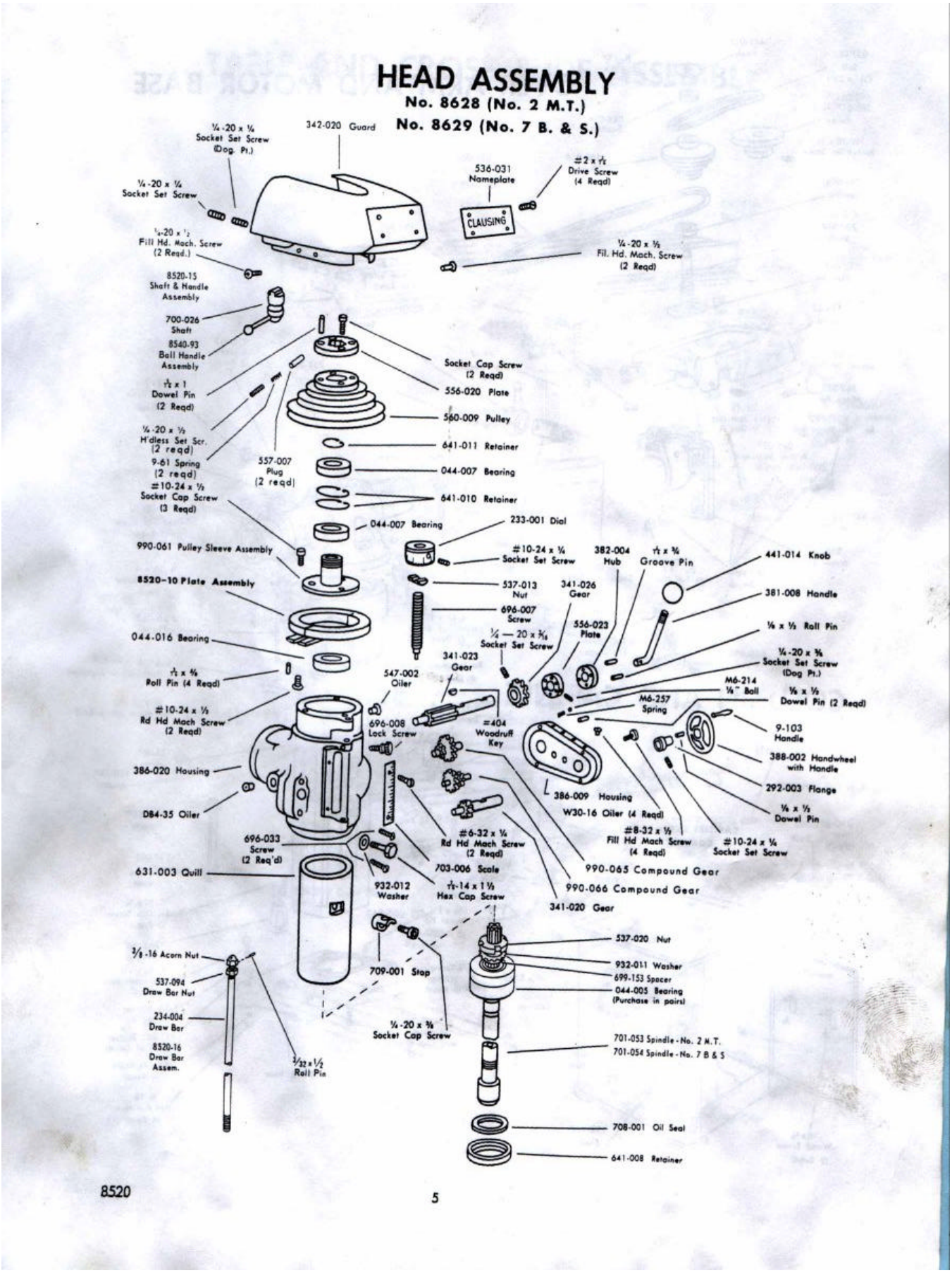
DISCLAIMER: I am, do not claim to be, nor aspire to be a machine mechanic. Following is how one amateur machinist repaired his machine to a much more usable condition. What follows is not an endorsed maintenance procedure. The author makes no claims or warrants that the procedure will work for anyone else. Proceed with caution.

