

## Belt Drive Conversion Kit for the Mini Mill

This kit provides an easy-to-install alternative to the noisy factory-equipped gears that drive the spindle of SIEG model X2 mini-mill machines. Switching to a belt-driven spindle also eliminates down time caused by broken motor or speed change gears. During the design of this retrofit the speeds of the high and low setting were enhanced to allow for a wider range of RPM low range and a higher top speed in the high range. This allows almost all standard milling and drilling to be performed in the low setting with speeds of 0 to 1700 RPM. The high-speed setting of between 0 and 4300 RPM can be used for very small end mills or drill bits, or carbide engraving bits. This provides new and exciting uses for your mini mill.

These ruggedly made kits are CNC machined from the highest quality materials, supplied with all the necessary fasteners and a belt. This kit was designed to be used full time, so it is built to last. Changing speed ranges is accomplished by removing the guard, loosening the motor plate lever lock, and moving the loosened belt from one set of pulleys to the next. No tools are required for changing belt positions.

You will need the following tools:

- Hex wrenches: 3 mm, 4 mm, 5 mm, and 3/32"
- Retaining-ring pliers or needle nose pliers
- Phillips screwdriver
- Blade type screwdriver
- Spanner wrench (furnished with your mini mill)
- Spindle lock pin (furnished with your mini mill)



The kit installation is bolt-on and should take ten to fifteen minutes to complete. *More time will be needed if you elect to remove the high-low shifter lever and gears.*

*Before starting, please read and understand all steps of the installation instructions before beginning. Also, keep any removed parts until you are certain they are no longer needed.*

*One more thing to consider before you begin. Although it's not necessary, you can remove the original high-low shifter lever and gears before you install the belt drive kit. For details, see Appendix 1 on page 7.*

## Part 1: Disassemble the Original Gear Drive

Machine parts referenced in this guide will use drawing numbers of the Harbor Freight Central Machinery 44991 Mini Mill. If you have another model of a SIEG X2 or X2D, consult your manual for correct numbers or download a drawing from [LittleMachineShop.com](http://LittleMachineShop.com). Drawing numbers will be referenced: (#123).

1. Unplug the power cord and clean the milling machine, in particular the area around the mill head.
2. Remove the drawbar cover (#126), drawbar (#210), and all tooling.
3. Lower the mill head to its lowest position to facilitate access to the spindle motor and the drive mechanism.
4. Move the high-low shifter lever (#109) to the back position (high setting).
5. Cut the plastic cable tie that holds the motor flex conduit and the control box's flex conduit together.
6. Loosen the set screw (use a 3 mm hex wrench) in the side of the spindle nut on top of the spindle (#119, #207).
7. Using the spindle lock pin and the spanner wrench that came with your mill, remove the spindle nut from the spindle. The nut is left-handed thread so loosen the nut by turning it in a clockwise direction.
8. Using a 5 mm hex wrench, remove the four M6 socket head cap screws (#75) that secure the black cast iron plate (#130) that sits between the motor and the mill head.
9. Lift the plate off the mill head, being careful not to stretch the flex conduit attached to the motor.
10. Remove the four M6 Phillips flat head screws (#131) from the underside of the motor plate that secure the motor to the plate. (Sometimes these screws are tight and may require extra muscle to remove.)
11. Set the motor down on the mill table in such a way so that the weight of the motor does not hang on the motor's flex conduit.
12. Remove the Phillips screw and washer that mounts the gear on top of the mill head (#132, #206).
13. Remove the gear on the top of the mill head and its key that is in the shaft. (#138, #153)
14. Remove the retaining ring (#129) on the end of the motor shaft using a pair of retaining-ring pliers. (If you don't have retaining-ring pliers, use needle nose pliers.) This ring is not used on the belt drive so don't worry about damaging it during removal.
15. Remove the motor gear (#128) from the motor shaft. If it is very tight on the shaft you may use two blade type screw drivers on opposite sides of the gear to gently pry the gear off the shaft. Take care not to misplace the shaft key (#127A) as it will be needed during the belt drive installation.

