A Lock-down Vise, version 2.4

By R. G. Sparber

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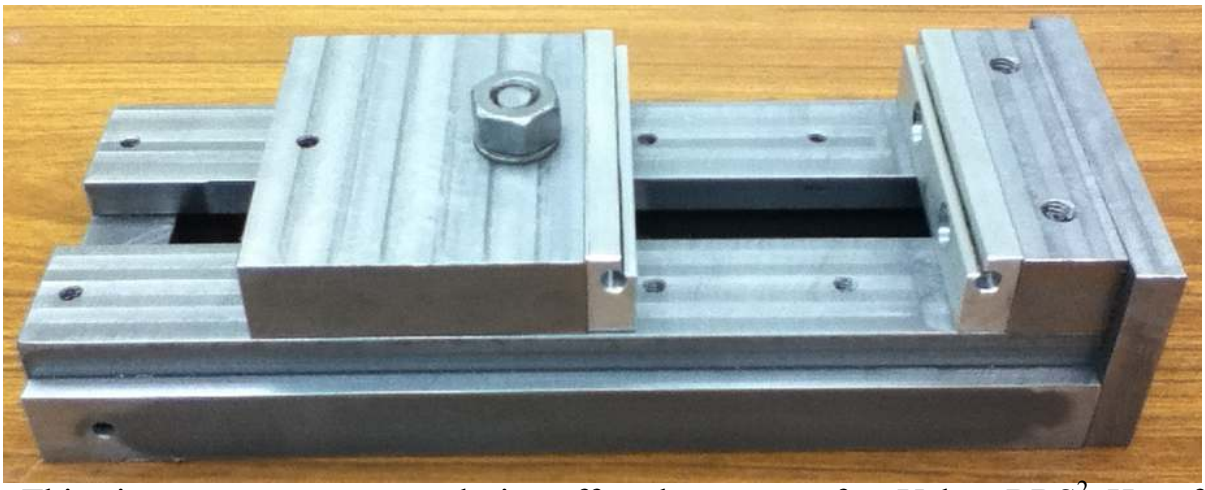


This vise represents a group design effort that spans a few Yahoo BBS[2]. Hopefully I have included all contributors in the Acknowledgement section.

The vise is 4″ wide at the top of the ways and 12″ long.

There are a few key design elements here. The most important one is that almost nothing is measured. Accuracy comes from match drilling[3] and machining after assembly. I have supplied detailed shop procedures that contain the strategy.

The design simulates a Kurt® type vise in that there is a horizontal and vertical force at play during clamping. However, in our design the forces come from separate and perpendicular screws while in a Kurt there is one screw which has its clamping force split into horizontal and vertical components.

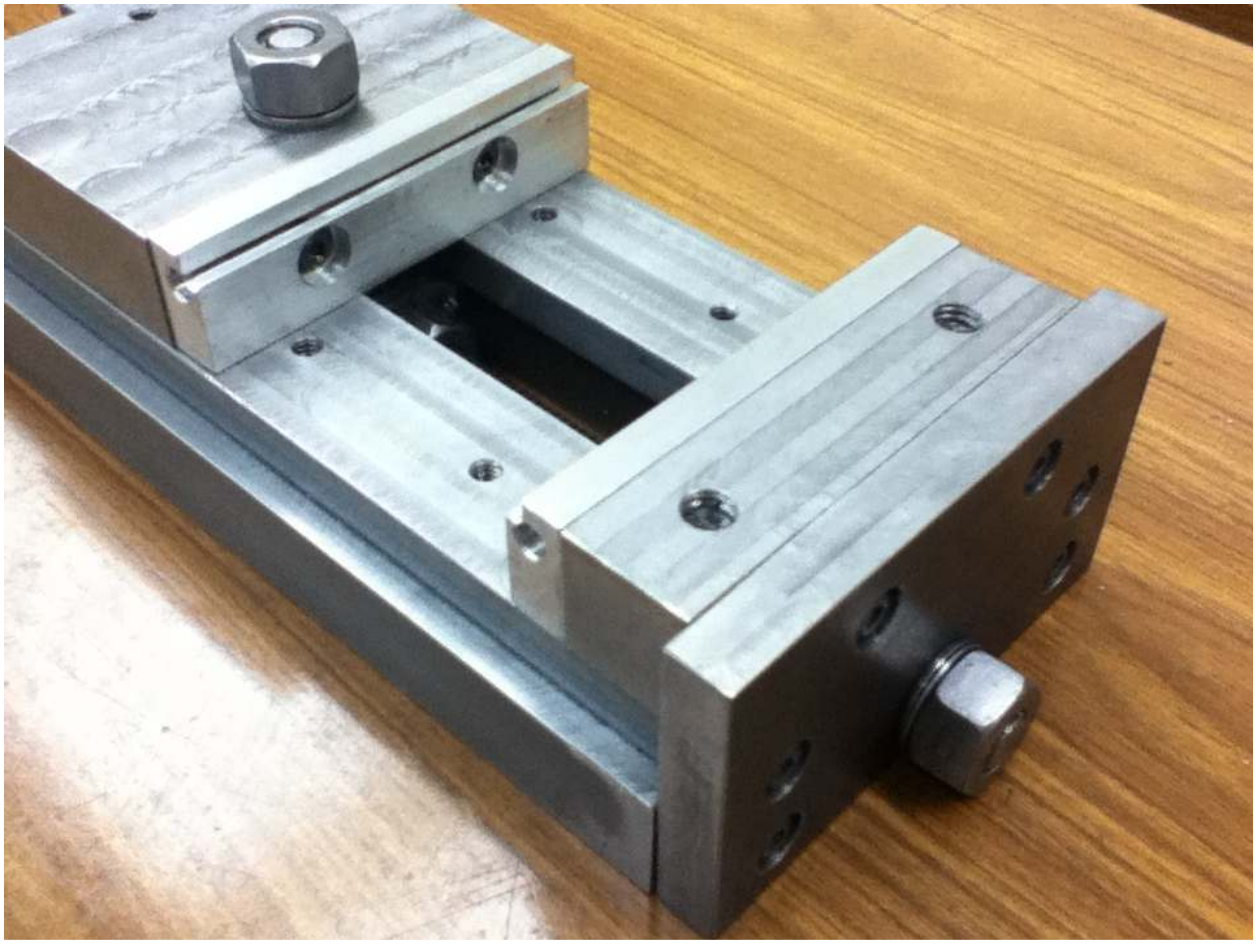
[1] You are free to copy and distribute this document but not change it.
[2] See http://rick.sparber.org/sv.pdf for background plus the theory behind this vise.
[3] Match drilling is the drilling through an existing hole into material below it. In this way the location of the top and bottom holes must be exactly at the same location.

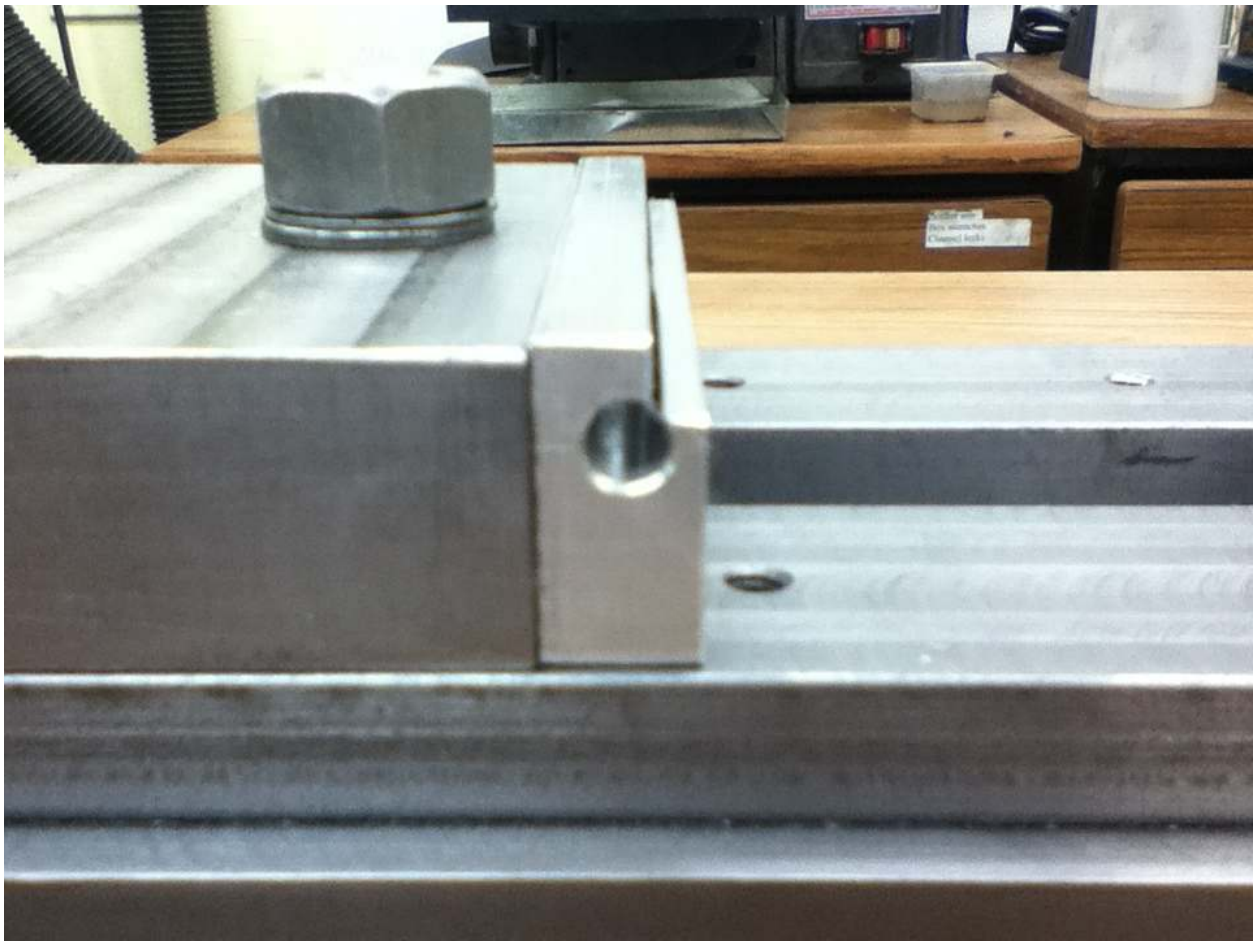
The softjaws have their vertical and horizontal contact surfaces separated by a hole that was drilled down the length of the bar stock. As these surfaces are re-cut over time, they will remain separated.