Preface: When I got my milling machine, the name plate said it was a Clausing 8525. S/N 000348. The 8525 machine takes a Brown & Sharpe #7 tapered collet. However, my spindle takes a Morse Taper #2 taper. As it was soon going to be obvious, someone had been inside the head and changed the spindle. Clausing says that by S/N, my machine is 1955 vintage. When running, the mill was noisy. I could not pinpoint the source of the noise, but figured that it was excess play in the splines and that one of the bearings was going bad.

Since the day that I got my machine, changing collets was never easy. Unlike the one or two good whacks that it takes now, it usually took 6-10 whacks while I held the quill up with one hand. One day, I was getting frustrated and I didn't hold the quill. I just whacked away. I noticed that the spindle nose was dropping as I hit the drawbar! Not a good thing. So armed with the manual page below manual and a good bit of determination, I decided that right then and there, I was going to tear the head apart and figure out what was going on.



This really sounds worse than it is. I must state that I have changed bearings out in a couple of other machine tools, notably a J-head Bridgeport. The Clausing was by far the easiest machine to work on.

To make the work access able, I tilted the head to about 45 degrees and pulled the ram out about 4". I also lowered the table to about half-way down to give me room. Total time for tear down took about an hour. Putting things back together took a little bit longer. I did have about

a weeks time in between disassembly and reassembly waiting for parts to think things through and pre-plan (writing this up took much longer).

Prerequisites: You need a pin spanner to fit your retaining nut. I spent some time making mine. The pins are 1/8" diameter, spaced about 1.750 inches apart. I say about because mine was already messed up so I had to re-drill the holes a bit to true them up. I did this in place with a hand held drill. The spanner should clear the spindle nose, which is about 1.250" in diameter. There is a picture below which should be self explanatory. The use of a slide hammer was also handy for pulling bearings out of housings but it wasn't a absolute necessity. I also used a lead hammer to tap things apart. If you don't already have one, you should get one. My 2 pound with a textured plastic handle was $10 from the supply house. You will need to use another spanner to remove and tighten the spindle bearing retaining nut. In lieu of the spanner, use of a lathe with a chuck and tailstock will do.

The procedure that I used to remove and replace the bearings follows.

Step 1. Remove the front pulley cover by removing the 4 Fillister head screws. The spindle brake band rotates as you withdraw the cover. Note the orientation so when you put the cover back on, you can mate the brake actuator with the brake.

Step 2. Remove the top knurled nut (if you have one) from the top of the spindle. If you machine is like mine, the nut is missing and the splines are a bit beat up. I spent a few minutes with a small file trying to true up the splines so that the spindle would pass through the drive plate.

