Mill Vise Soft Jaws

Version 6

By R.G. Sparber

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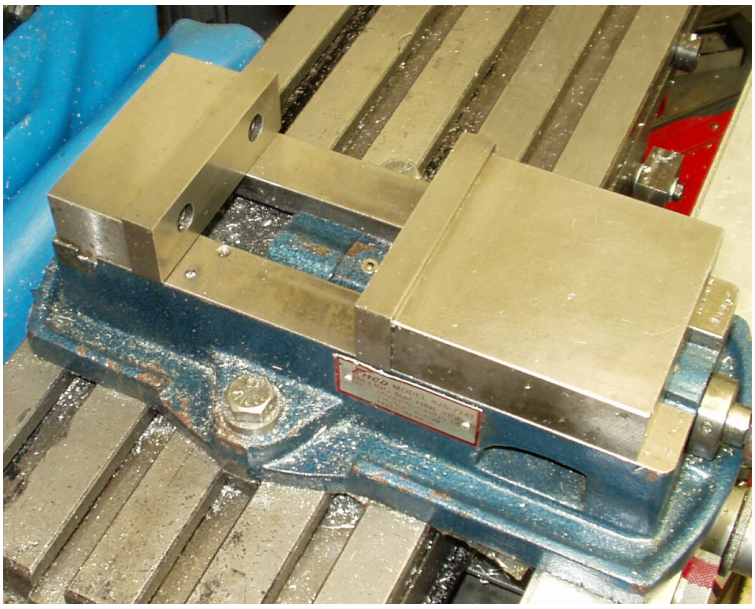
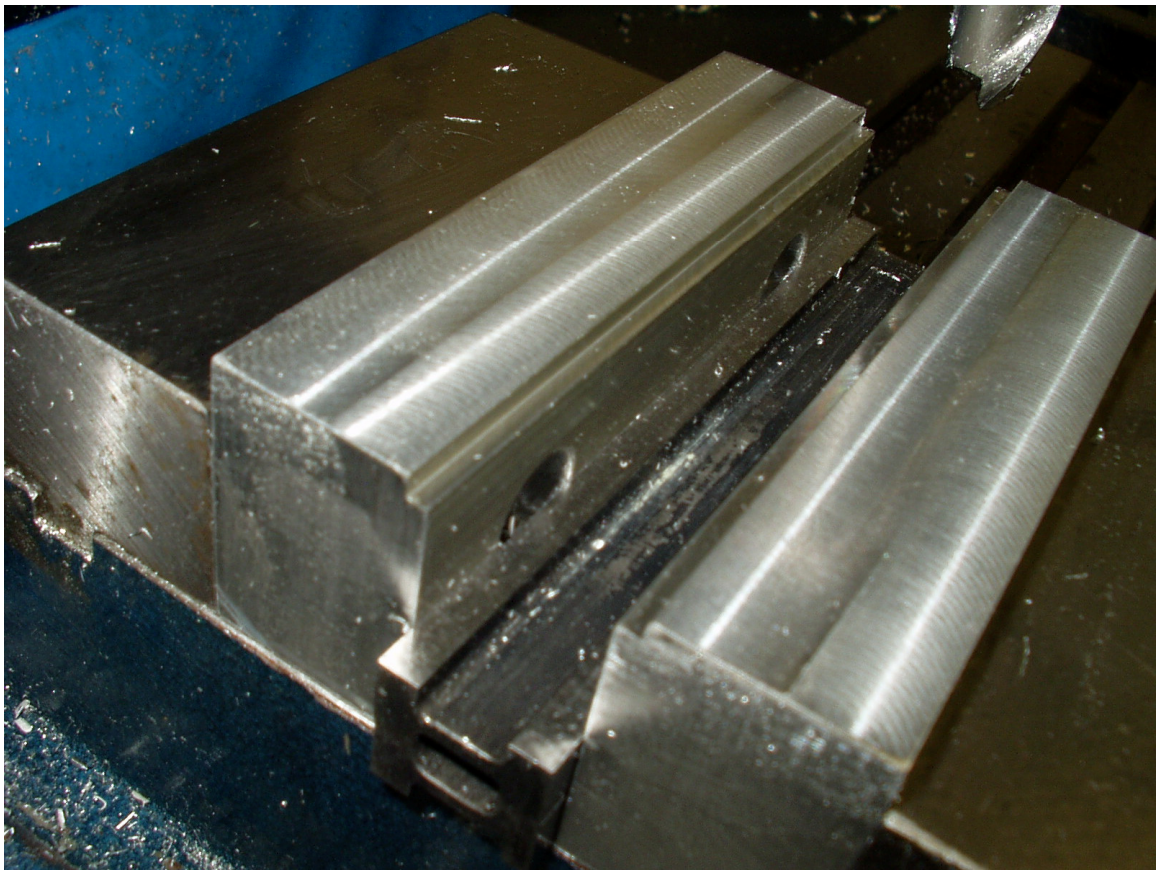


