SHERLINE PRODUCTS
INCORPORATED 1974

Lathe Alignment and Micro-Drilling

Headstock, Tailstock, and Chuck Alignment

Below is a link to an independent video about our lathe. The video noted below shows you one way to check the alignment.

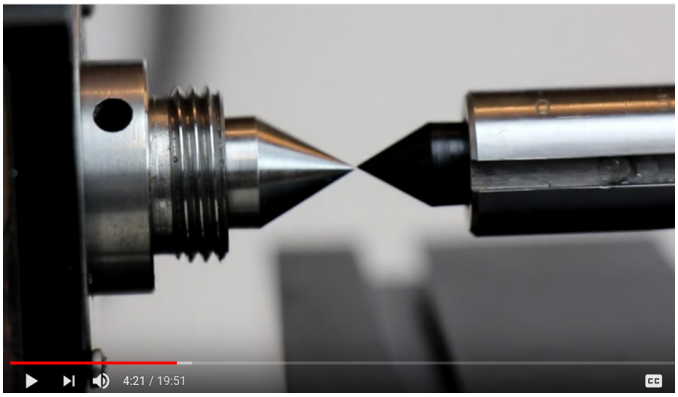


FIGURE 1—Links to videos for alignment: Sherline lathe 102-Alignment, Accuracy, and Capacity: (https://www.youtube.com/watch?v=oUrpa_NQVCE) ***NOTE:*** *The user's statement that you can adjust the tailstock gib screws to make minor adjustments to the tailstock alignment is inaccurate. Those screws are not for alignment purposes.*

Another Method for Checking Your Alignment

The diagram of the indicator setup (Figure 2) is so you can check your tailstock alignment. If you have more than .005 (.127mm) difference from side to side than your tailstock alignment is out of tolerance (please read the alignment instructions below).

1. Problem #1 is stack tolerance. We build the lathe with the tailstock aligned within .002 - .003 (generally .002 - .0025 (.051 - .076mm)). The chuck manufactures guarantee a run out of .004 or less. We check every chuck and make sure that they run out .003 or less. If both the chuck and our lathe are at the top end of their tolerance range your drill could be off center by .005.
2. For example, if you are trying to drill a .015 (.38mm) diameter hole into a .051 diameter shaft with a carbide drill. If your machine and chuck combined are off by .005, that is 1/3 of your drill diameter. If you attempt to drill your hole with it off by .005, your carbide drill will snap almost instantly. The reality of your situation is that if your drill was off by .002, it may snap your drill because it is so small. Small drills (especially carbide drills) have very little tolerance for run out. Larger drills and high speed steel drills will flex if the alignment is off a little bit, and then they will follow the center drill hole. Because the center drill cuts a 60 degree included angle and the standard tip angle for a drill is 118 degrees included, The initial contact point of the drill with the center drilled hole increases the backside gap from .005 to about .013 in this case. This increases the amount of drill flex and makes the drill look like it is even further off center (see print below). "One tip for center drilling for small holes, is to just center drill deep enough to make a spot, so the tip of your drill will pick up the spot, not the 60 degree angle."

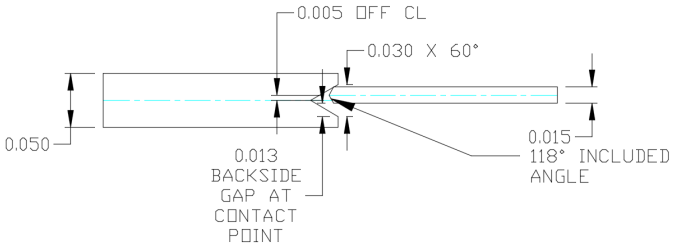


FIGURE 2—Indicator setup

3. If your center drill drilled the shaft without any issues, then your tailstock alignment is probably in tolerance. To check your tailstock alignment First you have to check your headstock alignment. The best way to do this is to turn a test piece of stock and check it for taper. Use a small piece of 1/2" or 3/4" (12.7 - 19mm) round stock, with the stock sticking out about 1" to 1-1/2" (25.4 - 38.1mm) away from the jaws. **NOTE:** if your part is sticking out too far, you will start to get flex in your part, which will cause a taper. If you believe that your part is flexing under the pressure of the cut, take a second cut (spring pass) at the same diameter or .001" smaller. Then measure your part. Turn the OD of the stock and then measure the turned part with mics at each end. If there is no taper, your headstock is aligned with the bed. If there is taper, loosen the locking screw in the headstock just enough to break it free. Leave the headstock key in place. Now twist the headstock clockwise if the far end is larger, and counter-clockwise if the far end is smaller. Then lock the headstock in place. With the keyway in place, your headstock will move a fraction of a degree in each direction. This amount of movement is usually all you will need to dial your headstock alignment in. Take another cut on the stock and measure again. If the taper changes you may have

to adjust your headstock a little bit more.