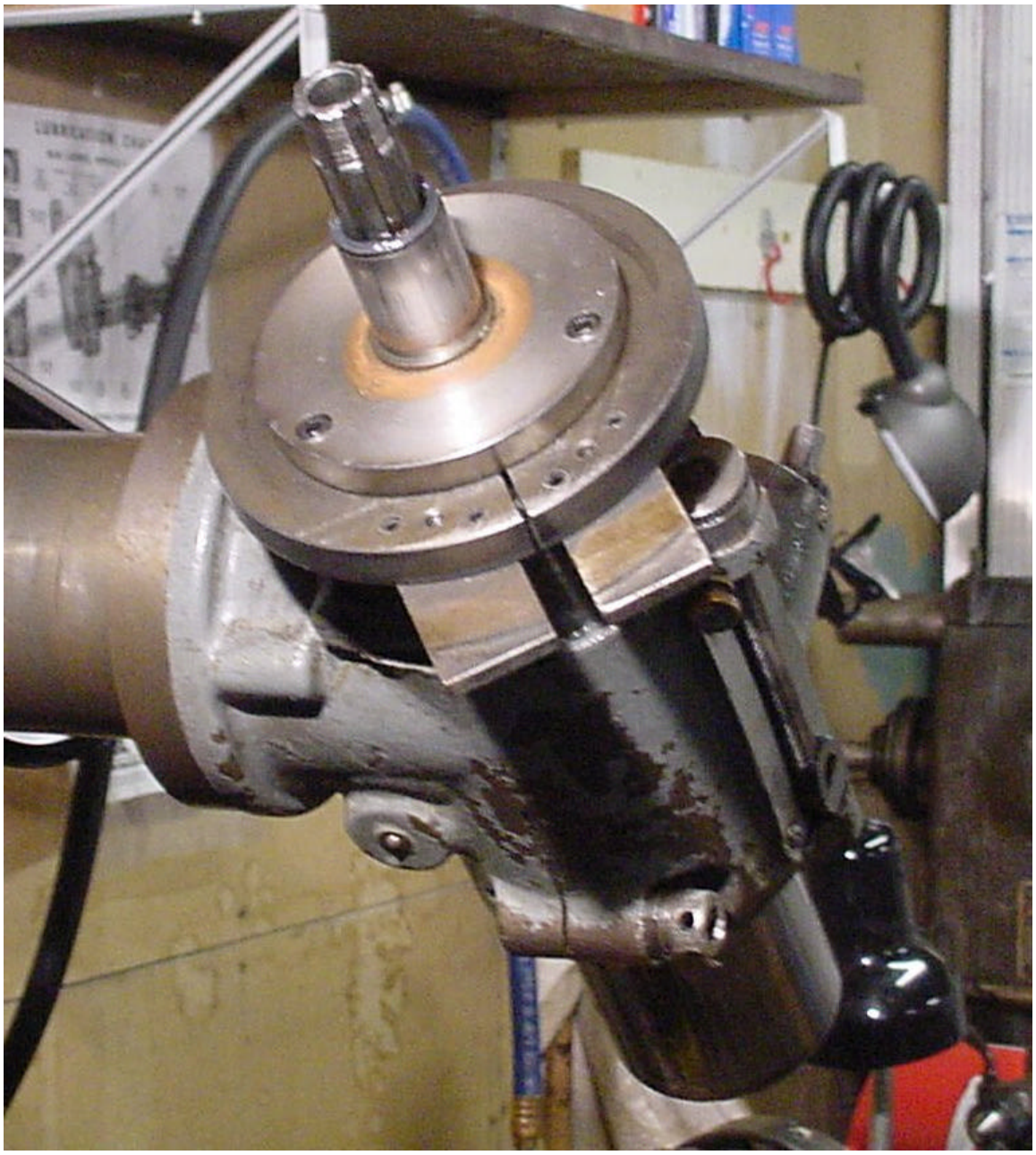
Step 3. Remove the 2 cap screws from the spindle drive plate. There are 2 dowel pins in there as well, but you can't remove them from here.
CAREFULLY pry apart the drive plate from the step pulley. Both the drive plate and the pulley are aluminum so watch what you are doing. You can scar the mating surfaces which will cause you agony later.

Step 4. Remove the drive plate. If your splines are still mashed up then take your time with the file. Remember, the drive plate is aluminum. The spindle and splines are steel. The spindle will win if you try and force it. You will end up with a very sloppy and especially noisy mill. Below is a picture of the drive plate separated from the pulley.

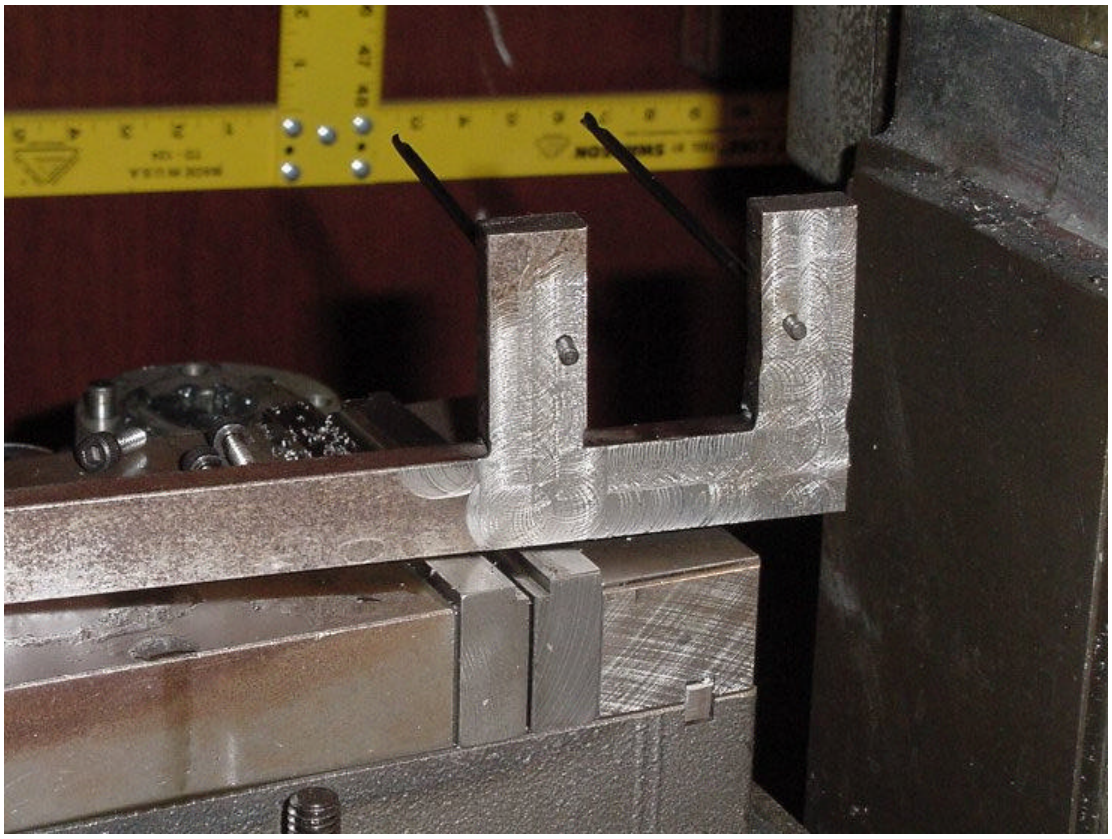
Step 5. Next to remove the pulley. My step pulley did not mount like the manual shows with retainers. There are no obvious puller holes to be seen. I did not want to push against the spindle so I lightly tapped the bottom of the pulley with a lead hammer (remember the pulley is aluminum) and rotated it as I tapped. The picture below is with the pulley about a third the way off. The hammer hits the inner most part of the pulley, the solid material behind the belt groove. The brake band is just inboard of that. The brake band is Cast Iron and has a relief hole opposite the tabs. It's strong enough, but too much abuse I would think that you might risk breaking it. It is somewhat repairable, but it will never be the same. I shudder to think what the replacement cost would be.

