



## **HiTorque<sup>®</sup> Deluxe Large Bench Mill Users Guide**

Model 6770

from LittleMachineShop.com<sup>®</sup>

*There may be detail differences between your specific machine and the information given here (with little or no impact on functionality). Please email us at [info@littlemachineshop.com](mailto:info@littlemachineshop.com) if you have questions about any aspect of the manual or your machine (or see our website [LittleMachineShop.com](http://LittleMachineShop.com) for more information). Your feedback is welcomed!*

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## Introduction

This user's guide covers the operation and care of the LittleMachineShop.com HiTorque 6770 Deluxe Large Bench Mill. This mill is a version of the SIEG SX3.5 built to LittleMachineShop.com specifications. Be sure to read and understand the safety guidelines presented in this book before using your HiTorque bench mill.

A new feature, introduced with this model of bench mill, is the LED mirror display which clearly and elegantly organizes the key controls for the mill. The panel features a start/stop button, spindle direction button, tapping mode button, and a variable speed knob. The spindle speed is displayed in a large easy-to-read digital readout.

The deluxe version of this HiTorque Bench Mill also includes a factory installed, hard-wired 3-axis DRO with mounted display. Magnetic scales are mounted on the table and column. The DRO system provides accurate measurement for the X, Y, and Z-axis in increments 0.0002".

## Safety Considerations

Always use common sense when using a power tool. Review the following safety instructions. Besides the general safety rules for any power tool, the following include specific considerations for the bench mill.

### *General Safety*

- Use common sense. Think through the results of your actions before you act.
- Understand the operation of the machine. Do not operate the machine if you do not know what is going to happen.
- Learn, don't experiment. Study, understand, and do things where you have a clear expectation of the outcome. Don't "see what will happen."
- We can't be held responsible for your actions when you use the machine.

### *General Machine Safety*

- Keep bystanders, children, and visitors a safe distance away while operating any power tool.
- Read the manual. Know the operation of every control before you attempt any operation of the machine.
- Make sure that all guards are in place and functioning before operating the machine.
- Check for damage and abnormal wear before operating the machine.
- Always wear safety glasses (side shields are recommended) that are ANSI Z87.1-2003 compliant.
- Wear hearing protection (ear plugs or earmuffs) when operating loud machines.
- Wear appropriate clothing, no rings, gloves, neckties, jewelry, or loose-fitting garments. Bind long hair or wear a hat.
- Don't use compressed air for cleaning machines. A shop vacuum works well and is much safer.
- Don't operate machinery while under the influence of drugs or alcohol.
- Ensure that your shop is well lit and has additional task lighting where appropriate.

- Maintain a clean and uncluttered work area.
- Avoid pinch points.
- Never leave a running machine unattended.
- Do not force or overload machinery.
- Do not attempt to use workpieces that are too large or too heavy for the machine.
- Maintain your machines. Ensure that it is well-adjusted and in a safe state.
- Make sure the machine is on a flat, level surface that can support the weight of the machine plus fixtures, vise, and workpiece.

### *Milling Machine Safety*

- Your bench mill is a small mill. Don't attempt jobs that are beyond its capacity.
- Check the workpiece after you secure it in the vise or other work holding device. Be sure it is secure before turning on the mill.
- Don't wear loose clothing or jewelry when operating the mill.
- Stop the spindle and make sure the machine is in a safe condition before:
  - Reaching into work area
  - Changing or adjusting tools
  - Changing or adjusting workpieces
  - Changing speed ranges
  - Clearing chips or coolant
- Use appropriate cutting tools with appropriate feeds and speeds.
- Inspect cutting tools for sharpness, chips, and cracks before each use. Replace dull, chipped, or cracked cutting tools immediately.
- Handle cutting tools with care. Cutting edges are very sharp and can cause lacerations.
- Cutting tools get hot during use and can cause burns if handled inappropriately.
- Center all tooling in the spindle. Unbalanced tools are a hazard and will have a negative impact on your mill's performance.
- Remove all tools (wrenches, chuck keys, locking pins, etc.) from the spindle immediately after using them.
- Clear chips (swarf) with a brush or other tool, *never with your hands or with compressed air.*
- Clamp work securely. Cutting forces are significant and can turn unsecured workpieces into projectiles.
- Be aware that chips and dust from some materials (magnesium, for example) are flammable. *Understand the materials you are using.*

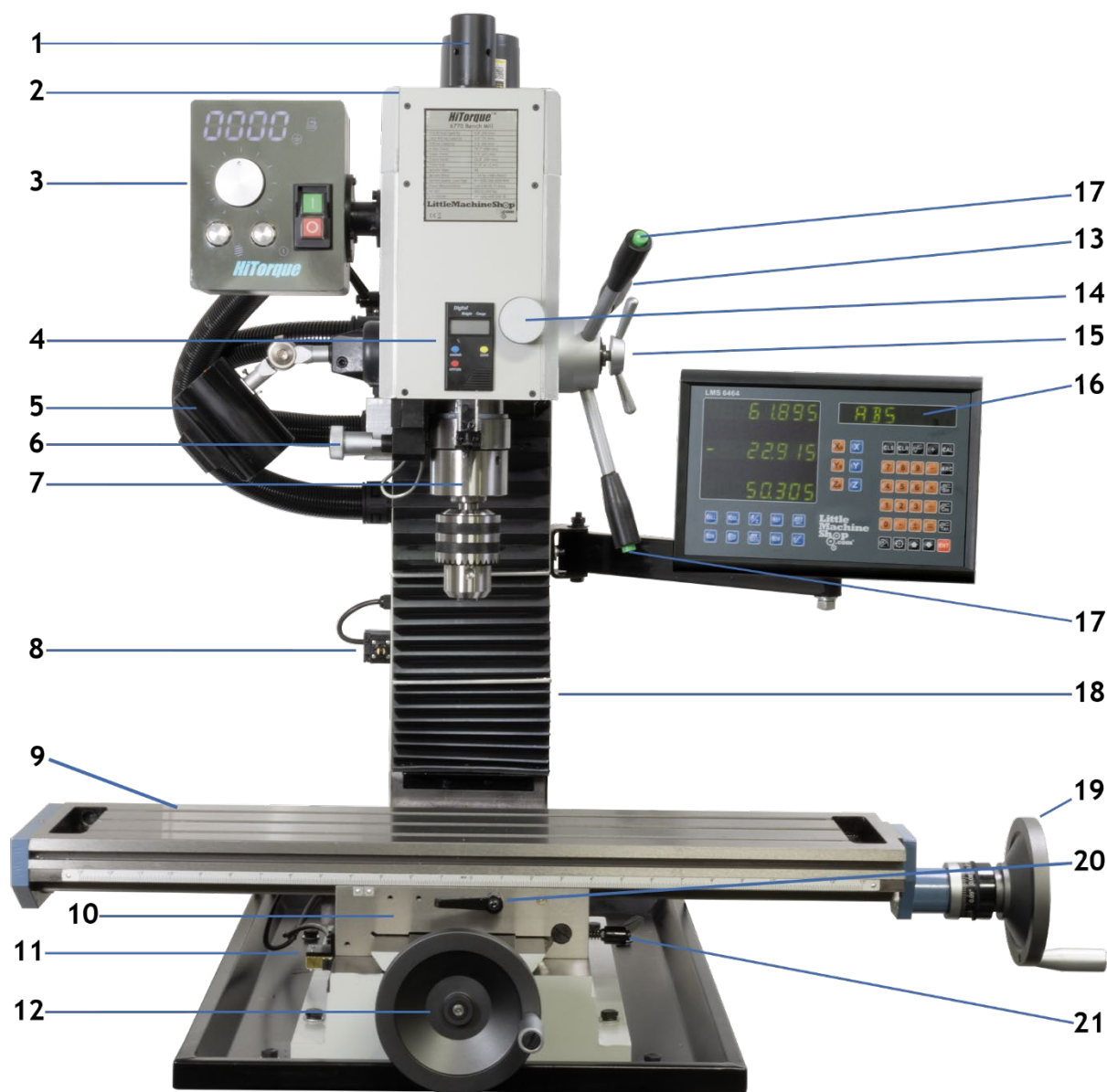
## Electrical Safety

- Plug the machine into a grounded, ground fault protected receptacle.
- Ensure that all components are properly grounded. The easiest way to ensure this is to plug your machines and devices into grounded outlets that you have tested.
- Use caution when using liquids and electricity. Ensure that coolants and lubricants are kept away from high voltage electrical components.
- Disconnect all components from the power receptacle before servicing.
- In the event of a power outage, turn off all components to ensure that the machine does not restart unexpectedly.