4. Once your headstock is aligned. Mount a dial test indicator in the headstock (use a chuck or collet). With the tailstock spindle fully retracted, move the tailstock towards the headstock until the tip of the indicator is just in front of the Morse #0 taper. Lock your tailstock body to the bed. Now push the indicator tip out at an angle that almost makes contact with the inside of the taper. Now hand crank the spindle out until the inside of the taper touches the tip of the indicator. Now slowly turn the headstock spindle and make a note of the indicator reading when the tip is at 12 O-clock and 6, and at 9 and 3. A total indicator reading change of .004 (.102mm) would mean that the tailstock is off center by .002 (reading difference of .006 would = .003) See Figures 3 and 4.

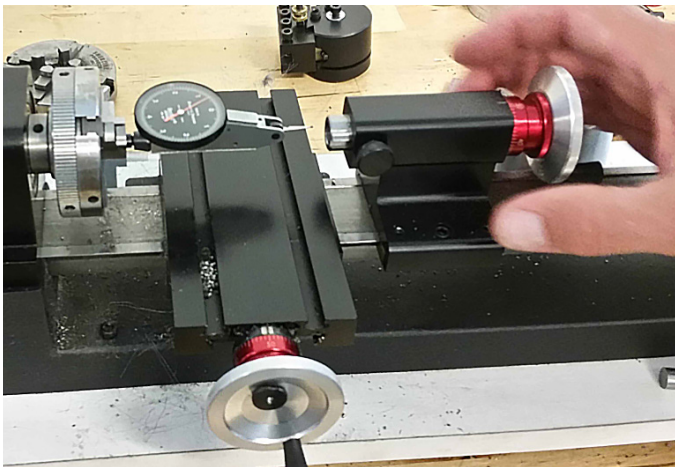


FIGURE 3

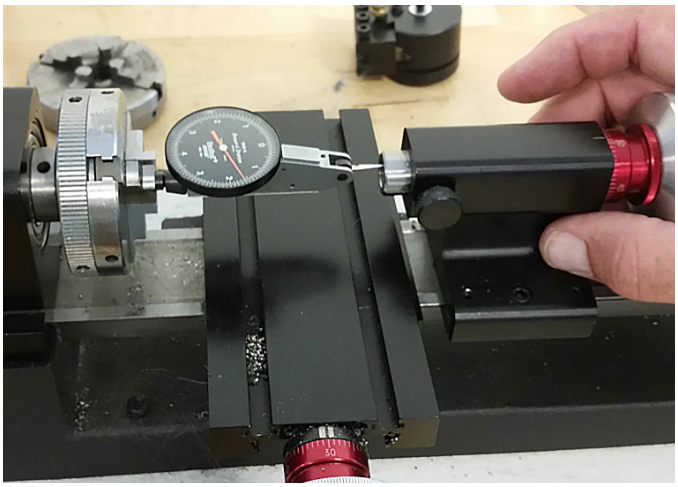
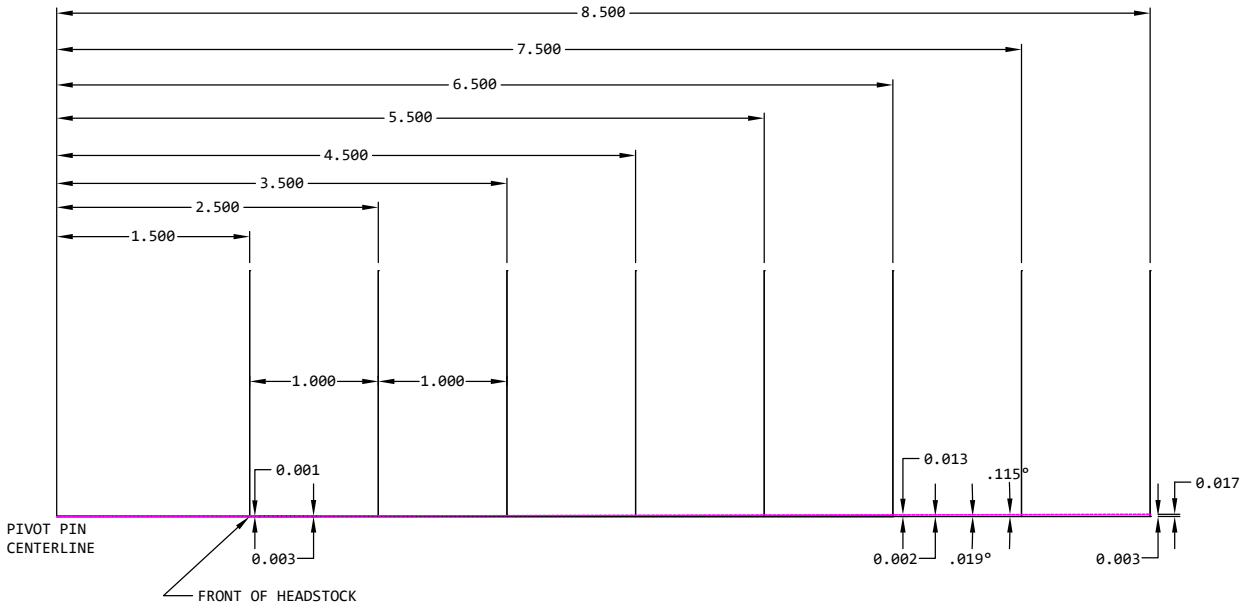


