there was some minor shrinkage. I've only gone in about 0.005” so will make another pass.



I ended up making two more passes for a total of 0.016" being removed. I now have a true primary reference plane 1.



Using a pair of knees, I cut secondary reference plane 2 which is the edge of the casting. Only 0.005" was needed to get a uniform surface.

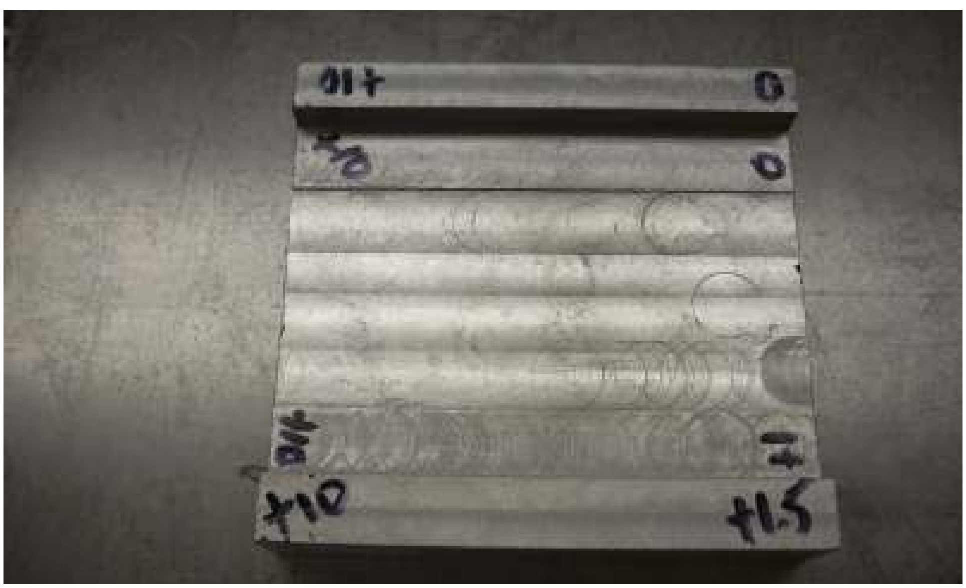


Secondary reference plane 2 is now down on the table. After taking 0.010” from primary reference plane 2 I still had an area in the center that was not touched. This was from the bandsaw and about 0.02” deeper. I decided to just leave it.

With primary reference plane 1 down on the table and primary reference plane 2 up against the soft pads, it was time to cut the clamp support blocks and the wear pads. Note that I did not bother to cast the relief depression beyond the wear pads. It is easy enough to mill that area out.

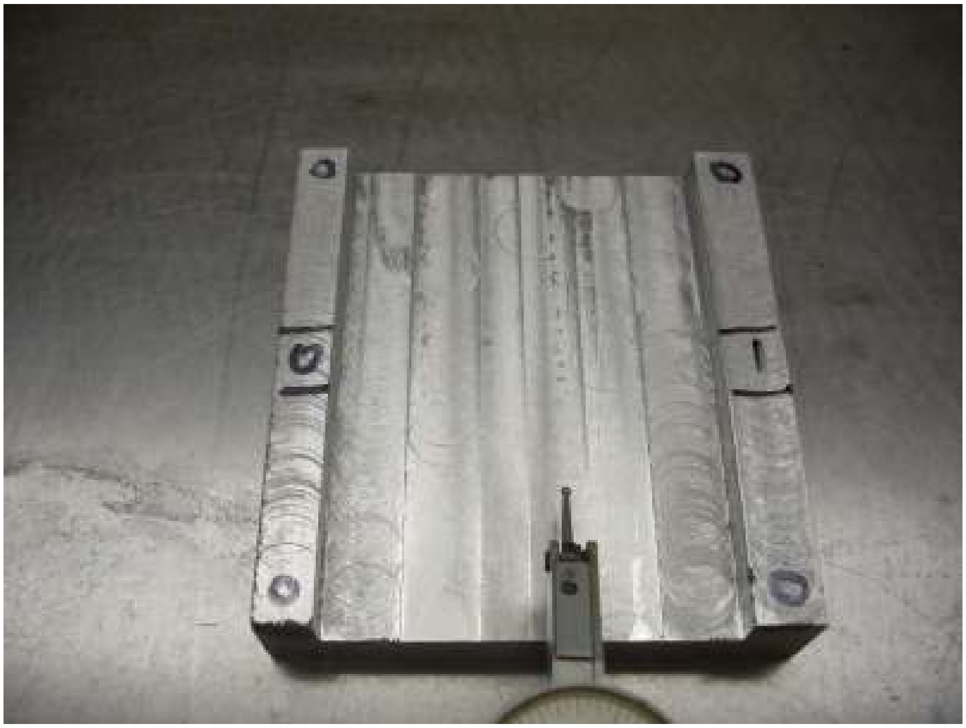
I cut both wear pads about 5/8” wide and then milled the relief depression about 0.02” deeper.

