How to achieve the best possible results with a Rong Fu Mill-Drill

By

Norm Berls

How It Is

- Novice interested in “hands-on” machine tool work.
- Productivity not a high priority.
- More interested in getting it right the first time.
- Really hate having to remake parts because of avoidable errors… it depletes my motivation.
- Have an “old school” bias… CNC is just more computer programming.

What's Up?

- Cut steel accurately.
- Put a good finish on steel parts.
- Learn new skills.
- Find or invent machine tool procedures that work for me.
- Don't break expensive tools.

Today's Agenda

- Mill Work Table
  - Old table made of angle iron and bolted together.
  - Old table kept giving away and loosing level.
  - This placed variable torque on the mill base and ruined the tramm.
  - The old table was junk.
- Tramming the mill
- DRO error correction
- Work Techniques

New Work Table for the Mill-Drill

- New table made from ½ inch steel plate from Rose Steel.
- Was going to make top 1 inch thick but, thank you all for talking me out of that.
- Gene Rowan did plasma cutting of table top.
- Legs made of 4 inch square mild steel tube from Rose Steel.
- Legs cut to specification by Rose Steel using a band saw.
- Shelf and leg supports made from angle iron.
- ½ inch steel foot pads from Rose Steel cut to size with reciprocating saw.

Work Table

- Design copied from YouTube.
- Table is over engineered and uses all welded construction.
- Legs welded to table top using a stick welder.
- Foot pads welded to table legs using stick welder.
- Angle iron welded to table legs using Mig welder with flux core wire.
- Edges and welds cleaned up with angle grinder.

Large Vernier Caliper

- Holes for bolting down mill-drill laid out with large vernier caliper.
- 24 inches long
- Both Imperial and Metric Scales

Same Large Vernier Caliper

- 1/128 inch precision
- 0.05 mm precision
- Made of aluminum so actual precision very much depends on temperature.
- Mill requires ½ inch bolts.
- Drilled 5/8 inch holes in table.

Leveling the Work Table

- Foot pads drilled and tapped to accept common machine leveling pads.
- Monroe pads.

Yes, the leveling pads work.

Near-Finished Work Table

- Note the four holes for bolting down the mill.
- Table weighs about 350 lbs.
- Table is
  - 24 inches wide
  - 32 inches deep
  - 27 inches tall (+ pads)
- Mill weighs about 650 lbs.

Lubricating the Mill-Drill

- X axis lead screw is easy to get to and lubricate.
- It is exposed on the underside of the T-slot work table.

Lubricating the Mill-Drill

- Back half of Y axis lead screw easily accessed by removing swarf shield.
- The front part of the Y axis lead screw is completely concealed by the mill base. There is no access to it.

Lubricating the Mill-Drill

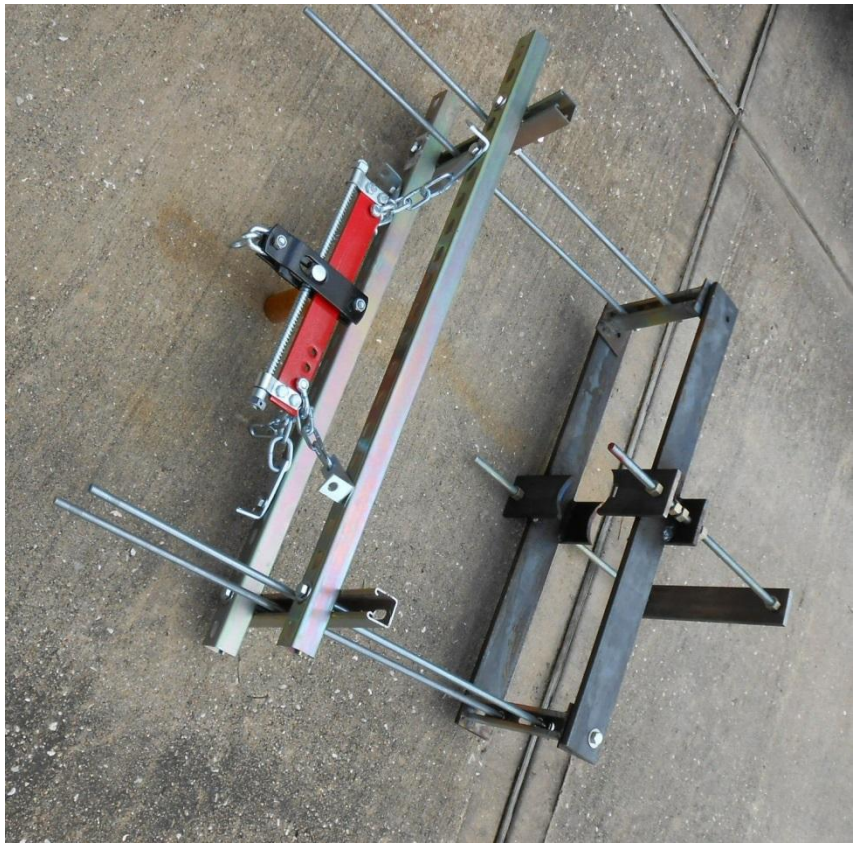
- Used an acetylene torch cut a hole in the Work Table.
- This allows application of way oil to front part of Y axis lead screw.

Lifting the Mill-Drill

- Lifting accomplished with 2 ton engine hoist from Northern Tool.
- Had to make a special lifting jig to fit the Rong Fu Mill-Drill.

The Lifting Jig

- Top view
- From top to bottom:
  - Balance bar
  - 1.8 inch channel
  - ½ inch all thread
  - ½ * 3 mild steel
  - 5/8 inch all thread
  - ½ * 3 mild steel



The Lifting Jig

- Bottom View
- Lower plate sandwiched under mill column and above mill base.

The Lifting Jig

- Closer view of middle of jig.
- Note the heavy jaws.
- Cut to fit around the central column of the mill.
- Slot in top jaw fits around rack on column for raising mill head.
- Welding done with a stick welder.

Suspense!