For over 15 years I have used my Enco® copy of a Kurt® vise with a good measure of success. Using my modest selection of parallels, I have been able to accommodate a variety of parts for machining.

As my desire for more accuracy increased I became unsatisfied with my parallels. Two were bent .002" from a lack of understanding and too heavy a hand on my dead blow hammer. Others were of poor quality, which became evident when I started to look at errors under .001". I mentioned my frustration on Kurt Daubieone's "3_in_1_Lathe_Mill_Drill" Yahoo group and was greeted with enlightenment from "Rick aka ussca". He suggested I forget about using parallels and go with soft jaws. It did not take long for me to appreciate this sage advice.

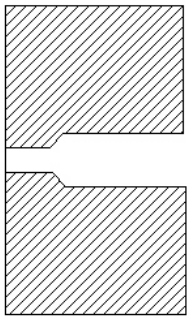
The hardened steel jaws pictured above came with the vise and hold work just fine. The problem that is solved with soft jaws is the ability to improve on the parallels while securely clamping the part.

Lets first look at my finished soft jaws and then discuss why they work so well to provide precision support for parts being machined.

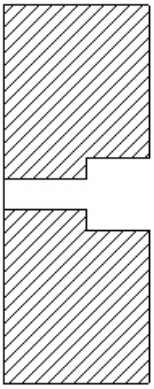


They jaws were cut from 6061 aluminum and were designed to fit my particular vise. They were made from stock that was already as square as I could cut. All I really had to do was square the ends and knock a few holes.

My steel jaws were about 1/2" thick but I happened to have 1" thick aluminum. This permitted me to have more room to cut into these jaws in the future. The steel jaws have two counter bored holes for the securing bolts. At the bottom of the counter bores is .2" of steel. Since I am now using aluminum, I chose to increase this thickness to .4" to help compensate for the weaker material. The steel jaws had through holes about the diameter of a "V" drill and a counter bored hole of about 1/2".