I have machined castings like this many times but still check the resulting part before declaring success. Good that I did because the clamp supports were out of true by 0.012”! I must have missed a speck of swarf under the casting. Oh well, back to the mill. At least I had the sense not to tear down the set up until the part was tested.



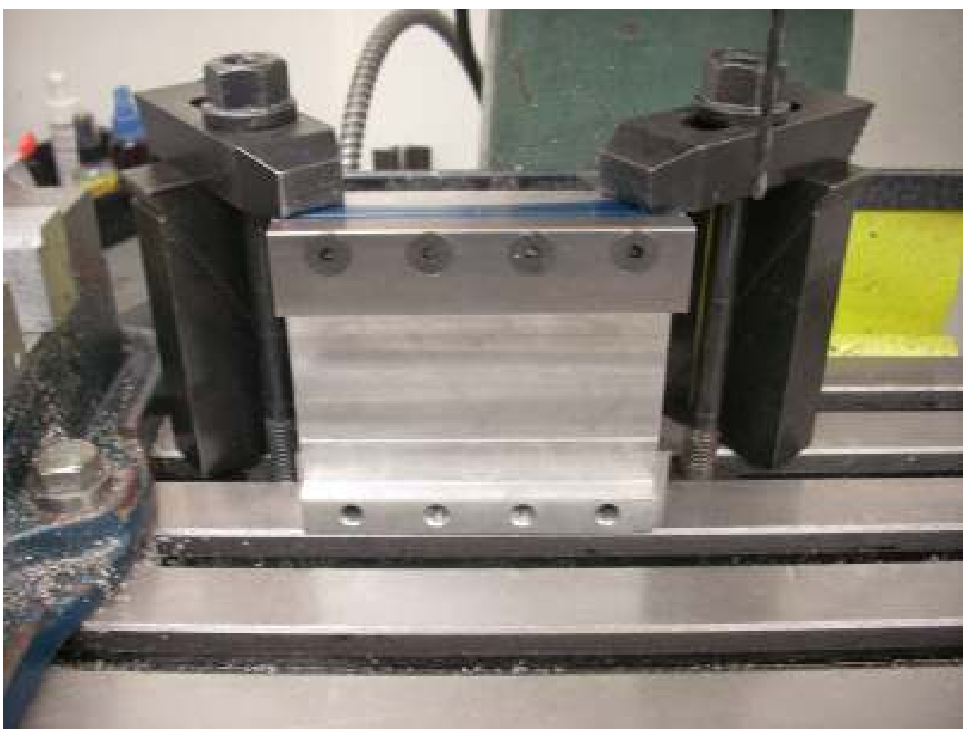
Here is the full story. The top right corner is my reference. Moving along the top pad I am high by 0.010”. The wear pad is off the same amount which is no surprise. Coming across to the other pad you see that I am off by the same amount. This says that the right edge of the casting was raised up by some debris.

Moving to the lower right corner I'm up 0.015” so the castings also had a little twist too. Fortunately I have plenty of metal here so will just re-machine this face.



This time I got 0 along the left clamp pad and across the right clamp pad. Zero was set at the near end of each pad. I then ran the DTI from left to right in the center and saw 0.001” difference. This says each pad is true with respect to primary reference plane 1 (the back of the casting) but the right pad is slightly higher. This is not a problem since shims are placed between the clamps and the clamp pads.