16. Remove the steel sleeve that was under the spindle nut. (#118)

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*If you wish to do the optional removal of the high-low shifter and gears, perform the steps outlined in Appendix 1 at this time.*

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### ***Kit Installation Part 2: Install the Belt Drive***

1. Slip the clear plastic sleeve onto the shaft that had the plastic gear mounted to it on top of the mill head. Slide the sleeve over the shaft end and slide it down until it is against the bearing. You may need to support the bottom end of the shaft to keep it from pushing through while you install the sleeve. If you have trouble getting the sleeve in place, warm it in your pocket or under warm (not hot!) tap water to soften its plastic. This sleeve is meant to keep the shaft from dropping down from its normal position during machine operation. If you plan to remove the shaft and speed change gears, you may omit the use of this sleeve.
2. Position the base plate on the mill head and secure in place using four M6 countersunk flat head cap screws provided with the kit. (Use a 4 mm hex wrench.)
3. Install the large pulley onto the spindle. (Align slot in pulley with key on spindle.)
4. Reinstall the spindle nut by using the spindle lock pin and the spanner wrench that came with your mill. Tighten the nut by turning the left-handed nut in the counterclockwise direction until it is tight against the large pulley and then loosen it slightly. There should be a small amount of preload on the spindle bearings. Verify that the spindle turns freely and that the large pulley is being firmly held in place.
5. Retighten the set screw on the spindle nut.
6. Position the small pulley onto the motor shaft. The small turned end goes towards the motor. Make sure the shaft key is in place during assembly. Push the pulley all the way on the shaft until it stops and then tighten the set screw (use a 3/32" hex wrench) to secure in place.
7. Using four M6 countersunk flat head screws provided with the kit (use a 4 mm hex wrench) to mount the motor to the new belt drive motor plate. Take note where the flex conduit goes into the motor and appropriately position the motor to the plate with this flex conduit in mind.

Note: Some motors have shallow blind-tapped mounting holes and the supplied M6 screws may be too long. In this case, use the original motor mount screws.

8. Before mounting the motor/plate assembly to the standoffs, position the belt to use later in the assembly.
9. Mount the motor plate to the standoffs using the supplied shoulder screw with its friction washer on the pivot side, and the lever lock and its flat washer on the slot side. The lever lock is the same as are used to lock the X-, Y-, and Z- axes of your mini-mill. The lever lock

will need to be disassembled to install it to your belt drive. Remove the slotted screw and the small spring that is under the screw. Lift the handle off the screw portion. Install the screw portion with a flat washer onto the belt drive to hold the motor plate in place. Reinstall the handles, spring, and slotted screw onto the lever lock. Adjust the lever lock handle position so that it may be tightened or loosened easily. The shoulder screw is tightened in its position with its friction washer under it.

10. Loosen the lever lock and move the motor/plate assembly to allow the belt to be aligned onto the lower pulley grooves which is the low range.
11. Apply tension to the belt by pushing the motor back and then tighten the lever lock to hold the motor in place and maintain tension on the belt.
12. Position the polycarbonate guard in place and install the thumb screw to hold it secure.
13. Replace the cable tie removed earlier from the two flex conduits with the one provided in the kit.
14. Now move the old high-low speed select lever (#109) as far as it will go in the forward position (low setting). It will run into the belt drive's base plate, and this should position it between gears so that the original speed gears will no longer mesh or play a part in driving the spindle. Verify that the gears are not turning by turning the spindle back and forth by hand. You should be able to feel or hear if the gears are meshing or not. It may be necessary to move the old speed select handle back a little to completely disengage the gears.



Photo Compliments of RED BEARD OPS YouTube Channel

## *Using the Mill*

Raise the mill head and ensure there are no tool bits in the spindle. Make sure the spindle lock pin, spanner wrench and chuck key are safely removed from the milling machine. Rotate the spindle by hand to make sure it turns freely and that the belt is properly installed into its pulley grooves. Turn on power to the mill and turn on the spindle, slowly at first to make sure everything is working correctly. Your new belt drive should be set in the low range which will drive your spindle from 0 to 1700 RPM. In the high range it will drive your spindle from 0 to 4300 RPM.

The mill head will now run quieter with the drive gears removed.

When working in the high range you will need to increase the speed slowly. This doubled speed of the spindle is an increased load on the motor and the circuit that controls the motor will shut down if overloaded. Just advance the speed slowly in the high range and you will have no trouble. This new maximum speed is great for engraving with carbide bits.

