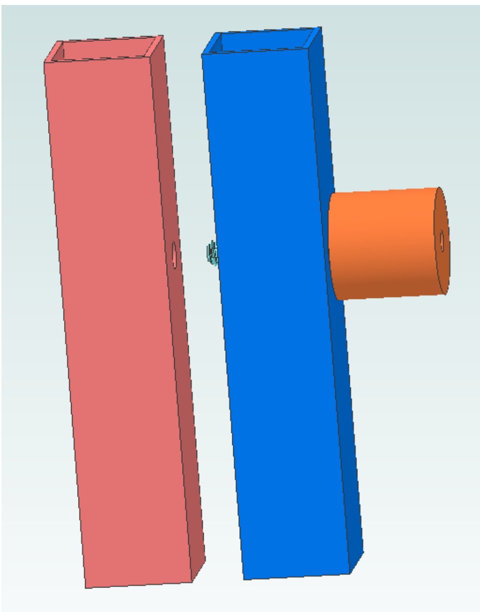
A Captured Fastener, version 1.2

By R. G. Sparber



I needed to be able to fasten two pieces of 16 gage 1" steel tubing together. There shall be no loose parts and no tools required. A misalignment of ±1/16" shall be tolerated. The fastener thread is ¼-20 and 4 to 5 threads shall engage.

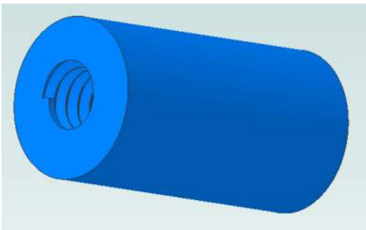
The fasteners are part of a structure that is occasionally set up in various places and then knocked down into 4 flats for transport and storage. It is 2' deep, 4' wide, and 8' tall.

Each corner has 3 of these fasteners plus there are two more to secure the top which can be seen laying on its face behind the ladder.

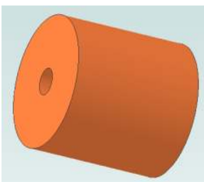
The male part of the fasteners are within the side frames with the knobs inside. This helps protect them. The female parts are within the front and back frames.

The tubing has a wall thickness of about .063" so there is no room to form 20 threads per inch (.050 pitch). I was also not able to weld a pad of steel on the tubing to increase this thickness.

My solution involved two machined parts.



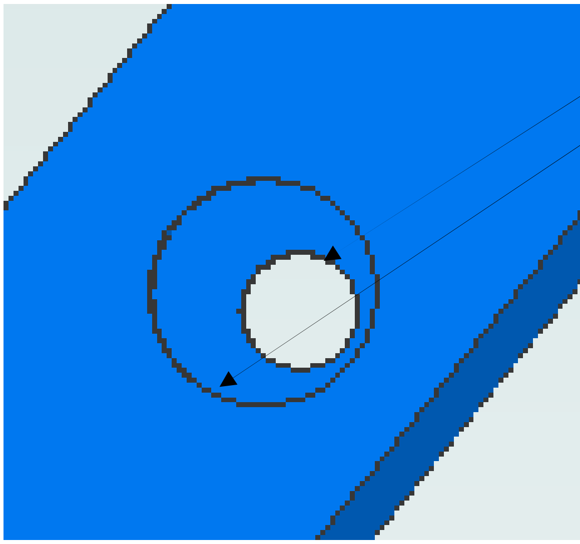
The female side of the fastener is a piece of ½" diameter CRS drilled and tapped ¼-20. Its length equals the outside width of the tubing minus one wall thickness.



The 1" diameter 1" long knob is made of 6061 aluminum and is drilled and tapped ¼-20 almost all the way through. See http://rick.sparber.org/tfs.pdf for details.