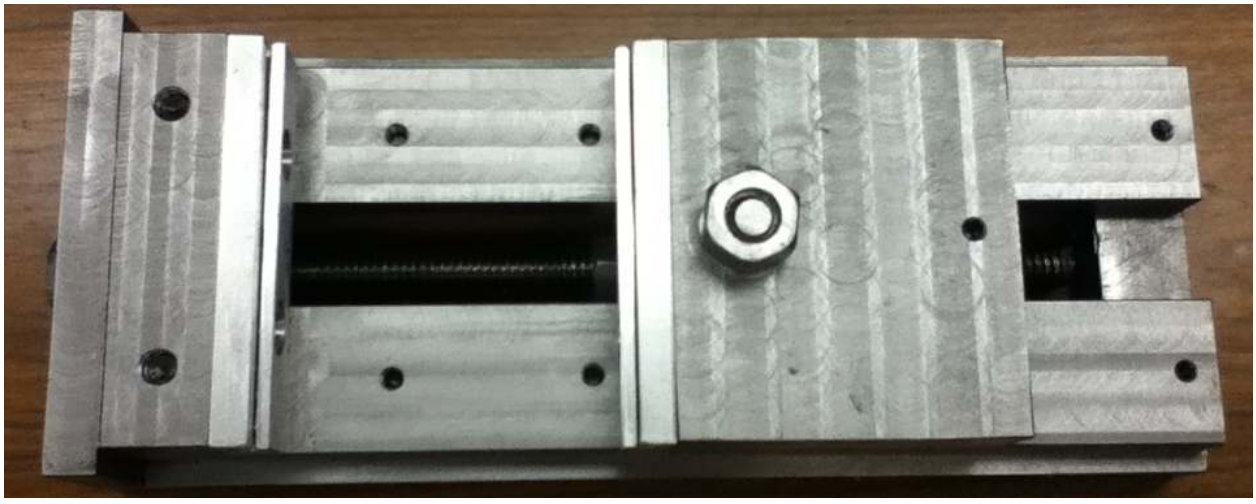
Most vises are arranged so the clamp screw pushes on the movable jaw. In this design it pulls on it. I believe this makes for a simpler design with the clamp screw supported only at the end plate and inside the movable jaw. It also avoids the problem of the screw bending due to compression.

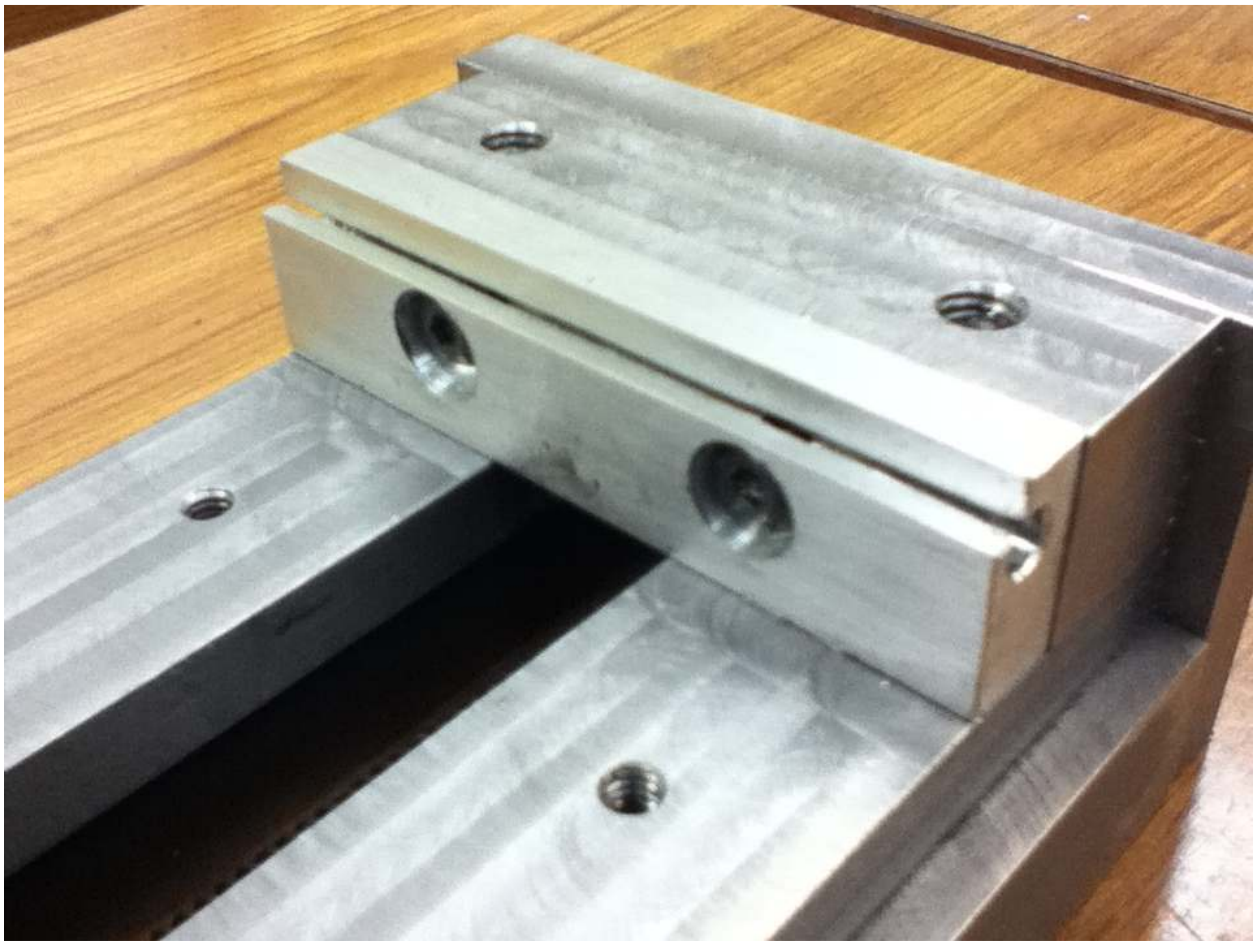
The length of this vise was chosen to be 12″ because all bar stock came in that length. You may find that a shorter vise is more useful.

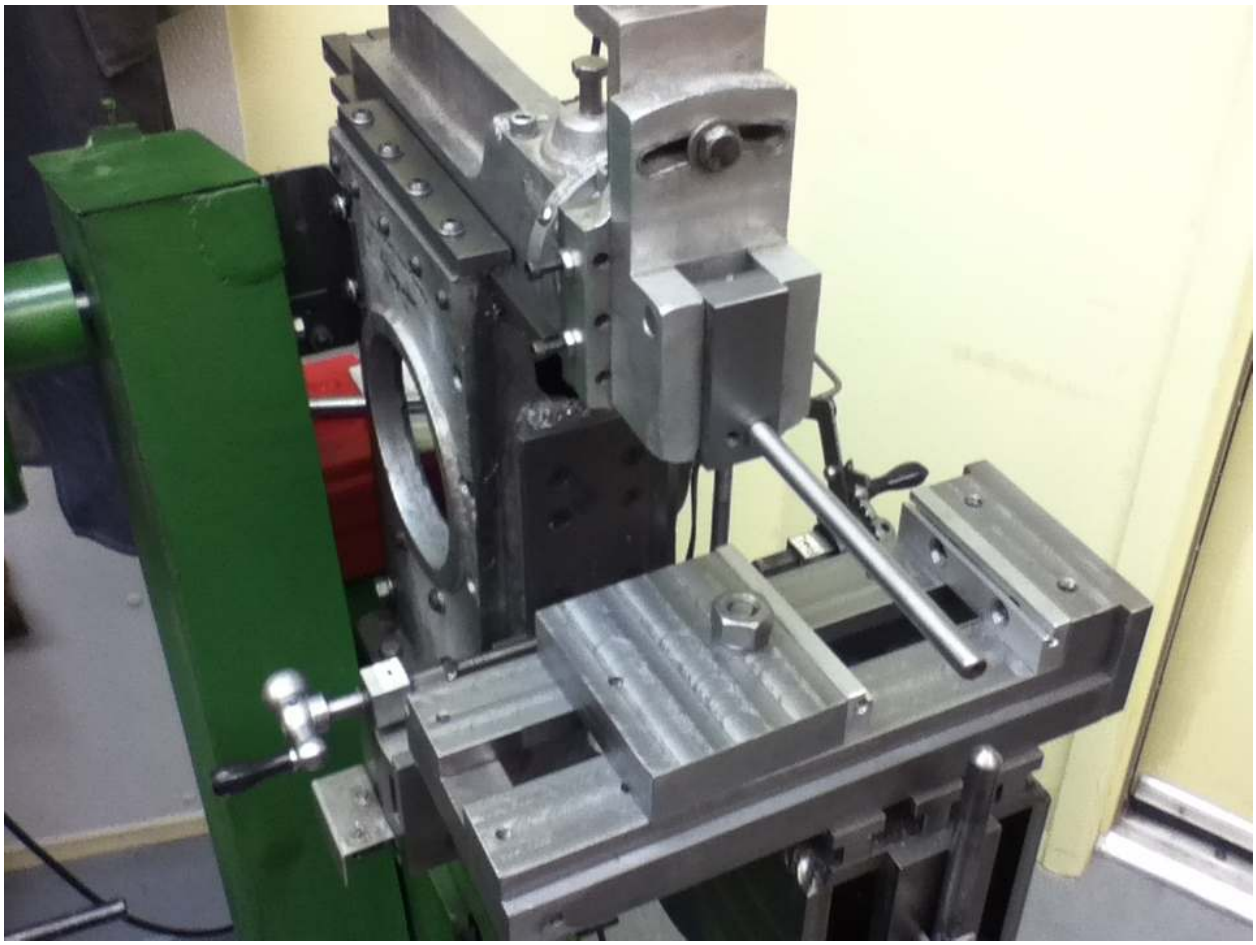
Before diving into the shop drawings and procedure, here are a few pictures of the vise.