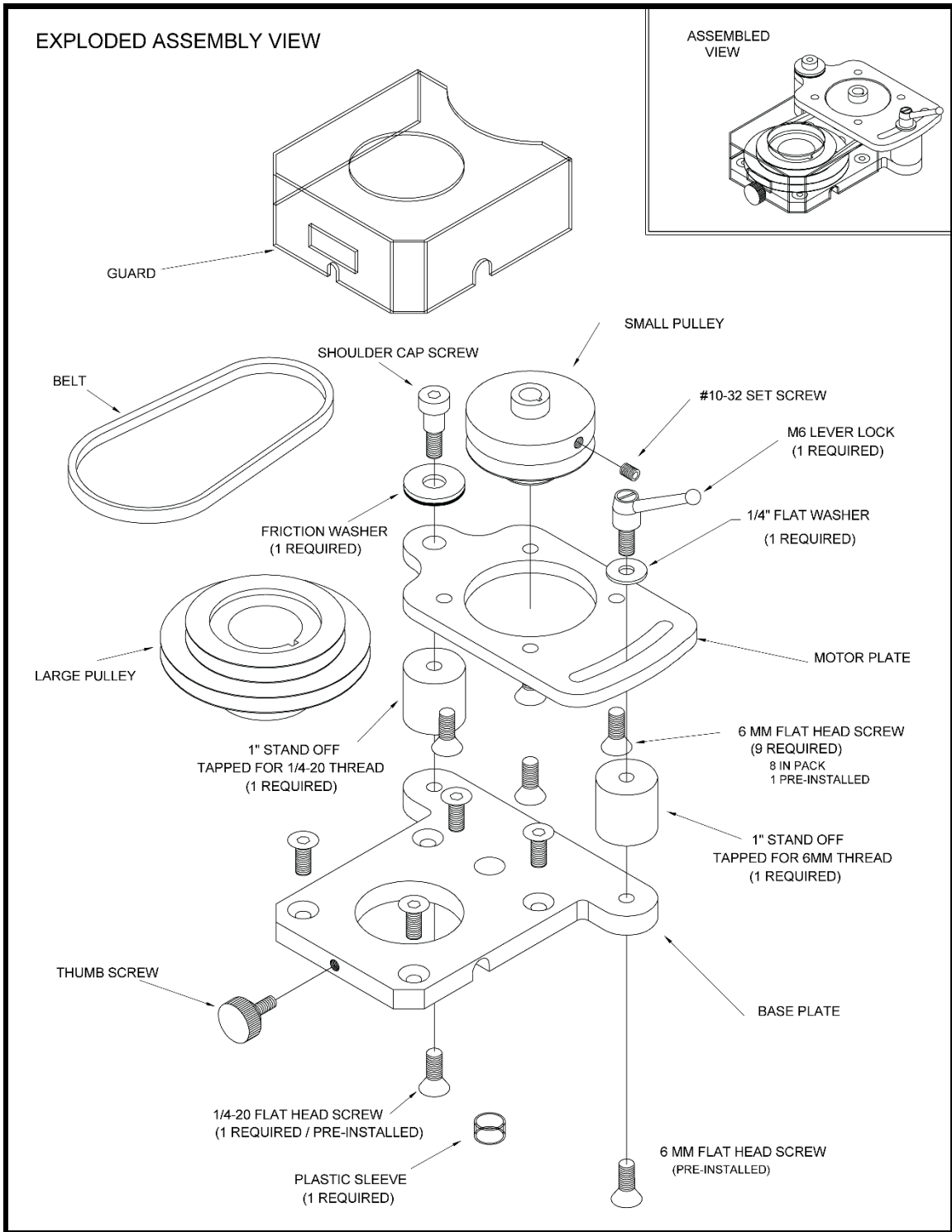
For normal milling and drilling operations you will almost always use the 0 to 1700 RPM provided in the lower speed range.

## *Replacement Belts*

The belt drive kit uses a Gates Truflex 0130 V-belt. The belt is available from LittleMachineShop.com. Visit <http://lmscnc.com/2657> to order.

## *New Speed Label*

While supplies last, LittleMachineShop.com has labels that display the new speed ranges. If you wish to have a label showing high and low speed ranges, visit <http://lmscnc.com/4956> to order.