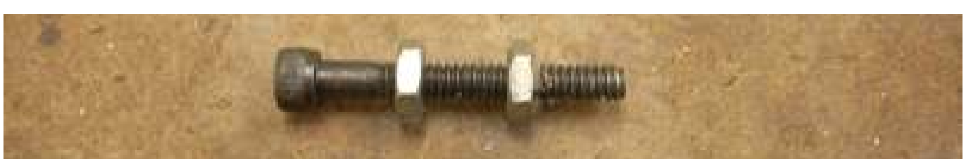
The clamps are match drilled to the casting. I had to be very careful not to drill too deep or I would damage the table.



The casting is placed on primary reference plane 2 in preparation for drilling and tapping the gib screw holes. The top clamp is left in place to help support the thin wall between the hole and the top of the pad. The bottom clamp was removed to insure that the table is in full contact with the casting. The back of the casting is pressed up against the soft pads.

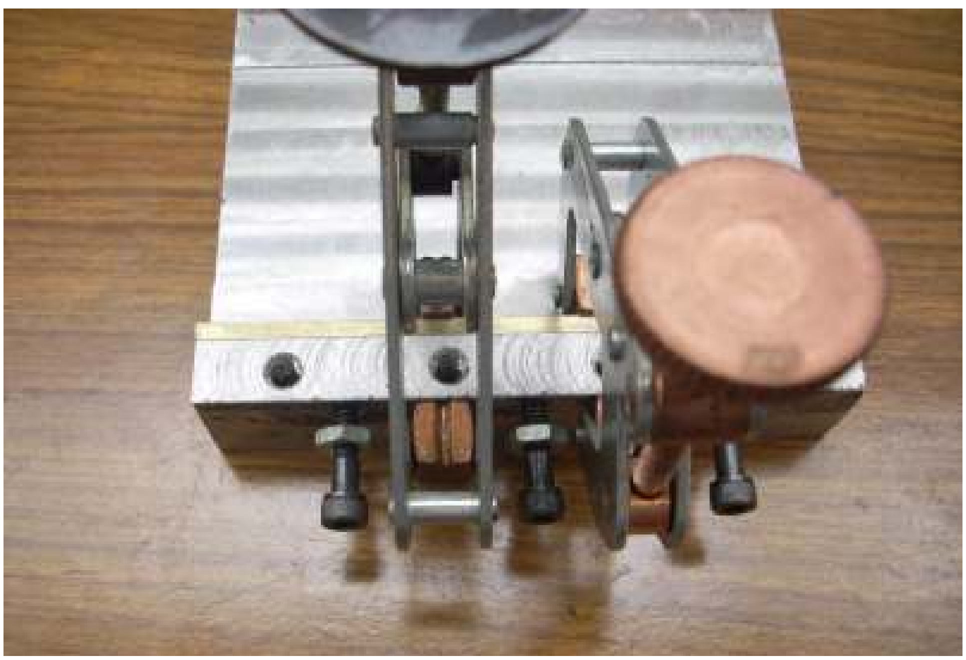
Nothing goes along smoothly for long in my shop. I misjudged the energy needed to tap this 10-24 hole. The tap went half way through the side of the pad. Fortunately, the thread that was left was not damaged. I was just too used to tapping 1/4-20 and larger holes.