Step 6. This is the pulley spindle and bearing retainer plate. There are 3 allen cap screws holding it to the head casting. the larger circle is the spindle brake band. You can see the two ears at 5 o'clock. The actuator for the brake is a rectangular boss on the shaft of the handle. It forces the two ears apart thus enlarging the diameter pressing against a recess on the backside of the pulley. Remove the 3 screws and remove the plate. You will see the shielded brearing under that that is the top support for the spindle. Be VERY careful with the brake band. It is basically an overgrown piston ring. The gap between the two ends is about 0.060.

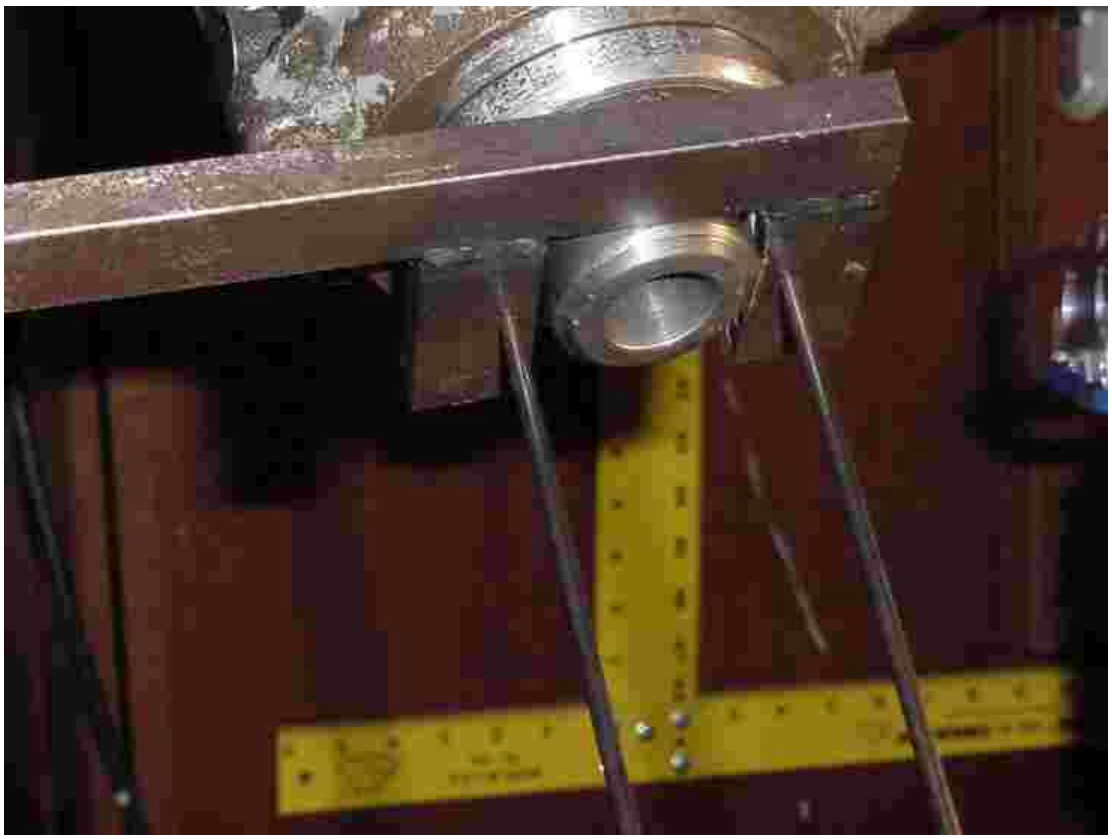
Initialy, I did not realize in what poor condition the brake band was in. I was flexing it with my hands and then it suddenly snapped! When I looked at the break surface closely, it was apperant that the brake band had an initiated fracture starting at the relief hole. The fracture had propagated almost 3/4 the way across the cross section. The surface was dark and sooty. The failure surface was bright and shiny. I cleaned the surface thouroughly and parially beveled the mating edges. After come carefull jigging and testing, I brazed the two pieces together with silicon bronze with the TIG machine. I used scraps of aluminum and shim stock to hold the gap open. I figured that a slightly smaller diameter brake band would be better to have than one that is too big. If its too big, then it would interfere with the pulley as it rotated and wear the inner surface. After a bit of grinding and filing the band fit and cleared the pulley.