## Kit Contents

1 Plastic Guard  
 1 Small Pulley  
 1 Large Pulley  
 1 Motor Plate

1 Base Plate  
 1 Lever lock M6  
 2 Stand Off's 1"  
 1 Thumb Screw

1 Set Screw #10-32  
 1 Flat Washer  
 1 Friction Washer  
 1 Cap Screw

9 Countersunk Flat Head  
 Screws 6 MM  
 1 Countersunk Flat Head  
 Screws 1/4-20



## Appendix 1

### *Optional: Remove the Original High-Low Shifter and Gears*

Although it's not necessary, you can remove the original speed selection gears and lever from the machine. To do so, you must remove the head from the mill and disassemble it, as described in the following procedure.

Protect the table you are working on by placing a suitable cushion, such as corrugated cardboard, on top of it.

#### Remove the Spindle Head

1. In Part 1, you removed the motor and set it to the side.
2. Remove the head travel stop and screw (#102, #103). These limit the upward travel of the spindle head. (See drawing page 12.)
3. Using the adjusting handle, raise the spindle head as high as it will go, until the pinion (#50) disengages from the rack (#46).
4. Set the Z-axis stop (#65) to hold the spindle in place.
5. If you have a torsion-spring (#155) head support, remove the screw (#160), and disengage the torsion spring arm (#159) from the torsion spring support (#158). You might need to loosen or remove the acorn nut (#157). The torsion spring is not very strong, and it will not spring out of control.
6. If you have an air spring head support (LittleMachineShop.com Model 4962 SIEG X2D), remove the two M6x20 socket head cap screws (#157) holding the connecting block (#76) in place. Rotate the connecting block out of the way.

#### Remove the Spindle Head Continued

1. Loosen the four gib adjusting nuts, screws, and the locking lever (#29, #43, #30).
2. Lift the spindle housing (#49) and spindle housing mount (#63) off the column. Careful; it's heavy! Ensure the spindle gib (#64) doesn't fall out.

#### Disassemble the Spindle Head

1. Remove the two Phillips head screws (#97) securing the Z-axis fine feed cover (#96) over the fine-adjustment rod.
2. Remove the two M5x25 socket head cap screws (#90) securing the Z-axis fine feed bracket (#89).
3. Remove the four M8x45 socket head cap screws (#60) securing the spindle housing mount (#63) to the spindle housing (#49).

## Remove the Idler Shaft and Gear

1. Remove the intermediate gear (#138), screw (#132), washer (#206), and key (#153).
2. In preparation for the next step, either elevate the bottom of the spindle box by putting blocks on each side of the intermediate shaft (#113) or lay the spindle box on its side.
3. Using a soft face hammer, tap the intermediate shaft from the upper end (not the end with the snap ring) until it is free from the countershaft bearing (#139). The shaft and lower bearing might come out of the spindle box together. This is preferred.
4. Slide the two-speed intermediate shaft gear (#140), and key (#114) off the shaft as you remove the shaft and bearing from the housing.
5. Remove the high-low shifter fork (#141) from the high-low shifter arm (#142).  
Note: on some older models, the high-low shifter fork (#141) and small shaft (#117) were two separate pieces. On newer models, these parts are one piece (#141, #171).
6. Remove the M5x8 set screw (#143) from high-low shifter arm (#142). Remove the small shaft (#117) and the high-low shifter arm (#142) from the shaft portion of the high-low shifter pivot (#107).
7. Remove high-low speed selection lever assembly (#107, #108, #109) from the spindle box.

## Reassemble the Spindle Head

1. Assemble the spindle housing mount (#63) to the spindle housing (#49) using the four M8x45 socket head cap screws.
2. Replace the two M5x25 socket head cap screws securing the Z-axis fine feed bracket (#89).
3. Replace the two M4x6 Phillips head screws securing the Z-axis fine feed cover (#96) over the fine-adjustment rod.