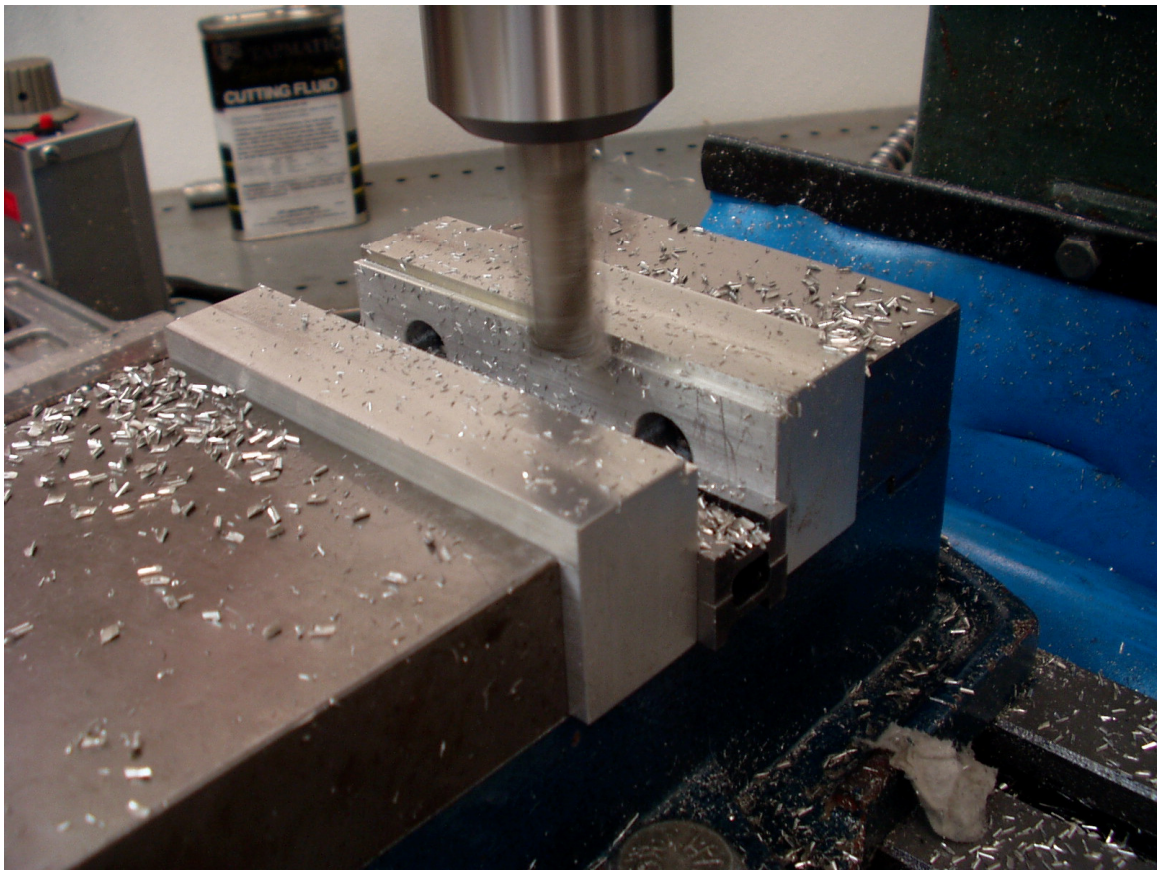
They used a drill for the counter boring which left a sloped surface for the bottom of the bolt head to hit as can be seen in this cut away figure. That can't be good.



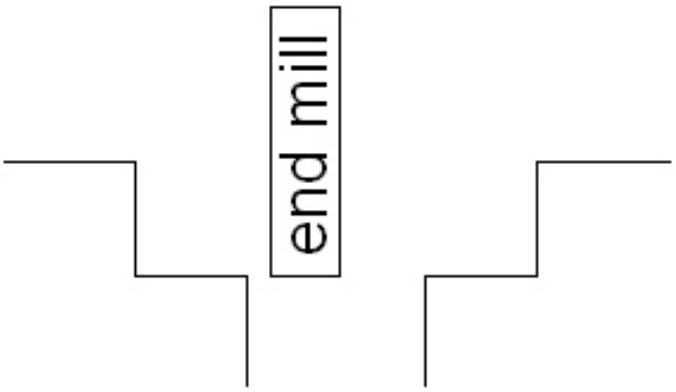
After center drilling, I used my V drill but then used a 1/2" end mill for the counter bore. In this way the bottom lip was nice and flat.

