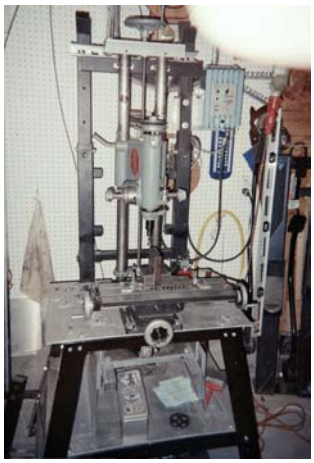


Model 10ER MetalMill Conversion

The purpose of this article is to outline my conversion of a Shopsmith Model 10ER woodworking machine to a dedicated vertical-milling machine for metalworking. I've owned the 10ER for 20 years and respected it for its sturdy cast iron parts and thick steel tubular ways. I have a Shopsmith Mark V that I still use for woodworking, and decided to proceed with this conversion after my father gave me a Taig Micro lathe for metalwork. I owe a deep debt of gratitude to my friend, Alan Trest, for his advice and mentoring during this project and as I learn about metalworking.

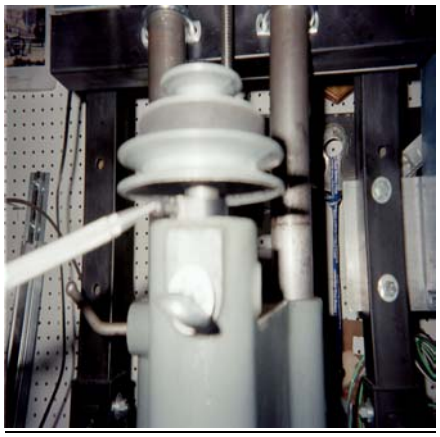
Many people are familiar with the more modern Shopsmith Mark V woodworking machine. I also own one of these machines and find it very useful for a multitude of wood working operations. In fact, my initial plan was to simply tip the 10ER up into the drill press mode, and leave it set up as a dedicated drill press. After years of working in carports or sharing space with the family garage, I finally got to build a stand alone workshop. To celebrate the occasion my father sent me the Taig Micro lathe. Suddenly, I had a way to work with metal, and it wasn't long before I began to see that the 10ER could become a dedicated milling machine.

After drawing several back of the envelope sketches, I arrived at the conversion as you see it. Simply put, the conversion consists of placing the machine in the vertical position, with its base resting on the lower shelf of a multipurpose tool stand. The carriage remains bolted to the tubular ways, and acts as the primary support to bolt the lower half of the machine to the 3/8" thick steel plate table top. The headstock is largely unchanged (so far) with the only modifications being a 1/2" acme threaded rod running through it for rapid vertical traverse, a fine pitch z-axis control replacing the drill press depth stop, and an additional lock on the spindle to help limit axial movement.

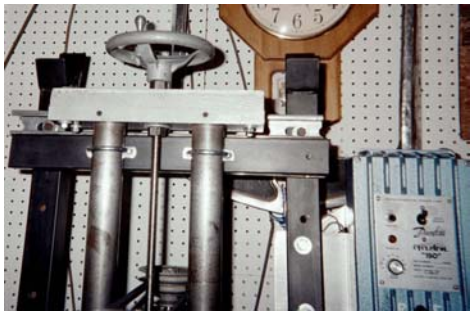
The DC treadmill motor and variable speed controller truly make using the machine a pleasure, but I suppose they are not absolutely necessary. The X-Y table is necessary for machining operations, and is certainly adequate in size for the projects I am interested in working on. Although long out of production, many fine examples of the Model 10ER are still available through local sales and certainly on eBay. Two aspects of this conversion would be useful for woodworkers and general shop use. The most universal application would be the treadmill motor conversion. The lead screw through the headstock could be very useful for moving the headstock up and down in the drill press mode, and would even be useful for wood turners.

Step One – Replace the Drill Press Depth Stop with a Fine Feed Z-Axis Control.