## Specifications

HiTorque 6770 (SIEG SX3.5)	
End Milling Capacity	0.8" (20 mm)
Face Milling Capacity	2.95" (75 mm)
Drilling Capacity	1.18 in (30 mm)
Table Size	29.1" x 7" (740 mm x 180 mm)
T-slots	3 slots 7/16" (12.0 mm) wide
X-Axis Travel	19.68 in (500 mm)
Y-Axis Travel	8.46 in (215 mm)
Z-Axis Travel	11.81 in (300 mm)
Throat	9.05 in (230 mm)
X and Y-Axis Feed Screws	0.100" (2.54 mm) per rotation
Quill Travel	3.07 in (78 mm)
Maximum Spindle to Table	13.38" (340 mm)
Positioning Accuracy	0.0004" (0.010 mm)
Spindle Taper	R8
Spindle Motor	1.34 hp (1000 Watts)
Spindle speed - low range	80-1500 RPM $\pm 10\%$
Spindle speed - high range	280-5000 RPM $\pm 10\%$
Power Requirements	120 V 60 Hz 14 Amps
Machine Weight	396 lbs (180 kg)
Overall Dimensions (W x D x H)	37.0" x 30.5" x 36.5" (940 mm x 775 mm x 927 mm)

## Features



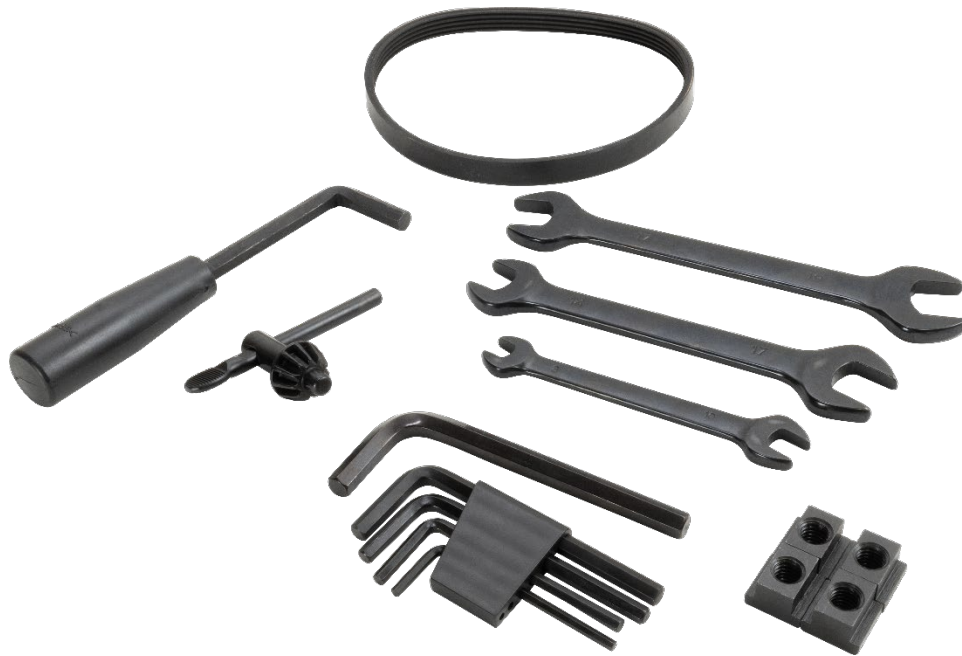
**Model 6770**

- |                                          |                                           |                            |
|------------------------------------------|-------------------------------------------|----------------------------|
| 1. Drawbar (under cap)                   | 8. Power lift height sensor               | 15. Quill coarse feed lock |
| 2. Headstock                             | 9. Table                                  | 16. DRO display            |
| 3. Motor controls                        | 10. Saddle                                | 17. Tapping mode button    |
| 4. Digital height gauge                  | 11. Y-axis DRO scale/reader               | 18. Solid column           |
| 5. Light                                 | 12. Y-axis handwheel                      | 19. X-axis handwheel       |
| 6. Electrically interlocked spindle lock | 13. Quill coarse feed (drill press style) | 20. X-axis lock lever      |
| 7. Spindle & quill                       | 14. Quill fine feed knob                  | 21. Y-axis lock lever      |



## Basic Accessories

- The following accessories come with the HiTorque Deluxe Large Bench Mill.
- L-hex wrench for drawbar
- 16 mm (5/8") Drill chuck (not shown)
- Drill chuck key
- T-slot nuts with 3/8"-16 thread
- Hex wrenches 3, 4, 5, 6, and 8 mm
- Open end wrenches 8/10 mm, 14/17 mm, and 17/19 mm
- R8/JT33 Drill chuck arbor (not shown)
- Poly-V timing belt for high-speed range



## Mill Setup

Your mill was fully aligned, adjusted, and inspected in the factory. Some minor movement may have occurred during shipping; therefore, it is always a good idea to inspect the machine. Later in this document we address how to adjust the gibs and how to tram the mill to refine your machine's performance.

## Assembly

There is only one thing to do to assemble your mill. Install the handles on the X and Y-axis handwheels. The handles should turn freely when installed.

## Cleaning

Your mill will arrive coated with grease to protect it from corrosion during shipment. Follow this procedure to remove the grease:

1. Wipe most of the grease off with rags or paper towels.
2. Coat the surfaces with oil. See the "Lubrication" section for specific recommendations for lubricants.
3. Thick or dried grease spots may be removed with denatured alcohol or other mild solvents such as WD-40.

## Installation

- Handling the mill is at least a two-man job. Lifting gear (sling, hoist, or forklift) must be rated for at least 1,000 lb. Ensure the sling strap is not contacting any wires, levers, or other delicate parts.
- Lower the center of gravity by hand-cranking the headstock down until the spindle nose is just clear of the table.
- The working location of the mill must allow full left-right travel of the table, and access to the top of the column (for Z-axis leadscrew maintenance).
- Power requirement is 120V, 60Hz, 14A minimum. *Extension cord not recommended.*
- Before connecting power for the first time be sure that:
  1. The machine is on a firm footing, adequately secured to bench or stand.
  2. No chuck or collet is installed.
  3. There are no clamps or locks on moving parts.
  4. The speed control knob is set for the lowest speed.

## Mounting Your Mill

If not using a dedicated mill stand, the bench mill must be bolted down to the workbench because it is top-heavy. *It is unsafe to operate the mill if it is not bolted to a workbench or stand.*