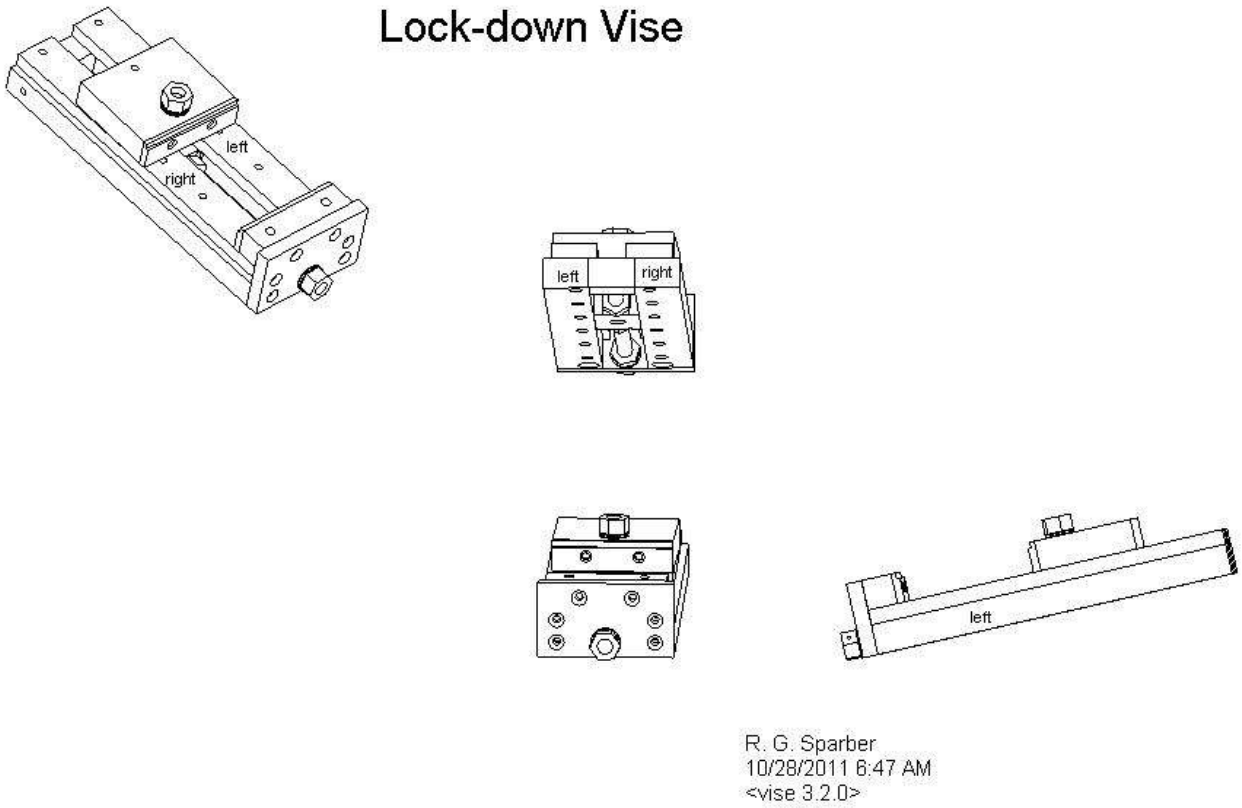


The soft jaws are cut in place for maximum accuracy.

I have yet to run bolts through the vise ways and into T nuts inside the table. Note that the vise is positioned 90° from most shaper vises. It can't fit the other way. I can clamp a part the same size as the maximum capacity of the shaper.

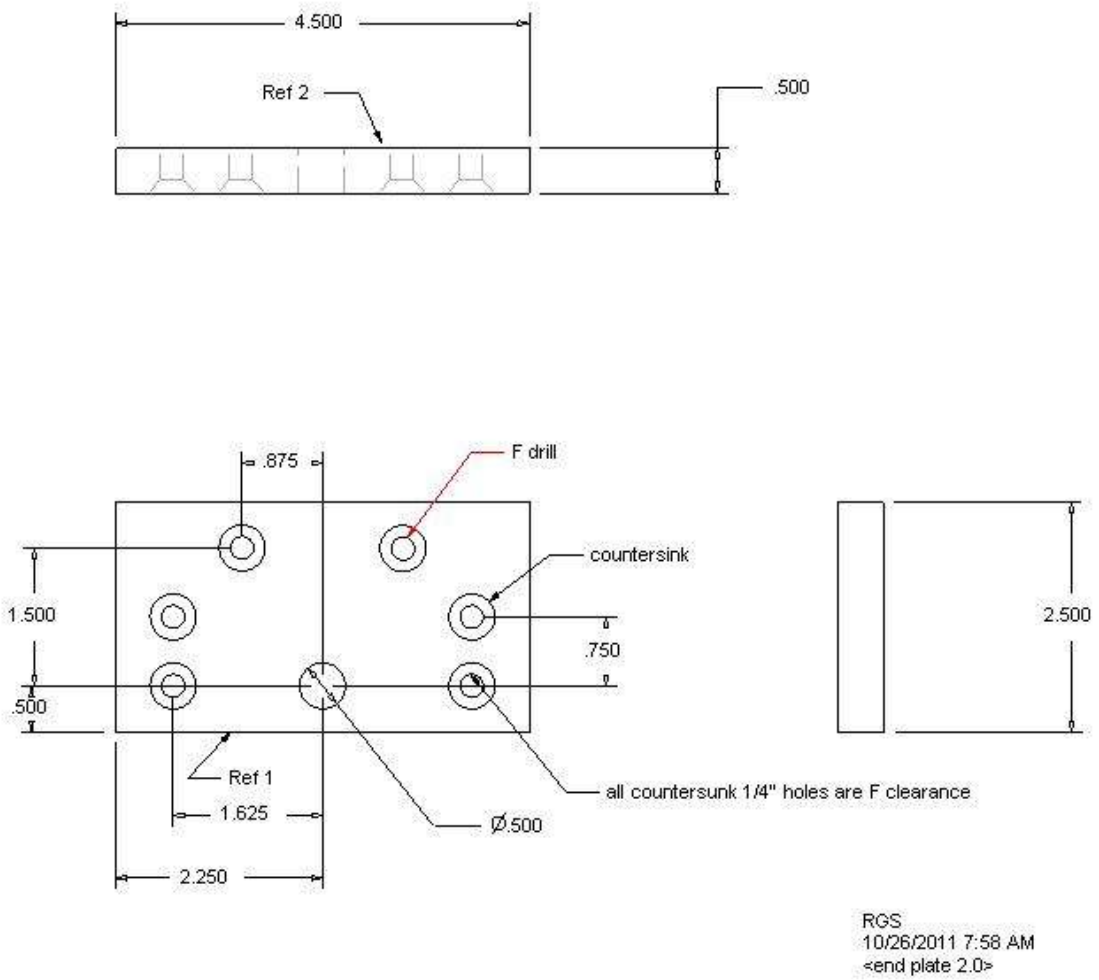
I will first present the shop drawings and follow them with my shop procedures.

Shop Drawings



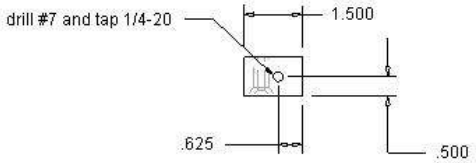
These views may help you during machining as well as final assembly. Due to the symmetry of the vise, I found it easy to get confused about what is left and what is right. Note the labels above.

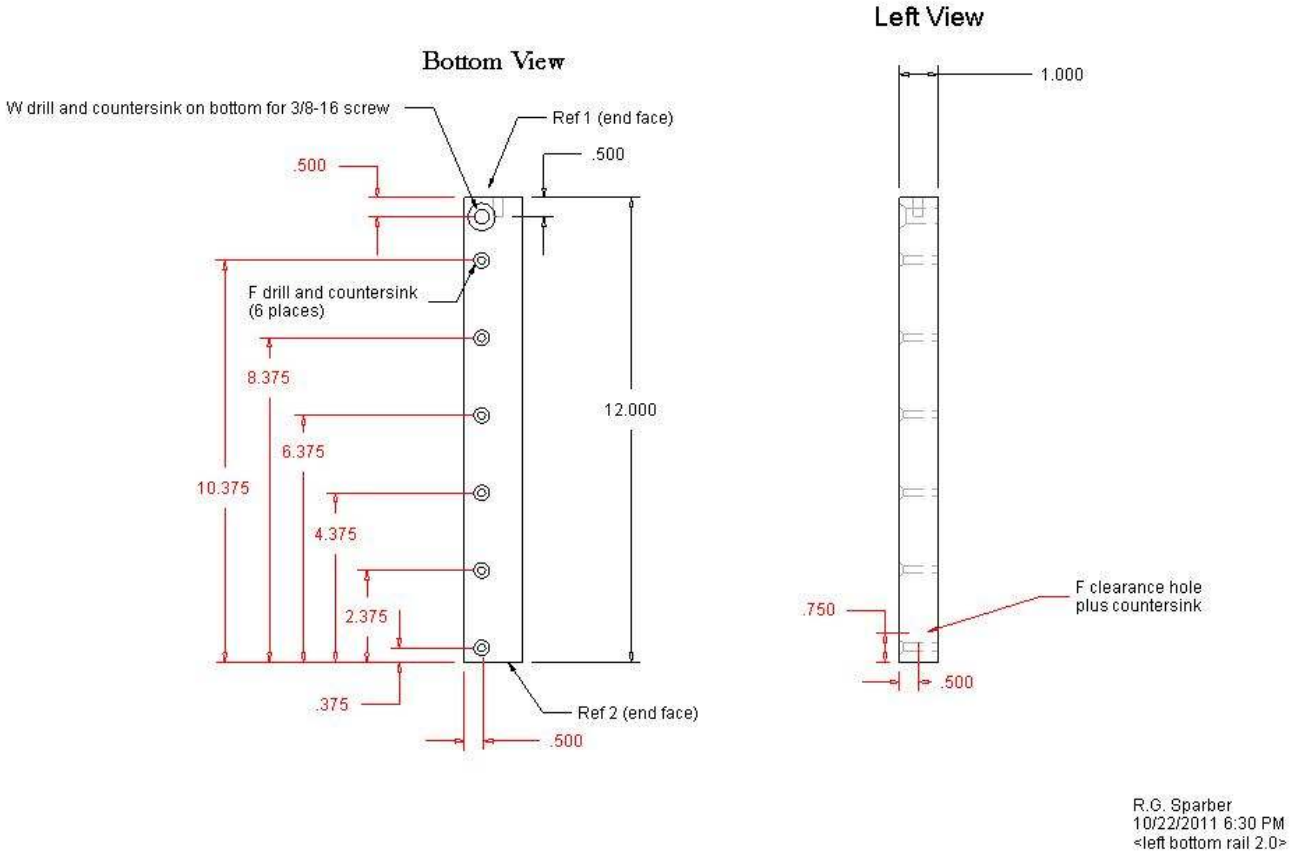
End Plate



The end plate is the crossroads of the vise. Many essential holes are drilled through this plate.