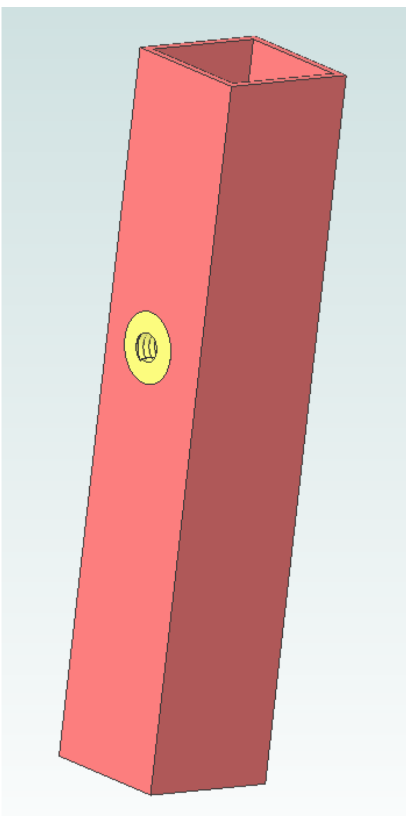
I used my lathe to face the ends of each piece and drill the #7 tap hole. Then I used my tapping head on my mill to cut the threads. A spiral point tap was used.

Off the shelf parts include a length of ¼-20 rod 2" long, a washer, and a self locking nut. This nut has a maximum outside diameter more than 3/8" but less than ½". Nothing special here. I also used a spring washer which can be seen in some of the photographs.



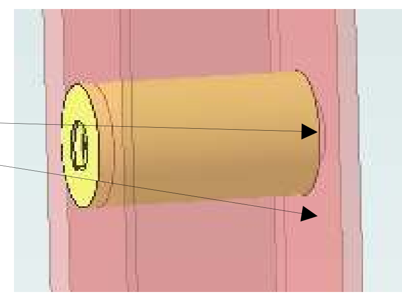
The tubing that will accept the CRS cylinder was first drilled through with an F drill and then one face was opened out with a ½" drill. Deburring of the smaller hole was essential.

The cylinder was pressed into the ½" hole and secured with a bolt from the other side. This insured proper alignment.



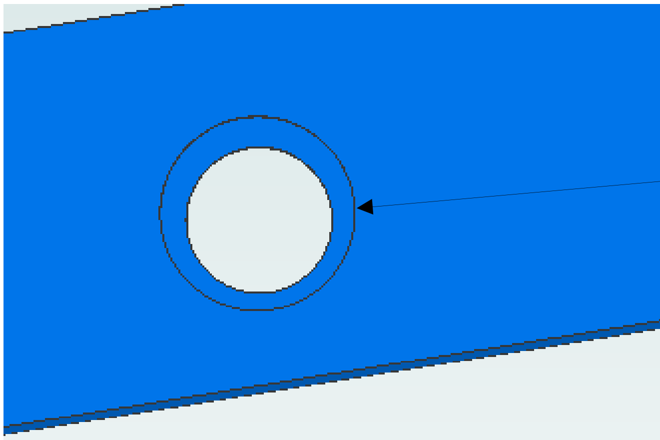
I did a lot of MIG welding on this tubing so it was a simple matter to also tack weld the CRS cylinders to the faces of the tubing.

By making the tubing translucent, you can see that the bottom of the cylinder rests securely on the inside wall.

