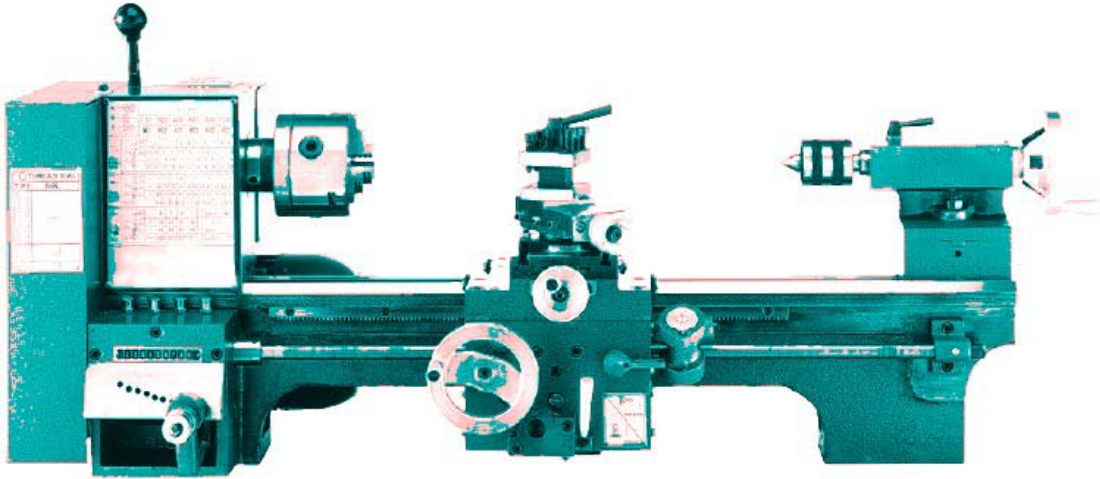


REBUILDING THE ASIAN 9X20 LATHE

Compiled by: Cletus L. Berkeley



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Foreword

The Asian 920 Lathe offers an inexpensive solution for persons wanting a capable machine without having to dip into “Johnny’s College Fund”. The Asian 920 Lathes are assembled from components originating in various Chinese factories. These components generally converge and are assembled and adjusted at one Main Chinese Factory and the finished product exported and sold by many retail outlets with or without various accessories and under various Brand Names, associated Colors and after market support. There is some consensus that these machines are referred to by hobbyists and metal working enthusiasts as “Kit Lathes” as the fit, finish and assembly may be somewhat incomplete and rough. However, the person willing to invest some “Sweat Equity” may fit and finish one of these machines to a point rivaling equipment costing many times that which was invested. This is not to say that these machines are incapable of running right out of the box, most of them do.

Above all, this manual strives to KEEP IT SIMPLE and attempts to outline the steps necessary to accomplish a rebuild, maintenance procedure and at the same time using such opportunity to achieve good fit and finish. This manual does not however, delve into the many useful modifications that are possible and popular among owners of these excellent lathes. A wealth of detailed information is contained in the archives of the following groups:

<http://groups.yahoo.com/group/9x20Lathe/>
<http://groups.yahoo.com/group/9x20Lathe2/>



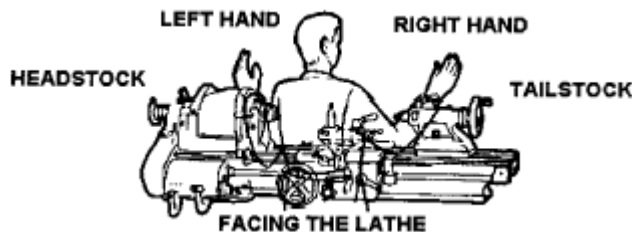
Grizzly G4000 in the shipping crate

1. Instruction Manual

The instruction manual accompanying these machines are at best loose English language translations of some very sketchy technical information originating in the Chinese language.

One of the best written manuals for this equipment, is the manual supplied by Grizzly Industrial, Inc. and is supplied with their G4000 Metal Working Lathe. Grizzly has seen fit to make this manual available without charge to the general public and it may be downloaded from:

http://images.grizzly.com/grizzlycom/manuals/G4000_m.pdf



The information and instructions given in “Rebuilding the Asian 9x20 Lathe” shall coincide with the G4000 manual in terms of Part Numbers, Part Identification, Diagrams and Illustrations. Further, this rebuild manual may be considered complimentary to the above mentioned User’s Manual and in no way attempts to replace it.

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2. Fasteners & Tools

The Asian 920 Lathe regardless of Make and/or Color originates in China and as such the fasteners used and the tools needed are Metric.

It is generally accepted that the fasteners (Bolts, Nuts, Washers, Screws, Circlips, etc.) used are made of a soft steel alloy and as such it is well worth replacing these during the rebuild with quality after-market components.

The tools supplied with the 920 (Allen Wrenches, Open-end Wrenches, Screwdrivers) also leaves much to be desired in terms of fit, feel and finish due to the tolerances held and alloys from which these are manufactured. For the serious user, these tools should be replaced with tools of a quality the user is comfortable with. The user will find T-Handle Allen wrenches particularly handy when working on this lathe.

(The author prefers wrenches that have open and closed ends, when working on this lathe)

Some special tools may be needed to rebuild and/or adjust certain parts of this lathe. These shall be identified as needed in the appropriate section.



3. Degreasing

Degreasing is easily achieved using Kerosene or WD-40[®] applied with rags and/or a paintbrush. If a new paintbrush is modified so that the bristles are cut short, this makes it easier to remove stubborn and accumulated crud from the machine. (there shall be **NO SMOKING**, when working with these solvents).



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4. Lubrication Requirements

Three types of lubrication are recommended for this lathe, Oil, Grease and Dry Lube.



Oil: Typically SAE140 Gear Oil (yes, the G4000 manual says SAE20, but it has been found that SAE140 stays longer) is injected into the various oil ports on various parts of the machine. The orifices are illustrated in Section 7 of the G4000 manual. A proper high-pressure oil can is indispensable for this. WD-40 is not considered a lubricant. Nor is it very good at long term rust prevention. It is however excellent at displacing water and as a degreaser.

Grease: is used in the headstock bearings and the type to be used shall be treated in detail under the appropriate heading. Do not use oil here.

Dry Lubricant: Graphite type dry lubricants are recommended as the only lubricants to be used in the various Chucks. Oil or grease type lubricants trap cuttings and debris within the device which may lead to increased wear, inaccuracy and/or malfunction.

Recommended Rust Inhibitors:

Boeshield T9 <http://www.boeshield.com/>

Slide No Rust <http://www.slideproducts.com/rust.htm>

5. Bed and Ways

The lathe bed is made from gray cast iron. The ways have been induction hardened and ground at the factory. Recommended Mounting bolts are 12mm diameter by whatever length suitable to go through your bench top.



The lathe should be bolted to the bench firmly (not tight) at the headstock side only, while the tailstock side should have a somewhat loose fitting bolt and locknut just drawn-up snug to keep the lathe from moving around. This will prevent warping of the bed and twisting the ways. The ways should be free of rust, dings gouges and marks. Thus allowing for a smooth traverse of the carriage and Tailstock. A coating of oil (SAE 140) should be applied to the ways with a lint free cloth to retard rusting.

Bolting Down the Lathe

It is customary to regard textbook instructions as being aimed at an academic perfection not really necessary for practical purposes and it may seem that the following details may fall into this class. But, so many lathes have been simply bolted down to a, more or less; uneven bench without apparent ill effects,

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that many amateurs may be tempted to do the same. If the following instructions are to be carried out, you will be provided with visible proof of their necessity.

It has been mentioned that uneven bolting down will pull a light bench lathe badly out of truth. To prevent this it is necessary to actually see what is happening as the holding bolts are tightened. The instrument used to witness any bending or twisting of the bed is the Test Dial Indicator or TDI for short.

Place the lathe on the prepared bed, the bolt holes having been marked out and drilled, and place the bolts loosely in position. Take a piece of mild steel bar, about 3/4in. in diameter and as long as will go into the lathe, and grip in tightly in the 3 jaw chuck. Preferably this bar should extend at least to the end of the ways with the tailstock removed. With the compound slide and toolpost removed, crank the carriage as far away from the headstock as possible and lock the carriage in position with the Halfnut engaged and the shift arm on the QCGB engaged in any one of the 9 selection holes. This will effectively stop the chuck from turning.

The TDI, attached to a magnetic base or similar holding device, should now be placed on top of the crossslide and the plunger located to the extreme end and on the top of the steel bar. Zero the TDI but be sure that the indicator hand is “under tension”; that is, that it will register a plus or minus movement either side of the zero mark if the crossslide is moved vertically away or closer to the bar during the bolt tightening process.

Now that the TDI is mounted and zeroed it is registering the lathe in an unstressed condition, but as soon as the bed is twisted or strained the indicator will move a certain amount. The obvious aim is to tighten the holding-down bolts, when finally tight, the indicator needle still remains at zero.

Tightening one bolt rarely shows movement of the indicator, so tighten the bolt at the headstock first until you are comfortable with the torque you have applied. If the TDI is now not reading zero tighten the opposite bolt until it does. If the TDI is still registering zero after you have tightened the bolt at the headstock, tighten the bolt at the tailstock end until you see the slightest movement on the TDI. Loosen that bolt a little and tighten it again but stop tightening before the needle shows any movement.

If you are not comfortable with the torque you have applied to the tailstock end and prefer it to be tighter you must add steel shims under the foot of the tailstock to put the lathe in a state of negative stress as indicated on the TDI and tighten the tailstock bolt until it reads zero again and is in a stress free condition.

It may be of interest to note that the author of this article has checked up the accuracy of several lathes which have been bolted down without these precautions. In every instance the lathe was found to be in a state of strain, in one instance as much as 20 thousandths of an inch!

6. Headstock

Do NOT take the Headstock off without very good reason to do so.

Do not even try to tighten the four hold down nuts. Because it is the torque of these nuts that makes the fine adjustment.

The headstock may look massive and solid, but its NOT: When doing the lathe alignment according to the specs & tolerances of the inspection protocol, we are looking at a taper the thickness of a hair some 200mm down a test rod. This kind of movement is within the elastic deformation range of the headstock casting and bed itself. This is why industrial lathes of same size are many times heavier than this hobby lathe! Even the preloading of the spindle bearings causes some elastic deformation within the headstock itself (BTW, this is how the different thermal expansion coefficients of spindle and Headstock are

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taken care of, in an old brochure Emco once mentioned with some pride how the Headstock casting interior was designed to do exactly this).

First thing, before you take the headstock off: use Rollie's Dad's method to "level" your bed, on the existing bench or stand. Because, any headstock alignment is utterly illusionary and useless without a flat bed. And I assume you do not have a truly flat surface large enough to put your bed on for headstock alignment, nor an MT3 test bar hence the hint to Rollie's Dad's method.

Now verify tailstock height. You see, it is much easier to correct tailstock height with the headstock alignment, rather than leaving this for after. You want to know NOW if the tailstock is high or low or spot on with the current headstock alignment. Up to a couple hundreds mm do not matter, you will be able to adjust this by torque on the headstock bolts. Anything more may require scraping or shimming or Moglice under the headstock. Take notes now to save time later.

Only now take the headstock off. Carefully. You want to know where the factory placed any paper shims. If the headstock was well machined, you won't find any. But if there are any, realize that it is not easy to machine a headstock that accurately that 500mm down the bed spindle and bed are parallel to within 0.03mm (or 0.015mm over 200mm as specified in the inspection protocol). Take notes.

Now you can clean the headstock and bed. Replace the Chinese "soft cheese" bolts by high tensile quality, use loctite to make them firm, cause later you will be pushing sideways on these bolts with grub screws to align the headstock. Clean and check the tapped holes for these grub screws in the headstock. The Chinese seem to drill them by hand (eg crook) and paint over them at the end. If necessary, drill new (straight) holes above or below and tap. Replace the soft grub screws by quality aftermarket components.

After these preparations, headstock alignment should be straightforward. There may however be some complications. Every lathe will be different, calling for a different approach.

Under NO circumstances must the headstock touch the Vee's. If it does, adjustment becomes virtually impossible. I suggest to mill the cutouts in the HS base larger if there is any chance they can touch the V's. As a hint, the Austrian Emco C8 has a gap of some 1mm between the HS cutout and the large bed Vee.

Case 1) There were no shims under the headstock

Adjust parallelism of spindle center line to longitudinal motion of carriage in horizontal and vertical plane (step 6a and 6b in Inspection Record). If you do not want to buy an MT3 test bar, use Rollie's Dad's method. The only difference is that now you do not shim under the bed. Use the four hold down bolts/nuts of the tailstock for the vertical alignment (the torque by which you tighten them provides this fine adjustment, but without any shims the range is very small). With the side grub screws you align the horizontal plane. Both adjustments interfere with each other, several iterations are necessary. If you run out of range with !reasonably! (no excessive differences) torquing the nuts, go to case 2).

Aim at the best accuracy you can get, the tolerance in the inspection protocol is the worst you should accept. There are limits as how good an alignment makes sense. Eg, if the bed is crook, you can perfectly adjust two pints along your test bar, whilst there will be errors everywhere in between. If the spindle itself has excessive runout, all you can do is align the headstock center line as evenly as possible inside the spindle runout.

At the same time you do these two alignments, you may check tailstock height. If out, go to case 2)

Optionally, you can use the grub screws to translate the headstock sideways using the grub screws, to align the punched tailstock mark for taper turning. This will interact with above alignments and several iterations are needed. If this seems too complex, you can choose to punch another tailstock mark later.

Do the final test by cutting a long bar. It must be same diameter everywhere along its length, eg no taper and no hourglass or convex shape. Else go to Case 3).

Case 2) there were shims under the headstock, or you found with Case 1) that shims are needed.

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You need to make some decisions now. You can stick with shims, or scrape the headstock base. Shims are quicker, scraping may make for a more rigid headstock/bed connection. If you go with shims, decide if you want to use paper or metal (feeler gauge cutoffs). Paper will give you greater range whilst torque shimming. Metal is more rigid and long term stable. Your choice. In case your tailstock height is low, you should go for scraping anyway. If it is high, do not consider it for the headstock alignment (better correct this at the tailstock itself, rather than shim up the whole headstock). If it is VERY close, you will have some range with torque shimming to bring it spot on.

If you go scraping: you do not necessarily have to scrape the whole contact area with the bed. Cut a relief in the center areas, that way you only need scrape the edges around the four bolt holes. Its much quicker and easier to do, and more rigid than a badly scraped large surface.

Shimming or scraping, it will take a LOT of iterations, particularly if you choose to correct tailstock height and tailstock punch mark at the same time (four interacting adjustments). But its fun. Do the final test by cutting a long bar. It must be same diameter everywhere along its length, e.g. no taper and no hourglass or convex shape. Else go to Case 3).

Case 3) You did not level the bed before starting, or the bed is crook

If you forgot to level the bed, you can still do it, but instead of 4 interacting alignments you now have six (shimming the bed). It is VERY time consuming, particularly if you have no MT3 test bar, as for every iteration you need to take several measurements along the bar, and calculate the error according to Rollie's Dad's method. It can be frustrating and slow.

If your bed is crook, all you can do is try to distribute the error as much as possible. There is no remedy.

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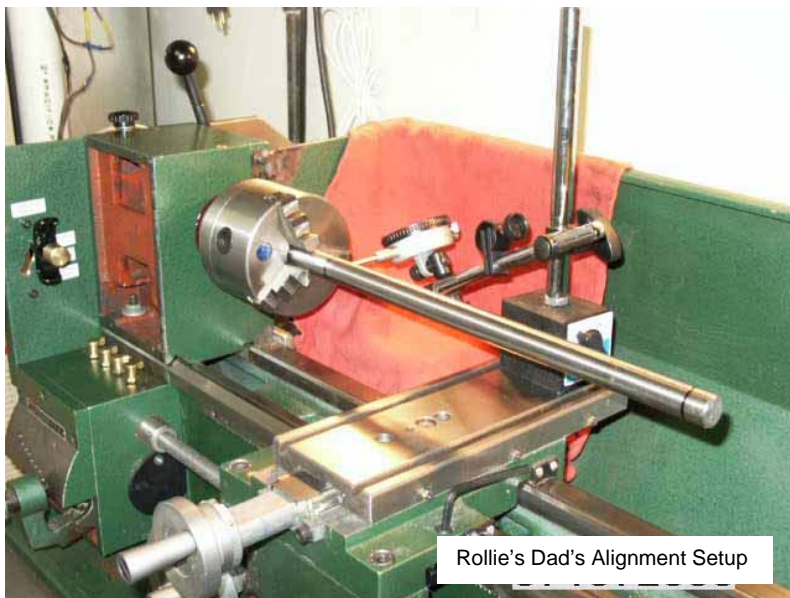
Jerry's Techniques for Aligning the Headstock on 9x20 Lathes

Before any meaningful discussion of “how to align the lathe”, a couple of terms should be explained. These are:

1. **RUNOUT**—Runout refers to the variation or oscillation or wobble of the workpiece as it rotates while being held in the chuck. Runout is not going to be addressed in this document. It can be caused by:
 - a. Bad spindle
 - b. Bad spindle bearings
 - c. Bad chuck
 - d. Bad chuck back plate or mount
 - e. Crud/swarf in the threads
 - f. Worn or damaged chuck jaws
 - g. Improper insertion into the chuck
2. **“OUT OF ALIGNMENT”**—This is the condition I plan on discussing in this document. Quite simply put, “out of alignment” means that the central axis of the **Spindle** is not parallel with the axis of the **Bed Ways**. This condition can occur in either the vertical or horizontal plane, or both. Another way of stating this is that the work in the chuck doesn't point toward the **Tailstock**.