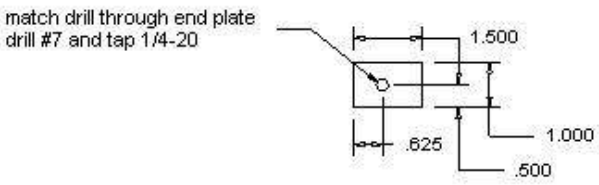
Left Bottom Rail

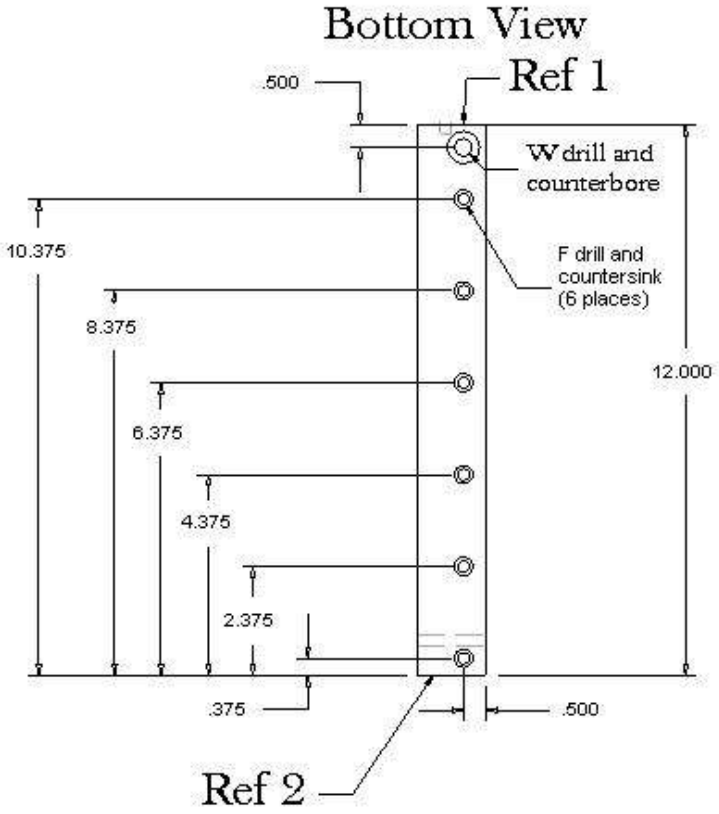


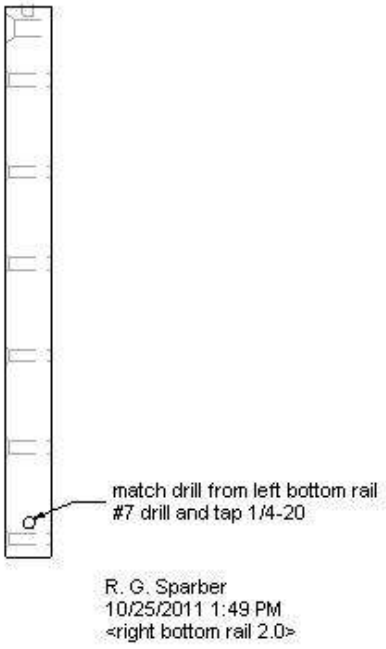


R.G. Sparber
10/22/2011 6:30 PM
<left bottom rail 2.0>

Right Bottom Rail

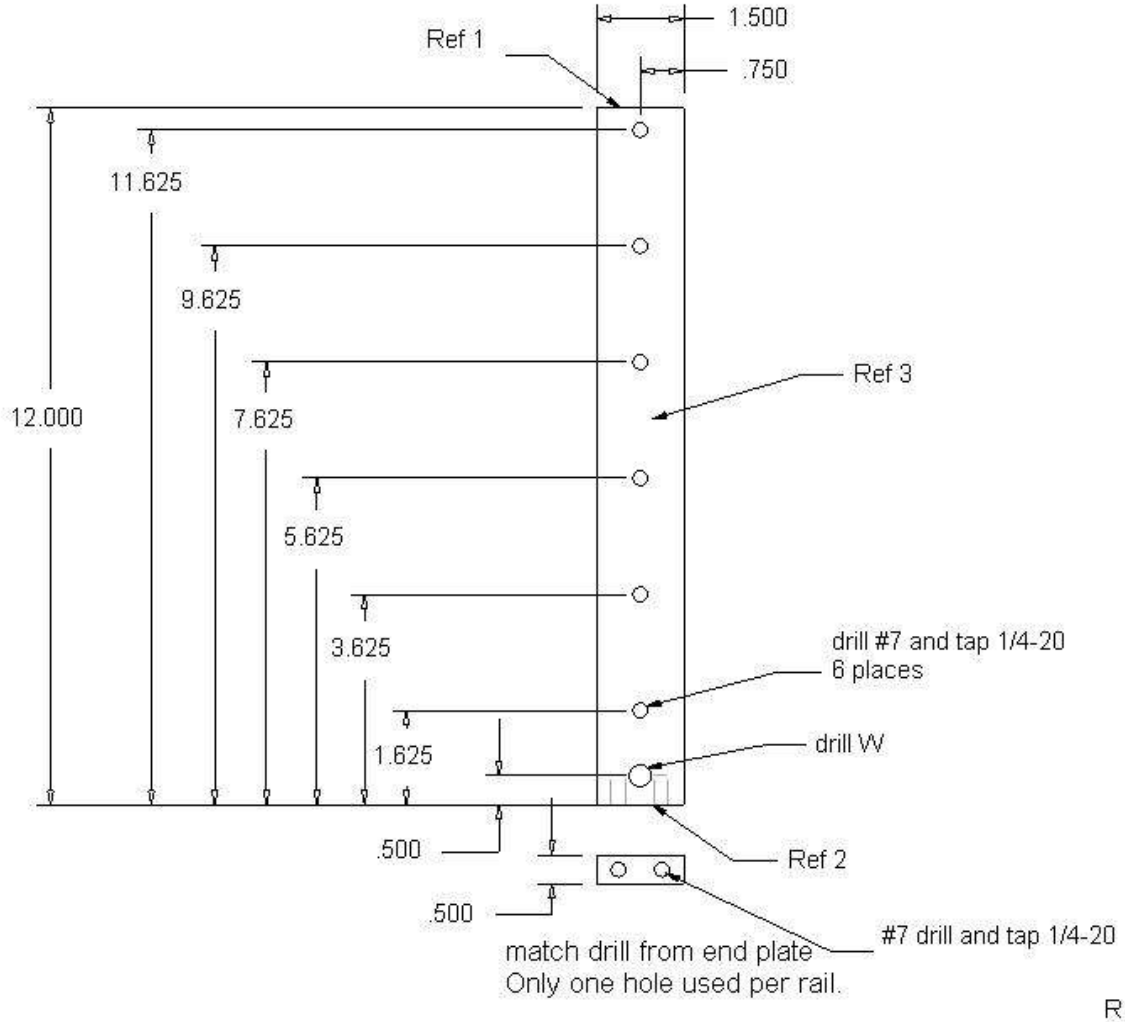






Left and Right Top Rail

Bottom View



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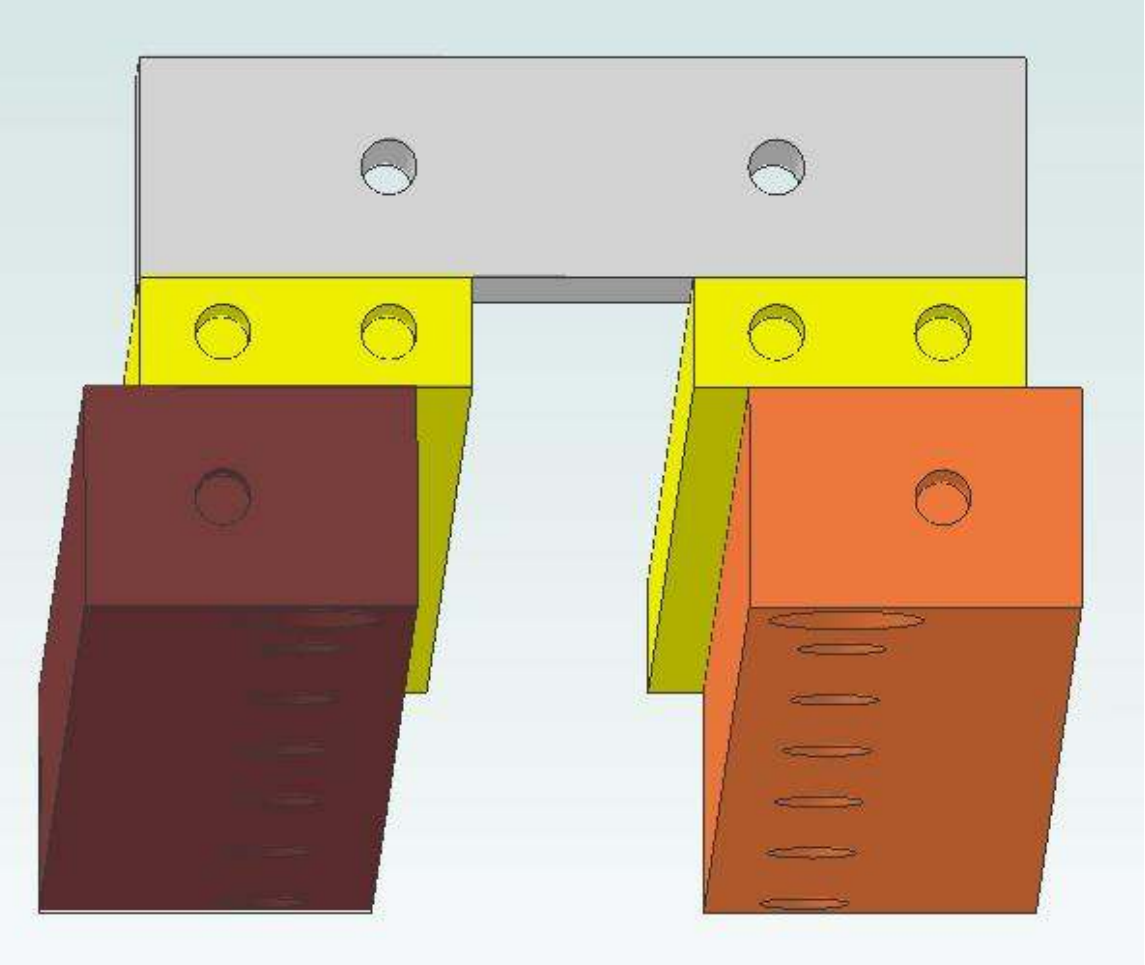
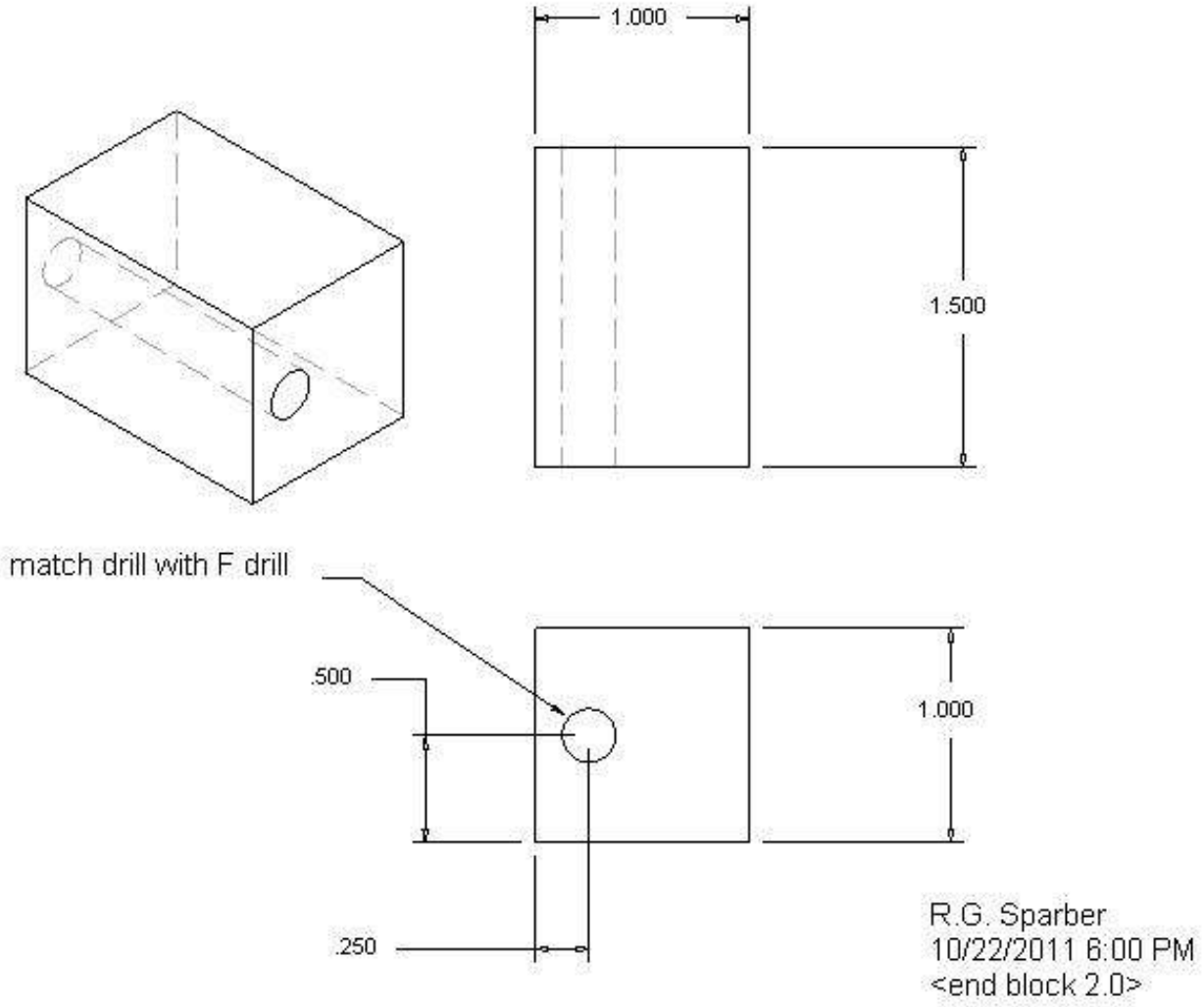
<left and right top rail 2.0>