Step 7. Here is a picture of my pin spanner. I made it out of 3/8x3/4 Cold Rolled. It works ok. Originally I used 0.125 dowel pins, but the were too brittle and broke when applying too much force on the retainer. I substituted drill bits of the same size instead and they worked splendidly. Ignore the scale in the backround, it just happned to be hanging on the wall behind the mill. I milled the face of it and worked from this reference face. I think that it was better to have the pin spanner fit flush against the face of the retainer.



Step 8. Loosen the small set screw on the backside of the quill. Trust me, its there. You don't want to damage the retaining nut theads. My set screw bears against a sacraficial plastic plug that deforms against the threads. You can see it in the picture below. After loosening/removing the set screw, use the pin spanner to loosen and remove the retaining nut. The main spindle bearings are visible now.



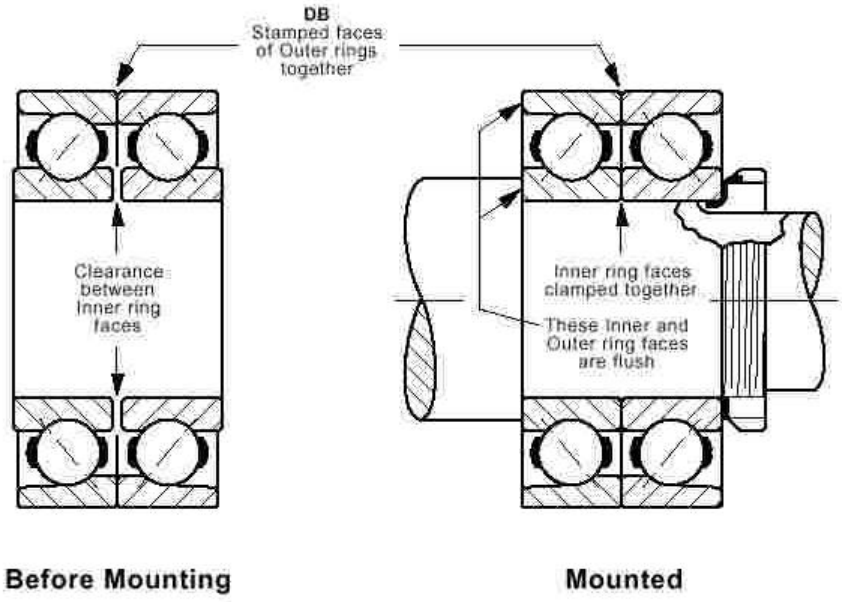
Step 9. Now for the moment of truth, remove the spindle by carefully tapping the splined end with your lead hammer. The spidle should come out slowly. The retaining nut and star washer were unthreaded and loose on the spindle. This I believe was a source of some of the noise. There was no spacer. I made a spacer out of an old 1" arbor bushing. I measured the lenght of the threads and then subtracted the thickness of the bearings, star washer and retaing nut. It worked out to just over 0.15 inches. I cut the spacer to 0.1 to make sure that I engaged all the threads in the nut.