## Replace the Spindle Head

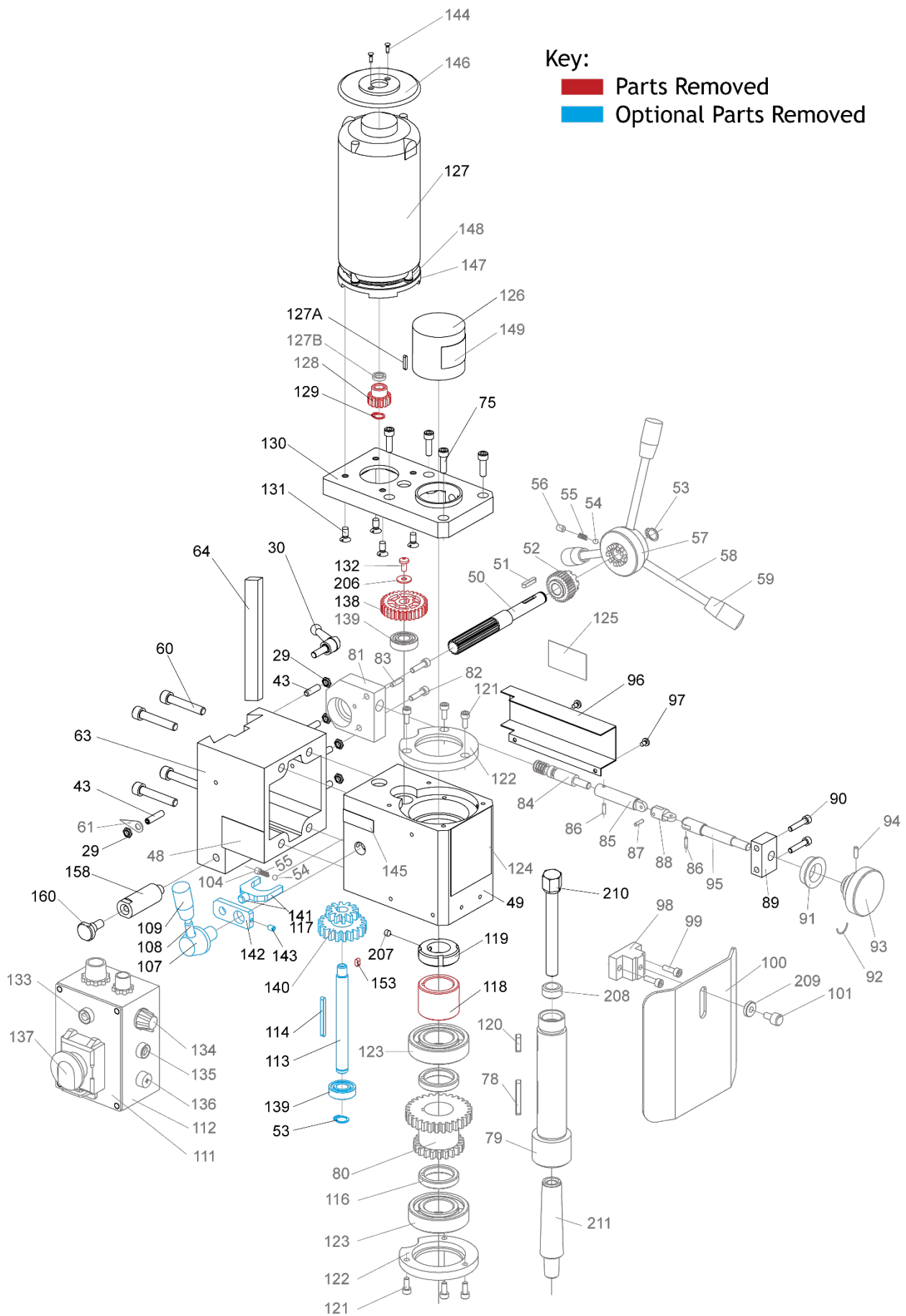
1. Place the spindle head assembly on the column, allowing it to rest on the Z-axis stop (#65).
2. Insert the spindle gib (#64) into place and adjust loosely.
3. If you have a torsion-spring head support, install the screw (#160), and engage the torsion spring arm (#159) from the torsion spring support (#158). You might need to tighten or install the acorn nut (#157). The torsion-spring is not very strong and will not spring out of control.
4. If you have an air-spring (#77) head support, install the two M6x20 socket head cap screws holding the connecting block (#76) in place.
5. Loosen the Z-axis stop (#65) so the spindle head can move down.
6. Install the head travel stop (#102) and M6x16 socket head cap screw (#103). These limit the upward travel of the spindle head.
7. Place the motor (#127, #148, #147) and mounting bracket (#130) on top of the mill head.
8. Replace the four M6x20 socket head cap screws (#131) in the motor mounting bracket.