FIGURE4

Please understand that this method of indicating is showing you a combination of headstock and tailstock alignment. If your headstock is dead on, then the indicator is reading the amount that the tailstock is off centerline. If the headstock is off at all, then your indicator reading at the tailstock will be exaggerated. The magnification of the error increases as the distance from the headstock pivot pin to indicator tip increases (the farther the indicator tip is from the center of the pivot pin, the farther off centerline the indicator tip is). See Figure 5 below.

If your headstock is aligned and the total indicator movement is less than .005, your tailstock is within tolerance.

IF THE HEADSTOCK IS OUT OF SQUARE BY .115° (.0015 OFF CL AT FRONT OF HEADSTOCK), AND THE TIP OF THE INDICATOR IS 7" AWAY FROM THE FRONT OF THE HEADSTOCK. THE CENTERLINE OF THE ROTATING INDICATOR WILL OFF CENTER BY .017. IF YOU TRY TO INDICATE IN THE BORE ON THE TAILSTOCK WITH THE INDICATOR EXTENDED FROM THE HEADSTOCK, YOUR MEASUREMENTS WILL BE OFF BY .017 ± THE AMOUNT AND DIRECTION THAT THE TAILSTOCK IS ACTUALLY OFF CENTER.



WITH THE FRONT OF THE HEADSTOCK OFF CENTERLINE BY .0005 FROM THE PIVOT PIN, AT 5" OUT THE TIP OF THE INDICATOR WILL BE .002 OFF CL. AT 7" OUT THE INDICATOR WILL BE .003 OFF CL.

WITH THE FRONT OF THE HEADSTOCK OFF .0015 FROM THE PIVOT PIN, AT 5" OUT THE TIP OF THE INDICATOR WILL BE .017 OFF CL. AT 7" OUT IT WILL BE .017 OFF CL.