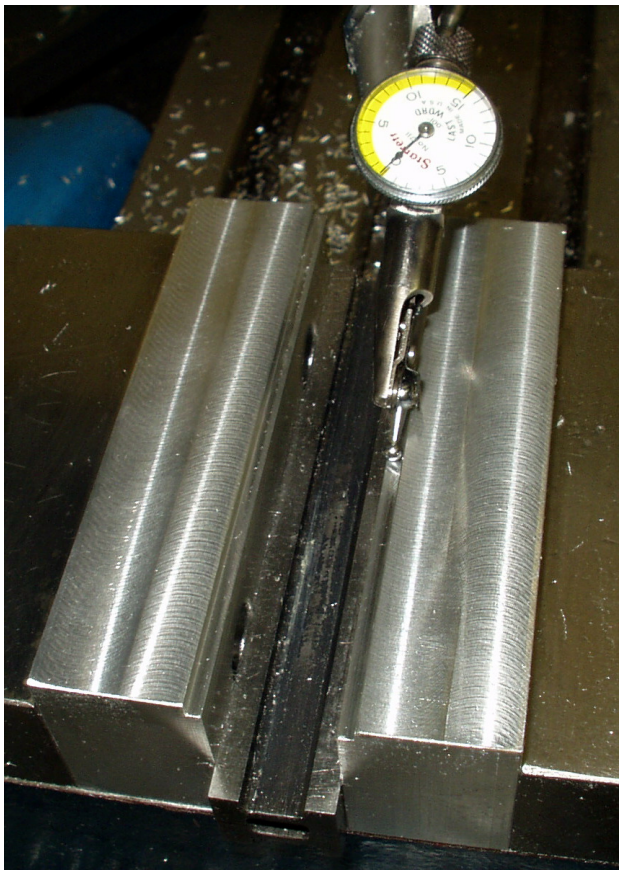
All surfaces were carefully deburred and cleaned before the jaws were mounted. I didn't want anything to prevent a solid fit.

Note the little steps at the top of the jaws. These steps perform the job previously held by my parallels. They are cut in place with the jaws clamping something with about the same width as the part to be held for machining. This spacer is often called a "jack block". In this way the movable jaw's position in the vise is the same as when in use. Variation in the vise is thereby minimized.



Here you see the finish cuts being made. My rough-cuts were .095" deep and .095" wide. Both jaws are cut at the same time. Then I lowered the cutter by .005" and moved into each jaw by .005" to make my two finish cuts. Deburring in place and cleaning all surfaces finished the job.





Since the step is cut in place, it must be dead true. The bottom of the step must be parallel to the table while the vertical part must be parallel to the X axis. If the mill's head is property trammed, the vertical part should also be parallel to the Z axis. Just to convince myself of this fact, I ran my Dial Test Indicator along the bottom of both steps. The needle did not budge until it fell off the far end. Both steps read the same within the accuracy of my DTI.

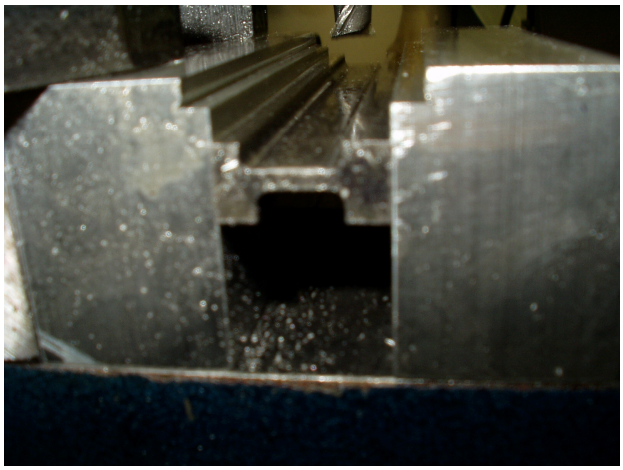
For critical jobs, these steps are lightly re-cut just before use. Do a good job of deburring the newly cut surfaces and then cleaning them.