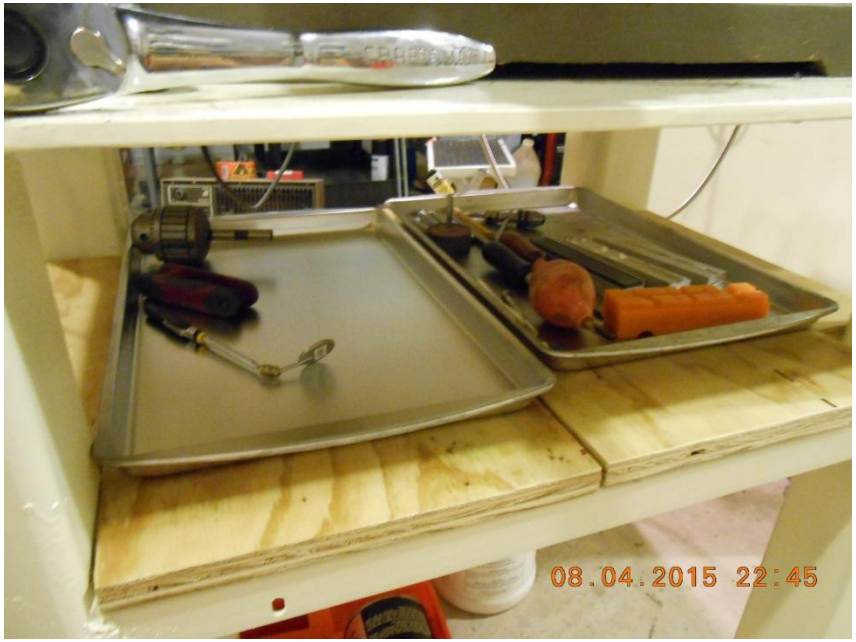
- Mill-Drill is hanging from the engine hoist.
- Old table has been removed
- In the process of shoving the new table under the mill.
- The welds in the jig are holding!!!!

Too lazy or too ambitious?

- Mill was lifted and positioned with all attachments in place:
  - Milling Vise
  - DRO
  - Power Feed

Shelf and Cookie Sheets

- Shelf under table made of ¾ in. plywood cut and lacquered.
- Two steel cookie sheets hold commonly used tools and keep them from rolling off the shelf.



Lubricant Caddy

- I keep all my lubricants in a portable caddy.
- Here the caddy is in place for use with the mill-drill.

Tramming

- With the lifting jig and engine hoist in place, I had an opportunity to install new tramm rods between mill column and base. Lifted the mill again without the base.
- Rods made of O-1 tool steel (left annealed).
- 5/8 diameter.
- Nuts are L9 alloy cadmium plated and waxed.
- Lower threads are 5/8-11 tpi to fit the mill base.
- Upper threads are 5/8-18 tpi
- Theory: Fine threads will allow fine tramm adjustments.

Tramming Methodology

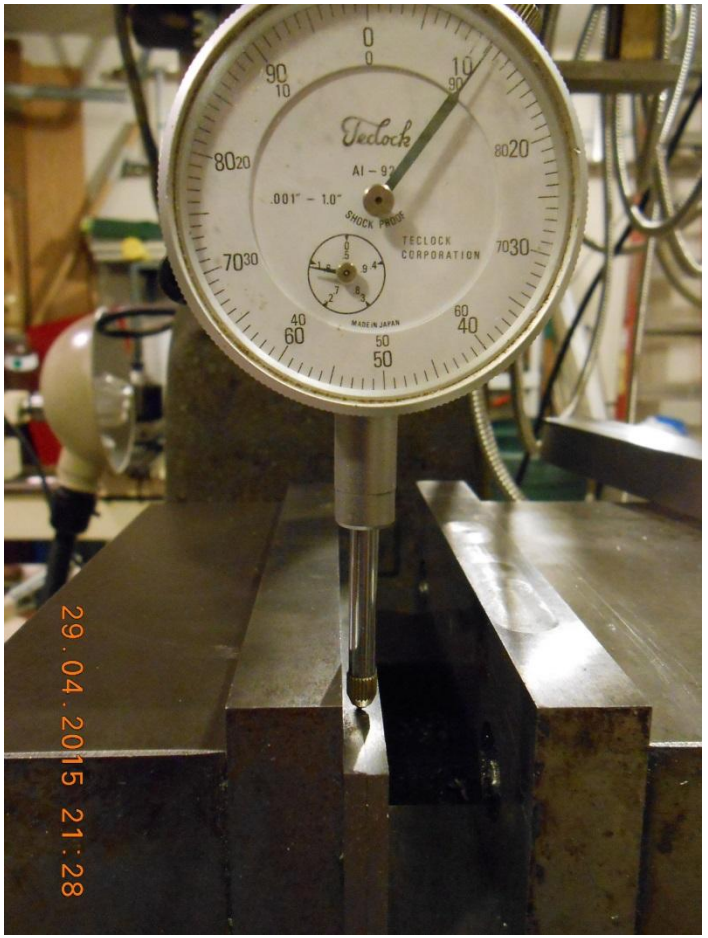
- With ½ inch drill rod in collet.
- Do rough tramm using machine square in both dimensions.
- Experience has revealed subsequent tramming steps will be difficult and time consuming without this initial step.

Tramming Methodology

- Tramming gage tool purchased from Edge Technology. $100
- Advertised regularly in The Home Shop Machinist magazine.
- Works sometimes. Other times it is a major source of frustration.
- Just followed the instructions that came with the tool.

You don’t want to see this

- After tramming the mill I mounted my milling vise on the mill.
- Put two factory made parallels into the vise and checked them with a dial indicator.
- Backs of parallels were 11 mils lower than the front.
- Concluded the vise was causing the trouble.
- Tried to fix problem by tampering with the tramm.
- BIG MISTAKE!!!



Fixing the Vise

- Sudden insight suggested possibility that there was swarf down in the bearing surfaces of the vise.
- Took the vise apart to clean it.
- No swarf… just a little preservative wax.
- Bottom of inside shown.