Now that we have identified what we are going to work on, it must be stated that the reason we want the alignment correct is simply that if it isn't, you will only cut cones or tapers, & not cylinders. The vertical alignment is not as critical as the horizontal; however, taking the time to get it “right” should be beneficial.

Many operators have expressed the need for the bed to be “level”. By this, it is generally meant to be free of twist. Whether the bed is level or not really has no bearing on the subject. If the bed is twisted, a totally new can of worms has just been opened. Checking for twist would be a good thing. It requires a real machinist level – carpenter levels do not have the necessary accuracy. Removing the twist, if present, is not within the scope of this document, although it is closely related to accurate aligning.



The tools needed for the alignment checking are listed in “Rollie's Dad's Method” which **SHOULD** be studied thoroughly several times before touching the lathe. Since the “method” is very good in its explanation, I'll not attempt to improve on it. What I will do, is to explain how I applied it to the 9x20 lathe. When doing the check, it is not important which (vertical or horizontal) is completed first. When doing the actual alignment, the vertical **MUST MUST MUST** be completed first.

You need to obtain a piece of relatively straight bar between ½ & 1 inch in diameter. Perfectly straight is not absolutely required; however, it must be of constant diameter & roundness (not oval or egg shaped). The

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junk sold in home improvement centers doesn't qualify, in my opinion. A piece of strut or shock will work, although a bit short. A piece about 10-12 inches long should work (the longer the better). If you have access to a friendly machine shop, drill rod or something similar would be perfect.

To check the alignment, follow the steps below.

1. Chuck up the bar.
2. Place a magic marker ring about 1 inch from the chuck.
3. Place another magic marker ring about ½ inch from the end. (These rings just aid in consistent relocation of the indicator.)
4. Rotate the chuck by hand a few turns (remove the skinny drive belt) to check that all is free.
5. Install a dial indicator on the carriage (behind the bar is best).
6. Position the indicator (horizontal) pointing toward the center of the workpiece near the ring on the chuck end of the bar & rotate the chuck slowly while observing the indicator. (Pretend the indicator is a tool bit on the back side of the workpiece)
7. **This is important!!!** Don't attempt to get the indicator to read zero. Set it so that the pointer remains in the range well above zero. (An example would be in the range of .040-.050 or .050-.080.) We don't care what the value is as long as the numbers remain above zero.
8. While rotating the chuck carefully & slowly by hand, note the maximum & minimum readings of the pointer. Lets use the example of maximum=.055 and minimum=.031.
9. Add the two values together and divide by 2 to get the average. In our example $.055 + .031 = .086$ divided by 2 = .043.
10. Write the average value down.
11. Gently retract the pointer & carefully hold it while cranking the carriage to the mark near the end of the bar. Be very careful not to move the indicator or change the position of the cross slide (lock the slide).
12. Repeat steps 8, 9, & 10. Let's use another example of .062 & .025. Our far end average becomes $.062 + .025 = .087$ divided by 2 = .0435.
13. Now, the difference between the chuck average value and the bar end average value is the horizontal misalignment for the lathe. In our example, $.0435 - .043 = .0005$. I would be thrilled with that number.
14. What if your number from step 13 is larger? It is up to you, the operator, to determine the maximum amount of misalignment you can tolerate.
15. To check the vertical alignment, the procedure is the same with the pointer being repositioned directly above the centerline of the bar.

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If you decide that you must realign your machine, keep reading, & I shall attempt to assist you with the procedure.

OK, you have determined that you cannot live with the amount of misalignment present in your lathe. You have a considerable task ahead of you. It is very time consuming, and patience will be required. Some unanticipated machining operations may be required, as well as considerable disassembly of the machine. Get comfortable, here we go.



1. You need to be able to get to the 4 Headstock (HS) nuts.
2. Remove the skinny drive belt.
3. Remove the shiny information plate above the gear box (operator side). Found 2 of them.
4. Get behind the lathe & attempt to locate the rear 2. I bet you can't see them.
5. Remove the motor controls.
6. If you can see them now, can you get a wrench on them to turn them?
7. Since the cogged belt is holding tension on the plate that holds all the gears to the HS, the belt has to be removed.
8. On my G4000, I also had to remove the motor to gain access to the nuts & set screws.
9. I still couldn't get to the nuts or the adjusters easily after removing the motor, so I removed *everything* from the HS.
10. Check on the outside of the casting just below the rear nuts, & locate 2 small hex head set screws. These are the adjusters.
11. Back to the front of the lathe. Are there any adjusters in the casting below the nuts? My G4000 didn't have any. The size for the set screws listed in the manual was not correct. If you want them the same both front & back, take one with you when you get the 2 new ones. Purchase the correct drill & tap at the same time.
12. Here the philosophy of the members diverge. Some say to loosen the nuts till just snug & use a soft hammer/mallet to knock the HS around till the readings obtained during the checking procedure are what you desire. If you feel lucky, have at it. If not, continue reading.
13. Drill & tap the new holes accurately so that the set screws are aligned with the center of the stud holes.
14. After loosening the HS nuts, I decided that now would be a great time to replace the studs in the ways with better quality ones. Good thing I did, too. 2 of them were pretty loose in the ways. I purchased 4 new ones & locktited them in after determining where the unthreaded portion should be so that the adjusters could bear on metal & not threads.
15. I also added the 2 set screws to the front of the HS casting while waiting for the locktite to set.
16. OK, remember when I said to do the vertical alignment first? Now is your chance.
17. Let's use an example. Let's say that the Tailstock (TS) end of the bar is high. Obtain some shims. (Kmart feeler gauges are great, as is shiny hard magazine paper)
18. Since we need to lower the TS end; that means shims are required under the gear train end of the HS. Still with me?

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19. Place the same size/number of shims under both the front & rear of the HS (**only on the flat part of the ways, not the V**). Redo the vertical alignment check & repeat as many times as required till obtaining your personal degree of accuracy. Remember that paper will be compressed when tightening the nuts on the HS.
20. Now that we have the vertical alignment *perfect*, we will continue to the more difficult part, the horizontal alignment.
21. I recommend just barely snugging down all 4 nuts on the HS studs.
22. Place a 3MT dead center in the HS & a 2MT dead center in the TS.
23. Bring the TS center to almost touching the HS center & roughly position the HS using the set screws.
24. Get rid of the TS – completely off the lathe is best.
25. Reinstall the chuck & test bar as per the alignment check procedures used earlier.
26. Run the horizontal check & determine the direction that the TS end of the bar needs to be moved.
27. **This is important!!!** Don't attempt to calculate the amount of movement that needs to be applied. It won't work!! There are 4 semi-tight studs with lots of built-in slop holding the HS down. You have no way of knowing where the pivot point will be. I really believe that "trial & error" along with a bit of educated guessing is the best procedure. This is why I said that considerable time & patience will be required. I estimate that I fiddled with the 4 set screws for over 3 hours before I achieved my goal.
28. When adjusting the setscrews, I recommend maintaining a bit of preload on the studs which will act like springs.
29. Run the horizontal check, apply a small correction to the set screws & repeat the check. Over & over & over & over. When you have it *perfect*, all that remains is to reassemble the whole machine & start working.
30. Well, there is one more important step remaining. You need to tighten the stud nuts. When I did this step, I tried a criss-cross pattern doing only small amounts of tightening before moving to the next nut. I offered incense, burned candles, and thought pure & lovely thoughts, hoping that the alignment would not change. You know it did. I had to almost start over with the alignment. This time, I kept the nuts just a bit tighter. It worked. Remember, that you can cause minute changes in the alignment by tightening the stud nuts.

That is all there is to it, really. Is it worth the time & effort? Only you can make that determination. I think it was in my case. I would strongly recommend that if you have even the remotest thought of replacing the spindle bearings that you replace them first. My machine went from very good alignment to almost ice cream cone tapers after the bearing replacement.

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7. Spindle and Bearings

A note on Spindle threads: some of these Asian made lathes are shipped with an imperial size spindle which is 1.5 x 8tpi and others like the Grizzly G4000 are shipped with metric 39 x 4mm spindles. Unfortunately the documentation that comes with most of these machines needs to be "taken with a pinch of salt".

It's been said "The spindle bearings on the Asian 9x20 lathe are essentially indestructible, and are the best part of this lathe, as they should be". Spindle runout is measured at the inside surface of the Morse taper. This is where it is measured at the factory and documented on the test sheet. The Morse taper determines runout of work held between points

Lubrication:

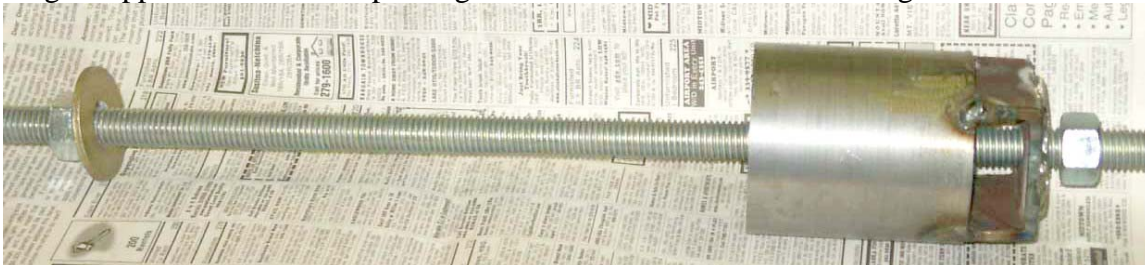
Both Lucas and Bel Ray make a "Red Tacky" #2 EP grease. These greases are excellent for use in the Headstock bearings. The important thing here is "Tacky" this used to be referred to previously as "Fibrous". As such during high RPM the grease is pulled back into the bearing instead of being flung-out by centripetal force. The bearings should be packed to 50% of their capacity. This gives room for expansion and movement of the grease within the bearing. A bearing so greased should operate for years in this application, without necessitating re-greasing.

Removing the Spindle:

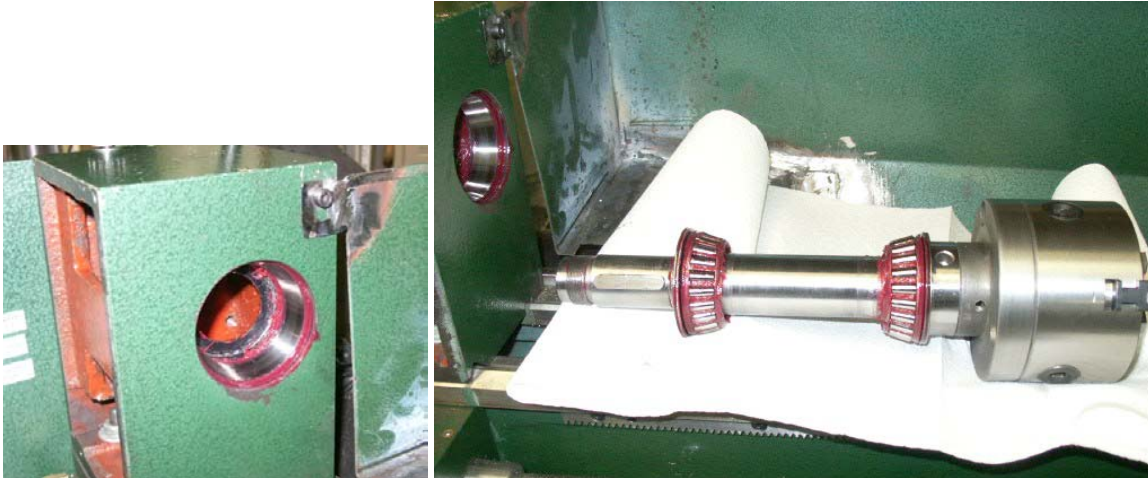


Above photo shows a commercially available puller being employed in the removal of the Spindle.

The photo below shows a hastily made (but very capable) spindle puller for the 9x20 series of lathes. The threaded rod is 5/8". The cylinder is 2.5" ID & 3.25" long. The channel welded to the cylinder serves two purposes. a) Extends the length of the cylinder because the builder didn't have a longer piece. b) Provides a rigid support for the nut to push against. A hardened washer was Mig welded to the channel.



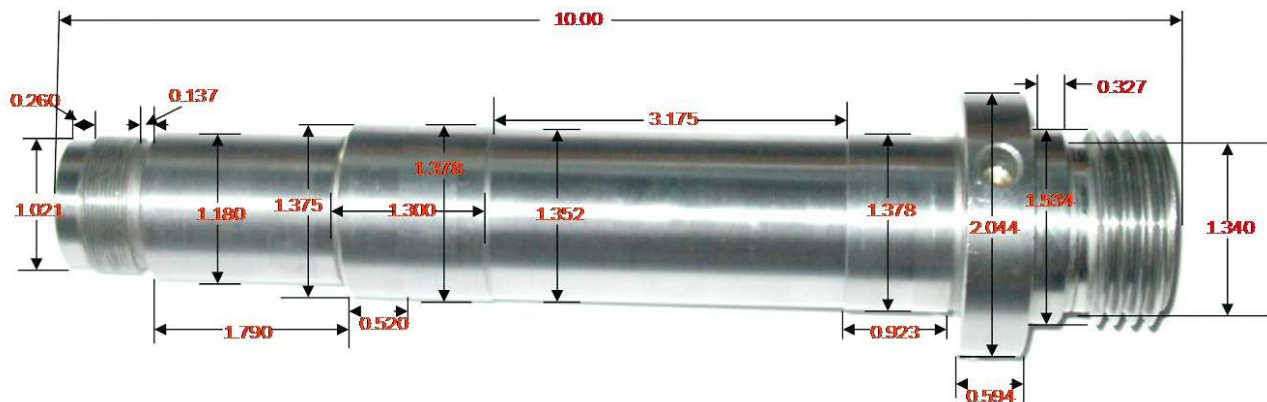
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Here are some spindle dimensions:

Spindle from Grizzly G4000 9X19 lathe. Dimensions taken with dial caliper. Your dimensions may vary.

6 Mar. 2005 Jerry Morris Anchorage, Alaska



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Bearings:

The two spindle bearings of all 920 lathes are very common and easy to find taper roller bearings of generic type 32007.

However there are options in terms of quality. The precision class does not change a bearings speed or load rating. They are made with the same materials on the same machines as standard bearings of same type & make from the same manufacturer. The difference is selection and matching of the components to tighter tolerances.:

Bearing Options:

1) Obtain two 32007 from a well known, reputable manufacturer such as SKF, Timken and many others that put their good name on the box. These will automatically be precision class P0 bearings.

Cost Approximately \$10-15 each.

2) The original Austrian C8 lathe used 32007P6 bearings, that's the next up precision class. Probably, the best price/precision compromise for this lathe.

Cost Approximately \$15-25 each.

3) 32007P5 bearings come with the inner and outer rings marked with a serial number and should not be mixed. This is the highest precision class that would qualify for an industrial lathe.

Cost from about \$40 each. Probably overkill for this lathe.

Better grades would be P4, P3.... but prices soon exceed the lathe value.

8. Spindle Preload

Although this is probably going to seem terribly un-scientific, the method does work and it's not Voodoo: Run the lathe at medium speed for about 10-minutes to warm-up the headstock and bearings. Power-off the lathe and install the 3-Jaw chuck on the spindle if it's not already installed. Remove the V-belt so that the Spindle is free to rotate. Grasp one of the extended jaws with one finger and pull towards you briskly and release. The chuck should rotate approximately one and one half revolutions before coming to a stop. Adjusted like this, you should feel a positive drag when rotating the spindle.. If it does, the Preload is correctly set.... Leave it alone. If it rotates more than one and one half revolutions before coming to a stop, refer to page 30 of the G4000 Manual, loosen the setscrew [12] (*if you remove the setscrew, lookout for a little brass disk that sits in there between the setscrew and the threads. This little disk prevents the setscrew from lousing-up the threads*) and tighten the Spanner Nut [13] slightly. Retest and readjust until satisfactory. If the rotation is less than one and one half revolutions before coming to a stop the Spanner Nut [13] needs to be loosened slightly instead. Retighten the Set Screw when done. The Headstock should feel warm to the touch after running for prolonged periods (>30-minutes). If the Headstock gets hot, the preload is definitely set too tight.

9. Drivetrain Gears & Bushings



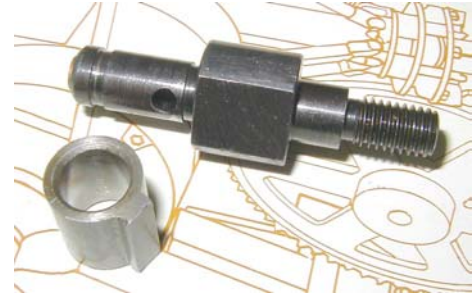
The change gears supplied with the 920 lathe are metric, Module 1 with a 20 degree pressure angle. When setting up these gears it is advisable to space them by putting a strip of paper between the gears while you set the adjustment. Don't forget to remove the paper when finished. This sets the spacing for proper mesh of the teeth.