If the soft jaws are removed, it is a simple matter to re-cut these steps. Eventually they will get chewed up since they are only aluminum and not hardened steel. No matter since making a new set is a quick task.

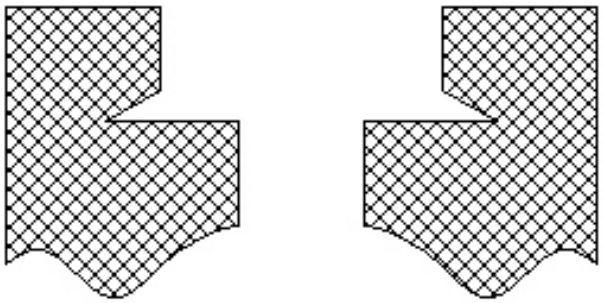
I have only explored using the soft jaws to replace parallels. They can also be cut to hold odd parts but I have not done that yet.

Since the initial publishing of this article, many improvements have been suggested plus a few discovered by me.

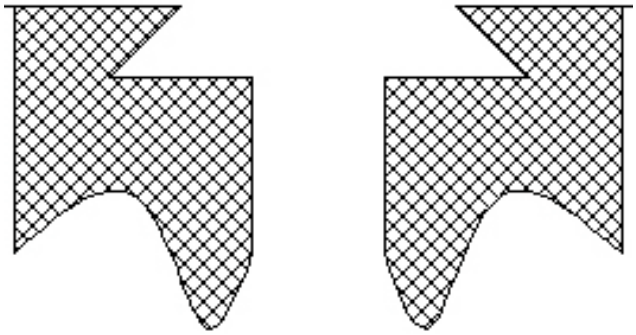
1. Many people suggested that it is best to place the jack block near the top of the soft jaws. The forces on the jaws are the same during machining of the steps as when the part being held is machined. This minimizes any error associated with the position of the movable jaw on the vise ways.



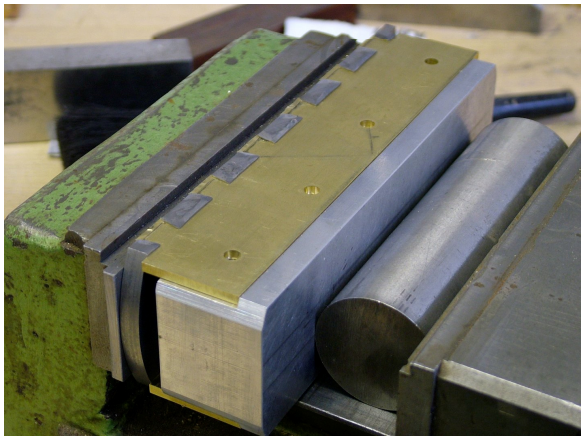
2. Ian suggested I cut the horizontal surface of the steps with a dovetail cutter. It will cut a relief in the vertical face. Then follow up with an end mill to true the vertical faces. The relief avoids the fact that a step cut with an end mill will most likely not have a perfectly square corner. Any curve at this corner will prevent a square cut part from being clamped solidly on the vertical and horizontal surfaces. A work around is to put a bevel on the part being clamped. It may be possible to cut a relief with a hacksaw but I did not have much luck. The blade damaged my surfaces and did not cut very deep.



3. Ian uses a dove tail cutter to form the steps such that he gets a profile with built in hold down properties. Any plate that is thin enough can be captured under this bevel and will be pulled down onto the flat of the step.