Fixing the Vise

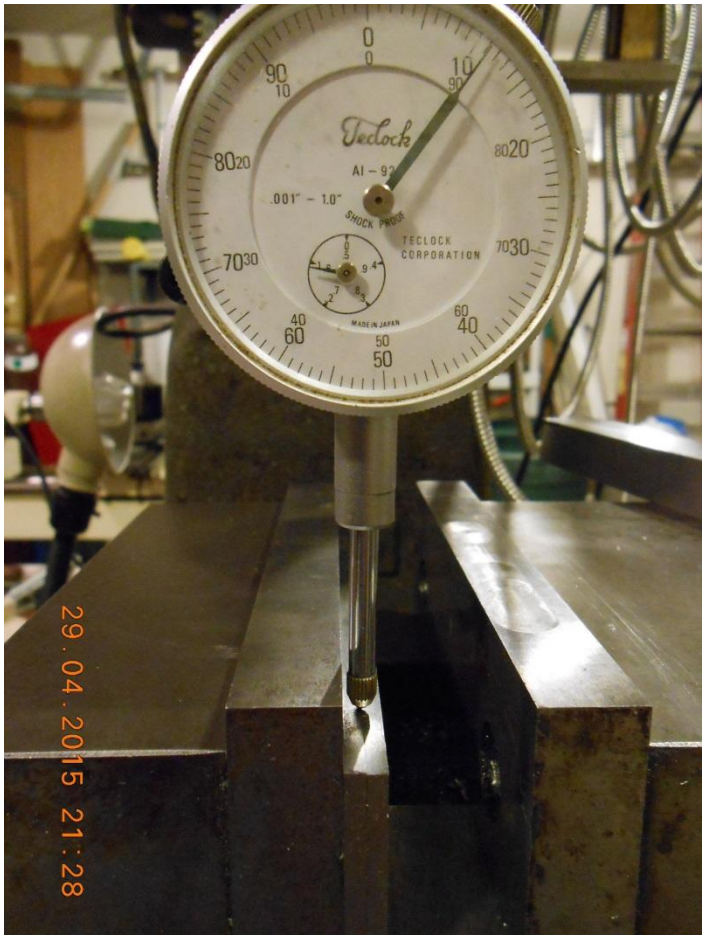
- Top of vise inside was also clean with only a little preservative wax to remove.

Fixing the Vise

- Bottom side of vise also had only a little preservative wax to remove.

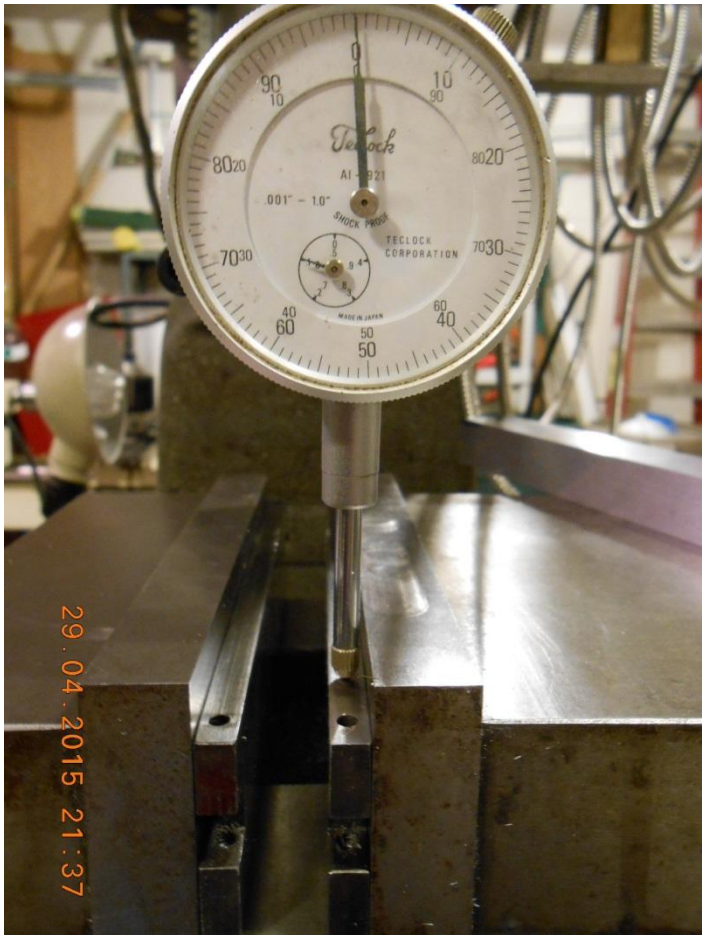
In a fix with the vise.

- Cleaning the vise bearing surfaces accomplished nothing.



Vise Problem Work Around.

- Adjustable Parallels to the rescue.
- Small set screw in the end of homemade parallels allows them to compensate for deficiencies in the vise.



Tramming Methodology

- Tramm rod adjustments made with 15/16 wrench and dead blow hammer.
- Adjustments made by gently tapping nuts through 10 degree rotations.
- Nuts turn very, very smoothly.

Tramming Methodology

- Decide which direction you are going to move (Up or Down).
- You have to make room for an adjustment before you can apply it.
- If UP, start by loosening the top nut.
- If DOWN, start by loosening the bottom nut.
- Every adjustment step ends with all nuts in fully tightened position.

Had to re-tramm the mill

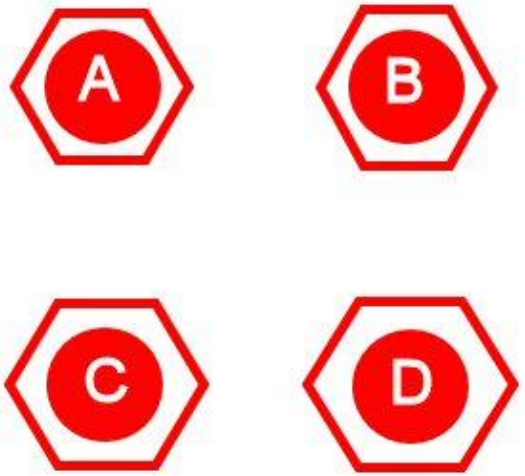
- Could not get the dial gages to work.
- Had to settle for machinist square method.
- Push the square hard up against the drill rod.
- Slide a piece of wax paper between the square and rod and slide it up and down to determine which direction has no contact.
- Adjust the tramm accordingly.
- When the wax paper will no longer fit anywhere between the square and rod… call it a day.
- Advice: do not use a pen light to determine the gap. Your eyes will get tired and you will not be able to tell a large gap from a small one.