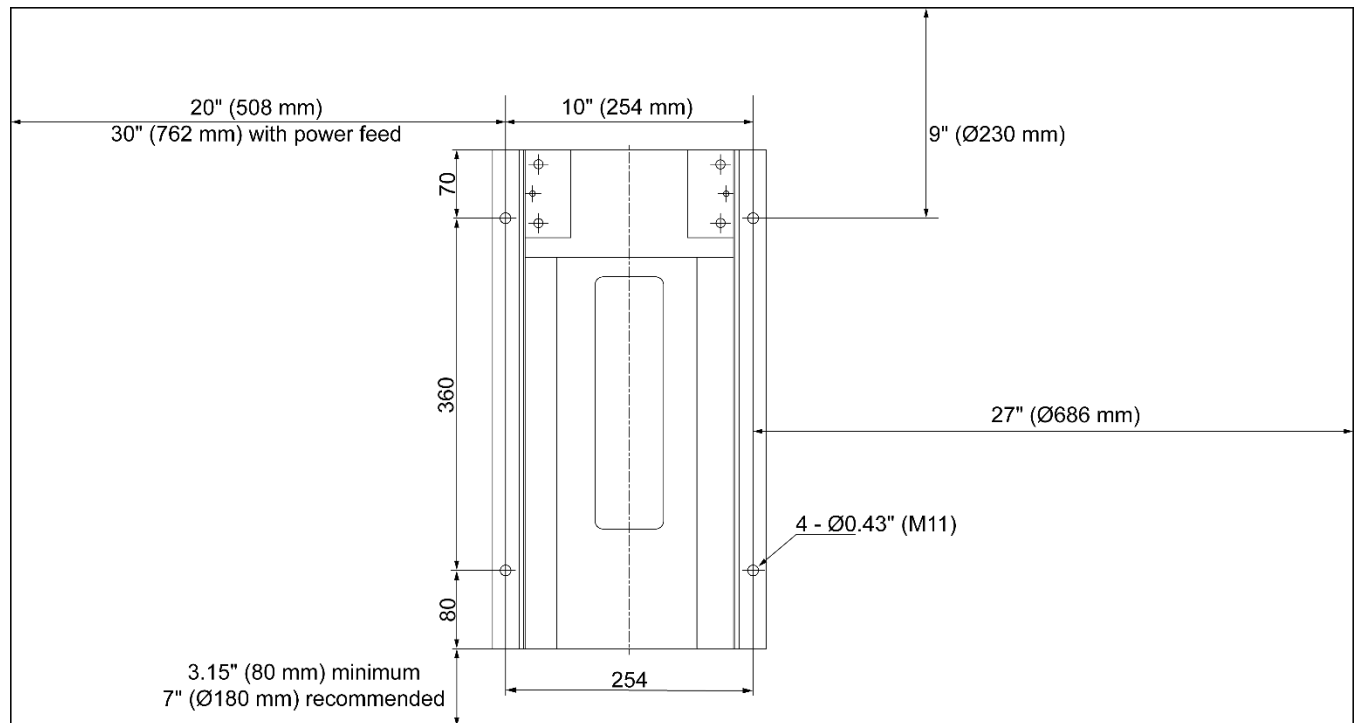
Chris' Tip: We offer stands and chip trays for each of our HiTorque machines. The recommended stand for the HiTorque 6770 is product [5989 \(HiTorque Large Bench Mill Stand Cabinet\)](#).

Before you mount your bench mill, plan the positioning carefully. Be sure that you have room on both sides of the mill for the X-axis travel.

When the table is centered, the ruler will have zero positioned over position indicator label. This positioning does not indicate the center of the table, but the center of table plus handwheel. When centered this way, the 6770 bench mill table will protrude 14.5" on each side when measured from the base.

The table will move to the left and right (X-axis) so that the end brackets are almost flush with the saddle. For adequate space, you will need approximately 20" of clearance on the left and 27" on the right, from the base of the mill. Additional room may be needed to the right to remove the table. If a power feed is added to the mill, additional clearance will be required.

The following diagram shows the holes required to mount the mill and the clear area around the bolt pattern to allow use and maintenance of the bench mill.



Mount the mill to the workbench with 3/8" or 10 mm bolts. The bolts should be about 1" (25 mm) longer than the thickness of the workbench. Use fender washers on the underside of wooden benches to prevent the nuts from pulling through.

## Operating Controls

Before starting to use this machine, the operator should go through the instructions carefully to get acquainted with the construction of the machine, the functions of the various controls, and the drive systems. There are several controls used to operate the mill. Familiarity with these controls will make your use of the bench mill easier and safer.

### Motor Controls



- |                               |                                                    |
|-------------------------------|----------------------------------------------------|
| 1. Spindle speed readout      | 5. Speed control knob                              |
| 2. Power lift Up/Down buttons | 6. Power switch and emergency stop (E-stop) switch |
| 3. Tapping mode button        |                                                    |
| 4. Start/Stop button          |                                                    |

### Spindle Speed Readout

The spindle speed readout shows the speed of the spindle in revolutions per minute (RPM). It also indicates the direction of turning, forward or reverse.

### Power lift Up/Down buttons

The model 6770 has no Z-axis handwheel. Vertical movement of the headstock is controlled by a power lifting system. The two buttons on the left side of the control box are the up and down buttons for this power lifting system.

## Tapping Mode Button

The tapping mode button engages the mill's tapping mode. When the tapping mode button is pressed (illuminated), the spindle speed is reduced by half. This button, when used in combination with pressing the green buttons on the ends of the coarse feed handles, will reverse the spindle direction for backing taps out. The motor will make a controlled change of speed and direction. A spindle direction icon, at the bottom right of the spindle speed, illuminates to indicate spindle direction. Press the green buttons to toggle between forward and reverse directions. You can change the spindle direction at any time while in tapping mode.

## Start/Stop Button

The Start/Stop button illuminates and starts the spindle when pressed while the power is on. The spindle runs at the last set speed. Press the button again to stop the spindle. Use this button for normal operation of the mill to start and stop the spindle.

## Speed Control Knob

The speed control knob adjusts the spindle speed. Always turn the speed control to the minimum speed position when starting or stopping the mill.

## Power Switch and Emergency Stop (E-stop) Switch

The power switch is designed to provide power to all components and to serve as an emergency stop switch.

The green power button enables power to the mill. The red E-stop switch immediately cuts all mill power.

Only use the E-stop switch to stop the spindle in an emergency. During normal operation, start and stop the spindle with the illuminated Start/Stop button. Regularly using the emergency stop switch to stop the spindle could negatively impact the main circuit board.

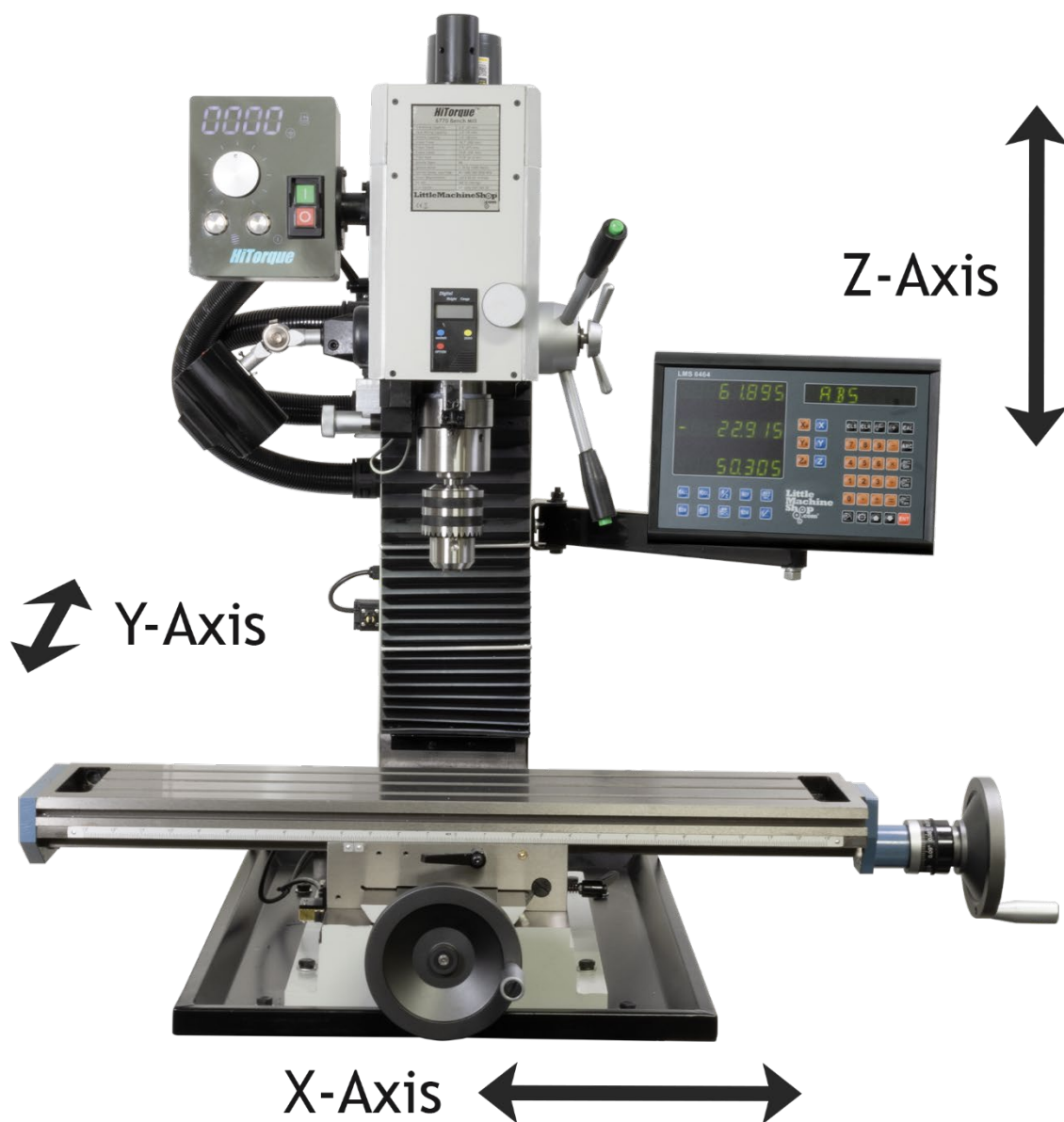
Stop spindle and then turn the power off when you are not using the mill.