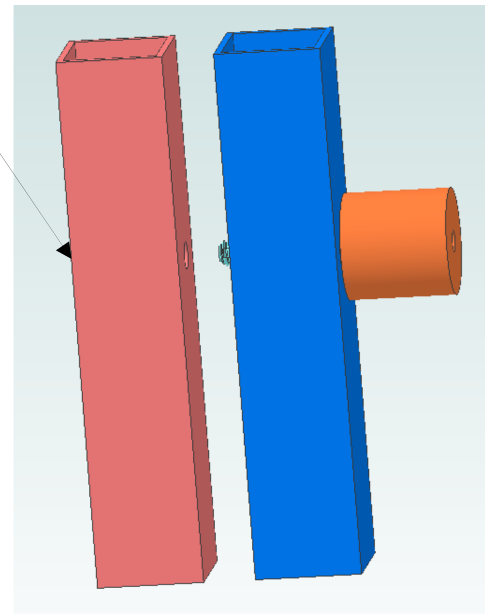


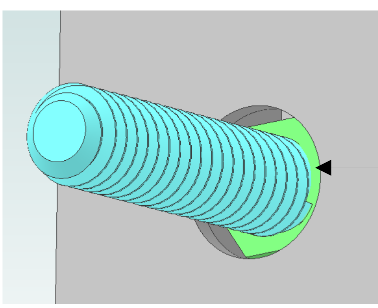
This arrangement solves two problems. The threaded material is ample compared to just trying to thread the wall of the tubing.

Secondly, the threads start right at the inside wall of the tube face. This means that the full extension of the male part of the fastener only needs to come out about ¼". If a nut was welded on the opposite face of the tube, the stick out would have been about 1" longer. This would have increased the probability of the threaded rod catching on something and being bent.



The tube that will accept the male part of the fastener is first drilled 3/8" through. Then the outer face is drilled ½".

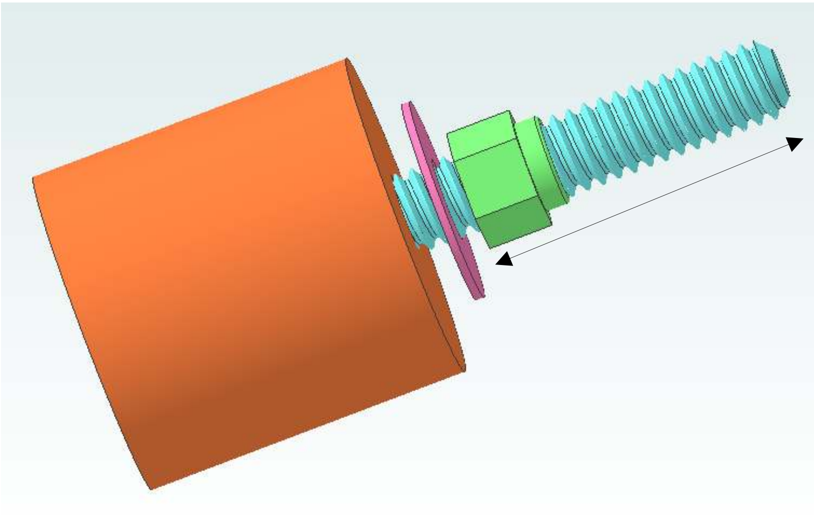




The ¼" diameter threaded rod passes through the 3/8" hole to give
± 1/16" of free movement.

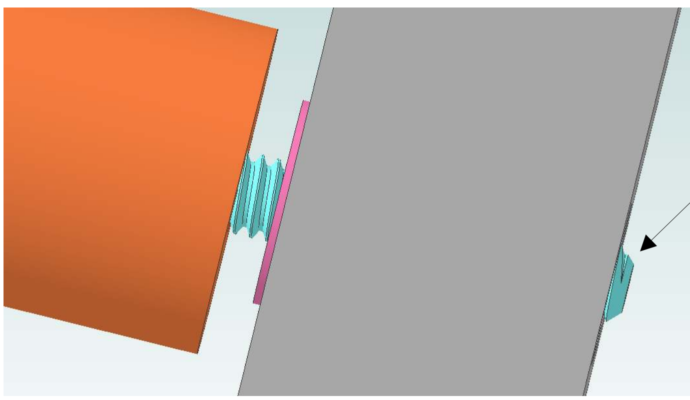
The washer and knob are hidden in this view.

If more free movement was needed, the two holes could be enlarged as needed. A washer would be used to prevent the nut from falling through the smaller hole.