Re-tramming the Mill

- Tried tramming X direction by itself and then the Y direction.
- Changes for the sake of Y ruined the X tramm.
- This can lead to a situation rather like a dog chasing it's own tail.
- Solution: both the X and Y tramm states must be taken into account simultaneously.

Re-tramming the Mill

- Here the four tramm bolts have been arbitrarily labeled A,B,C,D.
- Assuming that the machine square examination has revealed that the A corner needs to be raised.
- Begin by lowering the D corner by the prescribed 10 degrees.
- Raise C and B by 10 degrees.
- Raise A by 20 degrees.
- During each adjustment cycle make sure all 8 tramm nuts are loosened and tightened again at some point.
- Loosening and tightening each nut helps even out stresses in the column base.
- Uneven stresses in the column base will make the tramm process erratic and unpredictable.

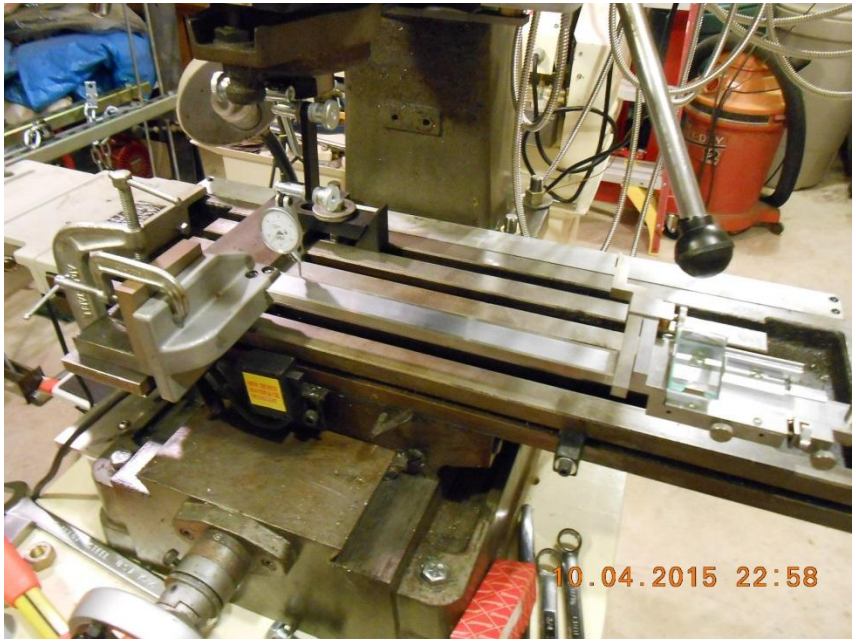


Tramming Conclusions

- Long hours of work followed by an attempt to tramm will make tramming especially difficult.
- Tramm when you are fresh.
- The dial device probably works but the tramm must be nearly perfect to begin with.

DRO error correction (X – Axis)

- Clamped a large height gage to the mill-drill work table in the X direction.
- Pushed the height gage out 10 inches with the drill rod and X Axis lead screw. DRO followed along.
- Fed 10 inches into the DRO as an X Axis correction factor.



DRO error correction (Y – Axis)

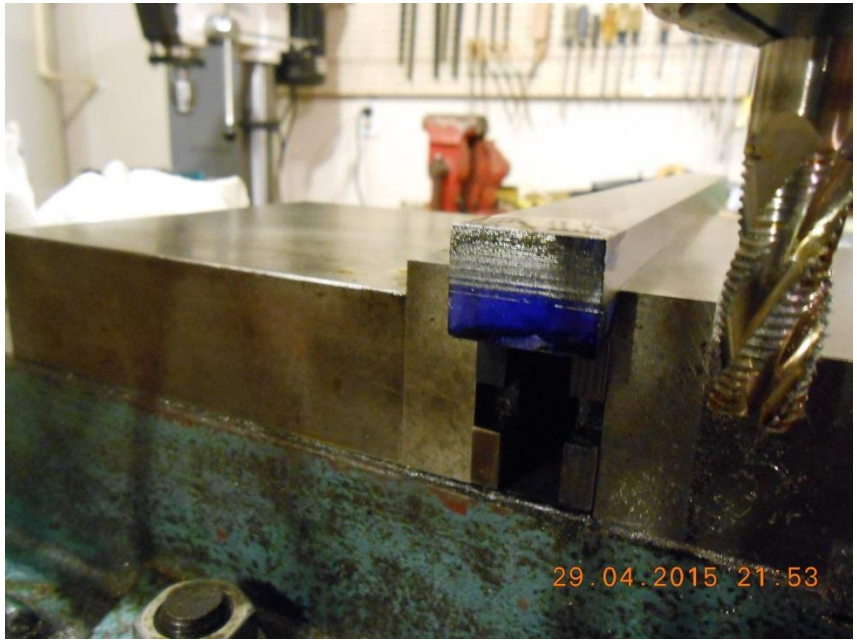
- Clamped a small height gage to the mill-drill work table in the Y direction.
- Pushed the height gage out 5 inches with the drill rod and Y Axis lead screw. DRO followed along.
- Fed 5 inches into the DRO as a Y Axis correction factor.

Sanity Check

- Oops, this is too much work.
- Besides, the height gages may bend when the drill rod pushes on them.
- Only need a couple gage bars (for X and Y) to test or reset the DRO.
- Edge finders will then allow precise positioning WRT the gage bars.
- This gage bar is 10.020 inches long and is for the X Axis.