Step 10. After removing the spindle, remove the top pulley spindle/bearing retainer plate. Under this you will see the top of the quill and the counterbored bearing. Mine popped out with a bit of prying. It was rough and was almost indexed at increments that would have matched individual ball bearings.

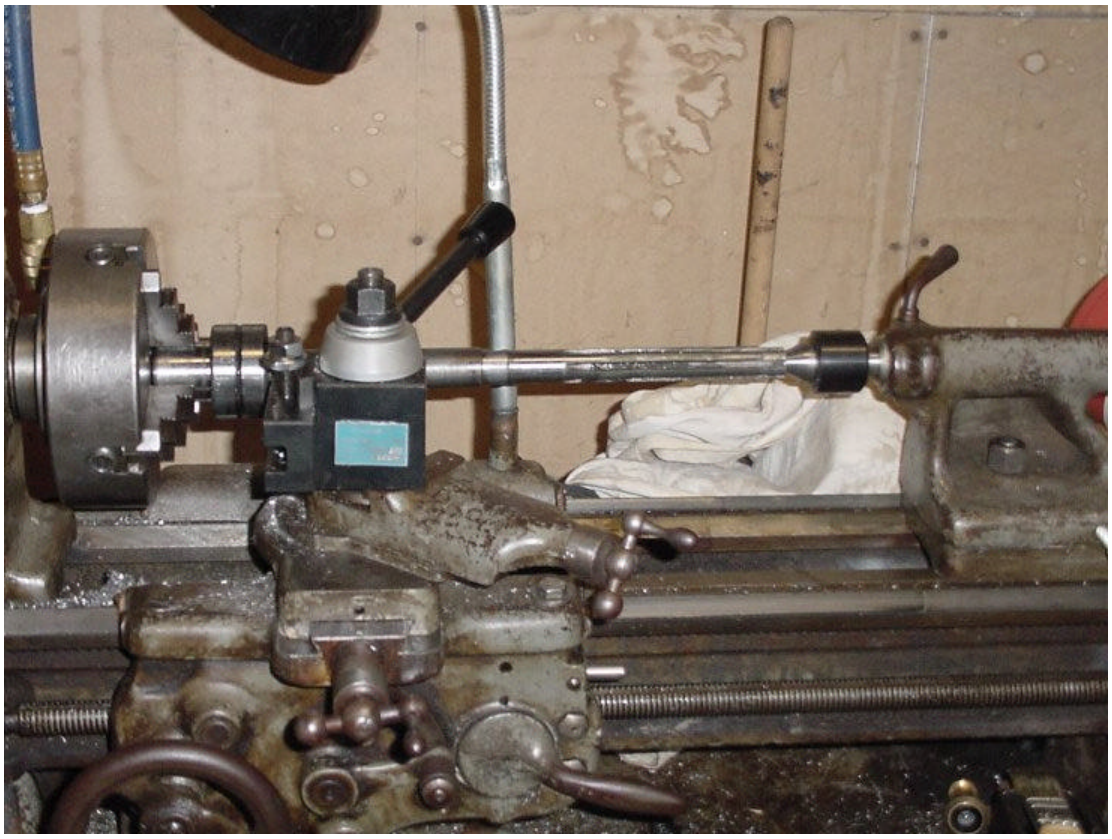
Step 11. Main Spindle Bearings: As my retaining nut was off, I removed the bearings by tapping the spindle through a pair of 2x4 blocks clamped to the edge of the so that the spindle nose would pass through the gap between the blocks but bear on the bearings. A shop press would have made this much easier.
The spindle bearings were quite old. There was an accumulation of dried greae/oil so thick that it crumbled off them as I handled them. The bearings were "New Departure 30305" and measured 25mm internal bore diameter and the external race diameter was 52mm. The bearings are 40 degree angular contact bearings and are match ground for duplex installation. Using duplexed angular contact bearings basically means that the two in an opposed configuration have capacity to take radial AND axial loads. It's a pretty good arrangement overall.