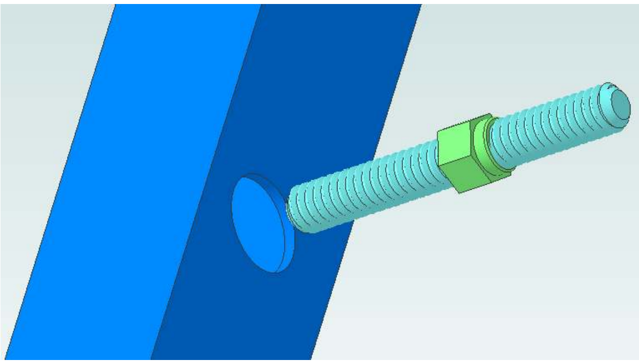


The male part of the fastener consists of the knob, a washer, a self locking nut, and the threaded rod. The ends of the rod are generously beveled.

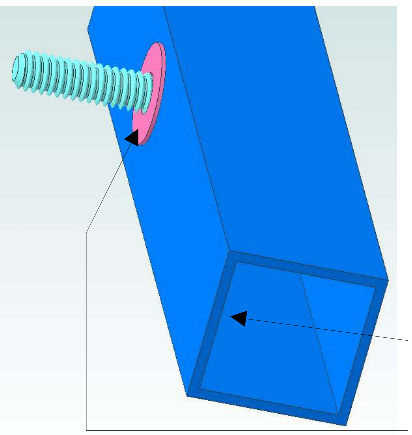
The nut is threaded onto the rod such that the distance from the bottom of the nut to the end of the rod equals about 1.1".



This distance lets the beveled end of the rod barely extend beyond the face of the tube. There is enough exposed to help with alignment but not enough to be snagged during transport.

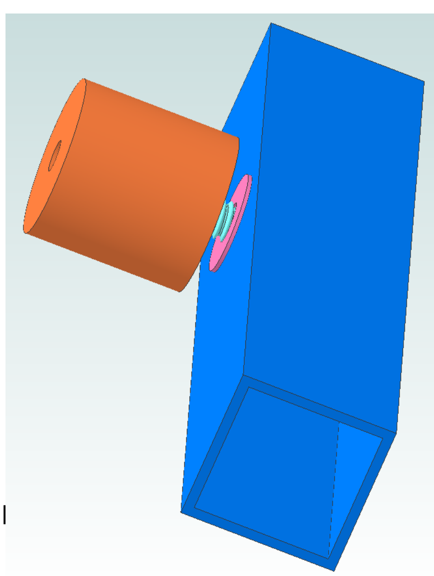


The rod/nut assembly is then fed into the tubing through the ½" hole. Note that the bottom of the nut is towards the tubing.



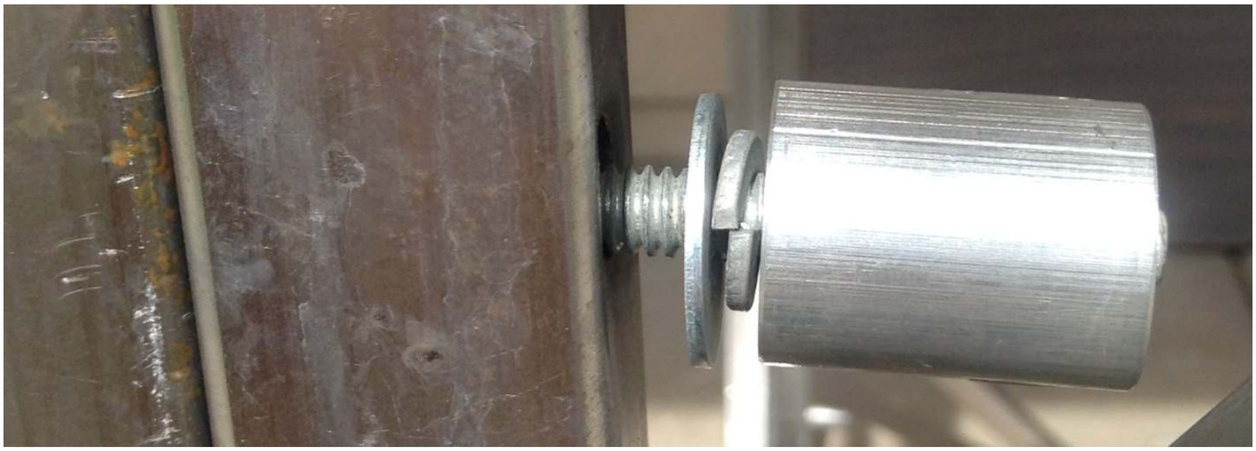
With the rod pushed in until the bottom of the nut contacts the far inside wall,