Rail Stack-up with Fixed Jaw on Top

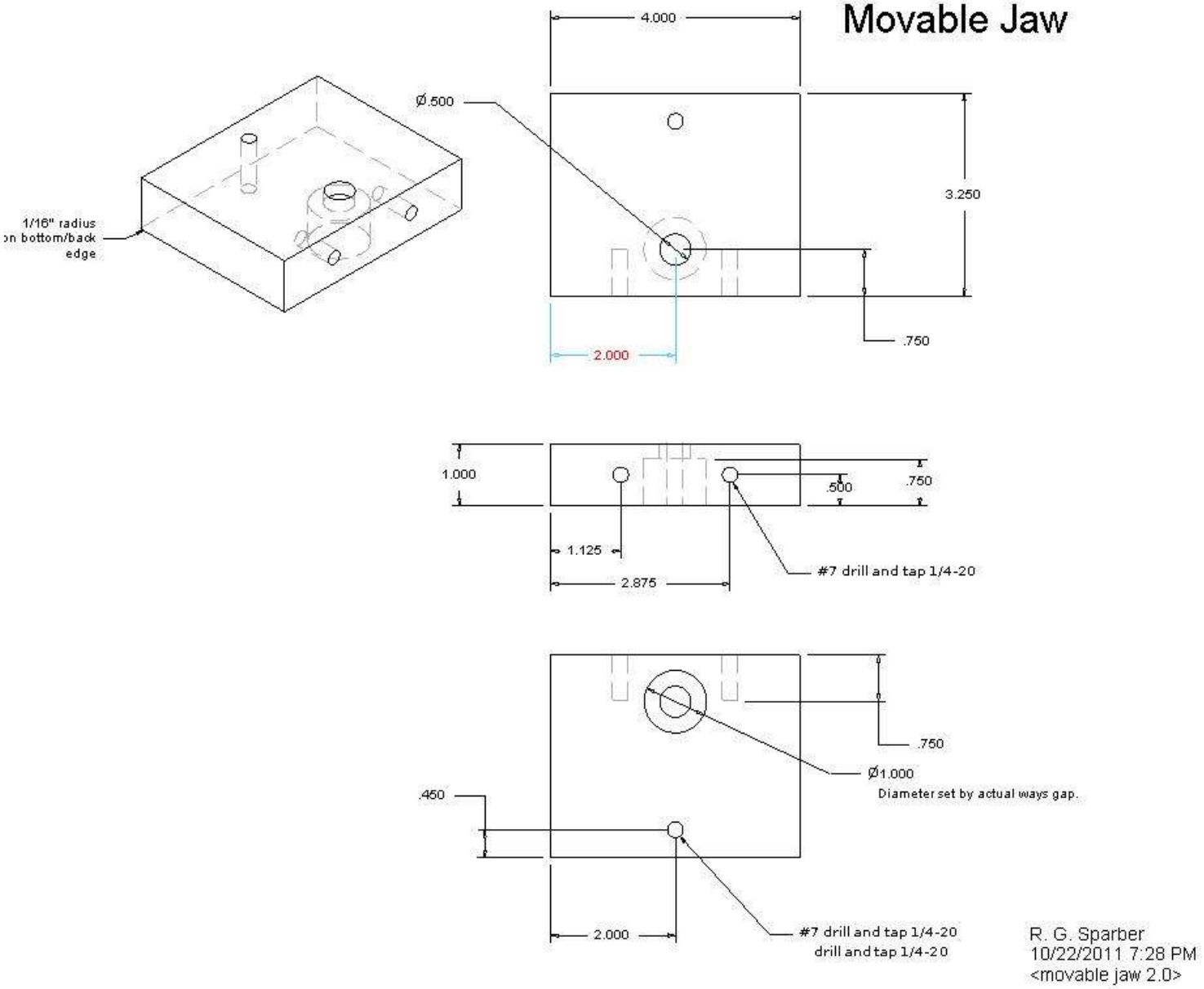


Although two holes are shown in each top rail, only one is drilled on each side.

End Block


1.000
1.500
match drill with F drill
.500
1.000
.250
R.G. Sparber
10/22/2011 6:00 PM
<end block 2.0>

Movable Jaw



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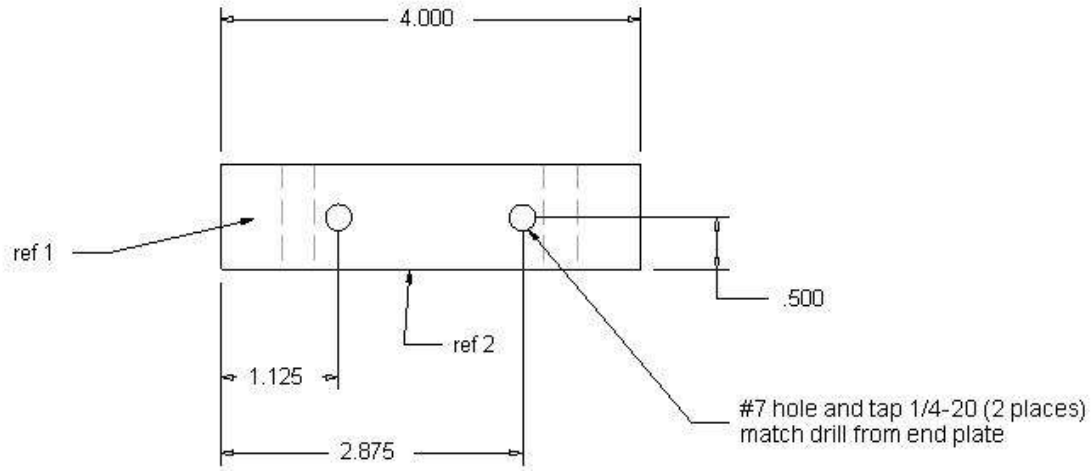
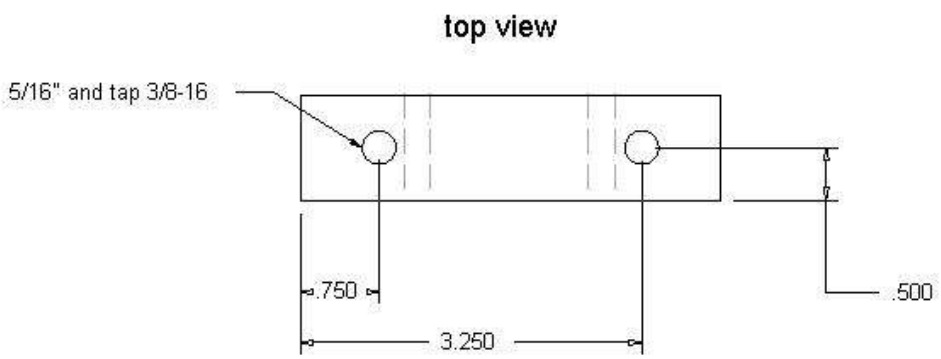
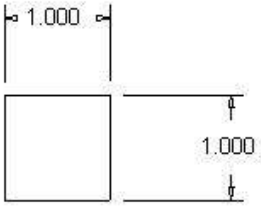
10/22/2011 7:28 PM
<movable jaw 2.0>