REBUILDING THE ASIAN 9X20 LATHE

Running-in gears:

Clean all the gears of oil and use the lathe for an hour or two with no oil or grease. They will wear into each other. Some owners recommend running the geartrain with some type of abrasive such as valve grinding compound in an effort to lap the gear pairs.

Major gearing authorities have spoken against this process for generations. The thrust of their arguments are these. Along the pitch line is a region of no rubbing. When lapping gear pairs, the flanks lose stock while the pitch-line simply rolls abrasive into the ductile metal, there to stay and shed abrasive into the lubricant. The result is a relatively unchanged pitch-line and load bearing tooth flank worn below the involute necessary for conjugate tooth action.



Gear Bushings:

The Austrian maker of the original design (C8) specified grease for ALL grease nipples, oil only for the change gears. This bushing is supposed to be made of sintered bronze (I wonder if the Chinese replaced brass for it, bronze is expensive). In any case, the shaft is supposed to be ground. If only roughly turned, every bearing material would wear out quickly. By the way, the original EMCO shaft was 12mm h7 tolerance.

10. Slip Clutch

In normal use the clutch should never slip. Meaning, the parts normally do not move relative to each other, hence a thin grease coat is all that's needed for 10 years of operation. Too much grease will eventually find its way out by centrifugal force, and just soil your timing belt. If the clutch slips for any reason other than a solid collision, something is wrong with it. The shaft is another story. It's hollow and must be greased every few days of use. Oil is not a good idea here, as it flows quickly out and right onto the V-polybelt causing it to slip.

Some have reworked this safety clutch so that it furnishes a usable torque, and some have drilled it through and pinned it with a soft pin to prevent it from slipping but still act as a breakaway safety device.

Take your choice, but don't underestimate the torque with a stalled lathe and the belt on this position. What gets wound up in the lathe may be some part of your anatomy.

I'll attempt to explain how to disassemble the slip clutch, and to improve it as per the instructions from the Grizzly tech support staff. I have photographed the unit, & hopefully these pics will enhance the following text. Before we start, you should be aware of a few items that look different on my machine than yours.

1. **Motor Mount** I have replaced the factory motor with a Dayton DC motor and fabricated a custom mount for it. Also, the pulley on the motor shaft has been modded to fit the new motor.

2. **Bronze Bushings** I had to replace the bushings on my slip clutch because they were drilled crooked & the entire assembly wobbled like a drunken sailor on shore leave.

REBUILDING THE ASIAN 9X20 LATHE

3. **Washer under clutch spindle** The washer under the spindle for the clutch is not stock. Mine fit poorly & leaned at an angle, so I modded it for a better fit.

Since my mods are designed to fit my machine only, I shall not provide any measurements, dimensions, or tolerances. (Your mileage may vary.) I do believe that my mods to the clutch assembly are typical, and can be of value to users of new machines.



Removing the clutch assembly begins with removing the toothed belt connected it to the motor shaft. **(UNPLUG THE LATHE)** One method that works without loosening the motor is to remove the “C” clip from the shaft & rotate the clutch/pulley assembly while pulling the assembly away from the lathe. The belt will walk right off the rear of the pulley. (You are on your own when putting it back on.) I recommend replacing the “C” clip while you have it off. Mine had nearly no spring in it. Lay the clutch assembly aside for now.

Now is a great time to inspect/clean/repair the spindle. Notice that I have positioned the oil hole up. If you use oil for lube I figured the hole being up would prevent the oil from running out freely. Carefully feel the shaft for burrs & scratches. Some very fine wet & dry would be a great asset here – don’t take off any metal except for the burrs or your clutch will wobble worse than it already does. Remember if you use any abrasives that you will need to do a very thorough cleaning of the shaft & lube opening. If you remove the shaft, you will see that it fits into a slotted hole that provides adjustment for belt tension.



REBUILDING THE ASIAN 9X20 LATHE

Continuing on to the clutch assembly. {Added: As an afterthought, a method for checking the tension prior to dismantling the unit might go like this. Locate an old leather belt & wrap it around the steel pulley. Carefully clamp it in a vise & twist the large Aluminum pulley to determine how much force is required to cause it to “break free”. After doing the drilling listed later, reassemble the clutch & use the belt/vise method to check for increased tension. Doing it this way will preclude reassembling it on the lathe to check for any improvement. Remember, you need to proceed gently, lest you drill too deep & ruin the unit.} Proceed with caution, or you will be looking for parts all over the shop. Lay the clutch assembly with the small pulley down. Locate a larger “C” clip (about 1 inch) holding a large washer against the aluminum pulley. **CAREFULLY** REMOVE THE “C” clip while holding downward pressure on the large washer. There are 5 springs under this washer with a bit of preload on them. Slowly release the pressure on the washer & it will rise approximately ¼ to 3/8 inch. After removing the washer your assembly should look like the above pic. You may remove the 5 springs & store them. The 5 ball bearings under the springs may or may not come out with the springs. Just be careful to not lose them.



Work the center (Steel) section out of the Aluminum pulley (being careful not to loose the balls) & you now should see something resembling the above pic. (Notice that the grease retained the balls on my unit.) Check the steel portion for burrs & polish it as required.



Now after a good & thorough cleaning, you should be able to determine how the clutch operates. The balls are pressed into the openings in the steel section by the springs. When the load becomes too great on the system, the balls jump from hole to hole thus preventing damage to the gear train. The concept is good; however, like several other aspects of our machines, it isn't quite right. Grizzly tech support told me to just dill the holes a bit deeper – that is all they told me. OK, I located a drill that was just a tiny bit larger than the opening in the steel piece. I stacked up some blocking on the Drill Press table so I could hold the unit nice & steady & deepened the holes just a tiny bit. I reassembled the unit and tried it out. I intentionally got aggressive, & the unit showed not much improvement over the way it came from the factory. Another complete disassembly & back to the Drill Press. I used the same bit; but, this time I went a bit deeper. As you can see in the Pic, there is a slight step before reaching the tapered region that the balls sit on. After a reassembly & lube, all is happy with the clutch. The new bronze bushings work like champs, & I'm one step closer to having a great machine.

All that remains now is to lube & reassemble the unit.

REBUILDING THE ASIAN 9X20 LATHE

11. Drivetrain Pulleys, Belts & Motor Alignment

First let's talk about the 8mm bracket plate (page 32, #1 in the G4000 Manual) as there seems to be 2 different models and may be an important factor in the belt alignment and tensioning of your lathe. The old C8 design had only a tight fitting hole for the B pulley stack shaft, and the only way to do a fine adjustment was to move the whole bracket plate. It is mounted to the headstock with two M5 .8x20 hex cap screws and has a fairly wide adjustment range in its screw holes. On the other model there is a slot to allow for adjustment of the B pulley stack assembly up or down in this slot. Procedures for both are listed but some important facts should be kept in mind when you attempt these procedures.

The toothed belt is very sensitive to the angular alignment of its two cogwheels. Their axes need be absolutely parallel. If not, the belt may want to wander off or "track" sideways and will rub on the shoulders of the smaller wheel. This creates vibrations which may be visible on the surface finish. Sideways offset of the motor is not a problem for this belt, because the larger wheel is wider than the belt and has no shoulders.

The V-belt is not as sensitive to angular alignment of the pulleys. But, it does not like the pulleys being offset sideways.

The angular alignment of the tension roller is also very important. There seems to be various different tensioning roller designs around. The C8 roller had bushings and was thus free to slide about 10mm along its shaft to adapt to the belt. Some 920 rollers have ball bearings and cannot slide sideways. Some other 920's seem to have bushings that also cannot slide sideways. The alignment of this tension roller, if not properly aligned, may push, pull, roll over or break your belt. Once a belt rolls over it may be damaged and is likely to do it again even though the pulleys are properly aligned.

WARNING: Disconnect the lathe from its power source before attempting any of the procedures listed below. Failure to follow this warning may lead to serious personal injury.



The adjustment:

Some Asian motors mount on four 6x1x35mm Allan keyed studs and is secured by 4 washers and nuts. The slots on the motor mounting bracket are somewhat oversize to allow for adjustment in the horizontal and vertical planes. Your model may vary but the principles of adjustment should be the same.

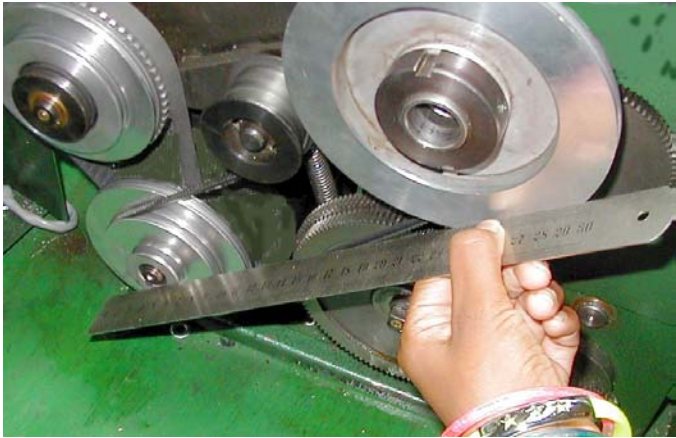
Because the spindle's C pulley stack is the only non adjustable pulley stack, all adjustments should be made in reference to the C pulley stack.

Face the back of the lathe with the tailstock to your left. With the mounting studs inserted into the lathe, mount the motor on to the studs. Move the motor toward or away from the tailstock with the v-belt encompassing the A and C pulley stacks.

Note: Never cross the belt on the AC pulley stacks. You are either on AC1, AC2 or AC3. Always use a small wheel and a large wheel.

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When the A and C pulley stacks are equidistant from the bracket plate and the v-belt runs in the same track the pulleys are aligned. A “straightedge” is very convenient for establishing pulley alignment.



The 4 securing nuts should now be “snugged up” but not tightened so as to allow for vertical alignment of the motor to tension the v belt.

Move the motor up or down to achieve correct v-belt tension and tighten the motor mounting nuts to secure the motor to the lathe. Correct tension is roughly when there is approximately a 1/8th of an inch of deflection when pushing with moderate finger pressure with the v- belt following any of the AC pulley stack combos. This should allow for comfortable AC pulley stack combination changes.

When this is complete, remove the v-belt from the A and C pulley stacks and attach the B pulley stack to the bracket plate if you haven’t already done so.

Note: in the next operation an Allan key may have to be cut and modified to allow clearance behind the C pulley stack to loosen the cap screws.

If your B pulley stack is not adjustable within the bracket plate, loosen, but do not remove, the M5 .8x20 cap screws attaching the bracket plate to the headstock and tilt the bracket plate counter clockwise to allow some slack for the toothed belt to be slipped over the large cog of the B pulley stack.

Attach the toothed belt to the cogwheels of the A and B pulley stacks.

Move the bracket plate clockwise to tension the toothed belt and tighten the 8mm bracket plate cap screws. It should flex about 1/8" under hard finger pressure.

Note: Again, this toothed belt is very sensitive to the angular alignment of its two cogwheels. Their axes should be absolutely parallel. If not, the belt may want to wander off or “track” sideways and may rub on the shoulders of the smaller wheel. This may create vibrations which are visible on the surface finish. To adjust tracking of the toothed belt, tilt the motor in its mounting, until you find the position where the belt does not touch the A pulley cogwheel guide flanges when the motor is both run in forward and reverse.

You may have to repeat these steps a few times to get the optimal positions. If it’s not possible to find an optimal position, then the hole for the belt pulley shaft may be drilled in the wrong place.

If your B pulley stack is adjustable within the slotted bracket plate, loosen the pulley shaft nut from behind the bracket plate and pull up on the B pulley stack assembly until the toothed belt is tight.

Hold this position and tighten the B pulley stack shaft nut.

If the B pulley stack assembly is at its maximum travel in the slot of the bracket plate and the toothed belt is still not tight enough, loosen, but do not remove, the two M5 .8x20 caps crews attaching the bracket

REBUILDING THE ASIAN 9X20 LATHE

plate to the headstock and rotate the bracket plate clockwise to gain a little more tension as there is a small amount of adjustment range in its screw holes.

Belts General:

The Grizzly G4000 Manual lists the V-belt as an M5x730 and the toothed belt as 160XL050.

The 5M730 v-belt means 5mm wide by 730mm long. The grizzly number for the V-belt is P4000237A. The Grizzly number for the toothed belt is P4000238A. There has been a lot of discussion on belt and belt lengths and many owners have stated their belts lengths differ from what's listed or what they feel is needed. The motor could well be the reason for different belt lengths on otherwise identical 920 lathes. Some lathes could use a motor made to American NEMA frame standards, others a motor made to IEC standards. The key difference between NEMA and IEC frames is the shaft diameter and the distance from shaft center to the mounting feet. The latter directly influences the required belt length. Motors are commodities, and it is not unusual for lathe makers to change make and model on the fly according to target country or dealer preferences, availability and price.

NOTE THE BELT SIZES FOR YOUR PARTICULAR MACHINE.

There has been a lot of interest in finding third-party suppliers of the Gates PolyFlex v-belts for the 9x20 lathes. A good idea is to take note of the belt numbers supplied with your lathe for future reference when ordering. The part numbers you will need may be printed on the belt itself or measure your belts if the numbers are not visible. The belt markings may not always be obvious and you may have to scan it closely. To measure your belt, if it's not broken, wrap a string around the circumference of the belt and measure the string. If it is broken, just measure the length of the broken belt. You can get the belts from your lathe dealer or from any good industrial parts distributor; i.e., a "bearing" house. This means you might get it locally. This is a somewhat common type belt. The local supply house may not have it in stock but may be able to order the correct size for you. Since you are going to the trouble, you might want to get two. You'll find the cost of two not very much more of an increase over the one, especially if shipping is involved. Experience has shown that if you are doing something which breaks the belt, you will probably break more than one. Experience has also shown that the supplied belt works well for the type of work intended for this size and type of lathe.

Protocol for changing belt pulley combinations is, "come off" the big pulley first; and "go on" the big pulley last. Some people may find the belt positions are really "tight" with a new belt and a tension adjustment may make pulley combination changes easier. One owner found slightly loose motor mounting bolts on his recently acquired lathe. He concluded that the motor mounting bolts must have loosened enough in shipping to allow the motor to drop making it almost impossible to change A/C pulley combinations due to the increased tension on the belt.

- ◆ Generally, If you have a 160XL Coged belt, you need a 5M720 V-Belt.
- ◆ If you have a 170XL Coged belt, you need a 5M730 V-Belt.
- ◆ Should you use a 5M720 V-Belt with the 170XL Coged belt the V- Belt will be too short.
- ◆ Using the 5M730 V-Belt with the 160XL Coged belt, the V-belt will be too long.

AGAIN.... NOTE THE SPECIFIC BELT SIZES FOR YOUR MACHINE *(this cannot be overstated)*

The belts should be kept free of oil and grease. However, because of their proximity to lubricated rotating parts, accumulation of lubrication on it's surface is inevitable. It is therefore advisable that the belts be cleaned periodically and Isopropyl Alcohol well for this.

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V-Belt



For Best performance “GATES POLYFLEX” belts are recommended. The 5M belts are "polyurethane, continuous (no splice) belts for high precision drives in machine tools". The Gates catalog expressively mentions lathes and mills as prime applications. These belts are rated for up to 12,000 rpm around very small diameter pulleys. This belt was specifically chosen by Emco in the design of the C8, its small size isolates motor vibrations from the spindle. Rest assured, that despite the small size, it is perfectly suitable for the kind of power to be

transmitted. Some owners have reported over 15-years of service without breaking one of these V-Belts.

Some Aftermarket, On-line, Belt Sources:

5M730 Belts obtainable online from: E.B. Atmus \$8.17
<http://www.ebatmus.com/cart.epl?Buy=1&Quantity=1&ItemID=204857&Query=5m730>

5M730 Gates Polyflex V-BELT **Item** #00738120 Motion Industries \$10.40
<https://www.motionmro.com/motion3/jsp/mi/motion.jsp>

Some 920 type lathes carry 160XL050 others carry 170XL050
170XL050 Belts available from: PEGASUS Auto Racing Supplies \$8.59
<http://www.pegasusautoracing.com>

160XL050 TIMING BELT **Item** #00673508 Motion Industries \$4.93
170XL050 TIMING BELT **Item** #00673523 Motion Industries \$5.03
<https://www.motionmro.com/motion3/jsp/mi/motion.jsp>

NOTE: Prices shown are at time of writing

12. Tensioning Lever

Referring to page 34 of the G4000 Manual. Essentially, the tension lever [23] cams a Roller mounted on a spring loaded [13] Axle Bracket [3] in or out of contact with the V-Belt. Roller rotates on two bearings [5] supported by an axle [4]. With the lever pulled towards the operator the cam action rotates the Axle Bracket rearwards and releases tension on the V-Belt. Moving the lever to the rear brings the tension Roller [6] into contact with the V-Belt under spring tension and thus imparts this force in tensioning the V-Belt between the two active pulleys.