**Chris' Tip:** Always turn the power off when you leave the mill. Leaving the power on when the mill is not in use and unattended is a safety hazard and could also result in unforeseen damage to the circuit board.

## X, Y, and Z-Axis and Handwheels

### *The Three Axes*

The bench mill has movement in three distinct axes, X, Y, and Z. These axes are referenced throughout this manual and are illustrated below for easy reference.



## Handwheels

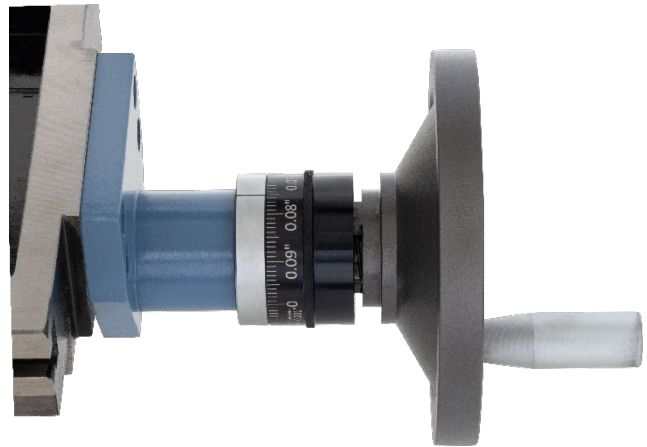
Handwheels on the 6770 HiTorque Deluxe Large Bench Mill have graduated dials with 100 divisions on the dial. Each division of the dial represents a movement of 0.001". Each full turn of the handwheel results in movement of the table or headstock 0.100" (1/10"). 10 rotations will equal 1" of movement in table or Z-axis. The factory installed DRO will also communicate this movement to the display. The graduated dial can be re-set/repositioned for convenience.

### X-Axis Handwheel

The X-axis handwheel is on the right side of the table and moves the table to the left or right, depending on which way it is turned. Use this handwheel to position the table to the left or right of center, relative to the spindle.

All models of the HiTorque bench mill have a safety feature on the X-axis handwheel, a clutch. The clutch is pre-installed to allow a power feed to be installed without having to change any parts on the handwheel side of the table. Without the clutch, a mill equipped with a power feed would experience the handwheel spinning whenever the power feed is engaged. This could be a hazard to the mill operator.

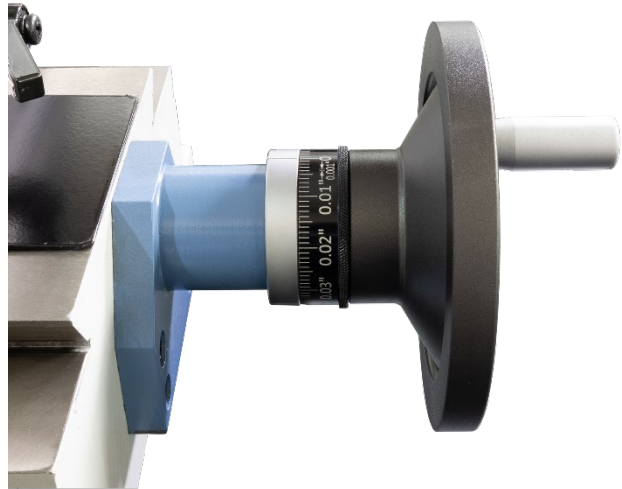
To use the handwheel without a power feed, simply push the handwheel in to engage the clutch and turn like any other handwheel.



Chris' Tip: We offer power feeds for all bench mill models. The power feed for the 6770 bench mill is product [4699 \(Power Feed, HiTorque Large Bench Mill\)](#).

## *Y-Axis Handwheel*

The Y-axis handwheel is on the front of the mill, below the table. This handwheel moves the table to the front or back, depending on which way it is turned. Use this handwheel to position the table forward or backwards from center, relative to the spindle.



## *Z-Axis Handwheel*

The model 6770 has no Z-axis handwheel. Vertical movement of the headstock is controlled by a power lifting system. The two buttons on the left side of the control box are the up and down buttons for this power lifting system.

Further positioning of the quill is achieved with the course feed drill press style handles. Fine positioning of the quill is achieved with the fine feed control knob on the front of the mill.



## Z-Axis Headstock and Quill Movement

### Headstock Power Lift

As mentioned earlier, there is no Z-axis handwheel on the HiTorque Deluxe Large Bench Mill model 6770. Movement of the headstock up and down the solid column is achieved by a power lift system. This system is for headstock positioning. To move the quill for milling and tapping operations, use the quill coarse feed handles and fine feed knob.

Vertical movement control of the power lift system is achieved via the two buttons on the side of the control box.



The vertical movement is powered by a dedicated motor and the movement limits are controlled by the interaction between limit sensors and an adjustable stop lock.

### Limit Sensors

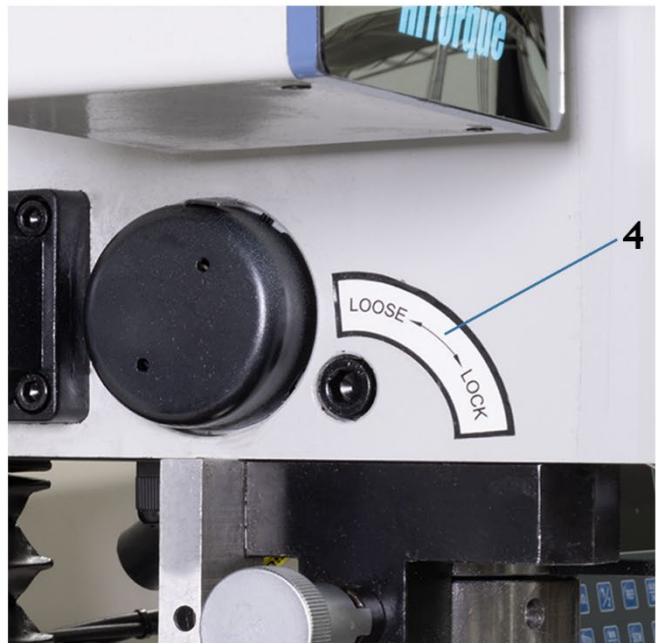
Mounted on the side of the column cover are two limit sensors. These sensors have a tip which recesses into the sensor body when pressed. When this is done, the sensor will send a signal to the motor to stop movement of the headstock.

## Stop Lock

The stop lock has a surface which engages the limit sensors. It has a vertical adjusting gauge so you can increase the stop distance if desired.



## Quill Movement



1. Quill coarse feed handles (drill press style)
2. Quill fine feed knob
3. Coarse feed handle lock
4. Quill lock

### Quill Coarse Feed Handles

The quill coarse feed handles are on the right side of the headstock. The three long handles allow you to quickly lower and raise the quill (like a drill press). Use them to position the quill for drilling as well as for tapping.

Once the coarse feed handles have the quill in the desired position, the fine feed knob may be used for more control in adjusting the quill for milling operations.