See, it wasn’t square

- Making a gage bar for setting the DRO error correction.
- Made first cut before I discovered vise was warped.
- Mill has been re-trammed.
- Depth of cut set to cover entire end of gage.
- End of gage painted with Dyken Blue.
- After first pass of end mill only part of gage has been cut.
- It was not square.
- I have adjustable parallels but not $1700 for a new Kurt vise… maybe try ebay?



Laying it all out

- Dyken Blue
- Granite surface plate 9x12
- Steel angle
- Height gage.
- Machinists squares
- Digital caliper
- Carbide Scriber
- Metal rule
- Sometimes use sewing needle in pin vise for scribing.

A Typical Quagmire

- Heavy lines made with height gage on surface plate.
- Circles and cross hairs drawn with sewing needle in pin vise.

Reciprocation is nice

- I like reciprocating saws.
- Carbide tipped blades allow me to cut off big pieces of mild steel and aluminum.
- Saves a lot of hard work with a hack saw.

Progressive Drilling Methodology

- Always use progressive drilling for large holes.
- To get a ½ inch hole:
  - Start by drilling a 1/8 inch hole.
  - Next re-drill with a ¼ inch drill bit.
  - Next re-drill with a 3/8 drill bit.
  - Finally drill with a ½ inch drill bit.
- Use stub length or screw machine drill bits whenever possible.
- Photograph compares Stub vs. Jobber length drill bits.
- Stub drills combined with the progressive technique will produce the straightest holes.

Positioning to drill a hole

- Given a layout mark where the hole is to go:
- Mount 1/8 carbide engraving bit in the drill chuck.
- Position as best I can over layout mark and use bit to put a small dimple in the work piece.
- Use magnifying glass and penlight to inspect dimple.
- If on center of layout mark: done.
- If not, adjust and make another dimple.

Positioning edges and holes

- Old school mechanical edge finders and center finders work best for me.

About End Mills

- Prefer ½ inch end mills for most cutting.
- Have 3/8, ¼ and 1/8 end mills.
- Prefer end mills that are HSS with some cobalt.

If you aren’t bored yet

- Always use the shortest possible end mill.
- Always set the mill head as close to the work piece as possible.
- Use 4 flute end mills on steel and 2 flute end mills on aluminum.
- Do all roughing work in steel with a fine tooth roughing end mill.
- Do near-finished work with smooth cut end mill.

About Carbide Burrs

- Do final cuts with a carbide burr.
- I like ½ inch diameter burrs.
- Beware of cheap burrs, they may contain runout.

Getting Stoned

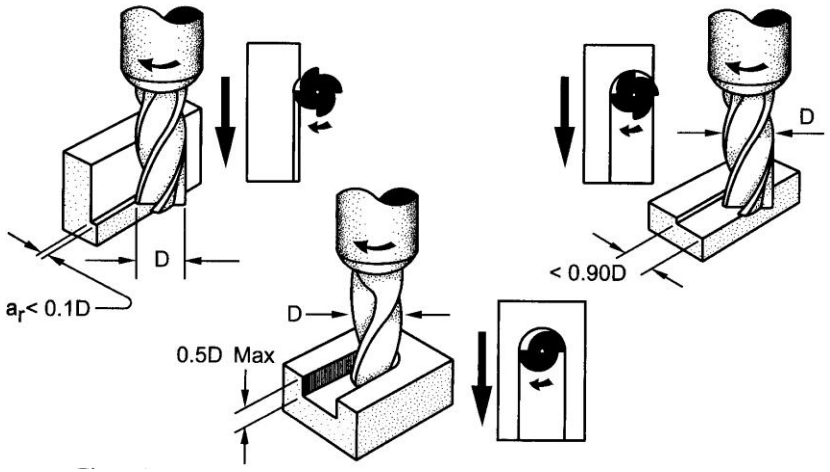
- I don’t have a precision grinder.
- Make do with grinding stones and Mill-Drill
- Aluminum Oxide
- Best way to get finest finish.
- When the stone gets worn, I use a diamond dresser to straighten the edge of the stone.

Regressive Milling

- Never take more than a 0.030 cut with a Rong Fu Mill-Drill.
- When you get down to 0.030 remaining, proceed in half steps.
- Only cut away half of the remaining material on any pass.
- Re-measure after every pass.
- When you get to 0.004 of material still left, switch to carbide burr.
- Only cut 0.001 at a time with the carbide burr and make a climb milling pass each time.
- Re-measure.
- Leave 0.001 or 0.002 for polishing or finished grinding.

Depth of Cut Advice

- Frank Marlow, PE and P.J. Tallman wrote Machine Shop Know-How
- It contain all manner of excellent advice including guidelines for depth-of-cut.
- Off the side of a mill < 0.1 D
- Off full end of a mill 0.5 D Max
- Off partial end of a mill < 0.90 D