Ensure the tension spins freely. It is recommended that the open-race bearings installed in the tension roller be packed with “Tacky” grease. The outer surfaces of the roller shall be wiped free of all grease before re-commissioning.

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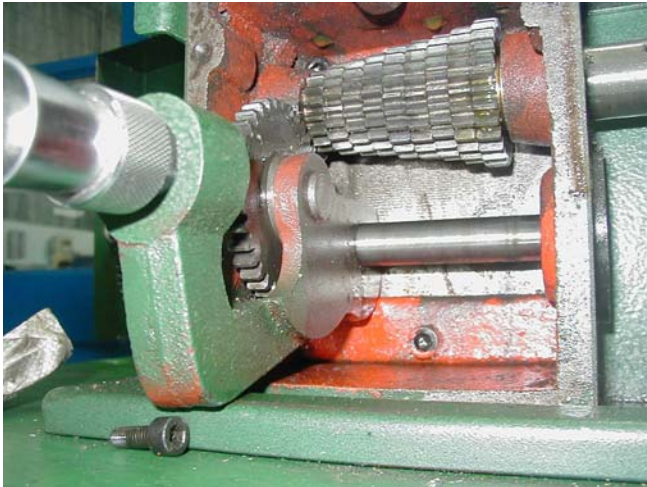
13. Half Norton Gearbox (QCGB)

The QCGB is pretty straight forward. It's used to transfer power to and rotate the leadscrew at predetermined rates as determined by different gear combinations chosen by the operator.

It consists of 2 assemblies. The shift arm assembly and the 9 gear stack assembly. The rotational rate of the 2 gears of the shift arm assembly are influenced by the combination of gears used in the A, B and the 127/120 toothed gear train. When the shift arm is lowered there is no engagement with the 9 gear stack so no power is transmitted to the leadscrew. When the shift arm is lifted and engaged into one of the 9 positions, power is transferred to the lead screw via the 9 gear stack. The 9 gears are machined to except a key which sits in its axel shaft and the axel shaft is connected to the leadscrew.

To remove the shift arm assembly and its components for repair or replacement you first must remove the front cover. The front cover is secured by three M6-1.0x10 hex cap screws. There are also two aligning pins at the top left and right corners of the cover to take note of.

Now open the side cover and remove the spacer and B gear from the shift arm axel shaft. Next, remove the bracket part # P4000633, ref #33 on page 41 of the Grizzly manual. It is secured with three M6-1.0x10 cap screws.



Now remove the bearing cap on the right side of the shift arm axel shaft if there is one. Some models do not have this bearing cap. Next remove the 2 15mm external retaining rings from the both ends of the shift arm axel. A snap ring pliers set is used for this operation.

Now by looking at the diagram of the shift arm axel shaft ref # 16 on page 40 of the Grizzly manual you will notice the shaft is key cut for a 5x5x12mm key. The keyway is machined all the way to the right side of the shaft. The key is held within the 36t gear. This means the shaft MUST be removed from right to left.

Using a plastic or wooden mallet, as not to damage the shaft, tap the right side of the shaft to push it flush with the bearing. Use a brass punch or similar soft drift to push the shaft through the bearing. At this point continue to push the shaft through the shift arm and through the other bearing. Be careful not to lose the 5x5x12mm key. Disassembly of the shift arm is straightforward using the grizzly manual parts breakdown on page 40 as a guide.

To remove the left bearing, insert a socket inside the housing and rest it on the inner surface of the bearing. Now insert a long punch or socket extension through the right bearing and gently tap out the bearing.

To remove the right bearing, remove the internal retaining ring located on the outside of the bearing if there is one and repeat the above procedure.

Inspect all parts for nicks or burrs and ensure freedom and ease of rotation of the shift arm gears and bearings.

Now would be a good time to upgrade your bearings if you so desire.

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The 9 Gear Rack Assembly

The 9 gear rack assembly is also pretty straight forward. The 9 gear rack assembly is just a collection of progressively larger gears mounted on an axel shaft that the shift arm engages to transmit power to the leadscrew at different rates of revolution depending on the change gears used and the position number selected for the shift arm assy.

You must remove the lead screw before you disassemble this assembly. Remove the external 16mm external retaining ring [page 40 ref #24 of the grizzly manual] from the outer left side of the axel shaft. Using a suitable soft brass drift and hammer gently tap the shaft towards the tailstock from the left. As the shaft is removed the gears will fall one at a time onto your drift. Remove each gear as they are freed from the keyed axel shaft and put aside. When the keyed axel shaft is removed and free from the gears inspect the shaft, key and gears for nicks, burs or worn components. Repair or replace any broken components. With the shaft removed ensure that each of the gears freely slide onto the keyed shaft before you try to reassemble this assembly. It may become a little tricky to align all the gears up during reassembly and binding of the gears will just add an unnecessary frustration factor. Remove all the gears from the shaft and insert it back into the QCGB and seat it in its bushings. Ensure free, easy and smooth rotation of the shaft in its bushings.

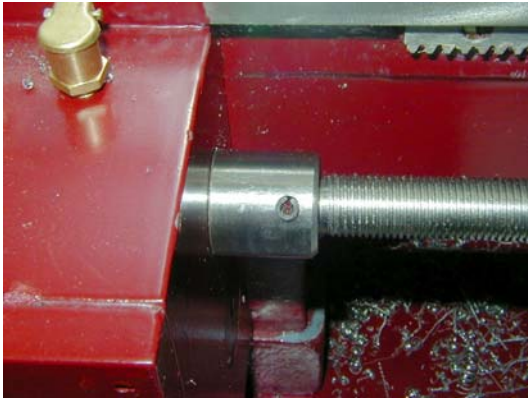
Now That you are ready to reassemble this assembly a good idea to aid in assembly is to make a mark with a black marker on the outer right edge of the shaft inline with the key so you have an approximate idea where the key is in relation to the shaft. Also mark each tooth of the gear with the black marker where the keyway is located to have an approximate idea where the keyway is on the gear. These two marks will aid in assembling the gears on to the shaft. Reinsert the shaft and install one gear on the shaft at a time starting with the largest until all gears are seated properly. It is important to note that you should not try and force the shaft through any one of the gears as this will damage the key on the shaft and make any further gear assembly very difficult. Proper alignment of the gear keyway with the key on the shaft will allow easy assembly; hence the reference marks to aid in assembly.

Once the axle shaft is reinserted, reinstall the 16mm external retaining ring using retaining ring pliers and check for free, easy and smooth rotation of the shaft in its bushings.

14. Leadscrew and Associated Parts

Removing the Leadscrew: Using a pin punch and a reasonably sized hammer, knock the pin out of the lead screw at the attachment point to the Quick Change Gear Box. Refer to page 53 of the G4000 Manual and undo the right end of the lead screw, by removing 2 hex cap screws [item 07]. Pull the lead screw [item 04] out (you can engage the half-nuts and then use the carriage crank to extract it, using the rack as a lever). When removing the lead screw, watch for a shaft key about an inch long to drop out or be stuck in the lead screw groove [refer page 42 item 4]. This runs inside the worm itself.

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Deburring: This job is best done with the leadscrew removed from the machine.

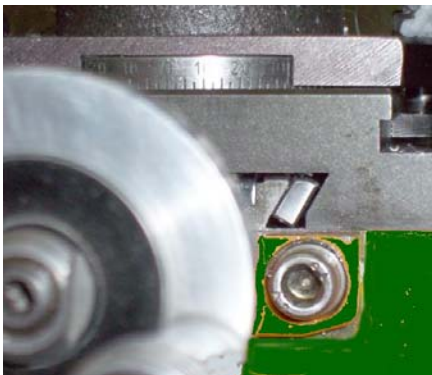
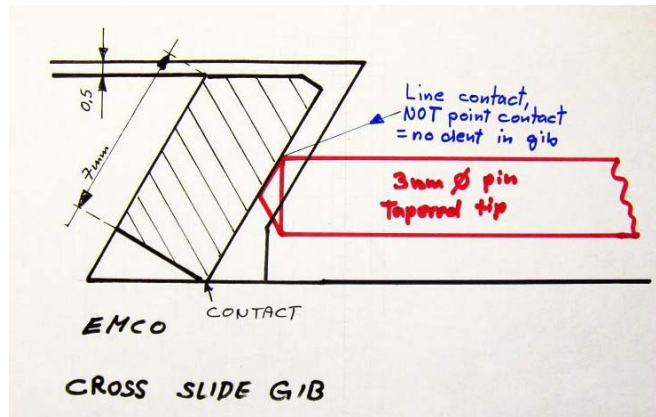
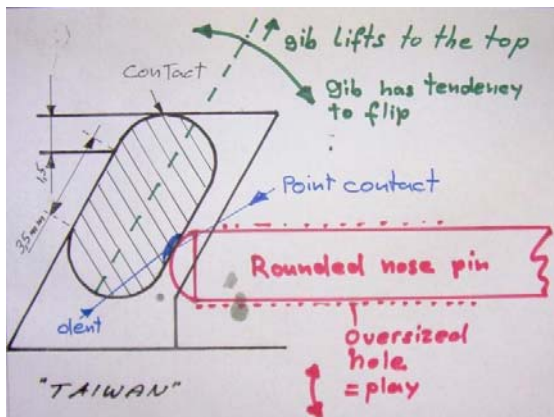
The Leadscrew as it comes from the factory may have burrs on the threads especially in areas where the slot and threads intersect. These burrs may sometimes escape notice even under magnification. The only sure way to detect these burrs is to rotate the LS in a halfnut held in the hand. If they are there, you will feel them. They are flexible and extremely hard to see, and wire brushing does not remove them effectively. Usually one has to stone and or file each corner until they cannot be felt any more, and then buff the whole LS.

It is a long tedious job, but well worth the effort, as it saves the half nuts from wearing out prematurely.

The leadscrew should be kept clean and free of debris (a 1½ " paintbrush works great for this and a ShopVac is wonderful) and should have a light film of SAE140 Gear Oil applied by brushing or with a rag.

15. Gibs, Cross Slide & Compound

The following pictures compare the Asian Gib structure and assembly to the original Emco Gib.



The slightest bow or twist in the gib thoroughly ruins the entire slide. Bad chatter or a bad sticky and irregular feeling to the handwheel (or both) are the inevitable consequences.

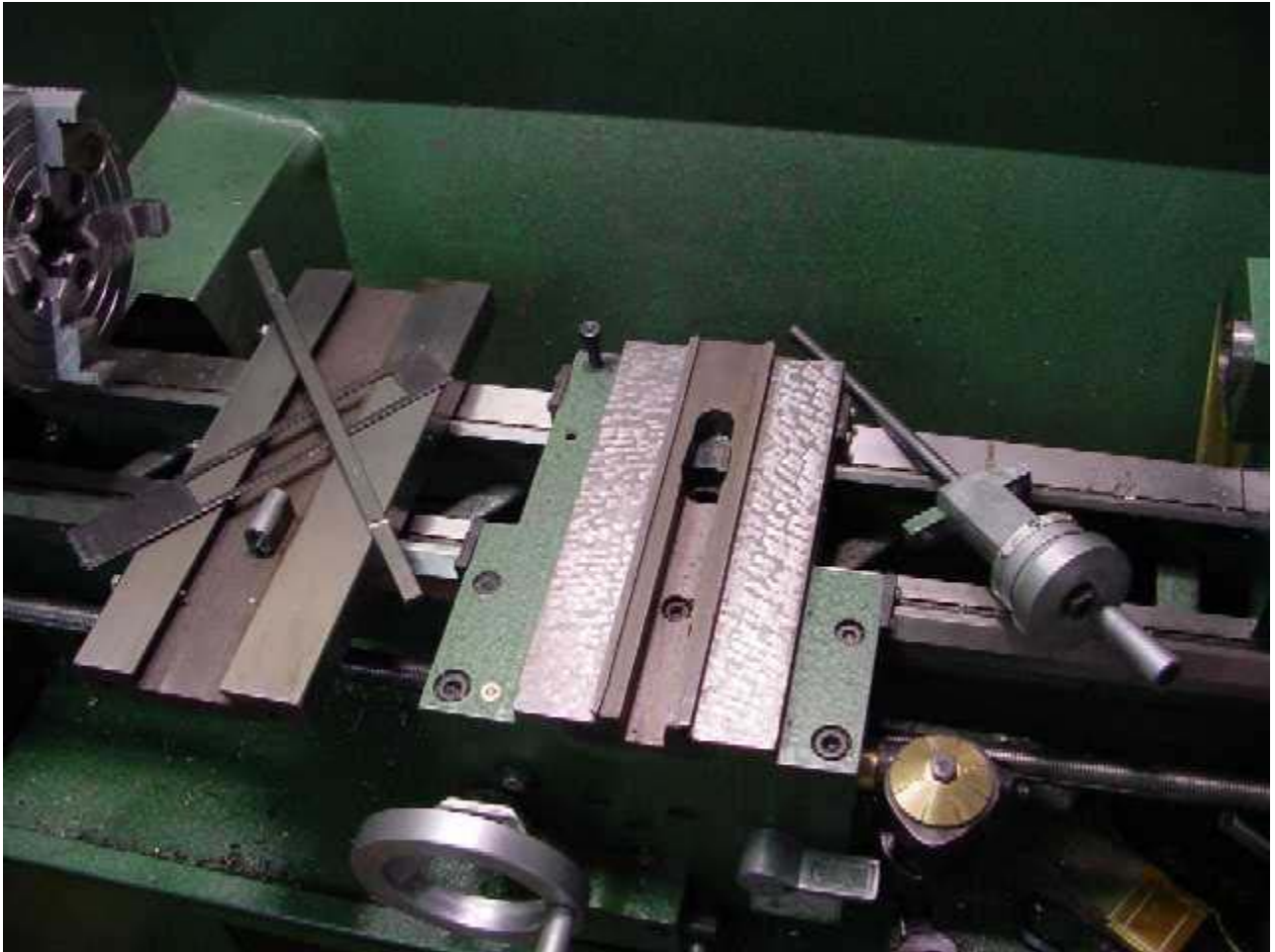
There are several adjustments you can make to significantly improve the accuracy of your lathe. These adjustments, properly done, can improve the quality of work you can produce. To get accurate,

REBUILDING THE ASIAN 9X20 LATHE

nicely finished work and minimum chatter, it is important to remove as much play as possible in the saddle, cross-slide and compound.

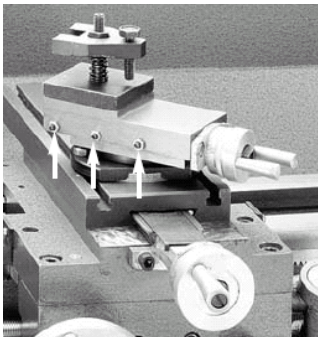
The pins should be cylindrical and of a ground finish, running as a slide fit in reamed holes. They should be tapered at the gib side for a line contact to the gib. On the grub screw side they are only chamfered and flat. The grub screw should have a nice flat tip. Optionally a 4mm steel ball can be inserted between pin and screw to make for an even finer adjustment "feeling". That is the ideal situation to aim for, its the way the C8 lathe was made. 818 and 920 lathes do not come this way from the factory, and may need some work to achieve this. Whether its worth doing depends on your demands of the slide

Try grasping the compound and twisting it from side to side. If your lathe is properly adjusted you should be able to move it very little.



Adjusting the Gibs

When adjusting the gibs, keep in mind that the goal of gib adjustment is to remove unnecessary sloppiness from the slide's movement without causing them to bind. Over tightening may cause premature wear.



One of the simplest and most effective adjustments is adjusting the gib screws. Gibs are metal strips that sit on one side of a dovetail slide, such as the cross-slide and compound, and which are adjustable to take up any slack or slop so that the dovetail slide is very smooth and snug.

Looking at the side of the compound rest you will see three small set screws surrounded by locking nuts. These set screws push on small metal pins which in turn push on the gib.

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If you crank the compound rest all the way back until the compound lead screw disengages, you can then slide the top part of the compound free from the bottom part, exposing the lead screw, dovetails and gib strip. Be very careful you not to lose the 3 pins that are now allowed to fall free from the compound rest as they will be no longer retained by the gib.

While you have the compound removed, apply a light coating of white lithium grease to the gib face, the dovetail faces and the lead screw.

White lithium grease is available from hardware stores in small plastic tubes which will last quite a while.



With the compound back in place and positioned about midway in its range of travel, here's the adjusting procedure:

1. Use a 7mm wrench to slightly loosen each locking nut
2. Start with the middle screw, grip the lock nut with a 7mm wrench and tighten the set screw using a 2mm hex wrench until the set screw is just snug.
3. Back off the set screw about 1/4 turn
4. **Holding the set screw to keep it from moving, tighten the locking nut. The lock nut should not be super-tight, just tight enough to firmly lock the set screw in place.**
5. Repeat for the other two adjusting screws.



Test the compound slide to make sure it moves smoothly. If you get the gib too tight it will lock the slide in place so don't force the crank or you might strip the leadscrew. Just repeat the above procedure but don't tighten the gib screws quite so much. Try tightening the set screws slowly while you are cranking the compound back and forth and you can feel the gib start to snug up the dovetail. This should give you a good sense of how tight the screws need to be.