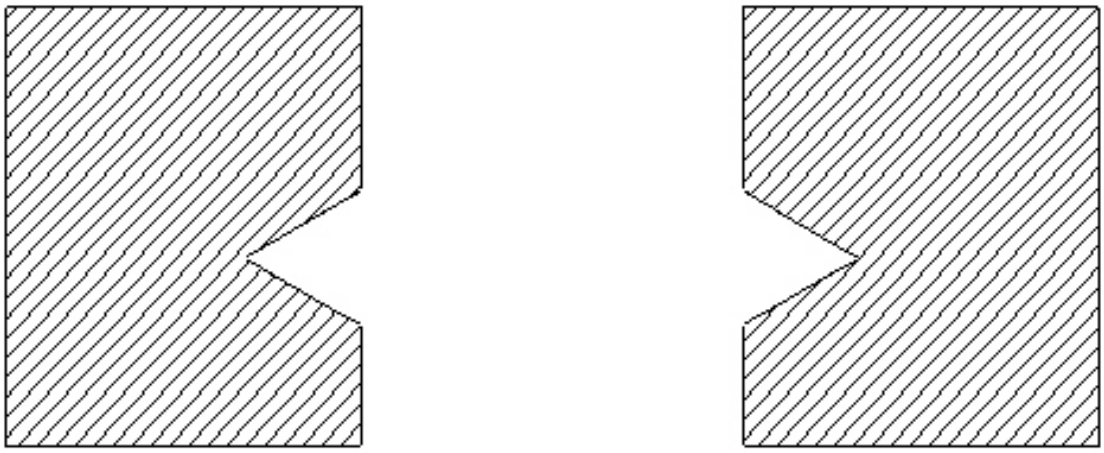


The picture shows a brass plate being held at the movable jaw side with an aluminum block cut with a dove tail lip. The round bar between this block and the movable jaw permits the block to rotate slightly as it finds the best fit.



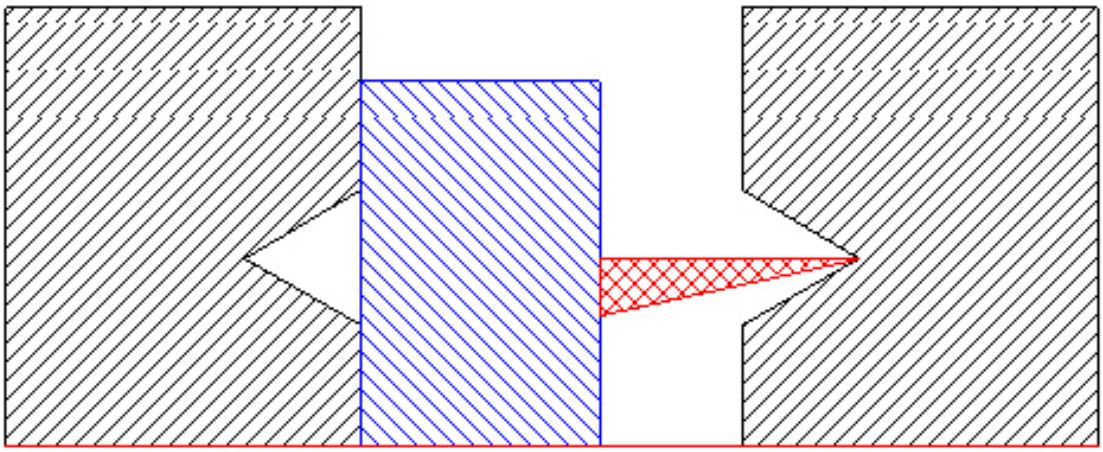
4. Ian also talked about using two identical vises placed side by side that shared the same fixed jaw. He is able to clamp large plates with this extra long jaw.
5. Les Harris suggested I run a drill into each end of the fixed jaw and tap the hole. A block of metal with a hole in it can then be bolted to either end of the jaw to provide a stop for any part being clamped.
6. Les also suggested cutting a V groove into the fixed soft jaw so it can hold round stock. If your mill head can tilt the end mill forward 45 degrees, this could be done in place. Otherwise the jaw must be removed, cut, and reinstalled. That will sacrifice some accuracy.
7. Martin expanded the discussion to address using soft jaws on the lathe. If your 3-jaw chuck has two part jaws, you can replace the top part with soft jaws. It is then possible to machine the soft jaw faces such that they run perfectly true. Just be sure to clamp something in the jaws of the same diameter as you wish to hold with the soft jaws. This spacer bar must be deep enough in the jaw so the cutter can get to the jaw faces. Then cut the soft jaw faces. Remove the spacer rod and clamp the part to be machined.