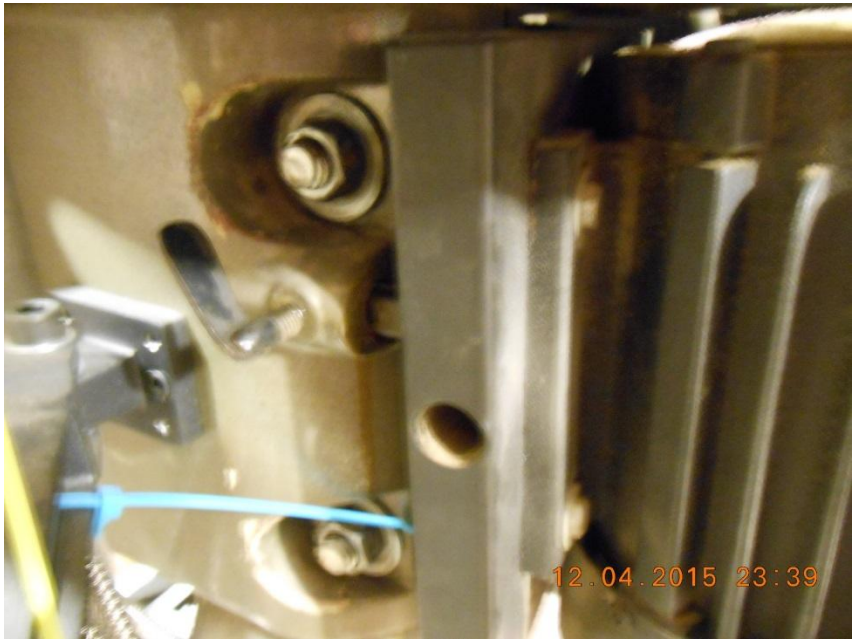


Speed Advice

- Drilling mild steel
  - 1000 RPM for 1/8 bit
  - 700 RPM for ¼ bit
  - 300 RPM for 3/8 bit
  - 100 RPM for ½ bit.
- Milling mild steel
  - 700 RPM for ½ end mill
  - 1000 RPM for ½ carbide bit.
  - 1000 RPM for a 1 inch stone.

Getting Belted

- Set screw holds motor and rear belt in position.
- Loosing this set screw allows motor to swing towards front of mill.
- Allows rear belt to be removed.

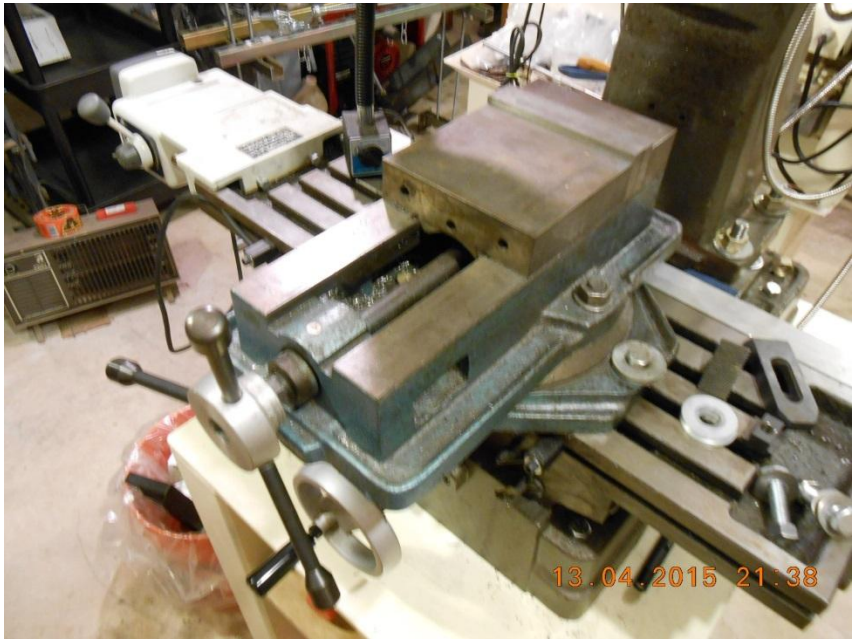


Getting Belted

- Note the two bolts that hold the middle pulley in position.
- These have to be loosened to move the front belt.
- When both belts have been positioned for the new spindle speed:
  - Push the motor into position. This will re-tension all the belts. Re-tighten the motor retention screw.
  - Re-tighten the center pulley bolts.
- Belts should have equal tension and should deflect about 1 inch when wiggled from side to side.
- Too much belt tension will cause bearings to wear out prematurely.

Even a warped one will do

- Get a large heavy duty vise where the movable jaw is forced down onto the vise base when screw is tightened.
- Avoid light weight vises that are used on drill presses. Work piece will rotate and result in bad cut.
- Three arm turning wrench speeds things up.

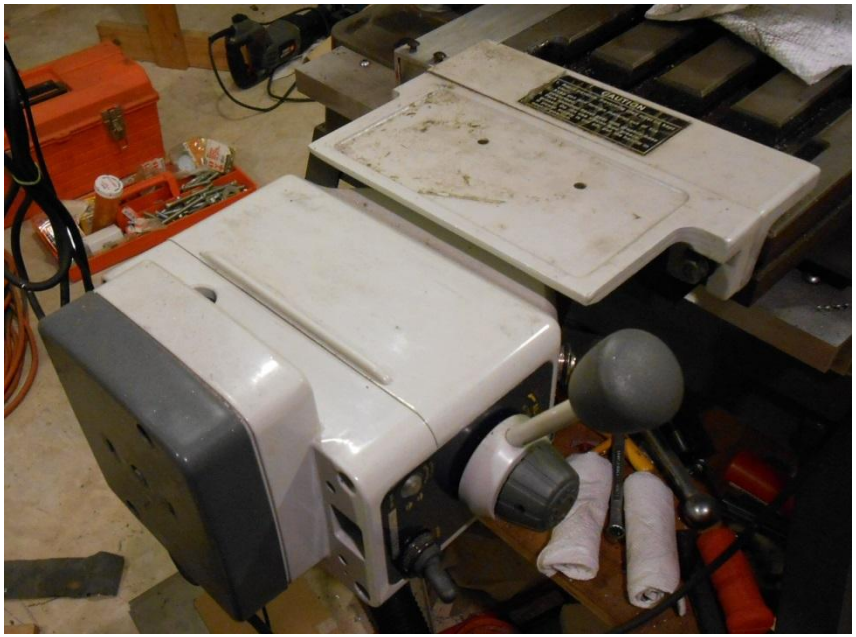


Aluminum Vise Jaws

- Magnetic backs
- Top jaws have rubber face- won't scratch work piece.
- 3x5 cards also will prevent work piece scratching.
- Lower jaws have V slots for holding round objects (e.g. steel rod)
- Used to hold Diamond Dresser when truing

Give me power

- Hand feeding of mill always results in irregular depth of cut.
- Power feed makes really consistent cuts possible.
- Essential for milling and especially grinding.



No smoking, please.