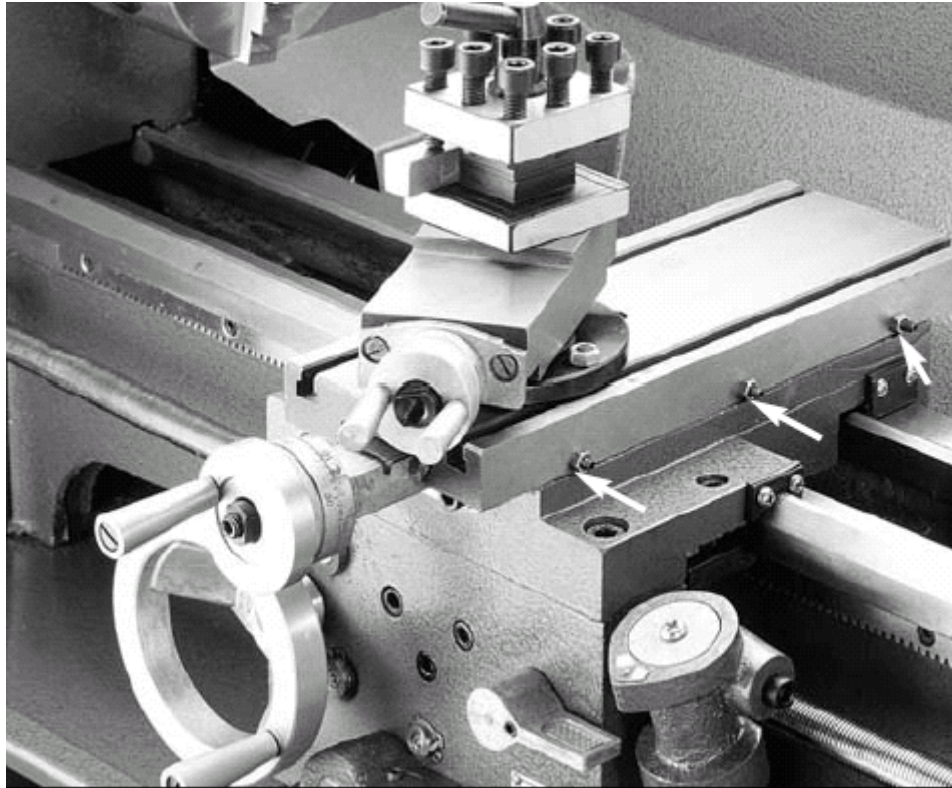
You may have to repeat this procedure several times until you get a feel for it. As you use the lathe, the dovetails and gib will wear down a little over time so you may need to repeat this procedure periodically.

After you have the slide moving smoothly, try gripping the compound rest at either end and try to wiggle it side-to-side. There

should be almost no play at all.

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The procedure for adjusting the cross-slide is essentially the same.



Backlash

Backlash in the usual magnitudes does NOT affect accuracy. It does only affect your perception of a lathes overall condition and build quality. Excessive backlash can be annoying to work with, and can in extreme cases lead to chatter under heavy cuts, but not under light finishing cuts. Now, what is "normal" backlash on this lathe? On cross and compound, 0.05 to 0.1mm is normal. On the carriage driven via half nuts, about 0.15 to 0.3mm is normal. On the carriage driven via the big hand wheel, 1mm and more is perfectly normal.

Adjusting Cross-slide Backlash

Grasp the cross-slide at either end and try to slide it back and forth. You will probably feel a movement of about .100 inches or more. By performing the adjustment described here you should be able to reduce this movement to about .020 or less.

Two adjustments are related to the longitudinal play.

1) The nut for the cross slide leadscrew is made from aluminum. This is a picture of the cross slide lead screw nut. The cross slide was removed and turned upside down to take this photo.



Although hard to distinguish in the above photo, there is a small slot in this nut. The nut is attached with a small Phillips head screw from the top of the cross slide. You can see the Phillips head screw in the centre

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of the cross slide when the compound slide is removed. Beside the Phillips head screw there is a grub screw used to adjust backlash in the cross slide lead screw. In the photo below the Phillips head screw, that retains the leadscrew nut, has been replaced with Allan key type screw by its owner and the threaded grub screw hole is plainly visible just to the right.



The grub screw is used to put pressure on the nut and because of the slot the aluminum nut will “compress” a little. This is used to remove backlash and adjust for wear. Do not over tighten it in an attempt to remove all backlash, this would just increase wear and a short while it gets sloppy again. Just tighten up as far as you can until you feel the handle getting very slightly stiffer, and then loosen again a tiny fraction.

2) The axial position of the hand wheel is adjustable by a special hex nut part # P4000814 on page 47 of the Grizzly Manual or your model may something different such as a threaded collar, part # P4000930 on page 49 in the Grizzly manual. Which ever variation you have they both should be threaded to accept a set screw. This is used to remove any axial play of the leadscrew in its bracket/bearing.

Loosen or remove the set screw and tighten the hex nut or threaded collar so the hand wheel rotates freely without resistance, but has virtually no axial play. Reinsert or tighten the set screw to lock the hex nut or threaded collar in place.

An additional problem on some Asian Lathes is that the bore for the leadscrew in the support bracket may be oversize or drilled off square, or the two milled surfaces (back/front) of the bracket may not be parallel and at right angle to the leadscrew. In this case you cannot adjust as above and expect the cross slide to move over the whole range without binding. You can try loosening the two bracket screws and moving the bracket to different positions within the mounting hole's play. There should be one position, where you can move the cross slide back and forth without feeling a "binding spot" (it usually binds when the table is closest to the handle).

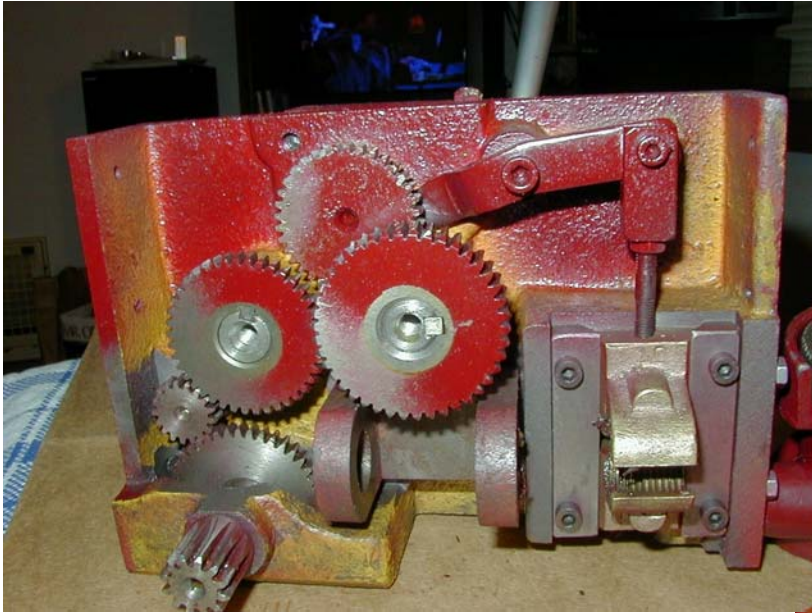
Once adjusted, tighten firmly the cross slide lock. You should now feel a dead play of the hand wheel (a region where the hand wheel rotates absolutely without any resistance) of about 0.04mm (0.0015"). This is about the best you can expect from this design (the best high precision lathes are about half of this, but there is always some backlash).

16. Rack

Referring to page 53 of the G4000 Manual, three roll-pins [not shown in the G4000 Manual] hold the Rack [2] in register with the Bed [1], while 6 Cap Screws mount it the bed. The Rack should be kept clean and free of debris (a 1½ “ paintbrush works great for this and a ShopVac is wonderful) and should have a light film of SAE140 Gear Oil applied by brushing.

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17. Carriage Apron and Halfnuts



See: G4000 Manual pg. 43, Once out on your table, open the back of the apron.

4 small screws hold the back cover [64] on. Just loosen them, the cover is slotted so you do not need to take the screws all the way out.

Remove the Leadscrew as per item #14 above.

Now, referring to the G4000 Manual pg. 46, all you need to do is pull the 2 front hex cap screws [37]. The apron will tend to drop. Since the lead screw is out already, the worm is not secured and will fall out if you tip the apron backwards.



operation becomes pretty obvious.

If the half-nuts work right now, Just clean with WD-40 and lubricate before reassembly, but otherwise don't take apart unless necessary.

The feed side, however, is not so sensitive. You can pull all the gears and shafts, and they will go back together just one way.

G4000 Manual pg. 42, The Handwheel [31] comes off by knocking out another roll pin [32]. Once removed, the apron is easier to handle on the table-top.

G4000 Manual pg. 42, At least 2 of the gears on the back (worm and either 41T or 43T) are secured with phillips screws [14] on special countersunk washers [13].

At least 2 shafts are secured with external snap rings [28, 40]. Although to the eye, the rings may look the same, they are not. One is 12mm and the other.

Basically, once you remove the Apron from the lathe and open the back, it's

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The detent screws on the feed and half-nut handles use springs and balls which can drop out and be easy to lose.

Otherwise, just keep the apron drawings from the manual with you to see what goes where. Although a couple items are drawn incorrectly or mislabeled, the parts drawings are generally accurate.

18. Threading Dial

There's not very much to the threading dial. Referring to Pages 43, 44, 45 of the G4000 Manual one can see it's basically a Dial [59] bolted to a Shaft [55], that's Keyed [56] to a 64-tooth Worm Gear [54] and the whole assembly is supported by the Thread Dial Body [53] that affixes to the right side of the Apron. The whole assembly may be pivoted to on or off contact with the leadscrew as the operator desires by the Cap Screw [63].

The recommended lubrication on the shaft is a dab of SAE140 gear oil.

19. 4-Way Toolpost

The 4-Way Toolpost is made to handle up to 1/2 inch tooling. Many will find that they get much better results with smaller tooling on a 9x20.

3/8 shank bits are the biggest many would ever consider putting in such a small lathe. In fact, 5/16 has plenty of rigidity reserves for the deepest cuts you can take.

The tool post may take up to 1/2" shanks. But it's not intended for 1/2" tools: rather it allows you to clamp say a sleeve holder for round boring tools, or a clamping holder for a parting blade. Both holders may well require up to a 1/2" tool post slot, but the tools they clamp are much smaller.

With a smaller tool you can reach far better into confined spaces. Not all jobs are just plain facing or turning, there are many more complex work piece shapes. And even if only plain turning/facing, imagine a rod of say 1/2" dia between centers, how do you avoid hitting the center turning it with a 1/2" tool?

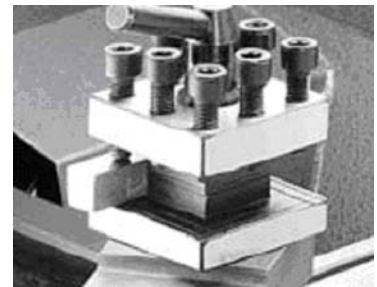
On this lathe, there is nothing to be gained by a tool larger than 5/16. The deepest cuts you will ever take, in soft material, is 1/8" (or 3mm). Now look at the insert of a 5/16" tool: you are going to utilize only a fraction of the cutting edge. The remainder will just be in your way when doing more complex jobs.

If using HSS blanks, you will find that grinding a 5/16 tool is 3x faster and easier than a 1/2" tool. and a 1/4" tool is 2-3x faster and easier than a 5/16 tool to grind. Why grind a cutting edge 12x longer than you will ever need, just because a set of 1/2" tools was on special? You would regret it many times over.

Rigidity - 5/16" tools are used in high speed production CNC lathes, if you ever seen at what speeds and depths of cut, you will never again blame tool rigidity on your 9" lathe.

Tool shimming - In a 4-way tool post you need to shim every tool, regardless of size, to correct center height. If you use indexable carbide insert tools, one shim will do for all, their center height is very accurate and does not change in use, cause you do not re-sharpen inserts (they are one way, wear and toss).

If you are out shopping for a first tool set, 5/16" is recommended as the ideal standard to start with. As you gain experience and tackle smaller jobs you may get some 1/4 or smaller tools later. But I guarantee you will never need any bigger unless you get a bigger lathe first. If you get carbide insert tools, you can



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choose between CCMT and TCMT style inserts (diamond shaped or triangular). Its personal preference, both are good. Settle for one style for all tools, as spares come in boxes of 10 and you do not want to stock too many shapes. Choose uncoated inserts, they are sharper and can take finer cuts, and this is very important until you learn to take deep cuts to a precise dimension. Choose an intermediate tip radius (.4mm is a good compromise). Only go for tools with POSITIVE rake, your lathe has NOT the rigidity to handle negative rake. Avoid the old style reversible inserts with rectangular cross section, however cheap they are no good on a hobby lathe. 5/16 tools may cost a little more than 1/2", because they are not sold by low cost tool discounters. Dealers specialized for us hobby users have them, the India made Glanze sets are excellent at 1/3 the price of brand name holders sold by the big expensive industrial tool shops.

If you decide to start with HSS blanks, go for some 1/4 and 5/16, and you need a grinder too, and you need to practice some grinding.

The contact surfaces between the tool post and the top of the compound needs as much contact area as possible to keep it from rotating under pressure. These surfaces should be absolutely flat and must mate with each other perfectly.

20. Tailstock, Steady Rest and Follow Rest

These devices are fairly straight forward and the exploded views (G4000 Manual pages 50, 51 & 52 respectively) make their operations quite clear.

Tailstock:

Referring to the G4000 Manual pg. 50 the Tailstock Ram [1] is essentially a cylinder with one end bored and left-hand threaded to accept a leadscrew [2]. The other end is taper bored to a #2 Morse taper specification so as to accept various accessories e.g. Live Centers and Drill Chucks. The outer surface of the Ram is graduated on one end (Morse Taper end) and an external keyway cut on the other. The external keyway together with the setscrew [8] keep the Ram from rotating in the tailstock body [12] when the leadscrew is turned to advance and retract the Ram. The Lever and Clamp [6 & 7] form a locking/drag adjusting mechanism for the Ram. The Morse Taper should be kept immaculately clean and free of debris. Debris may cause scouring of the taper and lead to improper fit, seizing and inaccuracy.

The sliding fit between the Tailstock base [13] and Tailstock Body [12] is supposed to be quite tight, eg it should take some torque with the adjusting screws [14] to slide it. With the setscrews removed, it should not be possible to slide it with hands alone. Of course, no paint is supposed to be on the bottom casting or in between. After reassembly, it's advisable to at least verify that tailstock height is still ok. You do this by chucking a DTI (by its shaft) into the main spindle, and have the DTI feeler finger touching the inside of the tailstock MT2 taper. Tailstock has to be firmly clamped, and its barrel locked. Now rotate the main spindle and observe the DTI reading. Allowed tolerance is +0.05mm and -0.00mm (+0.002" and -0"), eg the TS may be a little high but not low. At this stage you could also verify the TS barrel and its bore are still parallel to the bed ways, consult the inspection certificate for how to measure and tolerances. You should do this if you removed metal from the TS sliding surfaces

Tailstocks are usually left a tad high, one to allow for wear, secondly it is easier to correct. If you look up the inspection protocol, step G9, you will see that tailstock height is an OFFSET TOLERANCE: +0.06 and -0 mm. +0.06mm is 0.0023".

If you want to correct:1) I recommend not to fix anything before you check the headstock alignment. Cause if you only later find out the headstock axis was not parallel to the bed, you may soon wonder how to rise the tailstock again. Also check if the bed is straight. Best is to verify all alignments with the help of the inspection protocol in the file section, so you know exactly where you are and what to start with.

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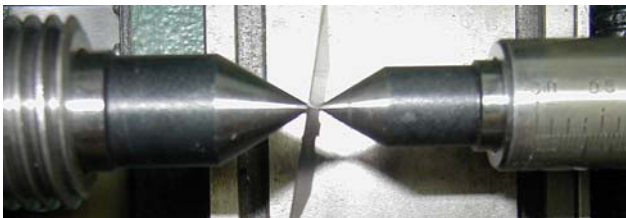
- 2) Separate the top and bottom TS castings, make sure the mating surfaces are clean and free of dents/scratches/paint leftovers etc.
- 3) You want the TS centerline to be at same height AND parallel to the HS centerline. The TS centerline you have to measure at the inside surfaces of the MT2, cause that is what counts to center a chuck or anything else you stick into the TS (some low cost dead centers are not ground very accurately). Put a DTI in the HS chuck (how well centered does not matter) and have its finger slide on the TS MT2 inside whilst manually turning the chuck. This tells you if & how much the TS needs to translate downwards. Repeat this with the TS barrel fully retracted and extended, this tells you if & how much the TS needs to be tilted.
- 4) Now you can scrape the top surface of the lower TS casting. If it is only a small error, you can also carefully lap it using wet&dry emery on a flat surface, just make sure it remains a FLAT surface. Frequently reassemble and check, cause material removal is a one way street.

Before correcting the tailstock height, I strongly advise you first work through the inspection protocol procedures (a copy is in the files section root directory). Chances are that you may need to tweak the headstock alignments. And better happens before doing any hard to undo "corrections" to the tailstock, cause it directly influences tailstock height.