- Remove the Gauge Rod (depth stop) Assembly (it unbolts).
- Remove the recoil spring from the depth indicator.
- On a metal lathe (I used a Taig lathe), turn a 1" long bronze "nut" to fit snugly in the round hole of the original Gauge Collar (mine measured 0.425" diameter).
- While still on the metal lathe, center drill and tap the bronze nut to accept a ¼" by 20 pitch threaded rod.
- Bolt the round nut into the Gauge Collar using a socket head set screw, but don't drill through into center of the nut.
- Take a piece of ¼" by 20 pitch threaded rod, mask the threads at the bottom, and turn the top 2.25" down to about 0.190" diameter. Then use a die to thread the 2.25" portion to number 10 by 24 pitch.
- On the metal lathe, turn a 1" diameter and 3" long piece of aluminum to make the Graduated Adjusting Knob (the hourglass shaped object in the photo) and the bearing block (these are 2 separate pieces, but it is easier to begin to make them together).
- Center drill the entire assembly all the way through, and then tap the Graduated Adjusting Knob section (about 2" deep) for a number 10 by 24 pitch threads.
- If you have a 50 hole division plate for your Taig lathe (see http://www.cartertools.com for a 60 hole plate then read Jose Rodriguez's article about using a circular saw blade to make the 50 hole circles), mark (scribe) 50 equal divisions at the bottom of the Graduated Adjusting Knob and scribe a single witness mark on the bearing block piece. This will allow you to move the quill by 0.001" as 20 turns move the rod one inch, so one turn moves it 0.050" , so one fiftieth of a turn will move the rod 0.001" up or down.
- Cut the Graduated Adjusting Knob section off from the bearing block assembly (using a lathe cutoff tool).
- The bearing block is still in the metal lathe, so turn a bearing face about 0.75" diameter and 0.125" proud (in other words, face off smooth, and then turn a 1/8" step in the outer 1/4" of the top of the bearing block. Reverse the bearing block in the chuck and face the bottom surface, then through drill about 0.195" so it will slip over the 10-24 threaded section.
- Thread the fine feed rod through the bronze nut, leaving the 10-24 portion only projecting above the top of the permanent "ears" cast into the headstock.
- Slide the bearing block over the threaded rod, clamp in position, and mark for 2 holes to bolt it (from the bottom) to the permanent ears.
- Remove the bearing block and drill 2 holes as marked. Replace the block use the holes to mark, then drill through the ears of the drill press depth stop on the headstock for 2 socket head set screws. Mount the bearing block on the _ears_, bolting it from below.
- Drill and tap the top of the graduated knob for the handle of your choice (I made a 2" tall bronze handle).
- Place a couple of brass washers on both the top and bottom of the bearing block (over the threaded rod) and thread the graduated knob onto the 10x24 thread, and lock in position with a 10-24 nut and some locktite.
- Check for smooth operation up and down.
- This device will let you move the quill out in increments of 0.001", and you will use the quill lock lever to lock after adjustment. I found that I also needed to add an upper spindle lock (photo next page), which consists of a steel collar, drilled and tapped for a setscrew which screws through a hole I drilled and tapped in the upper spindle shaft (under the drive pulley).



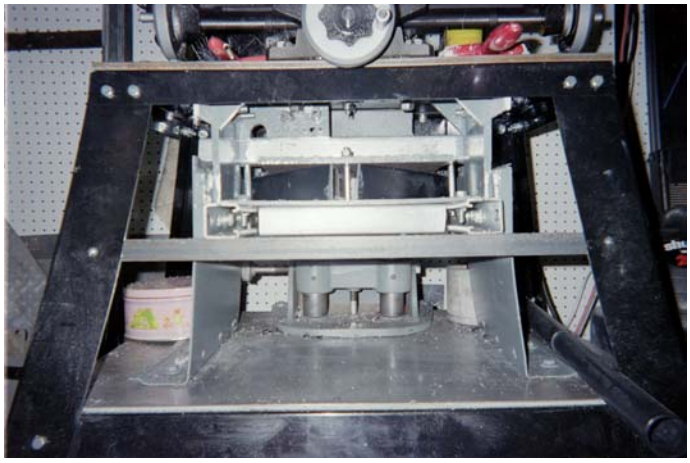
Step Two – Make a Large Z-Axis Control



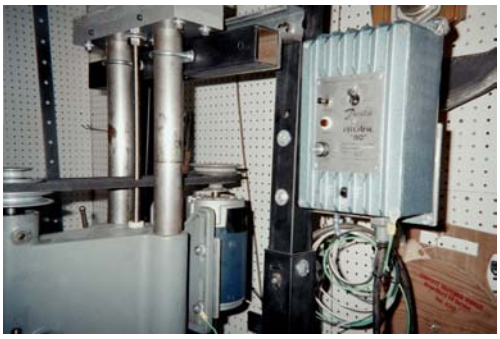
- This step will use a 3' long piece of ½" by 10 pitch Acme threaded rod as a lead screw to move the entire headstock up and down as it rides on the original tubular ways.
- Make a top support. I used a stack consisting of 2 pieces of ¾" thick hardwood and a ¼" thick piece of aluminum. One piece of wood was through drilled with 2 holes, 5.5" on center, 1.75" diameter, to fit over the tubular ways. Use the piece with the 2 through holes to make a template as described below.
- Examine the inside of your headstock above the castings for the motor mount tubes and double check the dimensions given in the step below, then drill the 1/8" pilot hole in the wooden template as described below.
- Modify the headstock. Slide the wooden template on the tubular ways (one side first, then the other) and drill a 1/8" hole exactly ½" above the centerline of the tubular ways (closer to the quill) and exactly in the middle between the tubular ways. The 1/8" hole will serve as a pilot hole to drill into the headstock. Drill a 1/8" hole in each side of the headstock, then enlarge the hole to 1/2" final diameter.
- To mount the 1/2" by 10 pitch acme threaded nut to the headstock, drill 2 equally spaced holes in the nut and tap them, then bolt it to a piece of 1.5" angle iron, notched on either side for clearance of the tubular ways and clearance drilled for the threaded rod. Then bolt the angle iron to the headstock, use nylon spacers epoxied between the headstock and all 3 fasteners (the acme nut in the middle and the 2 bolts which attach the angle iron to the headstock) to compensate for the curve of the headstock and to make sure the acme rod doesn't bind in the nut. These are shown in the photo below, taken from the rear of the machine.