### Quill Fine Feed Knob

The quill fine feed knob is located on the front of the control panel of the headstock. Use this knob to make fine adjustments to the quill. The movement of the quill is displayed on the digital height gauge on the headstock. For milling operations calling for precise, repeatable control of tool depth, tighten the coarse feed handle lock to engage the quill fine feed control knob. Precisely set quill depth and tighten the quill lock.

## Coarse Feed Handle Lock

The quill coarse feed handles have a locking mechanism at their center. When engaged, this mechanism locks the coarse feed handles and activates the fine feed knob. When the locking mechanism is loose, the fine feed knob is disengaged, and the drill press style handles may be used to move the quill.

### *To engage the quill fine feed:*

Turn the coarse feed handle lock clockwise until it stops. This action will disengage the coarse feed handles and engage the fine feed knob.

Turn the quill fine feed as needed to move the quill. See the movement on the digital height gauge.

### *To disengage the quill fine feed:*

Turn the coarse feed handle lock counterclockwise until it is loose. This action will disengage the fine feed and restore movement capability to the coarse feed handles.

## Quill Lock

There is a quill lock on the left side of the headstock. This will lock the quill in place for precise milling operations.

To lock the quill, use an 8 mm Allen wrench to tighten the locking bolt.

To free the quill for movement, loosen the locking bolt with the Allen wrench.

The quill is controlled in two different ways, coarse feed and fine feed.

With coarse feed (drilling mode), the mill operates like a standard drill press. The 3-lever handle lowers or raises the quill in the usual way by rack and pinion. Return action is assisted by a compression spring within the quill and spindle assembly.

With fine feed (milling mode), the quill is adjusted by a worm wheel rotated by the fine feed control knob. This allows the quill to be adjusted precisely to any desired position. The worm driven fine feed adjustment has no return-spring force on the quill (in other words, it stays where it's put). For milling operations, the quill should be locked by the quill lock on the left of the headstock to further secure quill depth positioning.

## Digital Height Gauge

The bench mill is equipped with a digital height gauge. This gauge measures absolute movement of the quill (like DRO scales). This gauge can display in both inches and millimeters, has a zero-out function, and can be manually turned off to preserve the battery.



Only quill movement will register on the digital height gauge. Moving the headstock using the Z-axis handwheel will not affect the gauge readout.

Moving the coarse feed handles or the fine feed knob, both of which will move the quill, will be measured by the digital height gauge.

## DRO (Model 6770)

The HiTorque Deluxe Large Bench Mill model 6770 comes equipped with factory installed DRO. Simply turn on the display and the X, Y, and Z-axis coordinates should activate. If one of the axes does not display, check the wire connection.



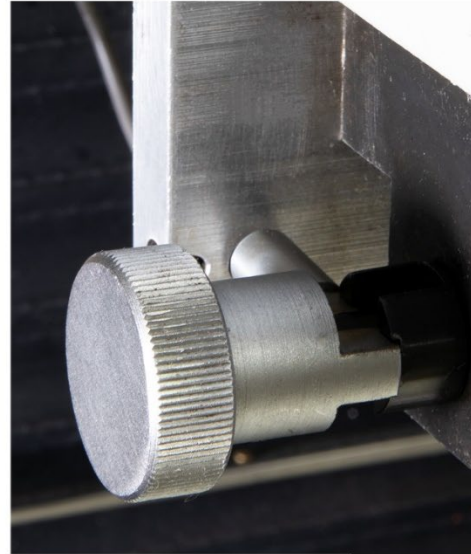
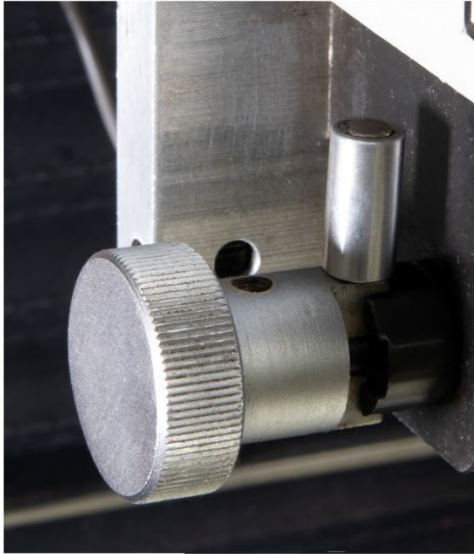
*See the display manual for use.*

Chris' Tip: The display comes with a protective cover. Users may remove the cover but should take care to keep items in the shop from scratching or damaging the display. If you remove the 9-pin connectors from the back of the display, mark them to ensure they are returned to the same ports; otherwise, your axes will display incorrectly.



## Electrically Interlocked Spindle Lock

HiTorque Model 6770 Deluxe Large Bench Mill has an electrically interlocked spindle lock. This mechanism makes tool changes easier, faster and safer. When engaged, the plunger automatically drops into the locking hole as the spindle is rotated. An electro-magnetic interlock disables power to the motor, locking the spindle. The mechanism should only be engaged when the spindle rotation has stopped. When the spindle lock is engaged, the mill no longer provides power to the spindle. You can turn off the power at this time, if desired.



## Changing Spindle Tools

The HiTorque bench mill has an R8 tapered spindle. Tooling such as collets, drill chucks and end mill holders must have an R8 taper with internal threading on the end to allow the drawbar to tighten the tool into the spindle. The threading of the drawbar is standard 7/16"-20.

R8 tooling is aligned in the spindle by a spindle pin. To place a tool into the spindle, rotate it until the spindle pin aligns with the groove on the back of the tool.

The tools are held in the spindle by the drawbar. The drawbar is effectively a long bolt that goes down through the spindle and retains the tool.

### *Installing a Tool into the Spindle*

1. Clean the inner hole of the spindle and the conical surface of the tool (tapered end).
2. Engage the electronic spindle lock on the left side of the mill adjacent to the spindle.
3. Push the tapered end of tool into the spindle from the bottom. Most tools have a groove cut into the tapered part that slides over the spindle pin to ensure proper alignment. Rotate the tool until the locking pin engages the slot in the side of the tool.
4. Lower the drawbar down through the spindle from the top.
5. Hold the tool with one hand, and thread the drawbar into the tapered end of tool. Tighten the drawbar with the drawbar wrench until the tool is set in the spindle and the drawbar is tight.

6. Disengage the spindle lock, and initiate milling operations

### ***Removing a Tool from the Spindle***

1. With the spindle not turning, engage the spindle lock.
2. Hold the tool with one hand to prevent it from dropping and unscrew the drawbar with the drawbar wrench. Remove the tool.
3. The tool should "auto-eject" if drawbar is fully unscrewed, but if friction keeps tool from dropping, tap the top of the drawbar with a soft-faced hammer to disengage the taper. The tool will not pop out.

Chris' Tip: If you need to persuade the tool by tapping the drawbar, use a soft faced hammer or rubber dead blow hammer. A light tap should do it. Do not hit too hard or you could damage the threading on the drawbar. Also, refrain from using a steel head hammer as it could damage the drawbar or the drawbar wrench. Finally, make sure you are holding your tool when you do this procedure to avoid the cutting tool dropping to your table and possibly damaging its cutting surface. This is a two-handed process.

### **Tapping Mode**

LittleMachineShop.com HiTorque Bench Mills and HiTorque Large Bench Mills have a tapping feature. When the tapping mode button is illuminated, the spindle speed is reduced by half and pressing the buttons on the ends of the coarse feed handles reverses the spindle direction for backing taps out.

Chris' Tip: The tapping mode is designed to use the quill course feed (drill press style) handles. Do not attempt to tap using the fine feed control as the downward pull of a tap could damage the fine feed worm drive.

### ***Turning On the Tapping Feature***

- Press the spindle half speed button on the control panel so that it is illuminated. (See #2 in image below.) The spindle speed is reduced by half (generally tapping is done at very slow speeds).
- The green buttons on the ends of the coarse feed handles are now set to reverse the spindle direction for backing taps out when depressed. (See #4 in image below.)
- Pressing the spindle half speed button again returns the spindle to full speed and turns the tapping feature off.