That said, the permissible tailstock height tolerance is offset, meaning the tailstock is only allowed to be too high, but never too low. See step G9 in the inspection protocol, the tolerance is $+0.06\text{mm} -0.00\text{mm}$ ($= +0.002" -0.000"$). All lathes are made like this, high precision lathes have just a smaller tolerance, but the rule remains the same.

Now, provided you are happy with the headstock alignment, it is easy to correct a too high tailstock. Separate upper and lower casting, then lap the mating surface of the upper casting on surface plate using good quality fine grit wet & dry paper. It needs only a few strokes, as the TS is seldom more than a few /100mm or /1000" off. Leave it a tad high to allow for some wear in the coming years. Before starting, make sure both mating surfaces are clean and free from paint or dents. Whilst at it, you may consider to correct for little errors in the parallelity of the tailstock ram to the center line, by lapping a tad more at the front or at the back. And remember, taking metal off is easy - but if you overdo it you may have to live forever with fiddly shims to correct your mistake.

Simple Lateral Adjustment



Put a dead center in the spindle and put a dead center in tailstock barrel quill. Bring both together carefully with a razor blade held between both and from above, watch what the razor blade does. This will indicate if the tailstock is centered laterally or not.

Steady Rest & Follow Rest:

The Steady and Follow rests are simple fixtures and are adequately explained by the exploded views on pages 51 and 52 of the G4000 Manual.

21. Setup & Alignment (General)

Rollie's Dad's Method of Lathe Alignment:

<http://www.John-Wasser.com/NEMES/RDMLatheAlignment.html>

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What you need

- A round bar
 - The bar length should be about 1/3 to 2/3 the bed length.
 - The bar should be of one diameter along most or all of its length. If it is not you will need a micrometer to accurately measure its diameters.
 - The bar does **not** have to be completely straight.

Since Rollie has a car repair shop, he uses the shafts from junked shocks and struts.

- A dial indicator
 - The end of the measuring rod should be flat.
- A means of mounting the indicator on the cross-slide at lathe center height.
 - To do a vertical alignment: A means to mount the indicator on the cross slide so it is directly above (or below) the lathe axis.
- A chuck of any type to hold the bar.
 - Runout in the chuck is not a problem (for the same reason that a slight bend in the bar is not a problem).

What you DON'T need

A tailstock, perfectly straight bar, a collet or precision chuck or any tool bits.

Applying the method (Horizontal Alignment)

1. Put the bar in the chuck.
2. Mount the dial indicator on the cross-slide at the center height of the lathe.
3. Pull the indicator's measuring rod back by hand (to avoid damage to the indicator) and move the carriage so the indicator is near the chuck end.
4. Release the indicator rod and, turning the lathe by hand, note the highest and lowest measurements on the indicator.
5. Average the high and low readings (add together and divide by two) to get the "near end average distance". If you suspect the bar of not being a single diameter along its length, measure the diameter and subtract half the diameter from the average to get a corrected "near end average distance".
6. Pull the indicator's measuring rod back by hand to clear any irregularities and move the carriage to the end of the bar away from the chuck.
7. Release the indicator rod and again, turning the lathe by hand, note the highest and lowest measurements on the indicator.
8. Average the new high and low readings (add together and divide by two) to get the "far end average distance". If you suspect the bar of not being a single diameter along its length, measure the diameter and subtract half the diameter from the average to get a corrected "far end average distance".
9. **The difference between the "near end average distance" and "far end average distance" is a measure of the misalignment of the spindle axis with the ways.**
10. To correct the problem, put a piece of paper under the near-side foot at the headstock end of the lathe (the feet at the tailstock end are sometimes pivoted to act as a single foot). Re-do the

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measurements starting at step 3. If the alignment gets better, add more sheets of paper until the alignment is perfect. If the alignment gets worse, put the paper under the far-side foot at the head end until alignment is achieved.

Applying the method (Vertical Alignment)

1. Put the bar in the chuck.
2. Mount the dial indicator on the carriage so that it is directly above the center line of the spindle.
3. Pull the indicator's measuring rod back by hand (to avoid damage to the indicator) and move the carriage so the indicator is near the chuck end.
4. Release the indicator rod and, turning the lathe by hand, note the highest and lowest measurements on the indicator.
5. Average the high and low readings (add together and divide by two) to get the "near end average distance". If you suspect the bar of not being a single diameter along its length, measure the diameter and subtract half the diameter from the average to get a corrected "near end average distance".
6. Pull the indicator's measuring rod back by hand to clear any irregularities and move the carriage to the end of the bar away from the chuck.
7. Release the indicator rod and again, turning the lathe by hand, note the highest and lowest measurements on the indicator.
8. Average the new high and low readings (add together and divide by two) to get the "far end average distance". If you suspect the bar of not being a single diameter along its length, measure the diameter and subtract half the diameter from the average to get a corrected "far end average distance".
9. **The difference between the "near end average distance" and "far end average distance" is a measure of the misalignment of the spindle axis with the ways.**
10. To correct the problem, put a piece of paper under both feet at the tailstock end of the lathe. Re-do the measurements starting at step 3. If the alignment gets better, add more sheets of paper until the alignment is perfect. If the alignment gets worse, put the paper under both feet at the headstock end until alignment is achieved.

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Why This Method Works

The bar acts as a circular cam. With a perfectly straight bar in a perfect chuck the bar is concentric with the spindle axis. Since we don't live in a perfect world there is almost always a slight offset between the center of the bar and the spindle axis. This offset varies from place to place along the bar due to slight bends and/or imperfect mounting.

At any place you pick along the bar the center of the "cam" is some unknown distance from the spindle axis. We'll call this unknown distance 'X'. As you turn the spindle axis the high measurement will be "Bar_radius + X" and the low measurement will be "Bar_radius - X". Their average will be:

- $((\text{Bar_radius} + X) + (\text{Bar_radius} - X)) / 2 =$
- $((\text{Bar_radius} + \text{Bar_radius}) + (X - X)) / 2 =$
- $(2 * \text{Bar_radius}) / 2 =$
- **Bar_radius**

As you can see, the value and direction of the deviation have no influence on the final result. That is why it doesn't matter if the chuck is accurate or the bar has one or more slight bends.

If the bar is not the same diameter at both places we need to measure the diameters and adjust the readings. Averaging the high and low readings gives us a reading for the local bar radius. We convert that to a reading for the bar center by measuring the bar diameter and subtracting half the diameter (a.k.a. The Radius).

Common Error

Some people will find the near-end average distance, turn the lathe till it reads that distance and then move the carriage down the ways with that mistaken assumption that the reading shouldn't change. **That method will only work if your bar is known to be perfectly straight and the chuck is known to hold the bar in perfect alignment with the spindle axis.** Do not confuse that method with this one.

I learned all this from a fellow member of the New England Model Engineering Society. Join us the first Thursday of every month at the Charles River Museum of Industry in Waltham, Mass.

22. Chucks

Chucks do need to be cleaned periodically. Make it a habit to shake out swarfs after each use, and dismantle/clean it as soon as you can feel the dirt when rotating the key. Never use compressed air for cleaning a chuck, or for that matter any machine tool (one of the first things a machinist apprentice learns). You just blow swarf and dust further in, and risk losing an eye. Dismantle the chuck and clean manually. Use graphite powder to lubricate - no oil or grease please, as this will either fly off when rotating, or make swarf stick very well.

NEVER LEAVE A KEY OR TOMMY BAR IN A CHUCK. Develop and maintain a habit of returning keys and Tommy bars to their cribs when not in use.

Lock-up to spindle (common Causes):

- 1- Chuck is threaded on by forward power on - bad practice.
- 2- 2 - Chuck comes loose whilst working in reverse, operator quickly switches power to forward to prevent chuck falling off, chuck slams tight.
- 3- 3 - Dirt in male or female thread. Thoroughly clean at every chuck change, keep lightly oiled.
- 4 - Ratchet effect of heavy interrupted cuts can tighten chuck onto spindle.

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5 - Homemade backplate not fitting precisely: too tight, rough thread surface, thread ridges not radiussed and touch spindle thread valleys, thread valleys not radiussed and collect dirt, Thread angles asymmetric, flange not exactly at right angle. (Commercial backplates are made to fit the largest tolerance spindle nose, they are often too loose and cause for excessive runout, but do seldom get stuck).

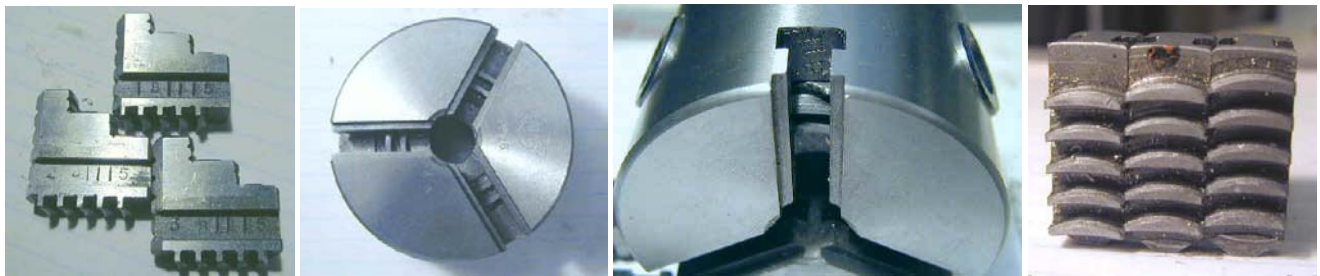
6- Damaged spindle nose thread - put on a protective nut when working without chuck.

7 - Rust - remove chuck and grease spindle nose for storage.

Some people put an o-ring onto the spindle nose. This effectively prevents a chuck from getting stuck, but is bad practice as it causes misalignment (the metal to metal contact of the flanges is required for correct registering).

3-Jaw Self-Centering Chuck

Most 3-jaw chucks, come with both inside and outside jaws. The jaws are numbered and must be reinstalled in the correct sequence to align properly. When you remove the jaws for the first time it's a good idea to mark the position on the chuck from which each jaw 1, 2 and 3 is removed so that they can be reinstalled in the same slot as they came from.



If you look at the channel on the side of each jaw you will see that the jaws are numbered 1, 2 and 3. If you stand the jaws up on end next to each other you can see that the teeth are staggered.

Looking at the front of the chuck with the jaws removed, you can see the scroll thread that engages the jaw teeth. If you slowly turn the chuck key in one of the key holes, you can see the leading edge of the chuck scroll pass by the slot for the jaw.

This leading edge of the scroll must engage with the first tooth of each jaw in turn, in the correct sequence, to properly reseal the jaws. Back off the scroll thread in a clockwise direction until it is just to the right of the jaw slot. Press jaw #1 into the slot until it stops against the scroll. Now, while pressing down on the jaw with your thumb, turn the chuck key clockwise to advance the scroll counterclockwise to engage the scroll with the first tooth of the jaw. Continue until the leading edge of the scroll is just to the right of the second slot. Insert jaw #2 and repeat for jaw #3. If you got it right, all 3 jaws should meet evenly in the middle of the chuck if you crank them all the way in.

Never use compressed air for cleaning a chuck, or for that matter any machine tool (one of the first things a machinist apprentice learns). You just blow swarf and dust further in, and risk losing an eye. Dismantle the chuck and clean manually. Use graphite powder to lubricate - no oil or grease please, as this will either fly off when rotating, or make swarf stick very well. Chucks do need to be cleaned periodically.

Make it a habit to shake out swarf after each use, and dismantle/clean it as soon as you can feel the dirt when rotating the key.

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NEVER LEAVE A CHUCK-KEY OR TOMMY-BAR IN THE CHUCK



A 3-Jaw Chuck does not have many pieces in it. Always match mark each piece that you take off (felt pens are great for this) and write down a few short notes so you can refer back to them. Cleanliness and no burrs are the main things to look for. Of course broken parts need to be replaced) Cheap chucks are not made to the high accuracy of industrial quality chucks, (you only get what you pay for) If your chuck repeatedly holds work true within .002" I would say that is acceptable. you can grind the jaws with a grinder in the tool post but you need to make a spider to clamp in the chuck (you have to have the jaws clamping or else when you grind them the jaws push away and are on the wrong side of the scroll) you only need to take a lick across the jaws and keep the same radius as the factory did when the jaws were made. you are only looking for one to two thou. For repeatability always use the same hole when tightening the chuck. Check which wrench hole gives the best results. this is known as the Master and as you get to "know" your machine life becomes easier and accuracy is easier to hold. The chuck should be lubricated with a dry lubricant such as Graphite, as oils and greases trap cuttings and debris within the device which may lead to increased wear, inaccuracy and/or malfunction.

A scroll chuck has a flat plate disk with a spiral cut groove in its face. "teeth" on the bottom of each chuck jaw fit into this spiral groove. When you turn the chuck key, the spiral (scroll) turns, and all the chuck jaws move together, ideally the same amount, since the scroll spiral is a constant distance per revolution.

There is a big difference in chucks whose scroll, and the teeth behind the jaw, are machined. I have seen very simple chucks where these parts are only cast, and not fully machined (these chucks usually have reversible jaws, instead of two different jaw sets for inside/outside holding). I have found that on these, runout can be improved by carefully filing the teeth at the rear of the jaws. It is often just one or two rough spots on one tooth that cause the big runout. I would certainly dismantle any chuck found wanting of concentricity; and look for burs and / or assembly dings and bumps before even considering re-grinding the jaws. A bit of time with some emery, a file, etc. might be all the "grinding" needed

A little study of how the scroll works will benefit anyone and dispel any mystery. Once the mechanics is understood, it will be easy to determine at a glance the order in which they should be installed. All the slots should be identical, but if the indexing is not perfect, (what is?) the variation in the jaws might be used to advantage by trying different start slots. Once that is determined, punch your own marks. It is a lengthy and tiresome process to do this, and the only shortcut is to use as near a perfect cylinder of the size where you want the best accuracy. Cheaper chucks can always be improved by internal deburring and buffing. Often that's really most of what you are paying for in a better name.

The punched numbers reference the jaws such that they are all at the same distance from center in a single lead scroll. each jaws teeth are in different places.

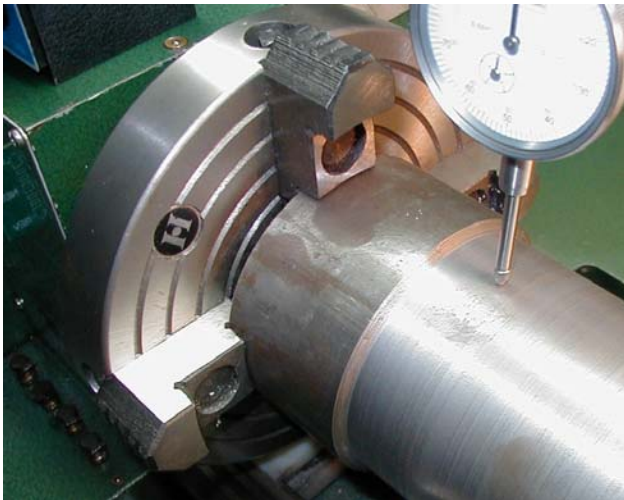
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All 3-jaw scroll chucks I have seen so far had numbered jaws and numbered slots. The numbers in the chuck body are punched in manually. This would indicate that the jaws have been selected at the factory for a perfect, stiff fit to the slots in the body. A sloppy fit would cause the jaws to taper when tightened, which in practice is a much worse defect than just plain runout. However, in real world production, I doubt whether most manufactures pay attention to which ones goes where, they just want you to get the order right, and so they stamp the correct order starting from whatever location and hopefully they should have been finish ground in that chuck in that location.

Most or all chucks display different runout, depending on which of the three key holes is used to tighten it up. It is customary to mark the key hole with the lowest runout with a punch, and always use this one for tightening.

4-Jaw Independent Chuck

The 4-Jaw chuck supplied with the stock 920 lathe is a basic Independently Adjusted Jaw chuck. The chuck is the essence of simplicity in design and therefore little service recommendations are necessary save for cleanliness, burr-free and worn or broken parts should be replaced. The main issue with these chucks is application and setup thereof.



The bolts which hold the 4 jaws to the face of the chuck should be snug. With the "stock" 4jaw, those holding bolt threads must pull out, or the bolt elongate, or the washer compress. Against this, there is a "built-in" clearance necessary for the sliding action of the new style 4 jaw. Which means that the jaws WILL "rotate" when they contact the work. In fact, they are often ground using special setups to accommodate this truth!

Now the machined slot in the chuck body will provide the resistance to further movement, much the same as the bolt and washer of the "old" style. So one type uses a thread and large flat surface to hold the jaw; the other uses shoulder of metal on either the jaws, or the chuck body, or both.

So we now get to the ONLY real advantage of the new style: Since the clearance is built-in, AND compensated for by grinding the jaws non-square: and since the multi-surface interface of the chuck body to the chuck jaw is tightly controlled... we DON't have to include a tightening of the jaws to the face as part of our setup! (Which we DO have to include when we use the older style "stock" 4-jaw.) That's it. THAT is the difference.

So the stock 4-jaw takes a BIT more "finesse" to arrive at the correct position AFTER everything is fully tightened... (But I gotta tell you, those "rotating" jaws in all but the very best new-style 4jaws can be just as tricky.)