Fixed Jaw



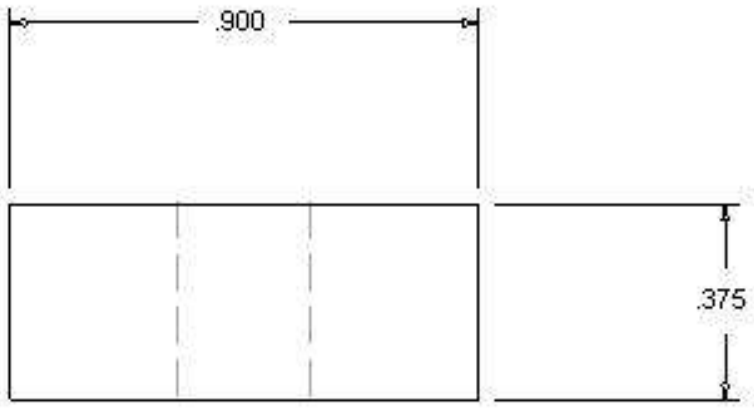
top view

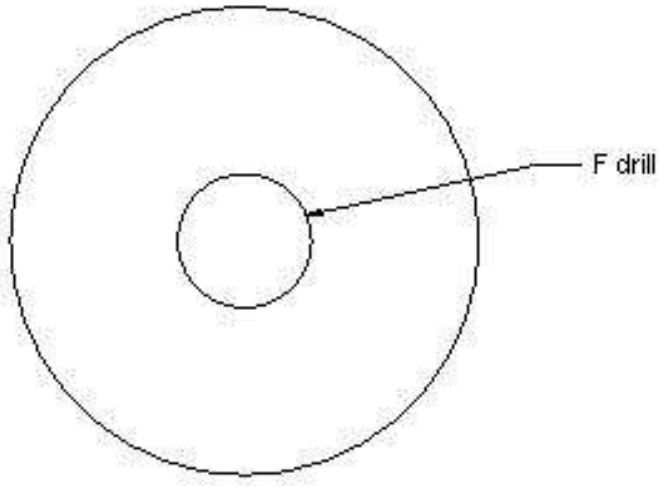




R. G. Sparber
10/26/2011 8:00 AM
<fixed jaw 2.0>

Anti-rotation Stop





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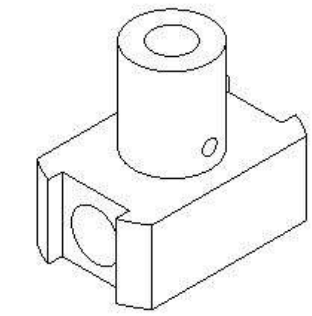
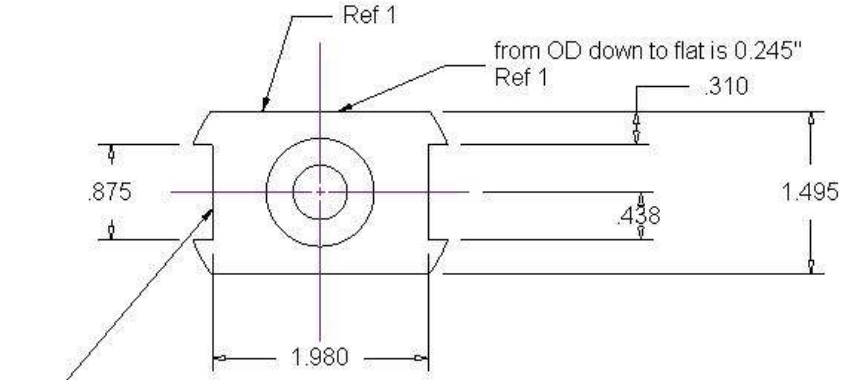
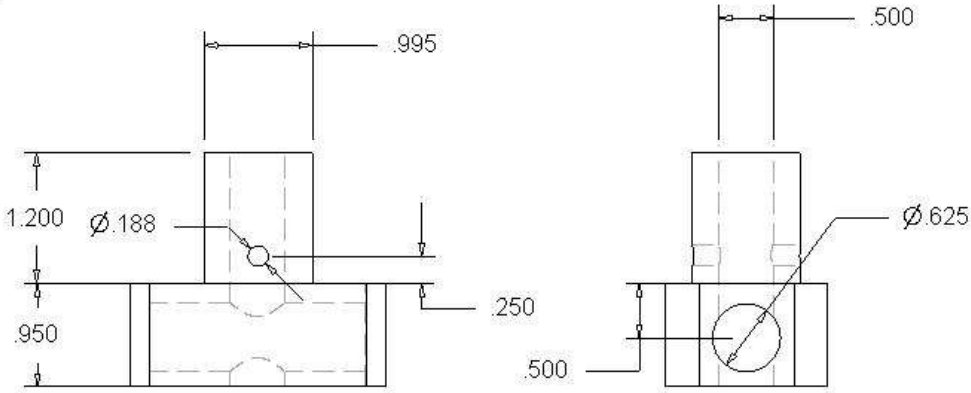
<anti-rotation stop 2.0>

Nut Assembly





from OD down to flat is 0.260"
Ref 2



All dimensions are nominal. Cut to fit.

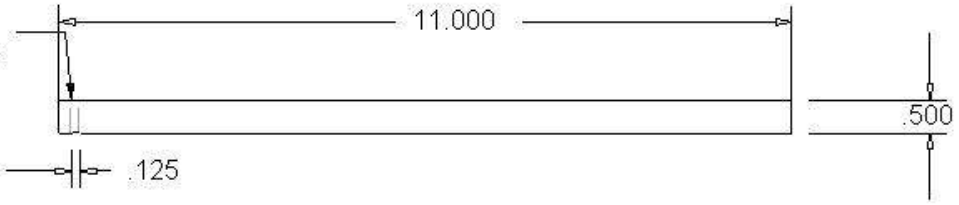
material: CRS 2.5" diameter round

R.G. Sparber
10/17/2011 6:34 AM
<nut assembly 2.0>

This part must be cut to fit the actual final dimensions of the vise body and movable jaw.

Clamp Screw

cross drill for 1/8"
dowel pin with nut in place



1/2-10 right hand Acme thread

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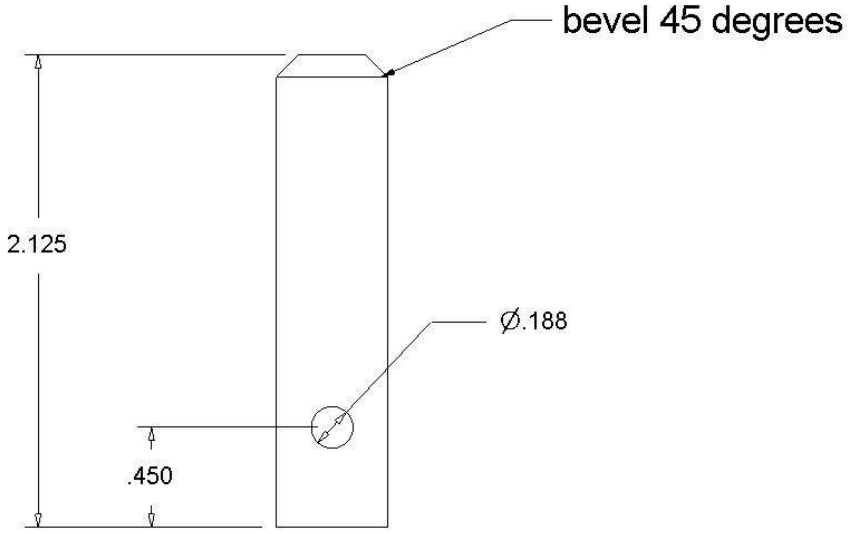
11/7/2011 5:50 AM
<clamp screw 2.1>

Lock Screw



1/2-10 Acme Right Hand threaded stock

R. G. Sparber
11/7/2011 5:37 AM
<lock screw 2.1>

In addition to these parts, one ½-10 Acme nut is cross drilled 1/8″ and pinned to the clamp screw. A second nut is drilled and tapped for a set screw. It is placed against the inside of the end plate.

Lock-down Vise Shop Procedures

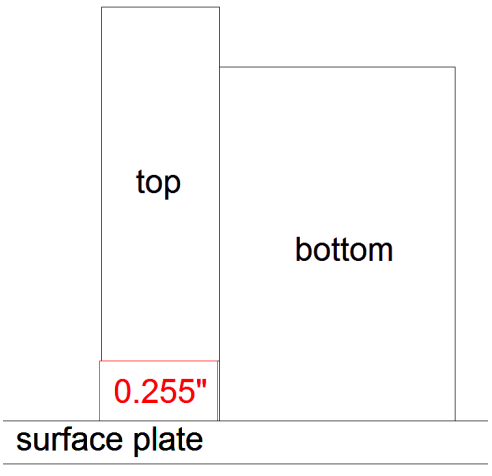
End Plate

- ☐ layout 1/2" plate with rectangle 2.6 x 4.6
- ☐ Saw to line
- ☐ Deburr
- ☐ Put in vise and line up long edge layout line to be parallel to the table surface
- ☐ cut one long edge true. Mark it as Ref 1 - it will be the bottom edge
- ☐ Draw 2.51 x 4.5 rectangle plus ½″ hole with respect to ref 1
- ☐ Mill second long edge to 2.510″ - this will be the top edge; finish cut when top of fixed jaw cut
- ☐ Mount plate in vise with reference edge against movable jaw.
- ☐ Verify mill head at proper height for ½″ drilling
- ☐ side mill left edge and zero DRO's X axis
- ☐ side mill right edge at 4.500
- ☐ layout all hole locations
- ☐ move to X = 2.250 and re-set zero
- ☐ move to Y = 0.500 and re-set zero; (0,0) is now at center of 1/2" hole
- ☐ Step drill out to 1/2″
- ☐ drill (6) holes with #7 drill (will open out with F drill later)
- ☐ countersink (6) holes
- ☐ remove part
- ☐ Deburr
- ☐ Flip plate over
- ☐ Take light clean up cut; this will be the end face that contacts the rails (Ref 2)
- ☐ Deburr