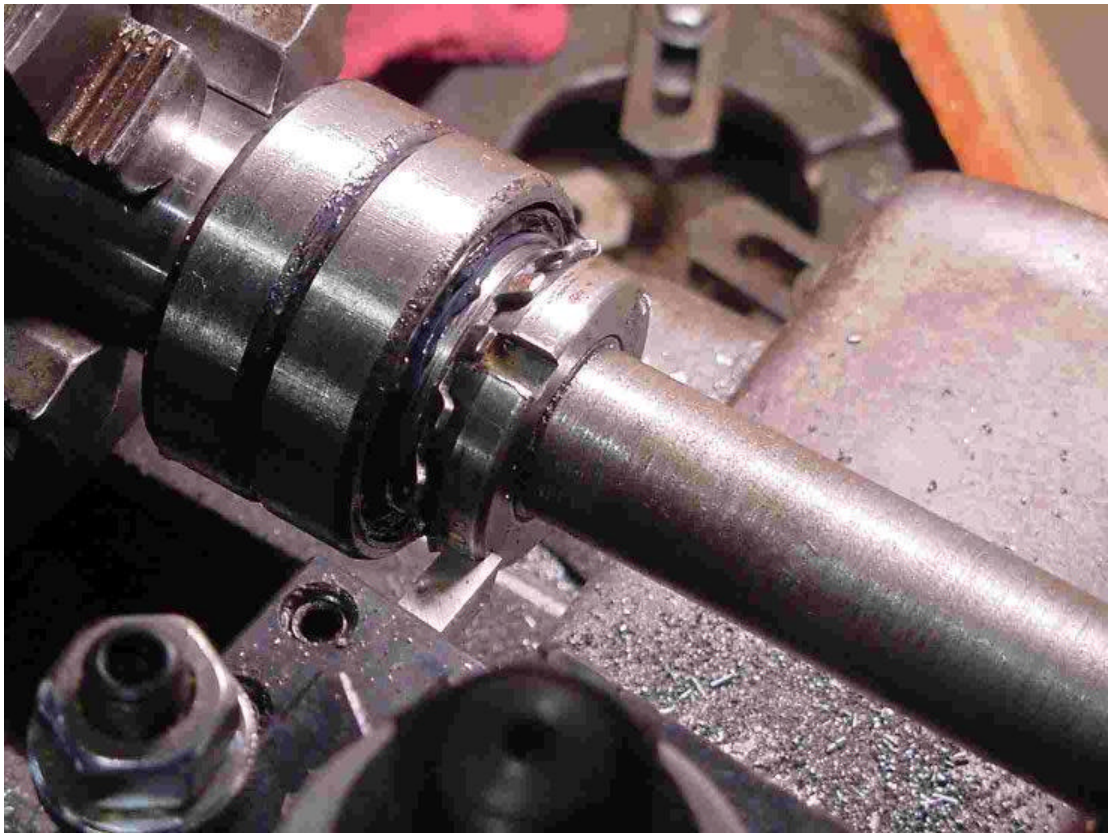
Step 12. Install new spindle bearings. Ok, so new bearings in hand, how do we install them in a duplexed manner? The replacement bearings need to be specified as a pair that are going to be mounted in a duplexing arramgement. They are precision ground so that the inner race and outer race are slightly out of plane. The best description on the matter I have found is from the Engineering Section of the Torrington Bearing Manual. I am quoting it directly:

"Duplex Bearings and Preloading
TYPICAL MOUNTINGS OF DUPLEX BEARINGS Back-to-Back Mounting, DB or (“O”)
(Contact angles diverging toward shaft centerline)
Before mounting, there is clearance between the two adjacent inner ring faces the bearings. After mounting, these faces are clamped together to provide an internal preload on each bearing. This arrangement is well suited for pulleys, sheaves and in other applications where there are overturning loads and also in all floating positions where thermal expansion of shaft occurs. It also provides axial and radial rigidity and equal thrust capacity in either direction when used in a fixed location.
Back-to-back is the most commonly used of all duplex arrangements. Specify bearing number followed by suffix DU. Examples: 7207W-DU, 2MM207WI-DU. Also available as two single flush-ground bearings, i.e., 7207W SU (2 bearings)." Here is the picture.