Step Three - Make a Very Stable Mount.

- As you can see from the photo above, I started out by mounting the Metal Mill on a Sears Craftsman universal tool stand (model 922231). I hesitate to include the model number, as although the size was perfect, the table is NOT sturdy enough for this application, without major reinforcement. I've added yards of 1/4“ thick by 2” x 2” angle iron as well as Super Strut pieces as cross bracing in an effort to get the table and machine to be _as one._ The original 10ER carriage is unseen below the tabletop, but it serves an important job in tying the tubular ways to the table. I bolted it to the tabletop and to the doghouse assembly described below. The original 10ER base plate is stoutly bolted to a metal plate below.
- In metal working, vibration translates into errors. If you look carefully at the photo above and compare it to the lead photo, you will notice that I replaced the original aluminum tabletop with a 3/8“ thick steel tabletop, and added side braces. The long vertical supports that bolt to the top of the tubular ways are actually an old bench press machine that I cut down to fit under the table. The gray doghouse unit you see (in the photo below) under the table is the bottom of an old X-ray machine (thanks Alan), which I cut to fit the space.



Step Four. Adding a DC Treadmill Motor and Variable Speed Control



- This modification has very wide application to all 10ER users, whether you keep the machine as a multipurpose woodworking machine, a dedicated drill press, or a dedicated milling machine. I again took Alan's good advice and purchased a Leeson model #098231treadmill motor from American Science and Surplus (their catalog number 31358). The controller I used is a Cycletrol 150 (bought used) which acts as both a converter from AC to DC power, and as a variable speed control device. Alan pointed me to the website http://bedair.org (specifically, http://bedair.org/Tmotor/Tmotor1.html, and 2), which contains several beautifully illustrated pages on both the motor and the controller.

- I would only add that for the motor mount I simply cut a rectangle of 1/4" thick aluminum plate, marked the centerline and drilled two properly spaced holes for the bolts to the motor, and four holes to mate to the 10ER motor mount plate. All I needed to do was use a couple of extra nuts as spacers on the four motor plate bolts to make room for the motor bolt heads. The photo below shows the very simple motor mount.

Step Five. Add a dedicated Milling and Drilling Table

- The table I chose was the Heavy Duty Mill & Drill Table from Enco http://www.use-enco.com, who also sells acme threaded rod and nuts) model number 201-2536. This is a very nicely made table with an 18.125" wide by 6.125" deep table, with two 9/16" T-slots located 2.350" on center. The hand wheels both have 100 graduations on a movable disk (this is a big deal) and you move the table 0.100" per revolution of each handle. The base is about 8" wide and 10.5" long. The tech sheet they sent me indicates it is made by Phase II, a good imported brand. The price and service were excellent.

- After marking for the table location, I drilled 4 holes in each corner of the mill drill table mount and tapped them for 1/4" x 20 socket head set screws (and locknuts) to use to level the table. There is no way to tram the head, so you need to be able to adjust the table to make it square to the head in both the X and Y directions. That's what I'm doing in some of the photos. I then bolted the mill drill table to the 3/8" steel table top, with 1/2" bolts that extend down through the extra bracing (the old x-ray machine and the extra angle iron).

Step Six. Future Improvements

- The next big change I'd make would be to refine the Z-Axis Fine Feed. There is really nothing wrong with the existing unit, except that it means you don't have the ability to use the original drill press function. I've recently found a Yahoo Group with plans for the Westbury Mill, and I think I may build a worm and gear device that can rotate in and out of engagement, thereby reclaiming the drill press. This would allow me to place a modified dial or digital caliper in the original depth stop area for greater accuracy.

- One cool addition I'm also considering is a tachometer. The variable speed function gives a great deal of flexibility to the machine and the addition of a tach that would also give surface feet per minute of a cutter could be very nice. The website Http://www.mkctools.com/tachulator10ER shows such a device. This is the site of Skip Campbell, the moderator of the 10ER Yahoo group, so you know it would fit

Other References:

- Alan Trest's website for great info on 8x14 lathes and DC motors: http://www.stickman4.homestead.com

- Jose Rodriguez Articles (an inspiring author and video maker):

  http://www.homestead.com/tool20895/files/INDEX

- I have no connection to any company mentioned herein. I urge you to use great caution in all your hobby work, and I assume no liability for any damage incurred. Please enjoy your wood and metal working safely