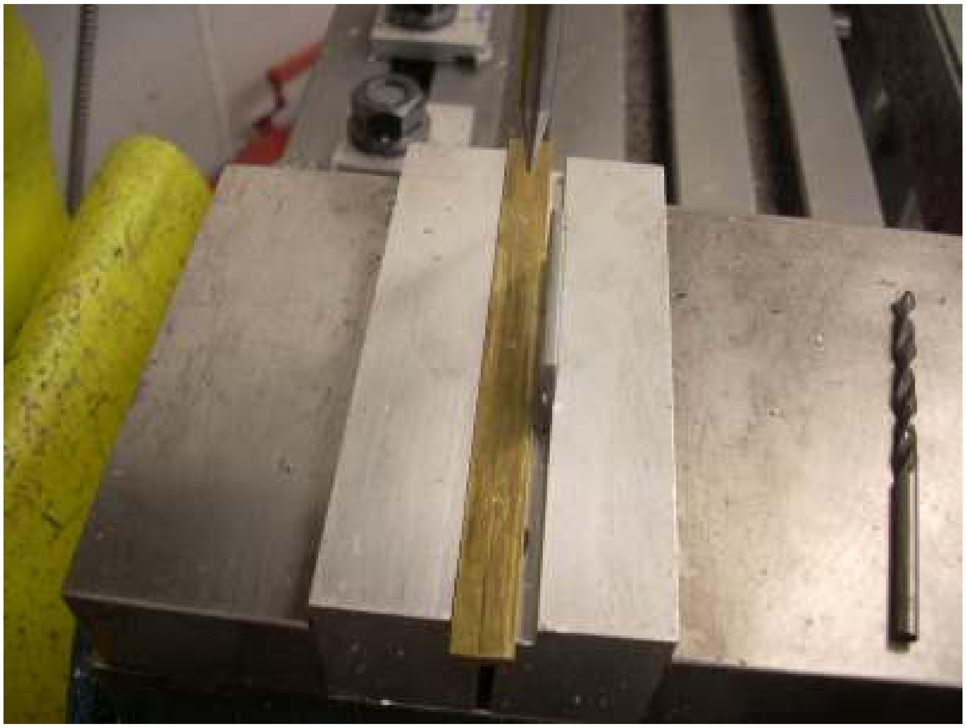
The rest of the holes came out fine.



The gib screws need to be shortened and pointed. Split 10-24 nuts are fitted to each screw and the assembly clamped in the chuck on my lathe.


Light cuts are required given that these split nuts do not grip the bolt very tightly.


The gib is clamped to the pad and the gib screws fed in enough to scribe their locations.

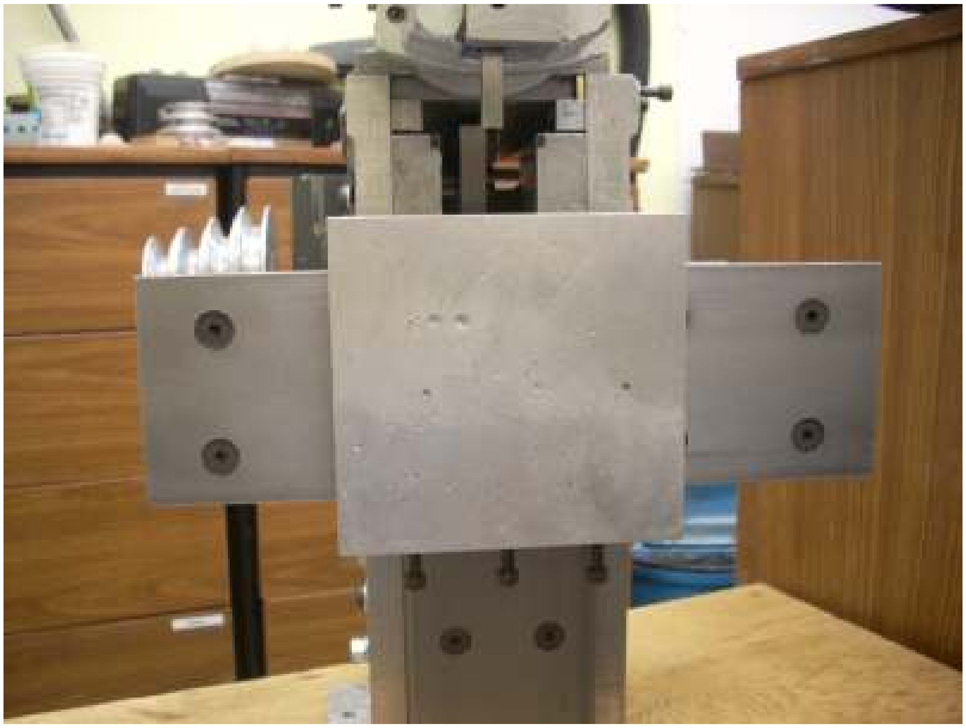


The gib is placed in my vise and a spud used to locate the marks for drilling. A cone shaped dimple is cut about half way through the gib.

A second gib faces the other pad. I'm using a piece of scrap CRS to hold the gib in place while Locktite® sets up behind it. The gib screws apply the pressure.