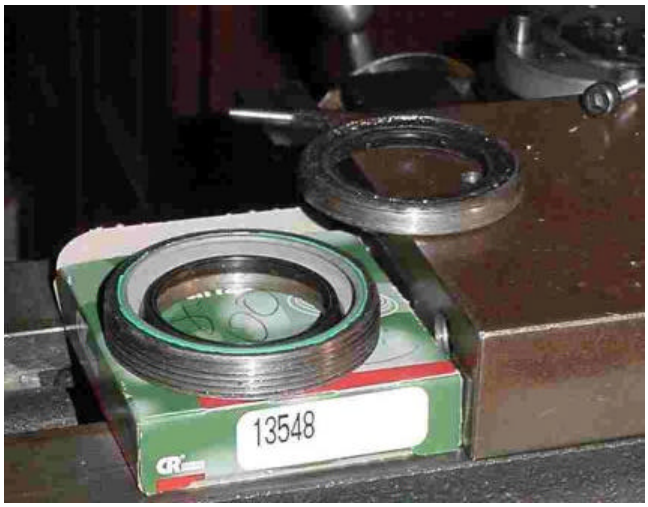
By taking up the gap between the bearings, you are in effect preloading them to reduce the internal play. You could also mount them face to face and but the inner races together and preload them with the retaining nut, but in this case, I thought it was going to be easier to draw them together with the retaining nut.
Working with bearings, I am a bit paranoid, so I try to be especially clean around them. I choose to grease the bearings. No rhyme or reason really.
Since they are open bearings it was easy to do. Next I carefully wrapped the bearings in kitchen plastic to keep the grease from contaminents and carefully started each one by hand. I drove them home by tapping on the spindle nose with the bearing against on my cantilevered 2x4 blocks. Next, I had to mount and tighten the spacer, washer and retaining nut. I did this in the lathe using the 4-jaw chuck and tailstock to center the spindle and using a 1/4" square tool bit in the tool post as the spanner pin. By adjusting the tool bit height I could trap the nut as I turned the chuck by hand to take up the threads. Try and engage as much of the notch as possible as the nut will advance as you turn the spindle. **CAUTION:**The spindle material is realtively soft. I accidentialy brushed up against the threads with the tool bit and gouged them a bit. I was very surprided how easily the threads deformed. I touched up the threads with a needle file and a magnifiying glass. A very tedious process indeed.
The nut will draw the two inner races together as it advances up the spindle. I tightened carefully until I felt the bearing play tighten up. Here is a picture of the finished affair. Note one the star washer teeth is lined up with one of the notches in the nut. I have not peened it into place yet (the picture is a bit rigged, I removed the kitchen wrap for clarity and put in a nicer tool bit for the picture).





While the spindle was in the chuck and tailstock, I used the tool bit and cairrage as a shaper to further clean up the splines on the top end of the spindle. Essentially, I rotated the spindle until the sides of the spline were parallel to the top of the tool bit and then raised the bit up to contact the spline. I then engaged the belt tension to hold the spindle and then advanced the tool along the spline to re-shape the spline to fit into the drive plate better. You can remove quite a bit of metal doing this so be careful and take you time.

Step 13. Seal replacement. Here is a picture of the retaining nut seal that I got from Clausing installed in the retaining nut. The old one is in the background.



Reassembly: The reassemble of the spindle is essentially the reverse of taking it apart. I inserted the spindle into the bore and started the lower bearings by hand. I then used the retaining nut and the pin spanner to press the bearings into place. I then lowered the quill and started the upper spindle bearing on the spindle. This bearing fits into a bore at the top of the quill. I lowered the quill to make sure that I had clearance to mount the the drive pully spindle/reatainer plate and started the cap screws. I then raised the quill as far as it would go until the bearing came in contact with the bottom of the plate. I then tightened the quill clamp bolt to lock off the quill. Then by tighening the cap screws in a radial pattern I set the top spindle bearing further in the bore. Then I slacked off on the cap screws and advanced the quill further up and repeated the process to finish setting the top spindle bearing.

Lastly, here is a list of the bearings that were in the machine and what I replaced them with. To be absolutely sure you are using the right bearings, you should get them from Clausing.

Bearing Location	'Original' Bearing	Replacement Bearing	OD (mm)	ID (mm)
Driven Step Pully	(2) Fafnir 9105KDD	(2) Fafnir 9105KDD	47 (mm)	20 (mm)
Top Spindle Bearing	(1) New Departure 3304	(1) Fafnir 304KDD	52 (mm)	20 (mm)
Bottom Spindle Bearing	(2) New Departure 30305	(2) Fafnir 7205WN-SU	52 (mm)	25 (mm)

On to making chips.....

It was an absolute night and day difference what the fresh bearings made on the overall operation of the mill. Its is much quiter and much better behaved now. No more tool chatter or spindle clatter. The joys of machine tools cease to amaze me.