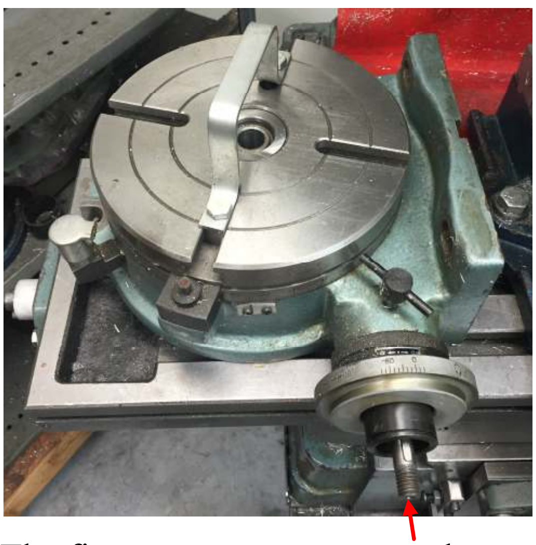
Converting an 8 Inch Rotary Table to an "A" Axis, Version 1.1

By R. G. Sparber

See this YouTube video for the axis drive going through its first test:

https://www.youtube.com/watch?v=yDUM5kTqXzc

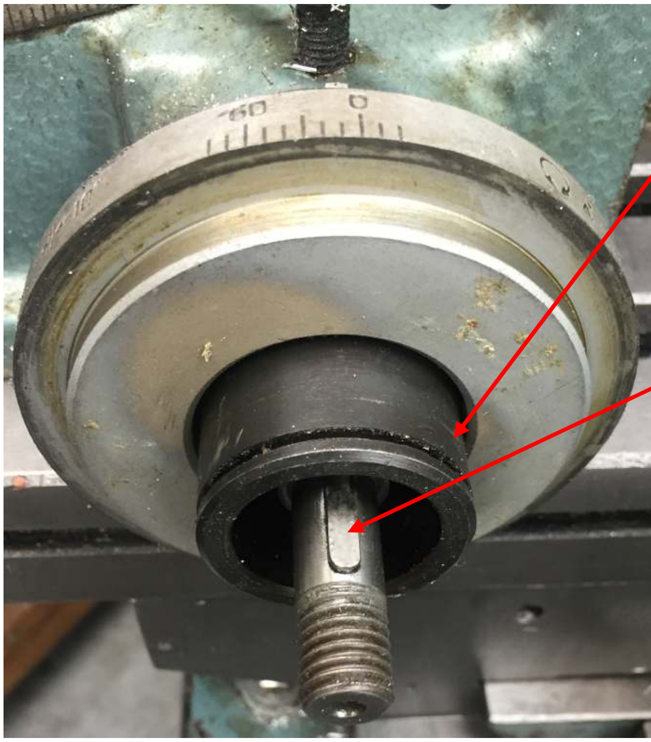
My RF-30 Mill/Drill already has Computer Numerical Control on its X, Y, and Z axis. Not to sound greedy, but having one more axis would be nice. This 4th axis is commonly called the "A" axis. My CNC software, Mach3, is designed to handle 4 axes as long as only 3 are changing at a time.



Many people have connected a stepper motor to a rotary table in order to perform the A axis function. I already had the rotary table. It was used on rare occasion but was still worth keeping. Once I went to CNC, its value decreased further. So it was a natural to turn this obsolete attachment into something useful.

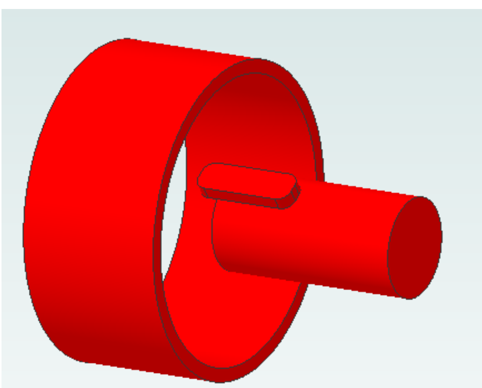
The first step was to remove the crank and dial. They would be saved just in case this mod failed.

The completed drive is mostly supported by the drive shaft and prevented from rotating by four strips of thin sheet metal. A hose clamp secures the assembly to the rotary table.