Bottom Rails

- ☐ Cut 1 x 1.5 bar to 12.1″
- ☐ mark bar L
- ☐ verify mill head height permits drilling 5/16″ hole
- ☐ layout all holes on bottom face
- ☐ mount bar in vise so one end is out about 0.2″
- ☐ side mill end - this will be the fixed jaw end and is ref 1
- ☐ drill 5/16" hole and counterbore 0.5" deep with 5/8″ end mill (will open out with W drill later)
- ☐ shift bar in vise so other end is out about 0.2"
- ☐ side mill end to 12″ - this will be ref 2
- ☐ layout all hole locations
- ☐ drill (6) holes with #7 drill (will open out with F drill later)
- ☐ countersink (6) holes
- ☐ deburr
- ☐ left bottom rail only: drill side hole (near ref 2 end) with F drill and countersink (need longer reach than possible with #7 drill)
- ☐ if needed, light clean up cut on top (face without countersinks)
- ☐ repeat for right bar: mark bar R

Top Rails and Assembly to Bottom Rails



- ☐ cut 0.5″ x 1.5″ bar to 12.1″
- ☐ if needed, light clean up cut on bottom (call it Ref 3)
- ☐ Deburr
- ☐ Place left bottom rail on a surface plate with the side of the rail in contact with the plate
- ☐ Place a 0.255" spacer against the vertical face of the bottom rail and on the surface plate (see also page 11)
- ☐ clamp left top rail to left bottom rail using a 0.255″ spacer to offset top from bottom longitudinally
- ☐ clamp top rail to bottom rail and remove from surface plate
- ☐ using #7 drill, match drill through bottom rail (6) places

- ☐ stamp mating surfaces to help with later reassembly
- ☐ unclamp bars
- ☐ deburr
- ☐ 1/4-20 tap (6) holes in top rail
- ☐ (6) F drill holes in bottom rail
- ☐ deburr and degrease in preparation for Loctite
- ☐ stack bars on surface plate with 0.255" spacer again using stamp marks to insure proper matching of bars
- ☐ run a screw through the hole near the end of the bar and tighten; repeat for hole at other end
- ☐ remove from surface plate
- ☐ using Loctite Red, run (4) screws through remaining holes and tighten
- ☐ remove end screws
- ☐ using Loctite Red, run (2) screws through end holes and tighten
- ☐ match drill through bottom rail 5/16" holes (will open out with W drill later)
- ☐ deburr
- ☐ repeat for right bottom and top rails (remember it is the mirror image of the left rail assembly)

Final alignment cuts on Rail Assemblies

- ☐ Mount left rail assembly in vise with 5/16" hole end extending out about 0.2″
- ☐ Take light finish cut across end hitting both top and bottom rail at end plate end
- ☐ Repeat for right rail assembly

End Block

- ☐ Side mill one end (reference surface)
- ☐ deburr
- ☐ Put reference surface into vise jaws
- ☐ End mill second end to 1.500"
- ☐ Deburr
- ☐ align end block with left rail assembly and clamp
- ☐ using F drill, match drill through left bottom rail and end block
- ☐ mark end block and left bottom rail so they will go back in the say way
- ☐ Deburr

End Plate Match Drilling

- ☐ align left rail assembly to end plate and clamp
- ☐ Match drill through end plate and into end of left rail assembly using #7 drill (2) places
- ☐ remove clamps
- ☐ Deburr
- ☐ 1/4-20 tap (2) holes in rails
- ☐ Open (2) holes in end plate with F drill
- ☐ Deburr and degrease in preparation for Loctite
- ☐ align left rail assembly to end plate
- ☐ Screw together left rail assembly to end plate using Loctite Red
- ☐ align right rail with end block and end plate and clamp
- ☐ Match drill through end plate and into ends of right rails using #7 drill
- ☐ 1/4-20 tap (2) holes in rails
- ☐ Open (2) holes in end plate with F drill
- ☐ deburr and degrease
- ☐ align right rail assembly to end plate and end block
- ☐ Screw together right rail assembly to end plate (no Loctite yet)
- ☐ using F drill, match drill through side of left rail assembly, through end block and 1/32" into right rail
- ☐ remove clamps
- ☐ using start of hole from F drill, use #7 drill through side of right rail assembly
- ☐ 1/4-20 tap hole in side of right rail
- ☐ deburr and degrease
- ☐ Screw together left rail assembly, end block, and right rail assembly using Loctite Red

Fixed Jaw

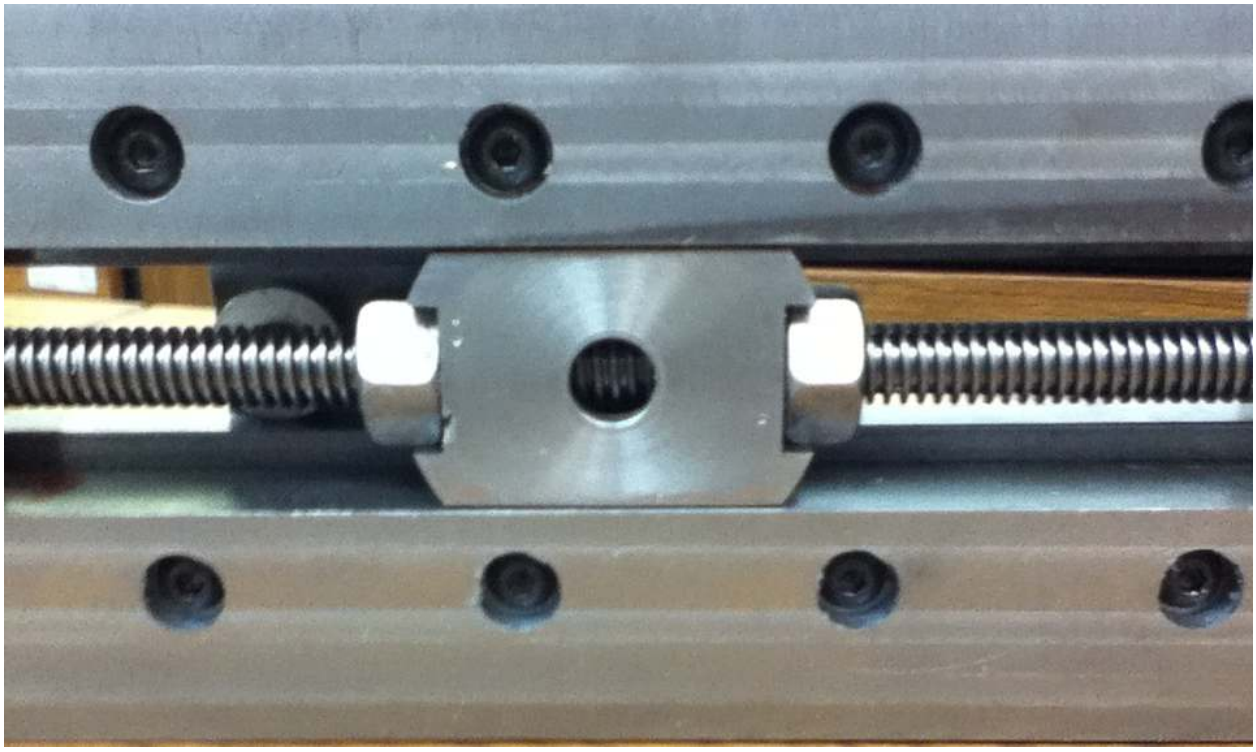
- ☐ Cut 1" x 1" x 4.1"
- ☐ side mill first end true
- ☐ side mill second end to 4.000"
- ☐ if needed, light cut bottom surface (reference 2)

- ☐ clamp to end plate and rails
- ☐ match drill (1) 5/16″ hole
- ☐ tap hole in fixed jaw
- ☐ drill clearance hole in ways
- ☐ screw in bolt
- ☐ repeat with second 5/16″ hole
- ☐ match drill (2) holes though end plate with #7 drill
- ☐ tap fixed jaw 1/4-20 (2) places
- ☐ F drill (2) holes through end plate
- ☐ Run (2) 1/4-20 bolts through end plate and into fixed jaw and secure with Loctite Red
- ☐ remove the two 3/8-16 bolts, clean bolts and holes, use Loctite Red to secure them

Final Body machining

- ☐ put vise on 1-2-3 blocks with bottom facing up
- ☐ lightly cut over entire bottom
- ☐ deburr and clean
- ☐ Put down soft pads on mill table to support vise body and align it with the X axis; vertical alignment contact on end plate with complete access to lower rails
- ☐ True surfaces of soft pads
- ☐ Deburr in place and clean area
- ☐ Place vise body on soft pads so length of ways is parallel to the X axis of the mill
- ☐ Clamp vise body down at side steps so top surface is unobstructed.
- ☐ Take light cut over top of ways, top of end plate, top of fixed jaw, and over vertical face of fixed jaw (don't forget to lock X axis before jaw cut)
- ☐ Lightly side cut inside vertical surfaces of top rails

Nut Assembly



Many of the dimensions on the nut assembly must be taken from the actual base you have machined. Measure the slot width between inside faces of the top rails. Subtract 0.005″ and use this value to set the diameter of the vertical shank. The drawing shows a diameter of 0.995″ which assumes your slot width is 1.000″.

The large flat to flat distance is the minimum distance measured from the inside faces of the lower rails. Subtract 0.005″ from this value. Ideally this distance is 1.500″ so the drawing shows 1.495″.

The width of the two nut recesses is set by the ½-10 right hand Acme nuts that you use. I found that the flat to flat distance varied so select a pair of flats and mark them with a punch. Note above that the right nut has a single punch mark and the left nut has two punch marks.

After cutting the two nut recesses but before you drill the 5/8″ hole, place the nut assembly into the vise body and verify it freely slides. Then fit a ½″ spud[4] into the ½″ hole that will accept the clamp screw. Blue one nut recess and then press it into

[4] A spud is a cylinder with a sharp point turned at one end. The point is perfectly centered.

the sharp point of the spud. Punch a small impression at this point and recheck with the spud. Also mark this end as facing the end plate. In this way you are placing the center of the 5/8″ hole at the center of the ½″ hole. No measuring has been done yet you will get excellent alignment. Drill the 5/8″ hole.

The distance between the bottoms of the nut recesses is nominally 1.980″ which ideally gives 0.020″ of play. I discovered that some filing was needed and in the end the two nuts fit closely to the Nut Assembly which is good.

Cross drill the 3/16″ hole. Then put in a length of ½-10 Acme threaded rod with 0.925″ or more sticking out the top of the Nut Assembly. Place a nut over this end and a second nut tightly against the bottom of the Nut Assembly. You can then run the cross drill a second time and go through the threaded rod without it moving. Remove the nuts, saw off the threaded rod, and bevel the top end. Deburr the bottom end and drive in the pin.