a washer goes on from the outside. A washer greater than ½" in diameter covers the ½" hole.



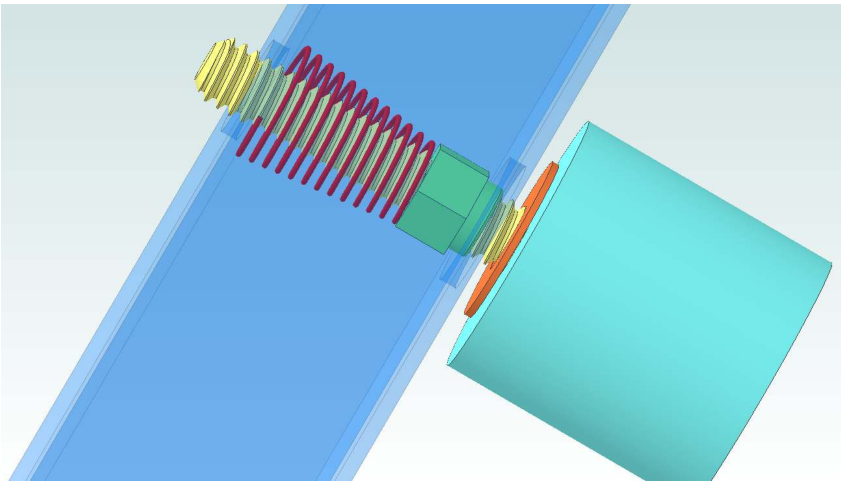
The aluminum knob goes on next but this is a thermal fit. The hole in the knob is first heated with a MAPP® gas torch for 20 seconds before being tightly screwed into place.

If you need to remove this fastener, saw it off. The heat needed to expand the knob is close to its melting point. This heat also travels down the threaded rod and melts the nylon insert within the self locking nut.



I have added a spring washer between the knob and the regular washer for this application. The knob was intentionally left smooth because very little force is required. Compression of the spring washer is all we need.

The threaded CRS cylinder was tacked in place and then the weldment ground flat. We only need to insure that the cylinder does not rotate or fall out during threading and when not in use.



I was contacted by Bill Libecap on an idea that employed a spring to retract the fastener plus keep it from flopping around when disengaged. After a bit of discussion, we came up with this modification to the design. A conical spring has been added.

The narrow end can pass the ¼-20 threaded rod and contact the face of the nut.

The large end is too big to fall through the ½" hole. The overall length is such that it is in compression when in place.

The spring is installed by screwing it through the ½" hole until it is entirely inside the square tubing.

I bought this spring at Ace Hardware. The small end has an ID of about 3/8" and the large end has an OD of about ¾". The overall length is about 1" uncompressed.

It was a simple matter to screw it through the hole.

The spring is now neatly secured inside the tubing.

The knob no longer flops around when not secured.

Acknowledgement

Thanks to Bill Libecap for his great idea using a spring.

I welcome your comments and questions.

If you wish to be contacted each time I publish an article, email me with just "Article Alias" in the subject line.

Rick Sparber
Rgsparber.ha@gmail.com
Rick.Sparber.org