8. An idea from a person on the Home Shop Machinist BBS involves turning any vise into a hold down vise. We start by cutting a pair of soft jaws such that they have horizontal V grooves in them.

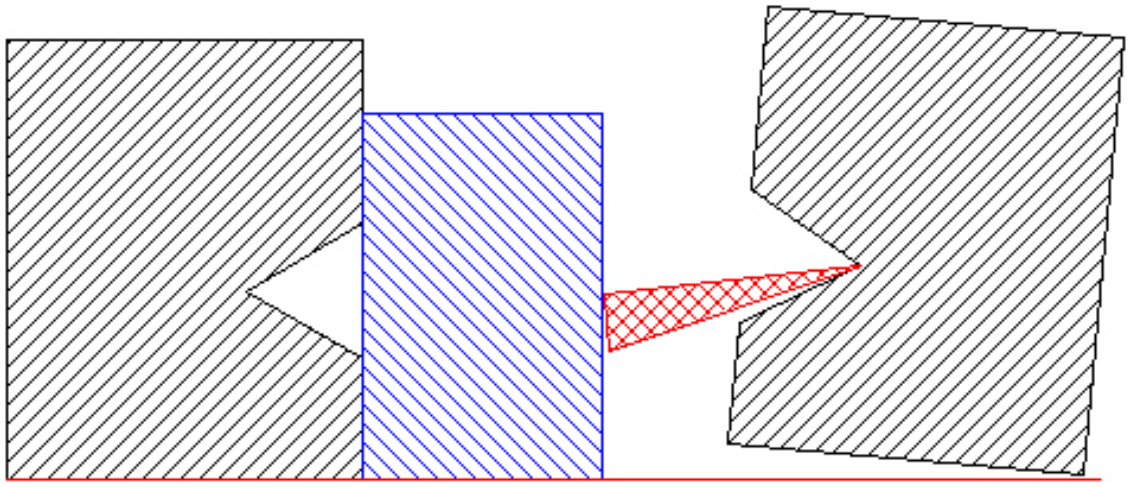


This is a side view of the fixed and movable jaws.

Then we cut 2 or more blocks with a right triangle cross section. They are used to hold down the block being cut.