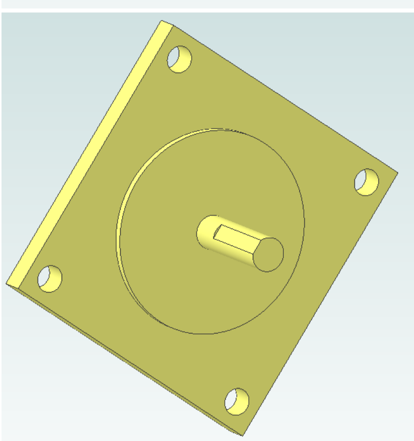


With the crank and dial removed, the driven shaft is exposed. It has a diameter of 12 mm. That black cylinder around it is 1.497 inches in diameter. It is solidly connected to the back dial disk.

The key must be a press fit because I could not remove it. No matter, I will make a coupler with an internal keyway that accepts it.

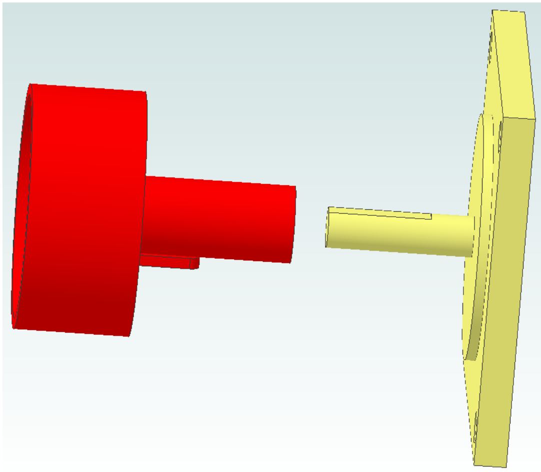


First I drew a 3D model[2] of the drive shaft and surroundings cylinder. All important dimensions are correct even though it doesn't look much like the real thing.

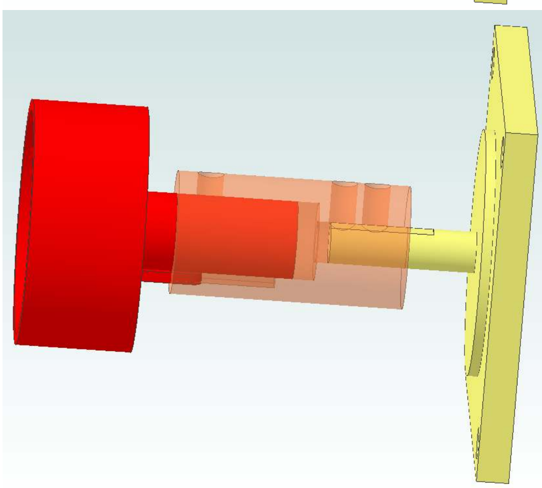


Then I drew a 3D model of the NEMA motor's important dimensions. The shaft is ¼ inch in diameter and has a 1 ½ diameter boss around it.

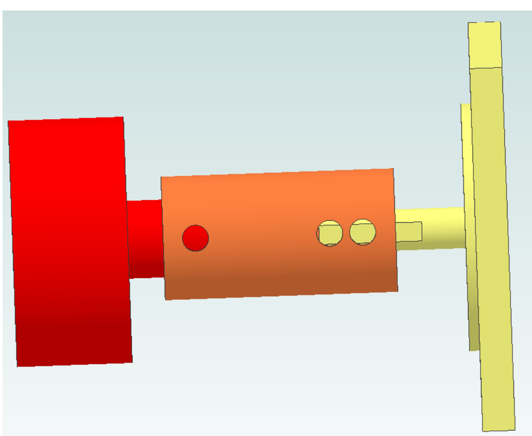
[2] I use Alibre PE for my 3D drawing work. It feeds my CNC software too.



Next I orientated the two shafts so I could visualize the coupler.

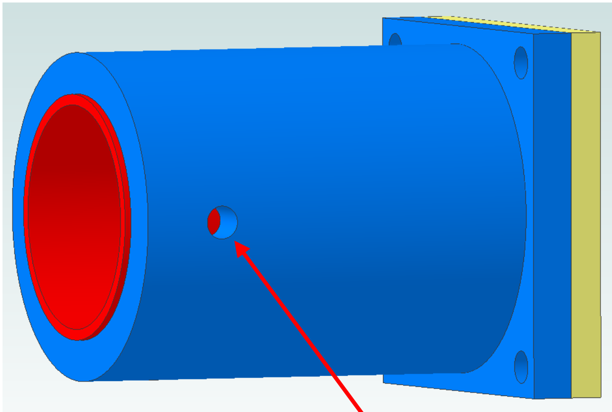


The coupler has been drawn in and made translucent so you can see how it mates with the rotary table shaft and the stepper motor shaft.