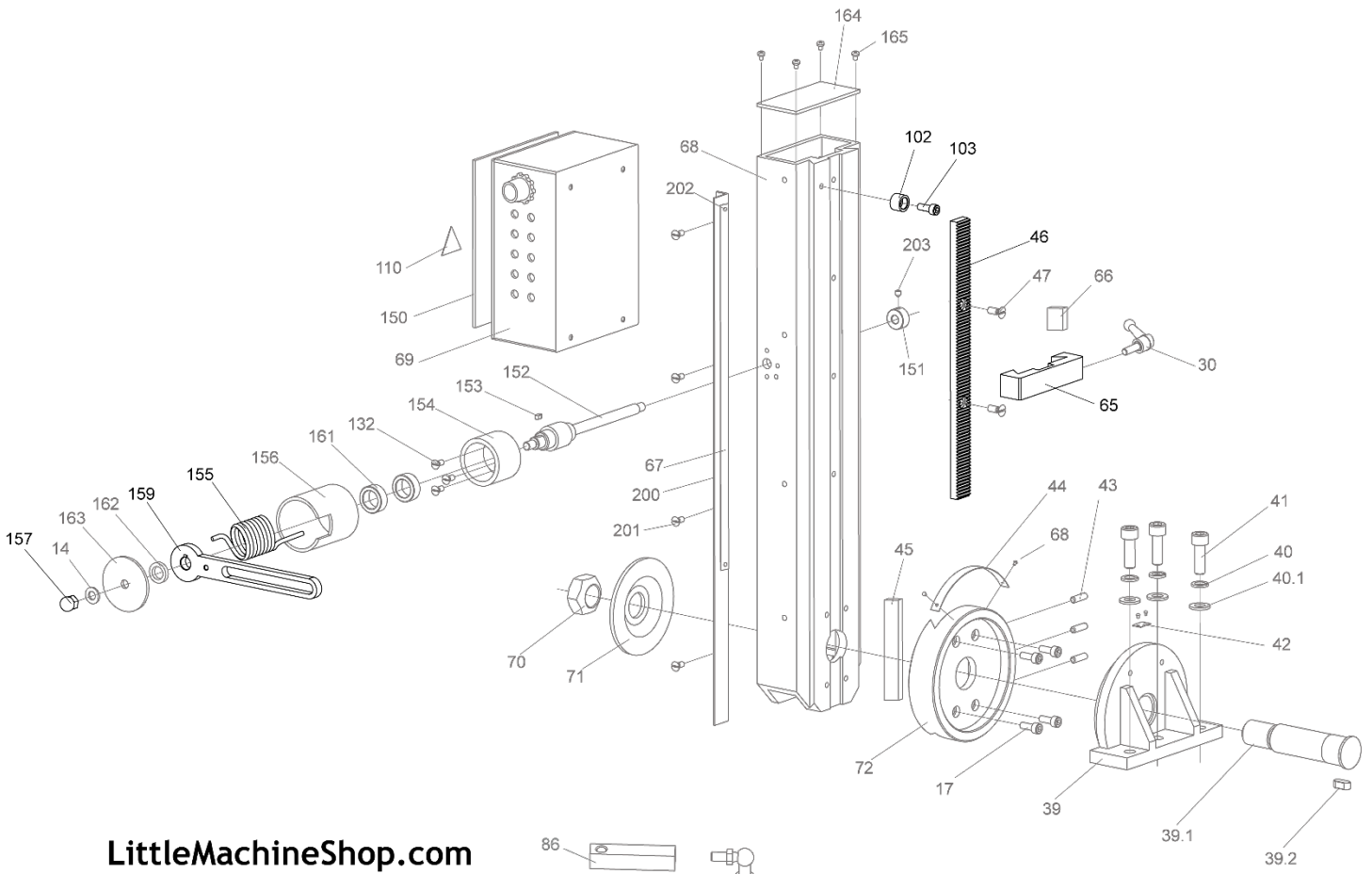


10. Replace the three M5x8 round head Phillips machine screws securing the control box cover (#111) to the head.
11. Replace the four M3x10 flat head Phillips sheet metal screws securing the control box cover.
12. Adjust the spindle gib (#64).

### Last Steps!

1. Replace or relocate the cable tie holding the two flex conduits together.
2. With the speed selection lever and gears removed, your mill now has no drive connection between its spindle and spindle motor
3. *You can now begin the belt drive kit installation (see page 3).*





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**SIEG X2D Mill - Air Spring**