REBUILDING THE ASIAN 9X20 LATHE

Anyway, they BOTH WORK. And they BOTH work WELL. There are simply two different procedures, which are NOT the same! (I personally feel that many who think the old style chuck is a "boat anchor" are simply not using the correct procedure with it. It is not hard to imagine that a person who has been schooled with the new-style 4jaw would have poor results with the one supplied with the 9x20, UNLESS he or she CHANGED their method of USING each DIFFERENT chuck. (For there IS an extra step in using the "old" style; which is to tighten the jaw holding bolts fully. This step is not necessary with the newer type. Going a bit further with this, there IS some skill involved in having everything "end-up" in the correct place AFTER this final tightening. Now we just need to notice that this is the same skill as what is needed/experienced with EITHER style with respect to basic centering.)

The newer style does not require the same care or skill as the older style. But generations of machined parts attest to the FACT that accurate work of ALL sizes is possible with the old style, as supplied stock with the 9x20Lathe. In exchange for this extra care, you don't need to rent a gorilla to lift it onto the spindle.

Drill Chuck



Drill chucks are not very suitable as Headstock chucks, since they were not designed to handle lateral loads. They however are indispensable for use in boring and in such cases they are tailstock mounted.

Drill chucks require the same care and feeding as outlined above for the other chucks except they cannot be easily taken apart by the average owner.

NEVER LEAVE A CHUCK-KEY OR TOMMY-BAR IN THE CHUCK

23. Electrical System

WARNING YOU CAN BE KILLED

These instructions encompass working with LINE VOLTAGE. If you are unqualified or uncomfortable working with electricity: SEEK PROFESSIONAL ASSISTANCE

Power Requirements: Generally the 920 lathes are shipped wired for 110 volt 60Hz, single phase operation (230V single phase 50Hz for European markets). The $\frac{3}{4}$ HP motor will typically draw 12 amps at 110VAC. A 15-amp fuse or circuit breaker should be used when connecting this equipment. Circuits rated higher are not adequate to protect this motor. It should be noted that European countries use 50 Hz power supplies while in the US, for instance, the standard frequency is 60 Hz. As a result, a motor designed to run on 60Hz current and operating on a 50 Hz supply, would be slower and power consumed would increase.

If you operate this lathe on a circuit that is already close to its maximum operating capacity, it may blow a fuse or trip a circuit breaker.

Motor:

The standard motor supplied with the 920lathe is a $\frac{3}{4}$ HP TEFC (Totally Enclosed Fan Cooled) Capacitor-start Motor, NEMA 56 Frame, 1725-RPM. The characteristic hump on the motor frame houses the capacitor (Figure 23-1).

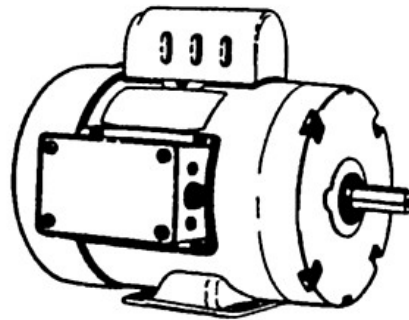
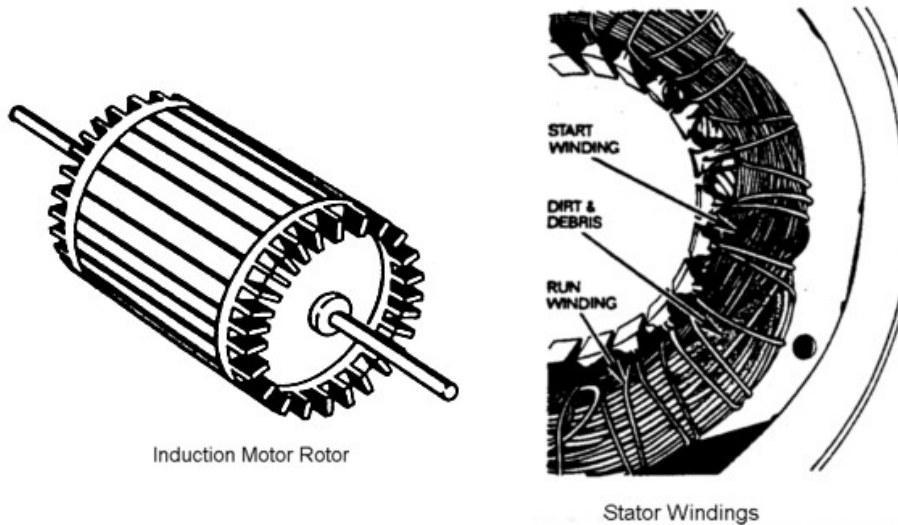


Fig. 23-1 Motor with Capacitor Housing (NEMA 56, TEFC)



REBUILDING THE ASIAN 9X20 LATHE

This equipment must be grounded

In the event of an electrical short, grounding reduces the risk of electric shock by providing a low resistance path to safely conduct the current to ground. These lathes are equipped with a power cord having an equipment-grounding plug. Under no circumstances may the grounding pin be defeated.

Capacitor Application

The capacitor is placed in series with the start winding. Figure 23-2 shows a line diagram.

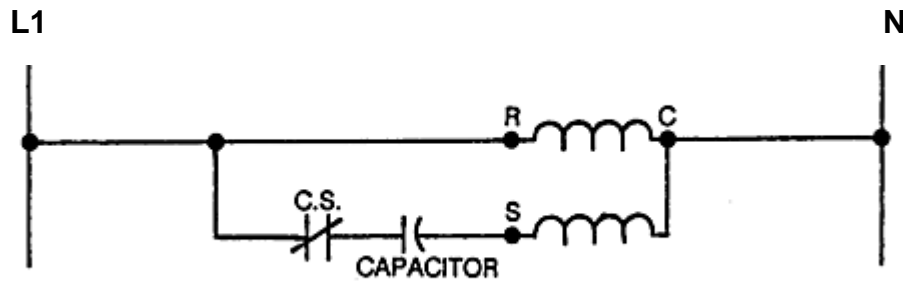


Fig. 23-2 Typical Capacitor Start Motor

Once the motor has attained approximately seventy-five percent of its rated speed, the start capacitor and start winding can be eliminated by the centrifugal switch. It is not necessary for this motor to operate on both windings continuously. Figure 23-3 and 23-4 illustrate how the centrifugal switch operates.

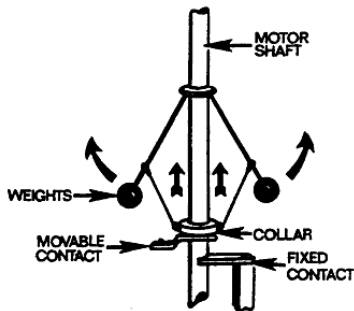


Fig. 23-3 Centrifugal Switch Operation

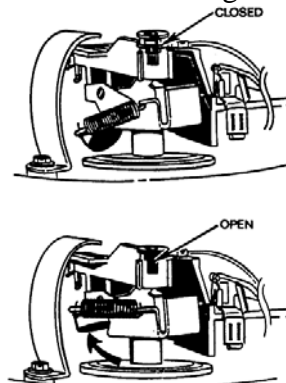


Fig. 23-4 Centrifugal Switch

Capacitor Testing

The internal condition of a capacitor may be checked with an ohmmeter (Figure 23-5). Remove the capacitor from the motor and disconnect it. Always short the capacitor terminals before making a test. If a spark occurs when you short the capacitor terminals, this is a good indication that the capacitor is serviceable and maintaining its charge. Figure 23-6 Shows the internal construction of a capacitor.

The correct range for testing capacitors with the ohmmeter is usually the range that provides the highest internal battery voltage from the ohmmeter.

Connect the meter leads to the terminals. Notice the meter display. A good capacitor will indicate charging by an increase in the display's numerical value. This indicates that the capacitor is accepting the difference in potential from the ohmmeter's battery. Once the display stops charging, remove the meter leads and discharge the capacitor (short the terminals).

REBUILDING THE ASIAN 9X20 LATHE

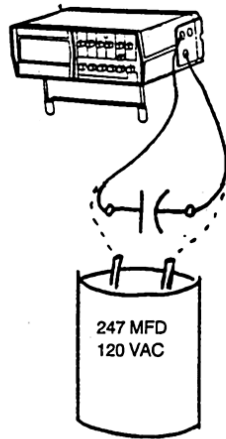
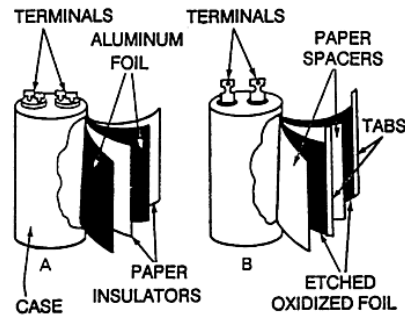


Fig. 23-5 Testing The Capacitor



Construction of capacitors varies according to their use.
A - Paper capacitor used with running motors.
B - Electrolytic capacitor used for starting ac motors
(Sprague Electric Co.)

Fig. 23-6 Capacitor Construction

Reconnect the ohmmeter again, but this time remove one of the meter leads just before the meter display would have indicated the capacitor has stopped charging. Remember the display reading. Wait 30 seconds and reconnect the ohmmeter leads to the same capacitor terminals. The meter's display should start off with the value displayed before removing one ohmmeter lead. If the meter returns to zero, this indicates that the capacitor is unable to hold its charge and must be replaced.

NOTE: Digital meters require some familiarity before this test can be done with a degree of confidence. It may take a moment for the digital meter to display the correct reading upon reconnection. Practice with known good capacitors.

Shorted and Open Capacitors

Capacitors that are shorted or open will not display a charge on the ohmmeter. These meters will show either continuity or infinity.

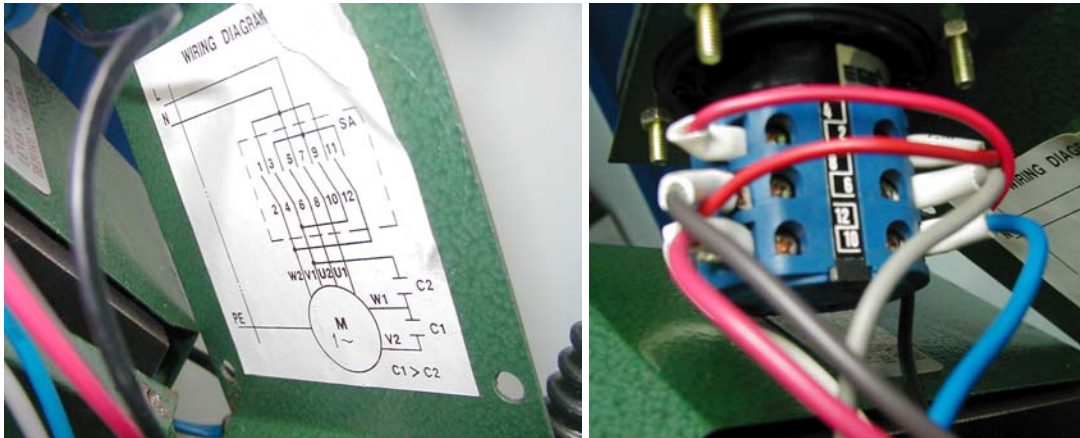
A shorted capacitor means that the plates of the capacitor have made contact with each other and pass current readily. This will be indicated by a very low and steady resistance reading on the ohmmeter. A shorted capacitor must be replaced.

An open capacitor means that the distance between the plates of the capacitor is too far apart. The ohmmeter will not show a charging condition. For example, when the terminals of the capacitor have become disconnected from the capacitor plates, there will be an indication of infinite or maximum meter resistance. The capacitor must be replaced.

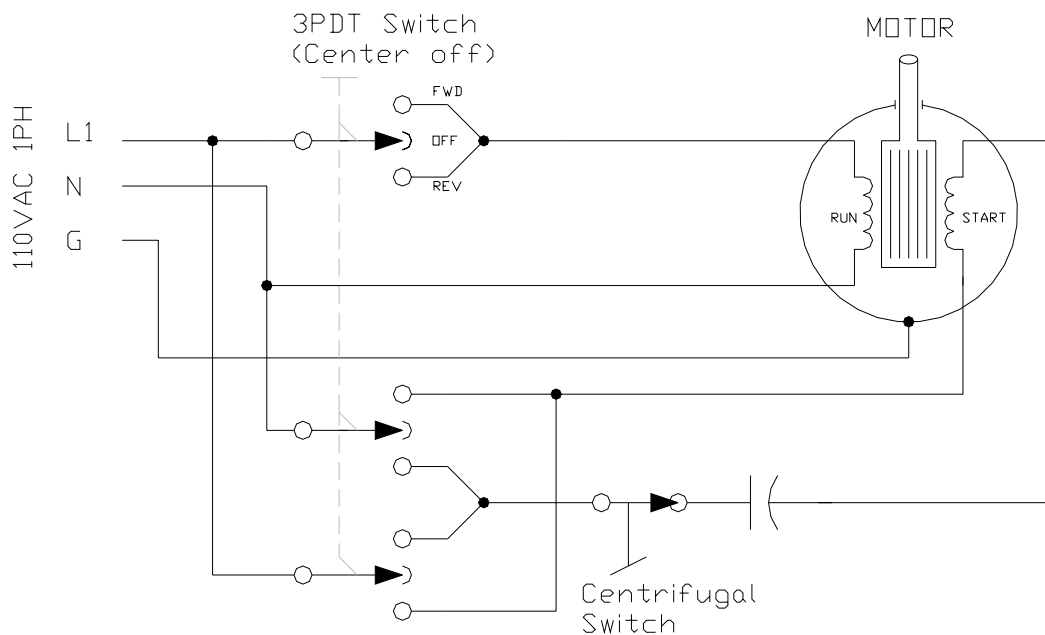
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Power/Reversing Switch:

The Power/Reversing Switch wiring color code may vary from manufacturer to manufacturer, There is usually a Wiring Diagram pasted inside the Switch Box. The photos below show a G4000 wiring arrangement.



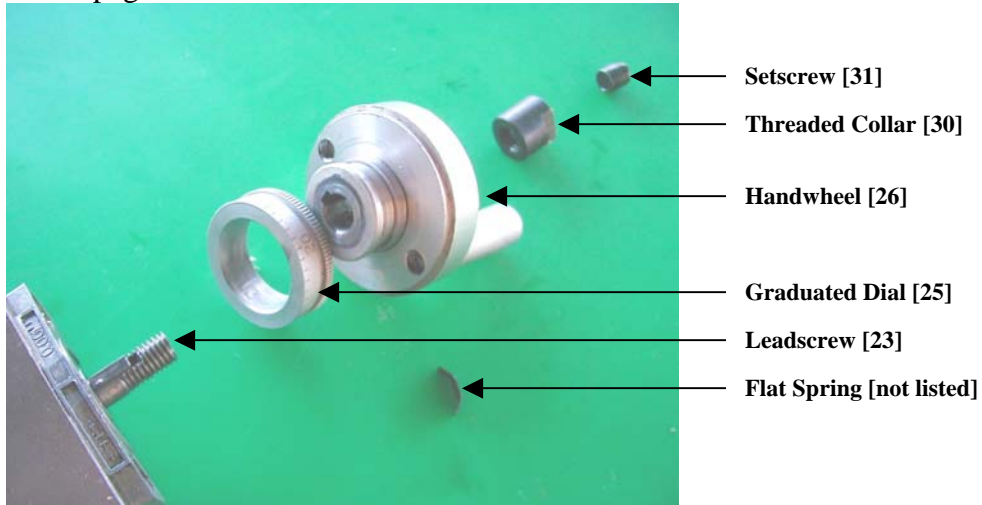
Motor Reversal is accomplished by reversing the phase of the start winding relative to the run winding. The diagram below illustrates a generic motor reversal switching scheme using a 3-Pole Double Throw Switch with a center off detent (*shown in the OFF position*).



REBUILDING THE ASIAN 9X20 LATHE

24. Graduated Dials

There are Three Graduated Dials associated with the Handwheels on the 920 lathe. These are mounted on the Compound, Cross Slide and Tailstock respectively. The operational theory of these Graduated Dials are the same and as such we will refer to the compound dial in this discussion. Refer to the photo below and to page 48 of the G4000 manual.



The Leadscrew is keyed to the Handwheel. The smaller diameter of the Handwheel accepts the Graduated Dial. A groove has been provided on the circumference of smaller diameter of the Handwheel so as to accept the Flat Spring which, rides in this groove and imparts drag to the otherwise free to rotate Graduated Dial. The Threaded Collar is tightened just enough to take-up any slack in the Leadscrew and negate any lateral movement and once set, the Setscrew may be tightened to lock the adjustment. A dab of “Tacky” grease in the assembly of the Handwheel to the Graduated Dial gives a nice “feel” to it’s operation.

25. Inspection Record



INSPECTION RECORD

of

PRECISION BENCH LATHE

MODEL

G 4000

MFG NO.