FIGURE 5

How to Chuck a Drill Bit Accurately

1. Remove your chuck from the tailstock spindle.
2. Using a clean rag, wipe the #0 Morse taper on the chuck arbor so it is free of any chips etc.
3. With the tailstock spindle extends half way out, use a twisted rag or paper towel and clean the Morse #0 taper in the spindle.
4. Insert the chuck taper back into the spindle. Once it is seated, put the chuck key in the chuck, now use the key in the chuck to twist the chuck into the spindle (as if you were trying to thread it in). After one turn +or- the Morse taper fit should lock up to the point where it is virtually impossible to turn it any more. This means that your taper-to-taper fit is secure.
5. Now place a "Center drill" in your drill chuck (not a regular drill).
6. Very Important: As you are tightening the drill chuck, "slowly rotate the drill bit clockwise and counter clockwise" until the chuck tightens enough to stop it from turning.
7. This next step is what the chuck manufacturer recommends. Once the chuck is snug on the drill bit, move the chuck key to another locking hole and tighten it down a bit more, then move it to the next hole and tighten it completely. Use a progressive tightening system.
8. Put a piece of stock in the headstock chuck do a facing cut so the front of the stock is flat.
9. Now with the center drill in the tailstock chuck, move the lathe saddle as close as possible towards the chuck, then move the tailstock as close as possible to the backside of the lathe saddle. Now drill a center hole in the material and watch to see if the center drill is being pulled from "off centerline" to "on centerline" of the part. It may move a bit because the centerline tolerance is within .003" (.076mm).
10. Now remove the center drill and put in a jobber style drill (1/8" to 1/4" diameter or 3mm to 7mm). Be sure to load the drill in the same manor that you loaded the center drill (turning the bit while tightening the chuck and using all three chuck key holes to progressively tighten the chuck)
11. Drill the center drilled hole and see if the drill bit is off centerline, and being pulled back onto centerline when it enters the hole.
12. If the drill is off of centerline, put the chuck key back into the drill chuck and turn the chuck about 90 degrees (**NOTE:** you will actually be turning the chuck and the taper 90 degrees). Now see if the drill is off centerline in a different direction.
    A. If the drill is off in a different direction, then the problem is the drill chuck.
    B. If the drill is still off in the same direction, then the problem may be the tailstock alignment.

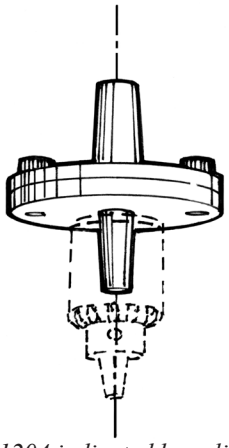
NOTE: Sometimes two negatives make a positive. If your drill chuck is off by .003" in one direction, and your tailstock spindle is off by .002". Turning your drill chuck could offset both against each other and put your drill within .001" of centerline. If this is the case, mark your chuck so the mark lines up with the keyway in the spindle, and mount your chuck this way each time you use it.

SHERLINE Adjustable Tailstock 0JT Chuck Holder P/N 1204

NOTE: A chuck is not included with the P/N 1204 tool holder. Use your existing 5/32" Jacobs chuck or purchase P/N 1016 to get both the chuck and tool holder together.

Use of the Adjustable Tailstock 0JT Chuck Holder

Much like the Adjustable Live Center, holding a tailstock chuck in perfect alignment without some method of adjusting it can be difficult or impossible. The adjustment screws and split design allow perfect centering for the chuck. With the tiny drills that can be held in a 5/32" chuck this is even more critical than with the 1/4" or 3/8" chucks. The 5/32" Jacobs drill chuck is pressed onto a tapered protrusion on the front plate of the holder. The rear plate of the holder has the #0 Morse taper that goes in the tailstock. Two slightly oversize holes in the rear plate allow adjustment screws to be loosened, the center located and then locked down where you want it. In this manner, highly accurate centering can be achieved. If the ultimate in accuracy is your goal, the Adjustable Tailstock Chuck Holder will help you achieve it.



P/N 1204 indicated by solid line

Mounting a Jacobs Chuck to the P/N 1204 Holder

If you purchased P/N 1016, the 5/32" Jacobs chuck is already installed on the front plate. If you purchased only the P/N 1204 holder and already have a 5/32" Jacobs chuck that has a Sherline #1 or #0 Morse arbor pressed onto it, you will first need to remove the arbor from the chuck. To remove the existing arbor, open up the chuck jaws. Insert a drift, a hex key or other appropriate tool down through the chuck jaws and steady it against the end of the tapered arbor that is pressed into the chuck. Give the drift a sharp tap with a mallet to unseat the taper and the arbor should drop out. After making sure that both male and female surfaces of the tapers are clean and free of lubrication, place the chuck over the taper on the front plate of the holder. Close the jaws. Put a block of wood on the front of the jaws and give the block a light tap with a mallet to seat the chuck on the taper. You can also hold the assembly in your hand, turn it over and tap the closed jaws on a block of wood to use its own inertia to seat it. It is not necessary to drive in on with a lot of force. The twisting force exerted by small drills on

a chuck this size is minimal compared to the surface area of the taper, so don't use any more force than necessary. This is especially important if you expect to periodically remove the chuck from the holder so the #1 MT arbor can be installed to use it in the headstock again.

Adjusting the Chuck to Be on Center with the Headstock

First, assure your headstock is square with the lathe by turning a test bar and checking for taper.