I'm using the clamp as my template for marking out the first shim. You can barely see the circles made by my scribe.

An industrial strength paper punch easily goes through the shim. I then use scissors to separate the strip from the rest of the sheet.



A trial fit of the cross feed support and cross feed slide looks good. I had to file a tiny ridge off of the cross feed plate but otherwise all worked the first time.

Fitting the Cross Feed Drive

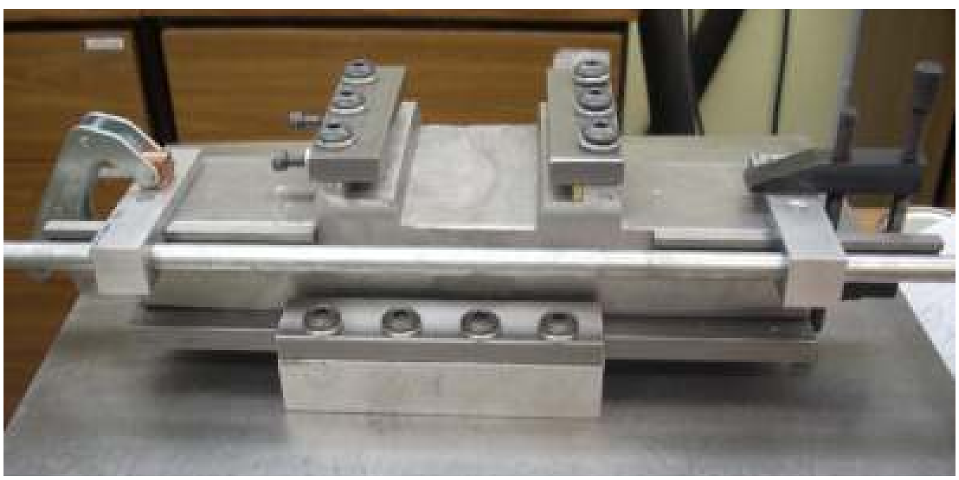
My first impulse was to cut the cross feed drive link. Rather than make it from 1/16" sheet metal I used 1/8" aluminum that was on hand.

I wasn't sure where the mounting holes would go so waited to drill them until final fit up.

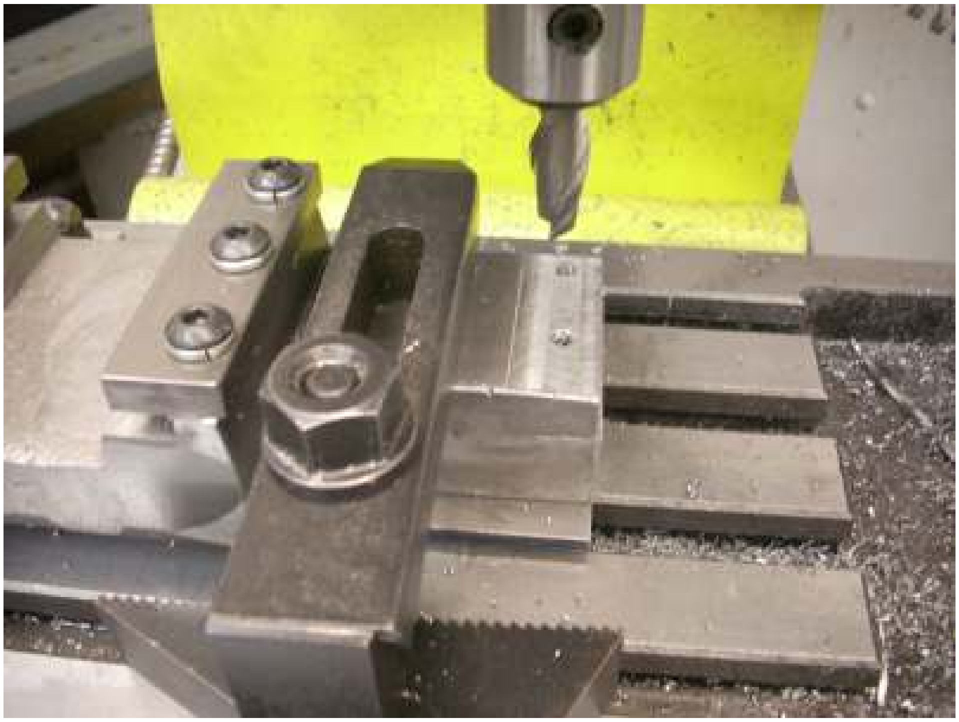
The position of the bearings was adjusted until the side face of the nut lined up with the edge of the cross slide.