- |                        |                                      |
|------------------------|--------------------------------------|
| 1. Speed control       | 3. Spindle activation (start) button |
| 2. Tapping mode button | 4. Tapping button (spindle reverse)  |

### *Tapping a Hole*

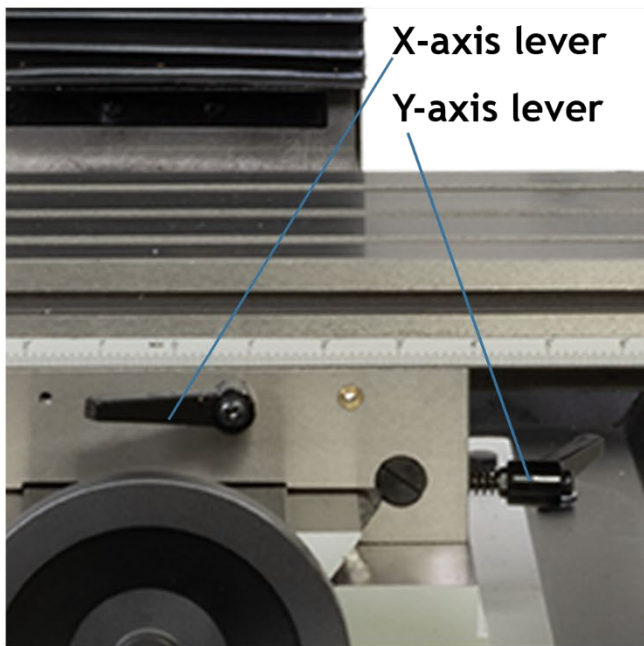
To tap a hole with a HiTorque bench mill, follow these steps.

1. Set spindle speed to a desired speed, double the target speed for tapping.
2. Press the tapping mode button to reduce spindle rotation by half. This is your tapping speed. (For best control, use a very slow speed such as 100- 250 RPM.)
3. Tap the hole using the Z-axis coarse feed handles and the quill digital display for reference.
4. When the tap reaches the desired depth, press the green tapping button on the end of the coarse feed handle. The spindle will stop and then reverse.
5. Back the tap out of the hole.
6. When the tap is clear of the workpiece press, release the green tapping button. Then, press the tapping mode button on the control box to return the spindle to normal speed. At this time, you may also press the spindle activation (start) button (#3 in photo above) to turn off the spindle.

## Locking Levers

Locking levers are used to lock the position of certain moving parts of the machine like the table or headstock. Locking these positions is important to avoid introducing unintentional movement in the precise setup of the machine. Upon completion of setup operations, the locking levers should be disengaged before movement of the locked part is attempted.

Pulling out on a locking lever and simultaneously turning it allows you to change the position of this lever, if needed, without dis-engaging the locking screw. Pulling out disengages the lever from the locking screw and allows it to move to a different position. You might need to adjust the screw in the base of the lever before you can disengage the lever.



### *X-Axis Locking Lever*

The X-axis locking lever is on the front of the saddle behind the Y-axis handwheel. Use this lever to lock the X-axis so it does not move inadvertently.

### *Y-Axis Locking Lever*

The Y-axis locking lever is on the right side of the saddle. Use this lever to lock the Y-axis so it does not move inadvertently.

### *Z-Axis Locking Lever*

The Z-axis locking lever is on the left side of the head assembly behind the quill lock. Use this lever to lock the Z-axis so it does not move inadvertently.

## USB Ports

The HiTorque bench mills have two USB ports on the back of the control box. On some models, these ports power the Bluetooth DRO display tablet. On hard wired DRO models like the 6770, they are available for other non-mill power needs.

## Maintenance

Maintenance of the bench mill is simple, but important. Regular maintenance will keep your bench mill working like new for many years.

The ongoing maintenance you perform most often is cleaning. Keeping swarf off wearing surfaces is the most important thing you can do to prolong the life of your bench mill.

- Use a 1" paintbrush to remove swarf from the machine as you work.
- Clean swarf from the mill, from top down after each use.

Aside from debris, lack of proper lubrication is the main cause of premature wear.

Apply the recommended way-oil with a dedicated short-bristle brush such as the type used for applying flux. Use a similar brush to apply oil or grease to the leadscrews.

Apply oil to ball oilers. Use a pump-type oil can with tip large enough to span the oiler's spring-loaded steel ball. Oil pressure will displace the ball, allowing oil to flow, provided the oil can tip is firmly pressed onto the brass seating. Before oiling check that the ball is not stuck - press it lightly with a probe. Using a stiff flux brush, clean the visible portions of the rack and pinion. Raise and lower the quill to expose the remainder of the working surfaces, locking and cleaning at each setting.

## Lubrication

The following points on your bench mill require lubrication.

Location	Lubricant	Frequency
Column dovetail and rack	Machine tool oil	Daily as needed
Table and other machined surfaces	Machine tool oil	Daily as needed
Table dovetails	Machine tool oil	Daily as needed
Table feed screws and nuts	Lithium-based grease	Yearly
X-axis thrust bearings	Machine tool oil	Yearly
Spindle tapered roller bearings	High quality automotive wheel bearing grease	500 Machine Hours

We recommend the use of the following lubricants on your mill.

- Where oil is required, we recommend Mobil Vactra Oil #2. Vactra Oil #2 is especially designed for machine tool way lubrication.

Chris' Tip: Mobil Vactra Oil is available from LittleMachineShop.com ([part # 6385](#)). If you prefer to purchase locally, get Mobil 1 synthetic motor oil, any viscosity, available at most auto parts stores.

- Where grease is required, we recommend Lubriplate 630-AA lithium-based grease. Lubriplate 630-AA is a NLGI No. 1 lubricant. Lithium grease is a plastic-friendly general use grease that is easy to find and easy to use.

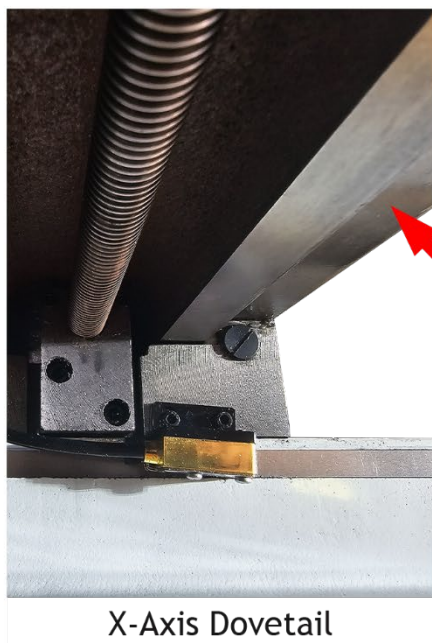
Chris' Tip: Lubriplate 630-AA grease is available from LittleMachineShop.com ([part # 3984](#)), but you might have trouble finding it locally. Don't worry about the brand name. Get white lithium grease. Auto parts stores and most hardware stores have it.

## Typical Lubrication Locations

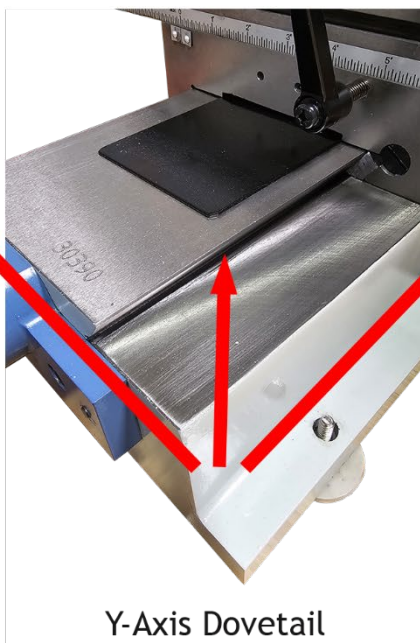
Below are areas of the mill which benefit from regular lubrication.

### Lubricating Oil Locations

The main areas needing way oil are the dovetails on the X, Y, and Z-Axes. These include the column (Z-Axis), the table bottom dovetail (X-Axis) and the dovetail under the carriage (Y-Axis).