- I use Mike-O-Cut cutting fluid on steel.
  - Lard
  - Sulfur
- I use A-9 cutting fluid on aluminum.
- Little squeeze bottles with needle tube apply enough lubricant safely and help control mess.
- If it's smoking, you're going too fast or cutting too deep.
- My work pieces, drills and end mills are just mildly above body temperature when I finish a cut.

A little dab will do ya

Tapped Out

- I use Mike-O-Cut #7 fluid for tapping in steel.
- T-handle extension on tap wrench fits into drill chuck and keeps me from breaking so many taps.

What's happening?

- I want to see what is going on.
- Swarf caught under an end mill forces extra cutting, eats up end mills and ruins finish.
- Don't have a coolant system.
- Chip brushes get chewed up.
- Air bulb is nice for moving swarf out of the way.

Puff the Magic Dragon

Cleaning up the Swarf

- Often I use an old shop vacuum to pick up smaller swarf.
- I use paper towels for wiping down the mill.
- Often I use magnetic pickups on swarf.

Cleaning up the Swarf

- Trash can is a plastic bucket from Home Depot.
- Cheap trash can liners make cleanup much easier.
- Often use double thickness paper towels to pick up swarf by hand.
- Place a paper towel over a magnetic pickup, tap the pickup against the swarf.
- Then over the trash can, pull the magnet away from the paper and the swarf will drop off.
- One paper towel good for a half dozen passes.

Yes, but does it work?

- Project: make a dial gage holder for a quick change tool post… after Martin Kennedy's article in January 2014 HMSC newsletter.
- This dovetail worked on an Aloris AXA tool post.

Better to Saw than End Mill

- Never use an end mill to remove metal that can more quickly be removed with a saw.

Better to Drill than End Mill

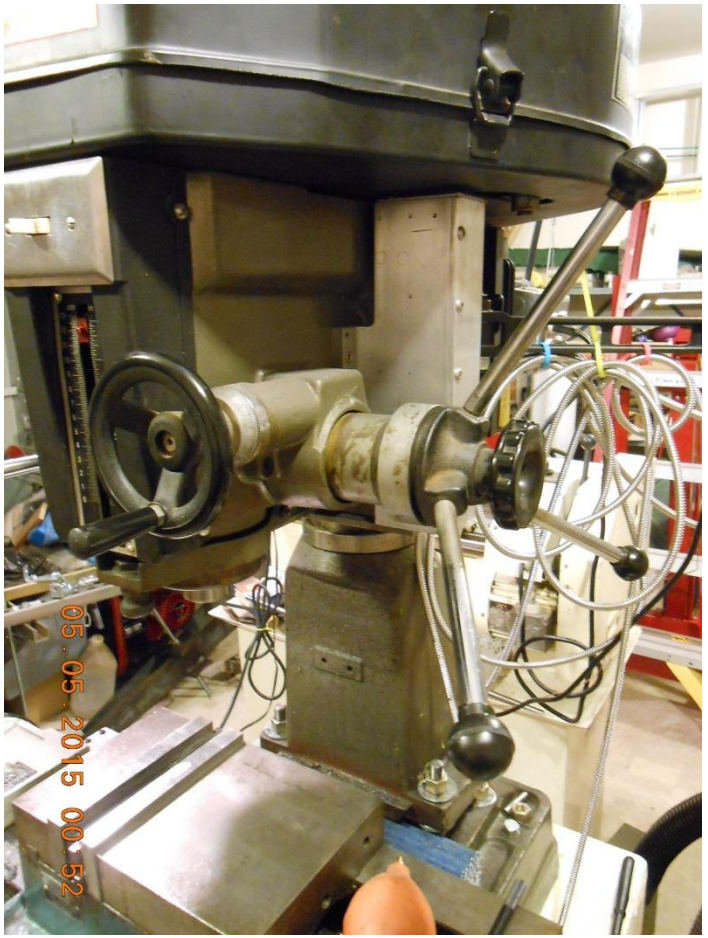
- Never use an end mill to remove metal that can more quickly be removed with a drill… and then a hack saw.

Strike One

- Depth of cut on the Rong Fu is very hard to control.
- Here the slot was cut too deep.
- Tried to compensate by cutting top surface deeper.
- Cut it too deep.
- Material is 1018 steel

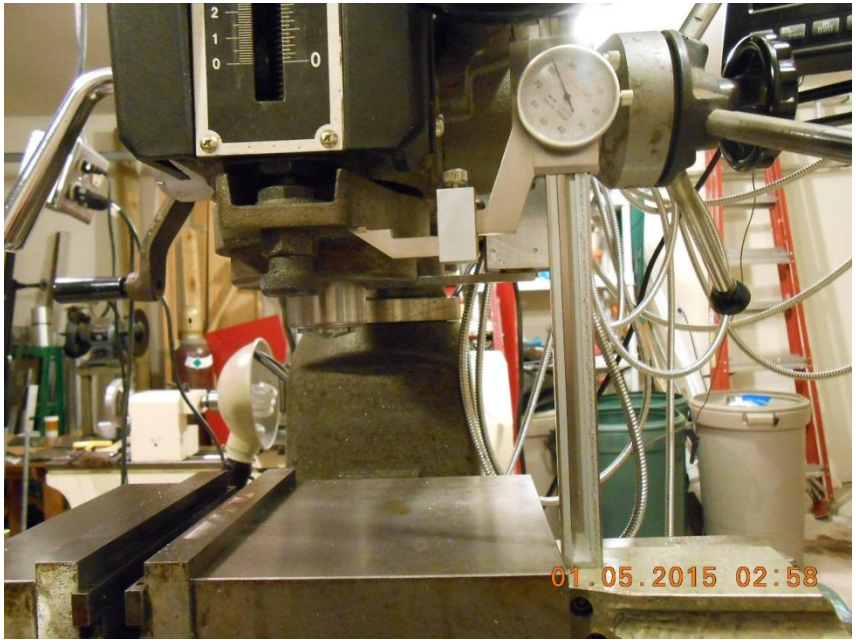
KA-LUNK… KA-LUNK

- The vertical controls on this mill are junk.
- The coarse control limps along in 0.010 mil steps emitting an audible KA-LUNK sound with each step.
- The fine control emits additional sounds and is less precise than the coarse control.