0468

DATE

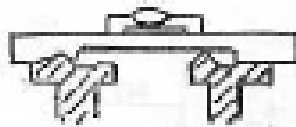
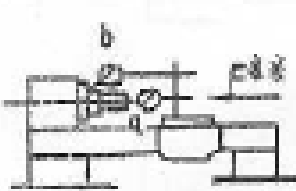
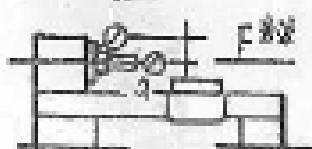
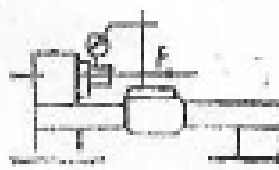
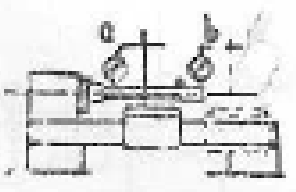
INSPECTOR

F. W

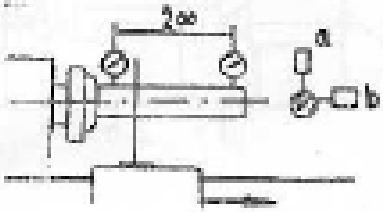
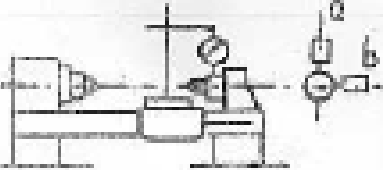
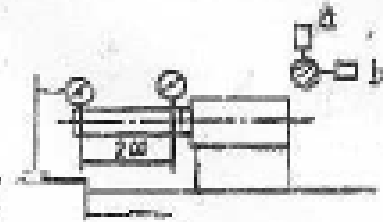
PLANT MANGER

R C C

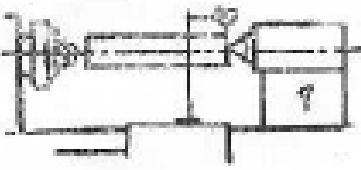
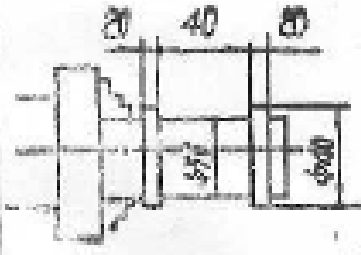
REBUILDING THE ASIAN 9X20 LATHE

NO.	Diagram of measuring method	Inspection item	Tolerance (mm)	Data
G1		Parallelism of transverse direction.	0.05	0.03
G2		Spindle longitudinal runout.	0.02	0.01
G3		Spindle face runout.	0.02	0.01
G4		Spindle nose runout.	0.02	0.012
G5		Spindle taper runout, a. At end of spindle nose. b. At end of spindle 300mm test bar.	a. 0.015 b. 200:0.03	a. 0.012 b. 0.022

REBUILDING THE ASIAN 9X20 LATHE

NO.	Diagram of measuring method	Inspection Item	Tolerance (mm)	Data
G6		Parallelism of spindle centre line to longitudinal motion of carriage; a, in vertical plane, (upward) b, in horizontal plane, (forward)	a. 200 ± 0.018 b. 200 ± 0.015	0012 0011
G7		Parallelism of centre line of tailstock spindle to longitudinal motion of carriage; a, in vertical plane, (upward) b, in horizontal plane, (forward)	a. 40 ± 0.015 b. 40 ± 0.015	0012 0014
G8		Parallelism of centre line of tailstock spindle hole to longitudinal motion of carriage.	a. 125 ± 0.03 b. 125 ± 0.03	0024 0022

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NO.	Diagram of measuring method	Inspection item	Tolerance (mm)	Data
G9		Difference in centre height between head-stock and tailstock, (tailstock upward)	0.06	004
F1		Accuracy of outside round cutting. a. Roundness. b. Cylindricity.	a. 0.015 b. 0.02	0012 0015

Inspector

T- W

Date

07 96

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The Inspection Record is issued by the factory. It is certainly NOT a worthless piece of paper. Even if somebody would not 100% trust it, it still shows how this particular machine was aligned during assembly at the factory. This is very helpful information as:

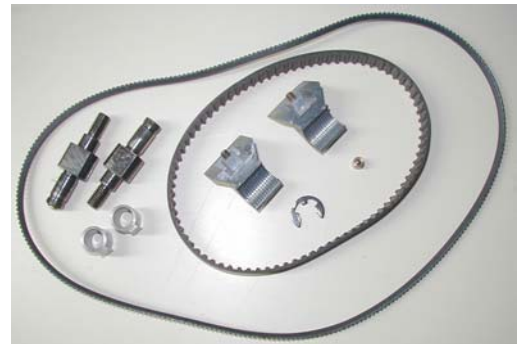
- a) One can double check it and see if his lathe is still a machine tool or a toy needing realignment.
- b) If it once was aligned the way the cert shows, it should be easy to realign it to the same specs, eg unless someone opened the crate and swapped the tailstock, it should be one of correct height not needing shimming or grinding.
- c) It is an invaluable short-form step by step instruction on how to align your lathe.
- d) It is likely to belong to a "1st choice" lathe made by this factory.

Given the wide spread of manufacturing tolerances for the components, there are bound to be some lathes that do not pass this inspection record in some points. It can be assumed those parts would not be discarded, but the whole lathe be sold at a lower price to dealers not requiring a cert. Maybe that could explain over-painting in a different color?

26. Recommended Spares

Here are some spares you may consider keeping on-hand (*at the time of writing, the author's experience over a two and a half year period of ownership and using the lathe daily and commercially, is not having to use any of these*).

PART #	DESCRIPTION
P4000115	Shaft
P4000405	Bushing
P4000121	Oil Port
P4000237A	V Belt 5M730 (or 5M720)
P4000238A	Tooth Belt 160XL050 (or 170XL050)
P4000741	Half Nut
P4000408	Special Washer
P4000120	Special Washer



Here's a compendium of numerous 9x20 replacement parts from Grizzly.

These are not shown in their printed catalog nor are they online. To order, one needs to call or send an e-mail to csr@grizzly.com

(Prices Shown are at time of writing)

General drive-side components:

P4000405	Bushing (keyed)	\$1.50
P4000636	Bushing (keyed)	\$2.00
P4000407	Gear 120T 1	\$7.50
P4000119A	Gear 80T (metal)	\$10.00
P4000422	Gear 60T 1	\$9.00

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P4000122	Gear 40T	\$3.50
P4000421	Gear 45T	\$4.50
P4000739	Gear 42T (NOT Worm!)	\$4.50 (part manual shows this to be WORM GEAR, but Grizzly shipped 42T change gear)
P4000412	Gear 30T	\$2.00
P4000727	Gear 41T (apron gear)	\$3.50
P4000121	Oil Port	\$0.75
P4000404	Shaft (Sm. on Quadrant)	\$2.00
P4000115	Shaft (Upper chg. Gear)	\$2.00
P4000116	Spacing Ring	\$0.50
P4000120	Special Washer (Lg shaft clip)	\$1.00
P4000408	Special Washer (Sm shaft clip)	\$1.00
P4000703	Worm (they shipped the gear)	\$2.25 (part manual shows annular WORM but Grizzly shipped WORM GEAR)
P1550637	Worm Gear Shaft 18T	\$22.50
P4000741	Half-Nut	\$10.00
P4000713	Washer(dished worm gear)	\$0.75
P4000203	Shaft (belt pulley)	\$2.00
P4000209	Washer (clutch spring)	\$0.75
P4000207	Bushing (belt pulley)	\$1.00
P4000901	Compound slide	\$10.00
P4000903	Gib	\$2.50
P4000910	Pin	\$0.75
P4000219B	Motor Pulley	\$15.00
P4000218B	Collar	\$1.00
P4000217B	Spacer	\$1.00

Spindle repair parts:

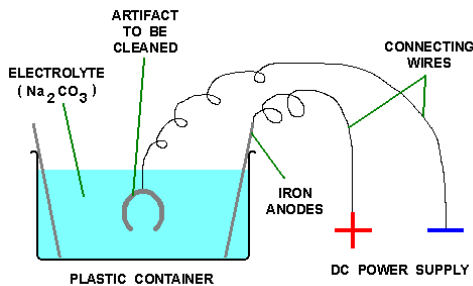
P320007	Ball Bearing 32007	\$15.00
P4000107	Cover (Inside of spindle bearings)	\$1.00
P4000105	Gasket (Outside of spindle bearings)	\$1.00

Other items of interest:

P4000102	4" chuck back plate	\$5.00
P4000706	Lead Screw	\$30.00
P4000103	Spindle 1	\$75.00
P40001102	Steady Rest Brass Jaw	\$3.00

27. Rust Removal by Electrolysis

Electrolysis is a standard technique in the artifact restoration field. The process requires a plastic tub, iron electrode, water, washing soda (NOT baking soda!!) and a battery charger.



Add about a tablespoon of soda (Sodium Carbonate or Sodium Bisulphate) to a gallon of water. Either of these can be purchased at any pool or spa supply for less than \$5. It is used to lower the PH of the pool or spa. If you want, a small amount of TSP (Tri Sodium Phosphate) can be added to enhance the mixture. If you have trouble locating the washing soda, household lye will work just fine. Add about a tablespoon of lye to a gallon of water, this solution will be a tad nastier to use. Always wear eye protection and be sure to add the lye to the water (NOT water to lye!!!). The

solution is weak, and is not generally harmful, though you might want to wear gloves.

The iron electrode works best if it surrounds the object to be cleaned, since the cleaning is "line of sight" to a certain extent. The iron electrode will be eaten away with time. Stainless steel (some alloys, but not all) has the advantage that it is not eaten away. The electrode is connected to the positive (red) terminal and the OBJECT being cleaned, to the negative. You can use any DC voltage (4, 8, 12 or higher) depending on the how quickly you want the cleaning to proceed. The higher the voltage the faster it works and the closer you must watch your brew. Submerge the object, making sure you have good electrical contact, which can be difficult with heavily rusted objects (a large alligator clip will help). Turn on the power. If your charger has a meter, be sure current is flowing. Again, although good electrical contact may be hard to make, it is essential. If necessary, wire brush a small area. Fine bubbles of Hydrogen and Oxygen will rise from the object. These



bubbles are potentially explosive, under the right conditions. So do not do this in a closed room but outside or in a well-ventilated area. Go away and come back in a few hours. Rub the object under running water with a plastic pot scrubber or Scotch Brite. Depending on the amount of original rust, you may have to re-treat as many times as necessary.

The polarity is important!! The surface rust is being converted to metallic iron, so the process is totally self-limiting. I have left things (by mistake) for several days: the water was largely gone, boiled away by the electrolysis, but the object was fine. Reverse the polarity and your object is being eaten away!!! The rust will go along with it, but then what do you have???

Photos on left show an old horseshoe before and after rust removal

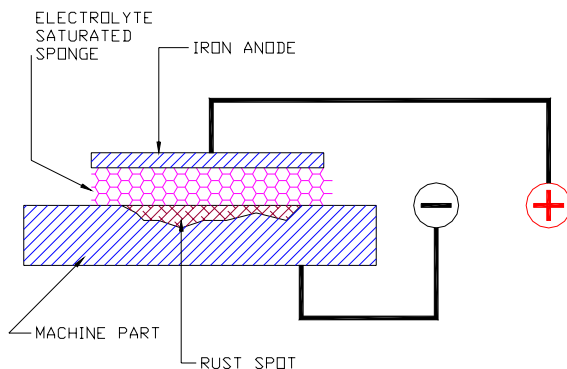
There are many variants: suspending an electrode inside to clean a cavity in an object; using a sponge soaked in the electrolyte with a backing electrode to clean spots on large objects or things that shouldn't be submerged (things with lots of wood). The surface of the metal is left black. Rusty pits are still pits. Shiny un-rusted metal is left untouched. This method will cope with any degree of rust, from surface to heavily scaled.

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You can use junk iron for electrodes. The brew will last until it gets so disgusting that you decide it is time for a fresh one. There is nothing especially nasty about the brew. It's mildly basic-so disposal is not a bio hazard, however you may not want all the crud in your drains. The flowerbed works as one alternative (iron is generally good for plants). One caution: Painted surfaces *may* be damaged when using this method.

The clean object will acquire surface rust very quickly. I worked for a company that sand blasted and coated the inside of line pipe. The studies they conducted showed rust begins to form in less than 12 minutes. So as quickly as possible you should wash with 90% isopropyl alcohol then wipe it dry, then further dry in a warm oven or with a hair dryer. Then oil with a 10w oil or one of the new synthetic oils can be used. I have found the synthetic oils last the longest by far.

On any metal on which I have just used electrolysis, I generally treat immediately with a hard paste wax, applied directly to the part. It should be hot enough to melt the wax (remove any excess wax with a shop towel or some Scotch Brite). The hotter the part the better the wax absorption as hot metal actually allows the wax to permeate the metal. This method will last for years. The oven or a heat gun is handy here. Try it--it beats any other restoration method I have used. This application gives a better end product rather than the pickled look that acid gives which totally destroys the value of the object. There are many variations to the process, the diagram below shows rust-spot removal from a large object, using a sponge saturated by electrolyte.



Electrolysis is a tried and true method of restoration. It does have pros and cons, caution and common sense should always be used. When working on any project, correct and adequate protection should be used when working with hot metal, chemical fumes, electricity or mild acid, which are dangerous when not used properly. Be sure you understand that electricity and some of the chemicals in this application can be hazardous. Use of common sense can prevent a trip to the emergency room.

One last note: The electrode is connected to the positive (red) terminal and the OBJECT being cleaned, to the negative (black). Reverse the polarity and your object is being eaten away!!!

CAUTIONS

Electric de-rusting of iron with sodium carbonate deserves a caution about using it on anything with Nickel parts or Nickel plating. Sodium carbonate can dissolve Nickel in the right circumstances, and the resulting Nickel Carbide is extremely poisonous, almost as bad as arsenic.

Many people using the electrolysis method for rust reduction swear by stainless steel, stating (incorrectly) that it's not consumed, stays clean and seems safe.

Stainless steel is indeed consumed when used in the electrolysis process, although slowly. The main problem with using it is the hazardous waste it produces. Stainless steel contains chromium. The electrodes, and thus the chromium is consumed, and you end up with poisonous chromates in your electrolyte. Dumping these on the ground or down the drain is illegal. The compounds can cause severe skin problems and ultimately, cancer. Hexavalent chromate is poisonous. These compounds are not excused from hazardous waste regulations where household wastes are.

These compounds are bad enough that government regulations mandate "elimination of hexavalent chromate by 2007 for corrosion protection."

28. Links and Recommended Reading

This work represents mere guidelines for the successful rebuild of an Asian 9x20 Lathe. The following sites contain vast amounts of data in its' archives and may be considered a full treatise on the subject :

Lathe Groups:

<http://groups.yahoo.com/group/9x20Lathe/>

<http://groups.yahoo.com/group/9x20Lathe2/>

<http://groups.yahoo.com/group/9x20Lathe/database?method=reportRows&tbl=1>

Belts:

<http://www.ebatmus.com/cart.epl?Buy=1&Quantity=1&ItemID=204857&Query=5m730>

<https://www.motionmro.com/motion3/jsp/mi/motion.jsp>

<http://www.pegasusautoracing.com>

Must Have Literature:

http://images.grizzly.com/grizzlycom/manuals/G4000_m.pdf

<http://www.metalworking.com/tutorials/ARMY-TC-9-524/9-524-index.html>

<http://www.resincasttrucks.com/introduction-to-9x20-lathe-operations.pdf>

<http://www.resincasttrucks.com/tricking-out.pdf>

<http://groups.yahoo.com/group/9x20Lathe2/files/920%20Lathe%20Rebuild%20Manual/>

Useful Products you should know about:

<http://moglice.com/newsite/handbookpages/handframes/contentframe.html>

Interesting Stuff:

<http://www.green-trust.org/junkyardprojects/FreeHomeWorkshopPlans.html>

29. Acknowledgements

Research and Development Team:

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REBUILDING THE ASIAN 9X20 LATHE

Author's Footnote



My first experience with a lathe goes back to around 1977 when I bought my Emco-Unimat SL and every possible attachment I could find for it (I can remember salivating over the thing for months, so much so during one window-shopping episode, the shop-owner came over and gave me a free Vernier-Caliper and said “maybe having this would entice you to take the lathe home”... I bought it the next day). This little machine has served me

well over the years and had in fact paid for itself within the first month of ownership (that’s another interesting story). Getting very acquainted with the Unimat and it’s many accessories, I longed for a machine and tooling that would have the same capability, except larger. I drooled over a popular 3-in-1 for many years. Finally two years ago I decided to take the plunge after building my new shop at the back of my home. Had the cash in hand and just before placing the order did a web search and found the 9x20lathe group. The good folks there showed me that separate machines was the way to go and introduced me to the 9x20 Lathe and Mini-Mill. I sent off the order for the lathe and accessories and while awaiting it’s arrival, I read everything I could find on the subject. Had it not been for this group, I would have made some costly and serious mistakes. The 920 Lathe paid for itself and it’s accessories and tooling within three months of commissioning in my shop (I certainly use it commercially and hobby wise). The production of this document has given me much pleasure and is my way of giving something back, by way of a thank you and at the same time rendering hopefully, some assistance to the newbie. It’s a pleasure being a member of this group and I personally wish to thank all who assisted in making this document possible and look forward to future projects with the group and to assisting others.

Above all, have fun, be safe and let common sense prevail.

Cletus L. Berkeley, MIEEE

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