X-Axis Dovetail



Y-Axis Dovetail

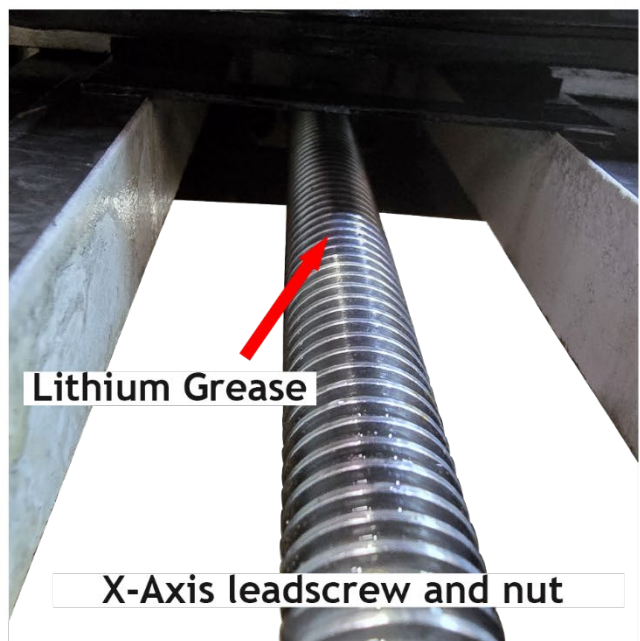
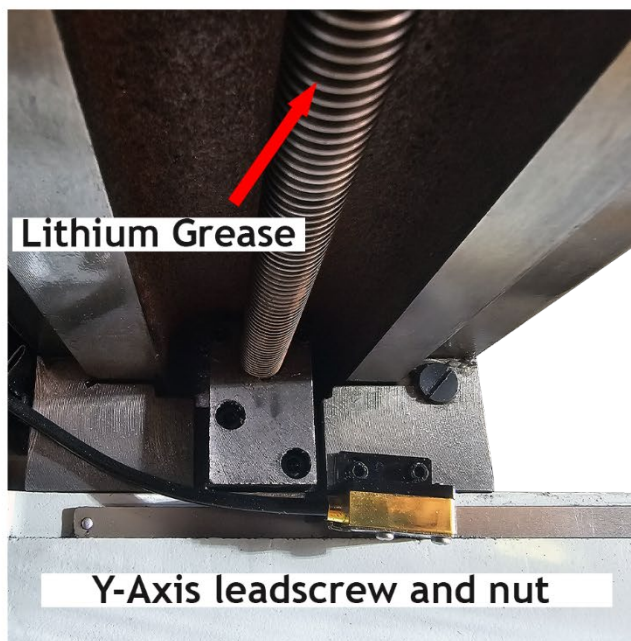
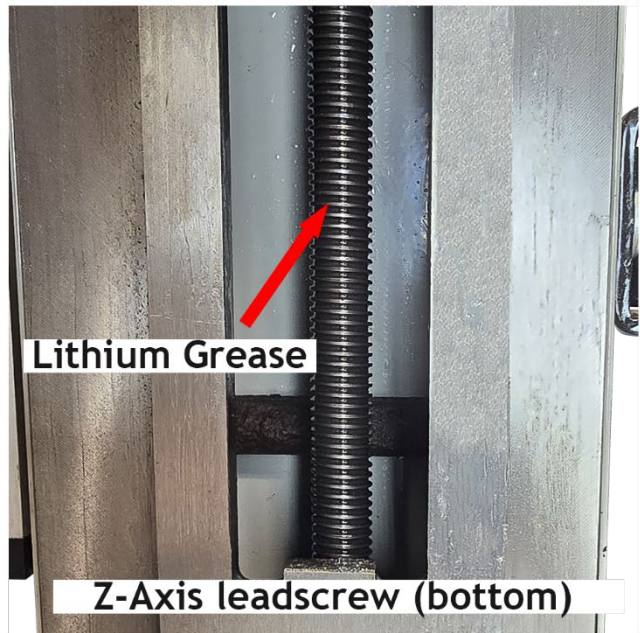
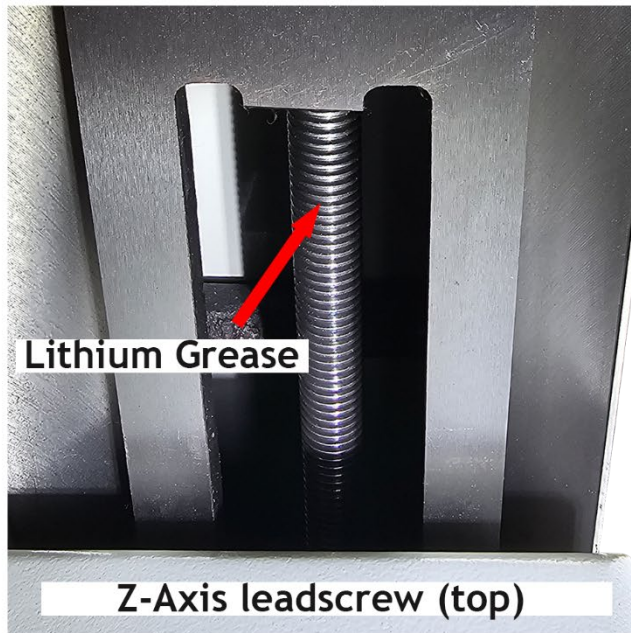


Z-Axis Dovetail



## Grease Locations

The main areas needing grease are the lead screws on the X, Y, and Z-Axes.



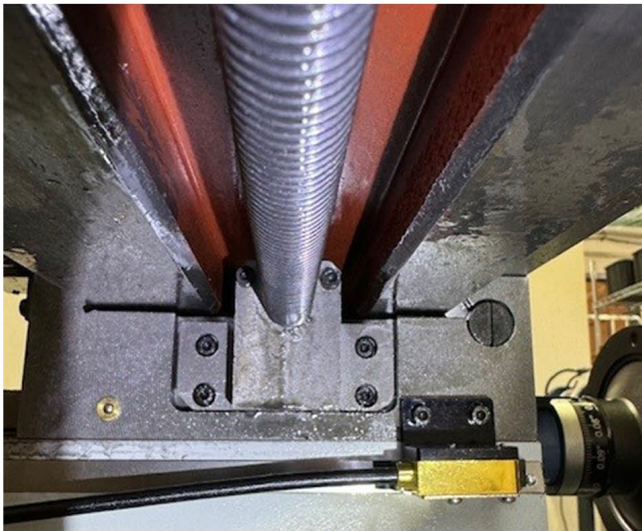
## Lead Screw Backlash

When alternating between clockwise and counterclockwise rotation of the X or Y-axis handwheels, the handwheels move freely a few degrees but the table stays put. This is backlash, a feature of all leadscrews other than the precision type found on CNC machines.

The acceptable amount of lost motion depends on the user, but 0.005" is generally a good compromise. Smaller numbers are possible but overdoing it can lead to premature wear of leadscrew and nut.

Excessive backlash can be corrected by compressing the feed screw nut. For the X-axis this is done by tightening the socket head screws on each side of the leadscrew. A long-handled 3 mm hex key is required, ideally one with an extra-thick shank to minimize flexing.

The Y-axis feed screw nut has two similar adjusting screws, normally concealed by the solid rubber way cover at the back the table. A 3 mm hex key on a universal-jointed driver, or other type of flexible driver, is necessary to adjust the screws.



X-axis lead screw

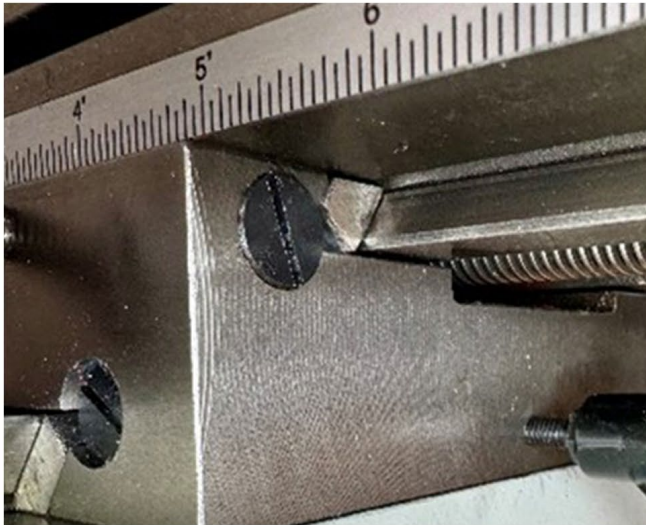


Y-axis lead screw



## Mill Gibs

A gib is a strip of metal placed between the bearing surface of two machine parts to ensure a precision fit and provide adjustment for wear. The bench mill has gibs in several places, including between the saddle and the table, and along the column dovetail. The bench mill uses tapered gibs that work like a very fine wedge between the two mating surfaces. Gib adjusting screws come in pairs at each end of the gib. The Z-axis gib screws are on the top and bottom of the mill head. The X and Y-axis gib screws are on the front & back and left & right sides of the saddle.