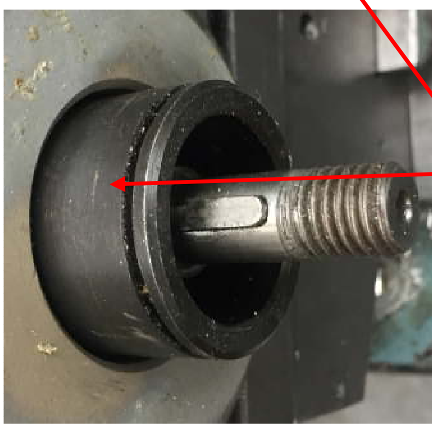
Initially I planned to have two set screws on the motor shaft and one set screw on the rotary table shaft. The internal key way that mates with the rotary table's key was a snug fit so I didn't bother adding a set screw on that end.

So far, so good. The coupler seems like a reasonable design. Time to work on the motor support.



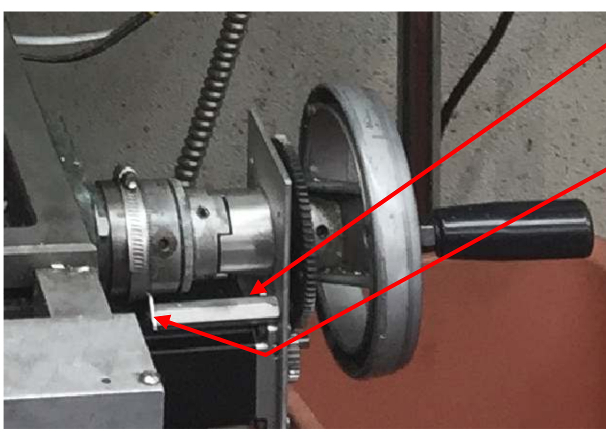
My initial design was massive. Cut from a single block of aluminum, it had a 1.5 inch inside bore and a flange on the end to match the motor. The cylindrical part had a wall thickness of 0.25 inches.

The red cylinder in this rendering is the black cylinder on the rotary table.



Set screws would be used to lock the support to the rotary table's black cylinder.

I had selected a nice piece of scrap aluminum but did not look forward to all of the hogging needed to make this motor support. Then I started to think about how Paul Thompson had solved this problem.

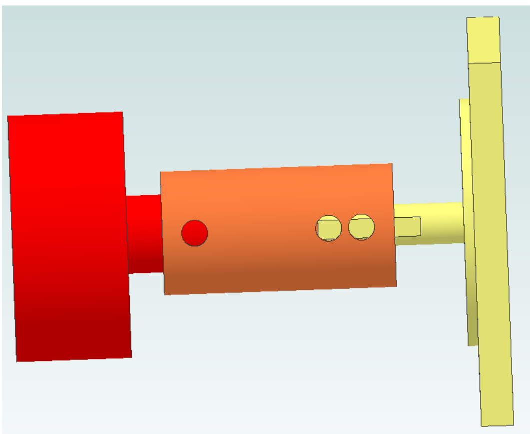


Paul used two cylinders flanking the drive shaft. One end of these cylinders bolted to a support plate for the gears and motor. The other end had L shaped brackets screwed in. The brackets were captured under a hose clamp. I know what you are thinking because that was my first impression too - how ***cheesy***! But over time I grew to appreciate this elegant design.

It is common to rigidly mount the motor and have a flexible coupler to compensate for any small misalignment between drive shaft and driven shaft. Paul turned this problem on its head. He rigidly connected the shafts and lets the motor move around a little. Most of the weight of the motor assembly is taken by the shaft. The standoffs simply prevent rotation.

That cheesy hose clamp applies plenty of pressure on the L brackets to prevent any rotation of the motor assembly. At first it was disturbing to see the motor wiggling around but after I understood why this was necessary, it wasn't so bad. Improving alignment minimized this motion.