Movable Jaw

Note that the 1″ hole is blind so you will need to bore it out. The diameter of this bore should be a close sliding fit to the actual nut assembly shank diameter.

Clamp Screw and Anti-Rotation Stop

I can't think of any sage advice for these parts. If questions come in, I will provide more detail.

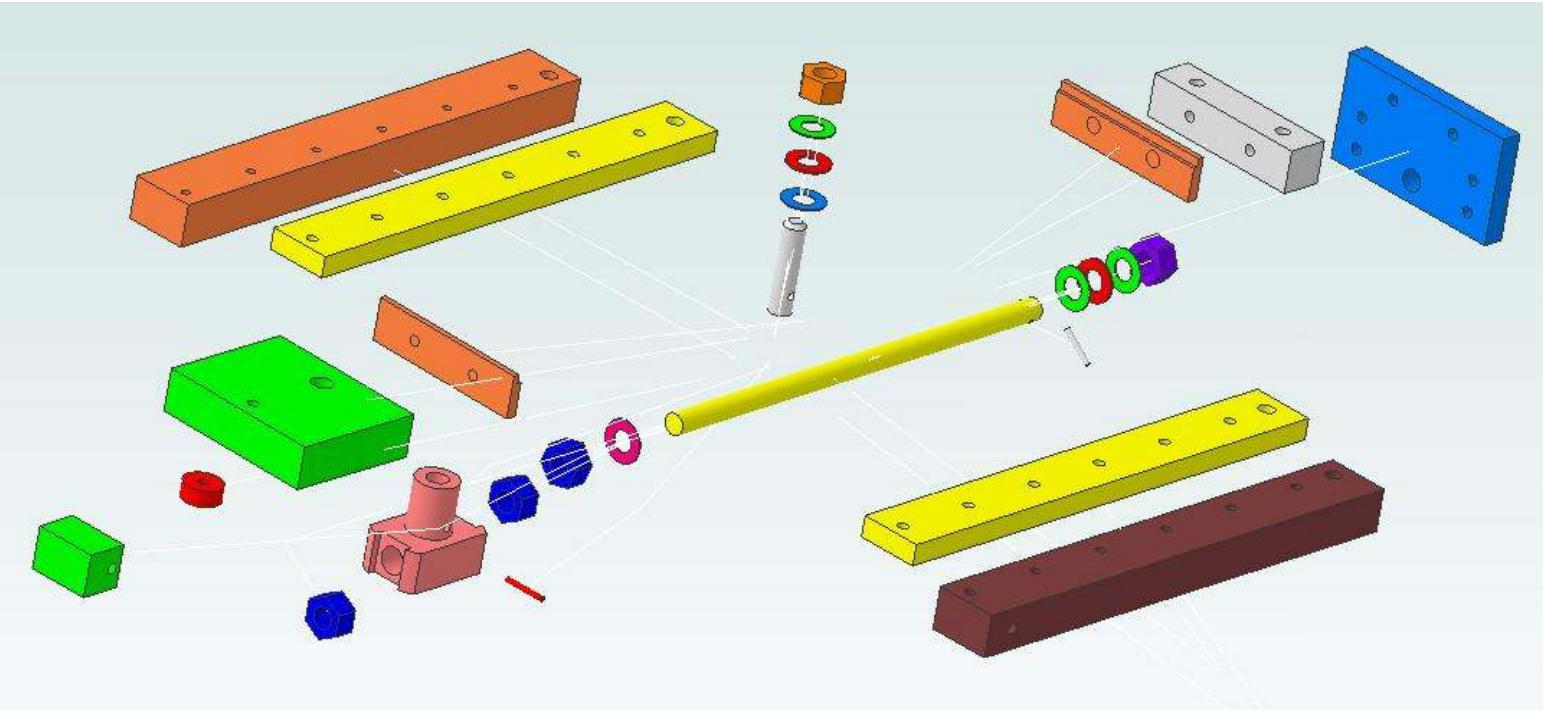
Softjaws

The mounting holes for the movable softjaw will probably be reasonably well placed. But the fixed jaw mounting holes were match drilled through the end plate and the holes probably drilled by hand. I found these holes were far from their expected location. Not to worry, just don't measure anything.

First prepare the softjaws by sawing about 0.05″ oversize and then side mill to length. Drill the ¼″ hole in as far as possible on one end. Flip the bar over and drill from the other end. Deburr. Mark the outside face that will later be counterbored.

Take a pair of ¼-20 set screw, point side out, and screw them into the tapped holes of the fixed jaw so the points stick out about 0.005″. Place a softjaw in position on the fixed jaw. Then tighten the vise. The points of the set screws will mark the correct hole locations on the back side. Drill out to clearance with and F drill. Then flip it over, use the F drill to find the hole center, and counterbore with ½″ end mill. Repeat for the movable jaw if necessary.

Final Assembly



- ☐ Locate the clamp screw with cross drilled nut on the end
- ☐ Drive an 1/8″ pin through the nut and cross drilled hole
- ☐ Grind the pin down so the ends are flush with the flats of the nut
- ☐ Slide a thrust bearing washer onto the clamp screw
- ☐ Slide a thrust bearing onto the clamp screw
- ☐ Slide a second thrust bearing washer onto the clamp screw
- ☐ Slide the clamp screw through the 1/2″ hole in the end plate
- ☐ Slide a washer on next (optional)
- ☐ Spin on the nut with the set screw in it for a distance of about 5″
- ☐ Spin on the first nut matched to the fixed jaw side of the nut assembly for a distance of about 2″

- Place the nut assembly through the base so the shank is between the top rails
- Turn the clamp screw such that the end of the clamp screw is flush with the movable jaw side of the nut assembly
- Place the second nut on the nut assembly
- Turn the clamp screw until the nut engages. If the gap between nut and nut assembly is more than 0.02”, try flipping over the second nut and try engaging it again. If the clamp screw engages with no visible gap but then binds, file the face of the nut down a few thou and try fitting again. Ideally, the nuts are a close fit on the nut assembly but should not bind.
- Turn the clamp screw until about 2” are extended beyond the nut assembly
- Spin the nut with the set screw until it is about 0.01” from the inside face of the end plate
- Tighten the set screw
- Attach the anti-rotation stop to the bottom of the movable jaw using a ¼-20 3/4″ screw
- Place the movable jaw over the nut assembly shank
- Place a thrust bearing washer over the lock screw
- Place a thrust bearing down next
- Place a second thrust bearing washer on top of the thrust bearing
- Screw on a nut
- Place the vise down on a flat surface and turn the clamp screw. Feel for any interference between the points of the nuts and this surface. File the points as needed.
- Lube the clamp screw. I used lithium grease.

Final Preparation

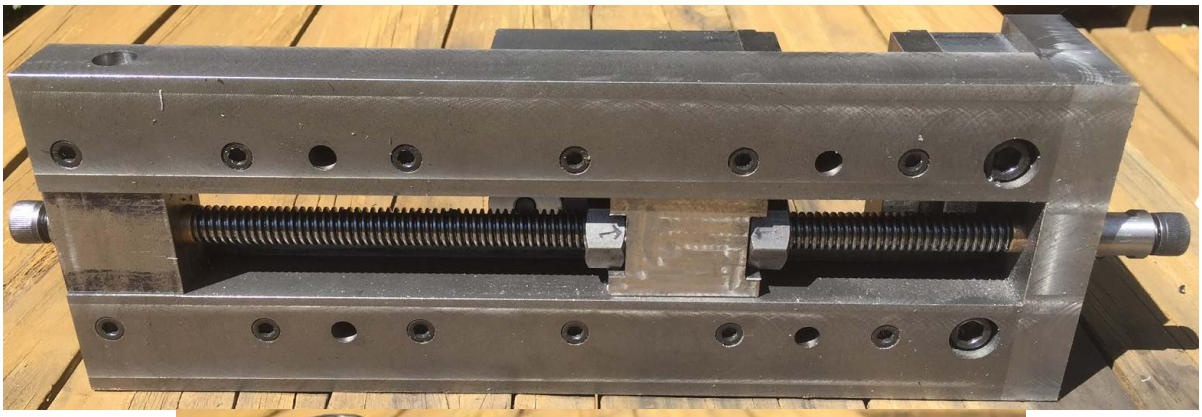
If you can clamp the vise to the table using the side ledges, then you are done. My Gingery Shaper table is rather small so I must run a pair of bolts through the vise ways that will engage T nuts under the vise.

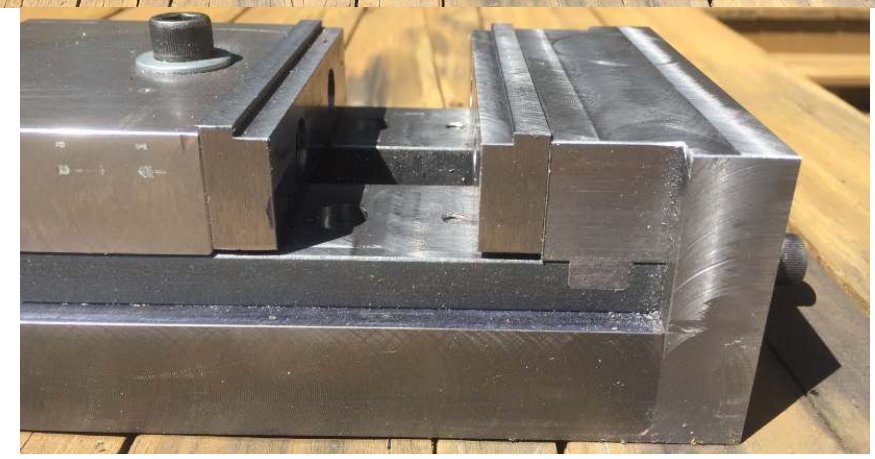
Using the Vise

The vise must be clamped down on the table and the softjaws lightly cut for perfect alignment. The lock screw nut should be loose enough to permit the movable jaw to freely move with a sliding fit. Place the part to be clamped down on the softjaws. Tighten the clamp screw. Expect the movable jaw to rise up around 0.002″ to 0.003″as force is applied to the part. Once the clamp screw is tight, tighten the lock screw. This will further grip the part plus draw it down onto the vise ways.

A Magnificent Version

Rex Landis made one of these vises but also added a key for the fixed jaw which is very impressive. Look closely for other refinements.





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Thanks to Rex Landis for improving the design.

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

I welcome your comments and questions.

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