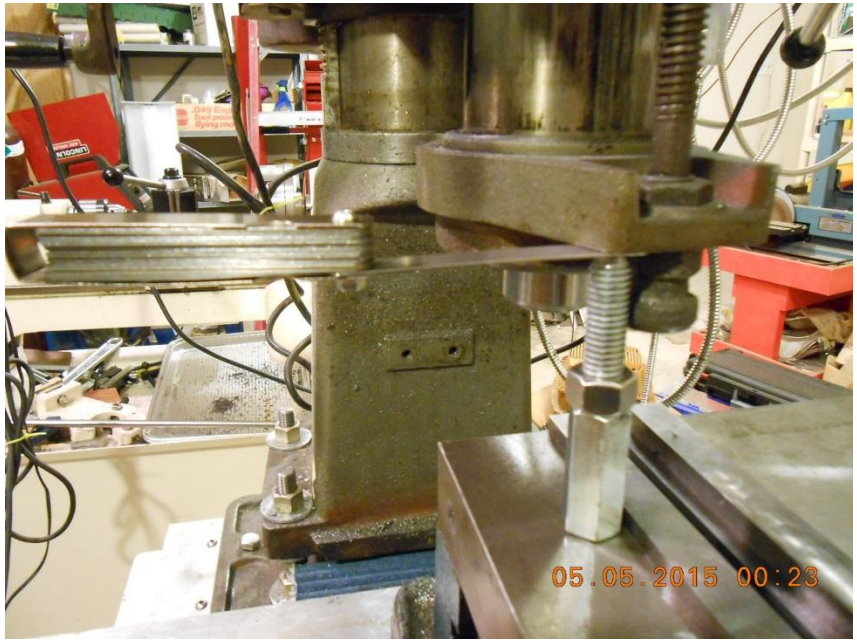
In Desperation

- Tried to control the depth of cut with a height gage.
- With quill locked at depth of last cut, place small height gage on vise.
- Set scribe upside down and move up so it touches underside of quill.
- Back height gage down to level of next cut and lock.
- Rotate height gage out from under quill.
- Unlock quill and lower it.
- Rotate height gage back in to test if quill is low enough.
- Lock quill when height gage just touches bottom of quill.
- This works sometimes but often not!!!



In Greater Desperation

- Made a rudimentary screw jack from a coupling, all thread and a jamb nut.
- ½ diameter.
- With quill still locked in place from last cut, select next desired depth of cut on a feeler gage.
- Place feeler gage under quill and screw up jack to a snug fit.
- Set the jamb nut.
- Remove the feeler gage.
- Unlock, lower and relock the quill.



Depth of Cut Summary

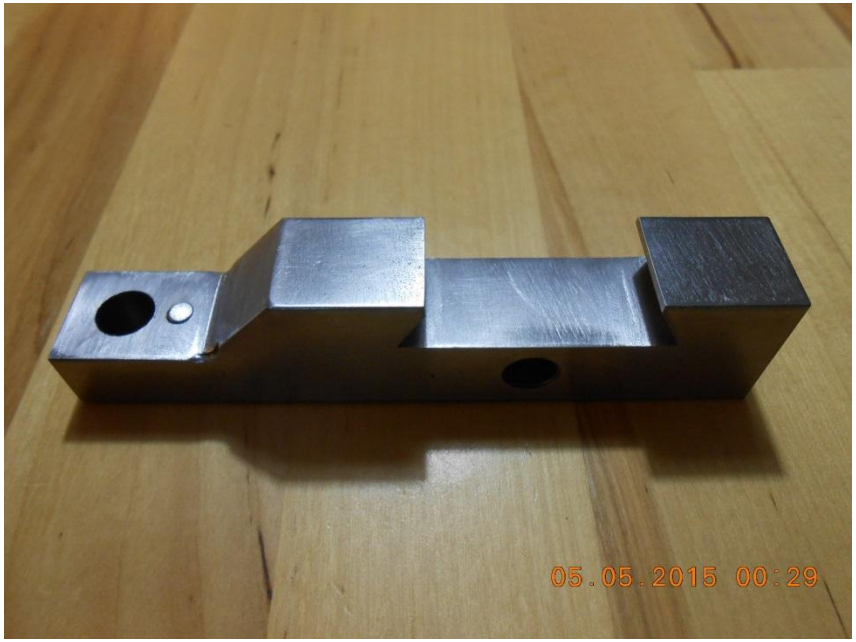
- Existing quill controls are adequate for crude hogging cuts where precision is not a big problem.
- Fine precision is only possible with some external supplement to the mill vertical controls.

Strike Two

- Cheap taps do not threads make.
- Tap has reamed out top of hole and caused wall to bulge into dovetail.
- Had extreme difficulty getting the slightest bit of thread cut.
- This was a cheap tap that came from a set and the work piece was tool steel.

Strike Three

- Material was 1018 steel
- Never had trouble cutting the dovetail… it fits the tool post.
- Other dimensions were easily controlled.
- Quality of this part was good until I blundered.
- Can you guess what I did wrong?



In Summary

- The Rong Fu mill-drill is a marginally viable tool.
- It’s OK for hobby work but I wouldn’t want to try production work on one.
- The X & Y control is very good and easy to use.
- The vertical control is pathetic.

About the DRO

- Have only a little experience using the DRO.
- The DRO is very nice for incremental cutting.
- I am not yet confident enough to trust it with layout work.
- Even the Z axis readings seem fairly good… it’s the mill itself that has poor vertical control.

About the Power Feed

- Don’t leave home without one.
- The power feed is what makes this Rong Fu mill-drill a tolerable tool to work with.

Maybe Someday

- Edges around the new table will allow permanent placement of a better work light.
- May build a steel stand for the DRO readout and fix it to the table.
- May replace floppy screws on gibs with knurled knob screws.
- Would like ball screws for the lead screws but nothing substantive to be gained… not going to CNC.

The End