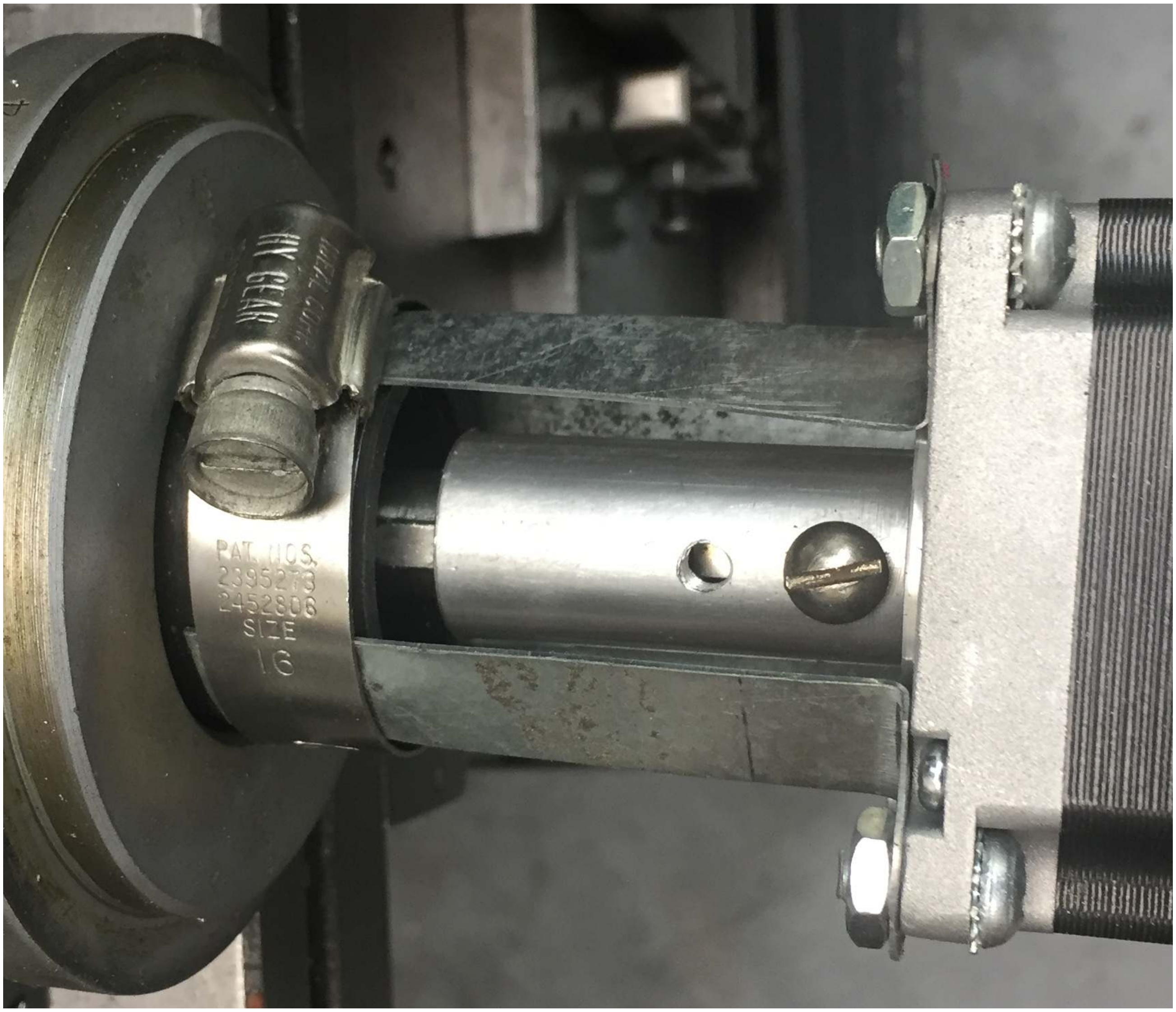
Being a minimalist, I looked for ways to simplify the cylinder plus L bracket subassembly. Then I remembers a very old trick using sheet metal. A strip of sheet metal easily flexes in one direction yet is extremely ridged along an axis perpendicular to the easy flex axis.



I first made the coupler and then…

cut a paper model for my sheet metal strips. Since this was a proof of concept, I didn't waste time making the sheet metal precisely. The holes were eye-balled as was the width.

First I cut out the strip and then drilled a hole near one end. After deburring, I bent the end up. The segment with the hole in it bolts to the face of the motor. The far end is clamped by the hose clamp. After a trial fit, I made three more.



Any rotational force is applied to the edge of the sheet metal. Not much chance of flexure there. However, misalignment between shafts is a potential problem. Say the motor needs to rise relative to the rotary table shaft. The top and bottom strips of sheet metal easily flex. But the side strips are going to resist. All is not lost because I accidently included an area of flexure. It is the part of the L parallel to the motor's face. Not a lot of range there but I found that it was enough as long as I did my best to align the shaft. A bit of filing was needed on the internal key way to insure the coupler centered on the rotary table's shaft.

There is one potential risk here. My rotary table has a 90:1 gear reduction. The stepper has a maximum torque of 3.1 Nm. This means that the output torque can theoretically be 279 Nm which would likely tear up the table's gears. I will dial back the motor's torque a bit to minimize this problem.

Acknowledgments

Thanks to Paul Thompson for the elegant motor support idea. Thanks to Marty Escarcega and Malcolm Parker-Lisberg for suggesting the use of a rotary table as the basis for my A drive. And thanks to Richard [edelec] for the warning about output torque.

I welcome your comments and questions.

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