Note the ¼” wide parallel providing a precision offset for the bearing block.

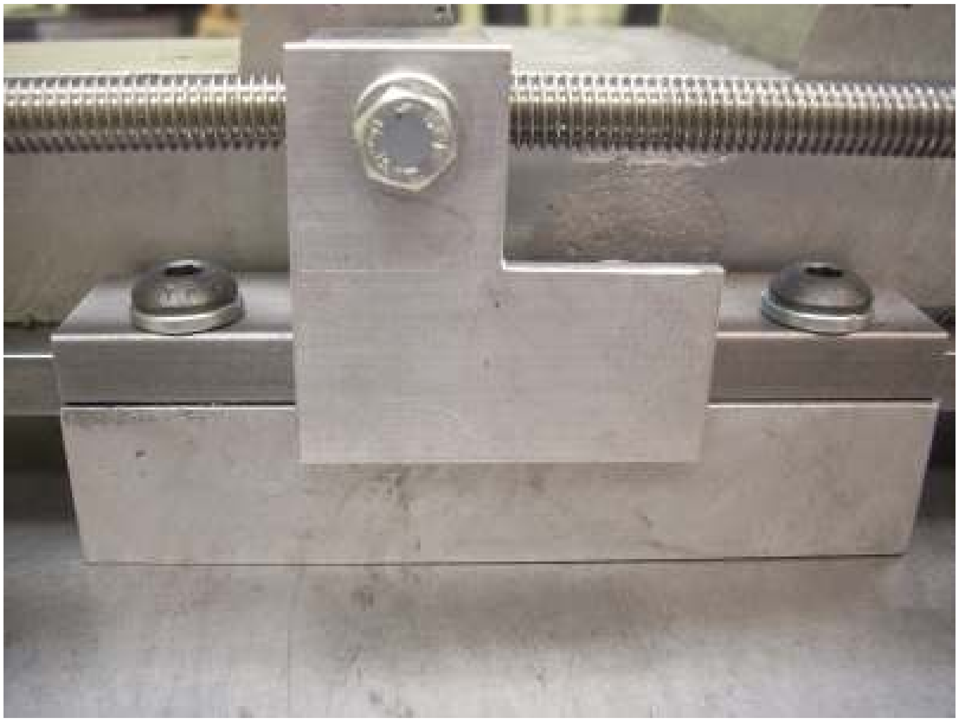
A length of straight 3/8” rod was used to align the two bearing blocks.



What could go wrong? Isn't everything aligned now? Nope. With both bearings clamped down, the rod bound up. One problem was that the mating surfaces were not machined and there was about a 0.005” difference in height between them.



After removing the cross slide, I mounted the assembly back on the mill and took a light cut on the cross slide support in the area to be in contact with the bearings. That helped a lot. Four screws with split washers were installed and the bearings were done, or so I thought...

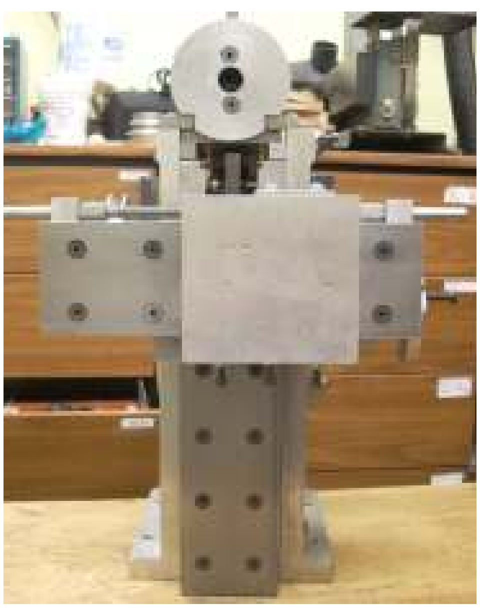


Well, the cross feed drive link didn't fit. Time to make another one.