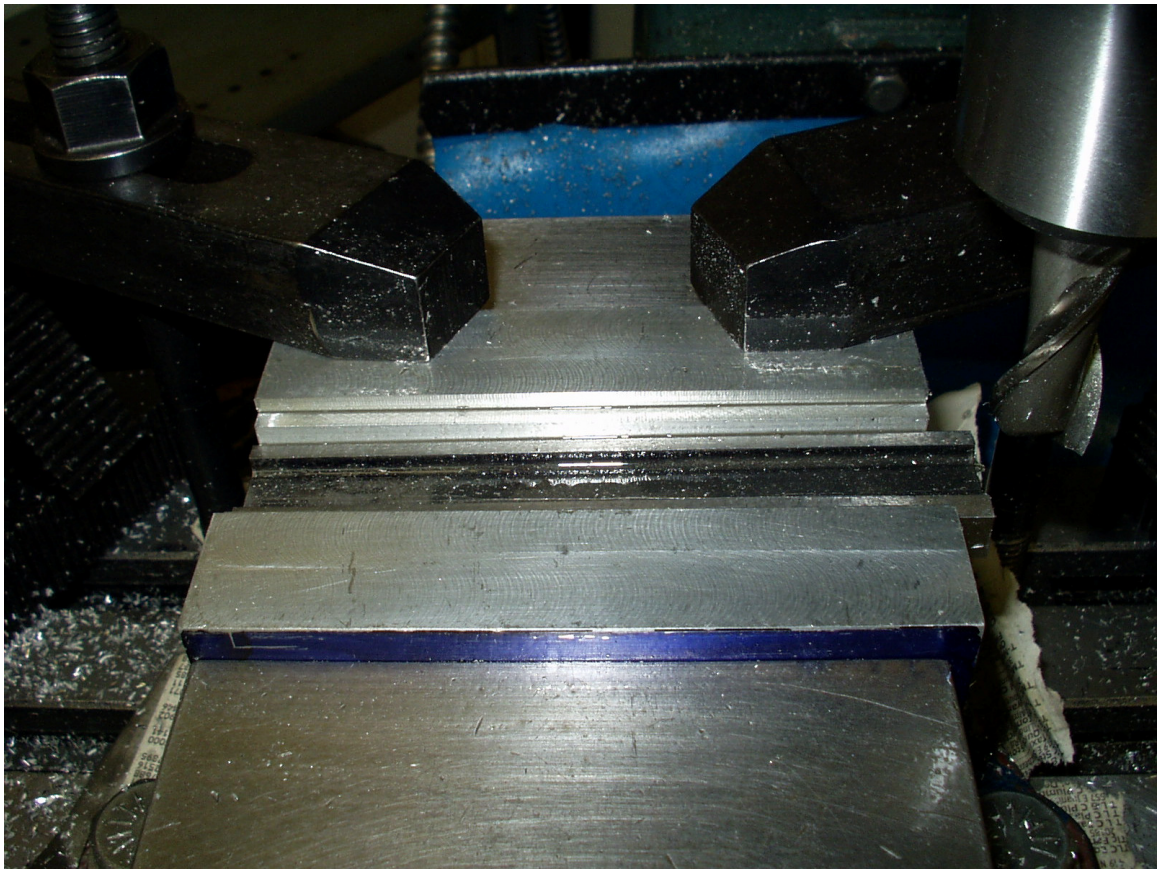


Look what happens when the movable jaw, on the right, starts to ride up.



The rising of the movable jaw causes the triangle block to tilt down. This downward force combined with the closing force of the vise will tend to hold the block against both the fixed jaw and the vise's ways.
Typically you would use one or two of these triangle blocks between the movable jaw and the block being cut. In some cases you may choose to put them between the block and both jaws.
I later learned that you don't need to use triangle blocks. A rectangular cross section works too as can be seen below. The author of this picture has placed a pile of feeler gages under the edge of the movable jaw to show how much it has lifted up.

9. This last addition is from me. As I looked closer at how a test cube was bedded into my soft jaws I discovered that the block behind the fixed soft jaw was lifting up about 5 tenths. The fixed jaw block was actually rotating with the top lip moving away from the movable jaw. I removed the fixed jaw support block, checked for burrs and cleaned all surfaces. Then I bolted it back in place. I still saw the same problem. Then I got mad. Taking out my largest hold down clamps, I put solid pressure on the top of the fixed soft jaw. This was done by first setting the soft jaw bolts to finger tight. Then I put light pressure on the top to be sure the soft jaw was bedded down on the vise ways. Finally, the bolts and hold down clamps were fully tightened. That did the trick. No more lifting as verified with my Dial Test Indicator. Sometimes brute force is the right answer to precision. And for a just a little bit better control, I used a



torque wrench when clamping the jack block and recorded the applied force. Then when I went to clamp the block to be cut, I used the same amount of torque. Over tightening can cause distortion and error.

This article resulted from advice given to me by "Rick aka ussca" of the Kurt Daubieone's "3_in_1_Lathe_Mill_Drill" Yahoo group. Additional details were supplied by Brian Lamb and Russ Huffman of the Valleymetal club of Phoenix, AZ.

If you have experience with soft jaws, I'd like to hear from you so this article can be improved. All of us are smarter than any one of us.

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