METHOD 1 (If you have another tailstock chuck): Once you are sure the headstock is square, place a piece of 1/2" to 3/4" diameter round scrap material in a 3-jaw chuck so that it sticks out about 3/4". Face off the end and then use a center drill in your regular tailstock drill chuck to drill a hole on center. Even if the chuck is a little off center, the center drill will find the center of the spinning part and drill a 60° hole on center. Now, mount the 0JT adjustable center and 5/32" drill chuck in the tailstock with the witness mark pointing straight up. Chuck up the center drill in the 5/32" chuck. With the screws loose in the plate holes, bring the tailstock up to the part so the center drill locates in the hole. When you feel it is centered on the hole, tighten up the two screws. Bring the point of the drill back into the hole to check your alignment and repeat the adjustment if necessary. The next time it is used after removal from the tailstock, assure that the witness mark is again pointing straight up. If this is done, it should not be necessary to readjust the alignment of the two plates each time.

METHOD 2 (If you don't have another tailstock chuck): If you do not have a second tailstock chuck, you can offset your headstock or use a compound slide to turn a sharp point on a short piece of stock 5/32" in diameter or smaller. Transfer that piece from the 3-jaw chuck to the 5/32" chuck in the tailstock holder. Remove the 3-jaw chuck from the headstock and install the dead center in the spindle. Bring the tailstock chuck holding the pointed stock up to the headstock dead center until the points of the two parts are opposite each other. Using a magnifying glass, adjust the front plate up/down and left/right as needed until the points are perfectly aligned.

This should be close enough alignment for a drill chuck, because they can only be guaranteed to be accurate to within .003" anyway. Accurate drill chucks that run out within .002" cost approximately four times as much. Some may claim .001" runout, but this is unlikely unless every part of the system is brand new. These are not really a good investment for the home shop machinist. In any case, because the tailstock chuck does not spin, runout should not be a problem once you get it perfectly aligned with the headstock. You should now be able to hold very tiny drills and not have to worry about them breaking due to not drilling on center.

Tailstock Chuck Centering

Once you know that your headstock and tailstock are aligned within tolerance, if your drill is off center, your drill chuck may be the problem. Below are instructions for checking your drill chuck alignment.

We guarantee that the chucks on our lathes will have a TIR of .003" (.076mm) or less. However, Jacobs guarantees that their chucks will have a TIR of .004" (.102mm) or less. This means that if our parts are perfect, you may still have a chuck that exceeds the tolerances that we guarantee. If our machine is off by the maximum of .003" and their chuck is off by .003" or .004" then the entire assembly could be off by .006" - .007". We can guarantee the tolerance on our parts. The problem occurs when we add someone else's tolerance to our machine. There is also a possibility that you may have received a bad chuck.

Thank you,
Sherline Products Inc.

Micro-Drilling by Jerry Kieffer

There are several issues that need to be addressed in order to be successful at micro-drilling.

1. You must have perfect alignment between headstock and tailstock. You can purchase a $20,000.00 Levin Lathe and return it for correction if alignment is not close enough. You can purchase a used or new jewelers lathe where about 25% are right on and the other 75% are hit and miss with no adjustment. Matching number Jewelers lathes with drilling tailstocks run about $500.00 and up with new lathes starting at about $10,000.00. Or you can purchase a $700.00 Sherline lathe and adjust alignment equal to the Levin or better anytime it becomes an issue, if ever.
2. You must use drills DESIGNED to drill the material to be drilled. Brands, types, and construction material are too numerous to discuss in detail. If someone lacks knowledge to determine what is needed, I would suggest contacting a large supply house like MSC Industrial Supply Co. and talking to a micro-drilling specialist for a recommendation. Personally I use 1/32 carbide spade drills held as short as possible to spot holes down to about .025" and regular spade drills for exact hole size or similar that are smaller. Drills for drilling as discussed above at no more than 3000 RPM with cutting fluid and optical observation of the drilling procedure.

As mentioned, the larger hand wheel on the tailstock gives added feed control. Spade drills are available from most watch and clock supply houses.

3. One of the most misunderstood things about micro-drilling is the drilling speed under manual control (most of the time too fast). If the drill is fed too fast it will break almost instantly from overload. If not fed fast enough, the drill tip will work-harden the work piece and damage the cutting tip. 2000-3000 RPM seems to be the most controllable under manual control using a stock Sherline.
4. Drills must be held accurately and preferably with WW collets. Drill chucks are just not repeatable or accurate enough with the exception of the small 1/16" Albrecht chucks.

Jerry Kieffer