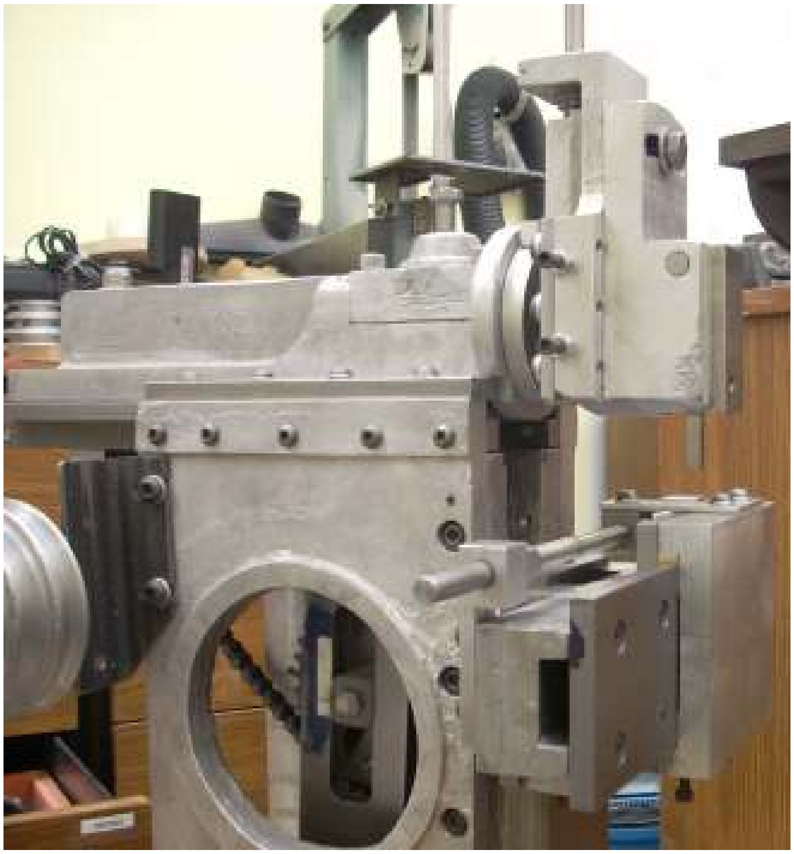
As the cross feed drive came together I realized there was a design flaw. The system was “over constrained”. This means that too many support points were fixed and the result was lots of binding of the drive. The first thing to realize is that the only motion that counts is the one along the cross slide. Small motions perpendicular to this axis don't matter. The cross feed drive assembly was not perfectly straight and the nut moved up and down about 0.01”.

My solution was to turn the nut attachment hole into a slot. A spacer was also machined so the screw was not clamping the cross feed drive link. About 0.005” of shim stock was placed between the cross feed drive link and the cross slide in order to center the link on the spacer.

A final concession to a less than perfect cross feed drive was to make one of the bearing holes 0.002" larger in diameter. That was enough to give me a smooth cross feed drive action. I do have about 0.005" of backlash from the slotted hole in the drive link. If necessary, some of this can be taken out by making a slightly larger diameter spacer.



As a final step, I wrapped some copper strips around each end of the drive and clamped on with a pair of Vise-Grips®. It was then possible to adjust the coupler nuts to a sliding fit against the bearing blocks and lock the end rods into the threaded rod. The action of tightening the end rods into the couplers helped the assembly straighten out so there was only about 0.005" of perpendicular movement of the nut.



Notice that the cutter can be place far enough back to plane the table when it is attached to the cross slide.

The vertical screw assembly will be built next.

The monsoons are not over yet so it is not safe to run my furnace. When I can be assured of a few days without rain, I will cast the 3 cranks. One of these cranks goes on the down feed. It will then be possible to finish designing the down feed collar and dial assembly. The other two cranks go on the cross feed drive rod.

If I can't do casting, I'll work on the shaper's table. It will be a welded cube of 1/2” CRS plate. I've been collecting many great ideas that will let me tilt the table, have a choice of hold down bolt sizes, have an integrated V groove, and a front support that will always point down. Long stock clamped in this V groove can extend down below the shaper's base when the groove is oriented vertically. Should be fun making this all work.

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