Y-axis gib adjusting screws



Z-axis gib adjusting screws

Keeping your bench mill in adjustment is an ongoing process. Adjusting gibs is a trial-and-error process that takes time and patience. Aim for the best compromise of rigidity and reasonably free table movement. Too tight means accelerated wear on the ways and leadscrews. Too free means workpiece instability, inaccuracies, and chatter. You should check all the following adjustments when you set up your mill and then periodically as you use your mill. **Before beginning, ensure your gibs are well lubricated and free of debris.**

## Adjusting Gibs

The process for adjusting gibs on your mill is essentially the same for each axis. Here is the general procedure. Each individual axis will be addressed after the overview.

If there isn't enough free movement in the table when a handwheel is turned, then the gibs are too tight. If there is too much movement (play) in the dovetails of the table, then the gibs are too loose.

Each axis will have a pair of gib adjustment screws; left and right for the X and Y-axis, top and bottom for the Z-axis. The process of adjusting the gibs is to loosen both screws of a pair and tightening the appropriate gib screw to move the gib in or out of the dovetail. When the gib is properly positioned, you tighten the other screw to set the gib in place.

### General Gib Adjustment

If a gib is too loose (too much play), you need to move it further into the dovetail by tightening the screw on the wide side of the gib. If the gib is too tight (not enough free movement), you need to move it further out of the dovetail by tightening the screw on the small side of the gib.

1. Loosen both screws to allow the gib free movement.
2. Finger tighten the screw on the wide or narrow end of the gib to move it further in or out of the dovetail.
3. Once the positioning feels correct, tighten the alternate screw to lock the gib into place.
4. Test gib adjustments by turning the handwheel to ensure the table moves freely but without play in the dovetail. Repeat adjustments as necessary.

### X-Axis Gib

The X-axis gib provides adjustment for the mating dovetails on the saddle and the table that provides the X-axis (crosswise) motion. The wide end of the X-axis gib is on the right side of the table.

If the gib feels loose, tighten the right-side screw (the wide end of the gib). If the gib feels tight, tighten the left-side screw (the narrow end of the gib).

### Y-Axis Gib

The Y-axis gib provides adjustment for the mating dovetails on the base and the saddle that guides the Y-axis (forward and backward) motion. The wide end of the Y-axis gib is on the front of the table.

If the gib feels loose, tighten the front screw (the wide end of the gib). If the gib feels tight, tighten the back screw (the narrow end of the gib).

### Z-Axis Gib:

The Z-axis gib provides adjustment for the mating dovetails on the column and the headstock, controlling the Z-axis (vertical) motion. The wide end of the Z-axis gib is on the top of the headstock.

If the gib feels loose, tighten the top screw (the wide end of the gib). If the gib feels tight, tighten the bottom screw (the narrow end of the gib).



## Tramming the Mill

Tramming is the process of squaring the column with the table on a mill to ensure spindle and table are perpendicular ( $90^\circ$ ). With a fixed column mill, the leveling is achieved by altering the tilt of the column relative to the table. This involves placing shims under the corners of the base of the column where it bolts to the base.

From the factory, your mill should be trammed within specifications. Over time or with specific applications it may be necessary to check or adjust the tram.

Tramming the mill requires the use of a dial test indicator mounted to a universal indicator arm so that it rotates with the spindle and reads against the table at the farthest distance possible from the spindle. Directly mounting to or in the spindle vs. a drill chuck or other tool holder will reduce potential runout from that tool holder in your measurements.

Tramming can also be accomplished with a spindle square although measurement area is generally restricted.



**Bench Mill Tramming Kit**



**Spindle Square**

Chris' Tip: You can find a bench mill tramming kit ([part #5586](#)), a spindle square ([part #6479](#)) and shim stock ([part #4304](#)) at [LittleMachineShop.com](http://LittleMachineShop.com).

## To Tram the Mill

Tramming the mill will be described here using a dial test indicator, universal indicator arm, and shim stock.

Chris' Tip: The factory specification is about 0.0005" per inch, or almost 0.010" over the width of the table. You may want to try to do better than this.

The fixed rigid column on this mill should not fall out of tram easily. If your tramming measurements fall outside of factory specifications, first check if your table is level, in good working condition, and seated properly in the saddle. As you set up your tramming tools, ensure that the universal indicator arm is set in the spindle collet properly.

### Measuring Tram

1. Mount the universal arm into a collet in the spindle and mount the dial test indicator so that it will reach to the front left and front right corners of the table.



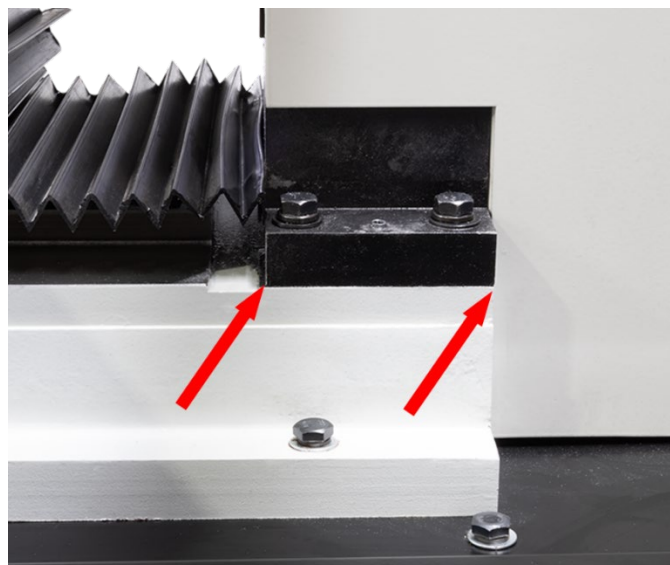
2. Zero the indicator on one of the corners. Hold the indicator plunger and move the indicator to the other corner (ensure arm is locked so as not to alter positioning). Measure the other corner
3. If you get a negative reading, the table is low in that corner. If you get a positive reading, the table is high in that corner. You can also check the other corners and get a sense of how level and perpendicular your table is to your spindle. Take readings on the front and back of the table as well to provide a clear picture of your column positioning in relation to your table. The table should be level and perpendicular to the column.

## Leveling to Ensure Tram

With a solid column mill, very small amounts of leveling may be accomplished by loosening and tightening the column mounting bolts. By loosening and tightening the bolts in a sequence where you tighten the high side first, you may succeed in achieving the leveling you desire.

If working with the bolts alone does not accomplish your goal, shim stock may be necessary. To do this, follow these steps.

1. To adjust your column, the next step is to place shims under the appropriate sides of the base of the column. Loosen the four bolts securing the column. They don't need to be removed, just loose enough that the column corner can be raised slightly, enough to place a thin piece of shim stock under it. The shim stock will raise the corner, adjusting the overall angle of the column.
2. In general, if you found the right side of the table was low, you would shim the left side of the column. This slightly tilts the column to the right and closes the distance to the table reducing the low point. If the other side is low, the opposite side should be shimmed. This process also applies to the front to back tram.
3. Take additional readings, adding or removing shims. Repeat until the readings are the same to within 0.002". Keep in mind that re-tightening the column bolts will likely result in some compression of the shim stock.
5. When satisfied with the measurements, it's time to retighten the column bolts. The order and process of tightening these bolts can impact the outcome. Crank down on one side with the other loose and you will tilt the column. It's best to finger-tighten all four bolts initially, and then slowly tighten each in turn, a small amount at a time. You may end up tightening each bolt 3-4 times, but you'll ensure the column is seated while preserving the adjustments made while tramming it.



**Place shims in corners as needed.**

## Using Your Mill

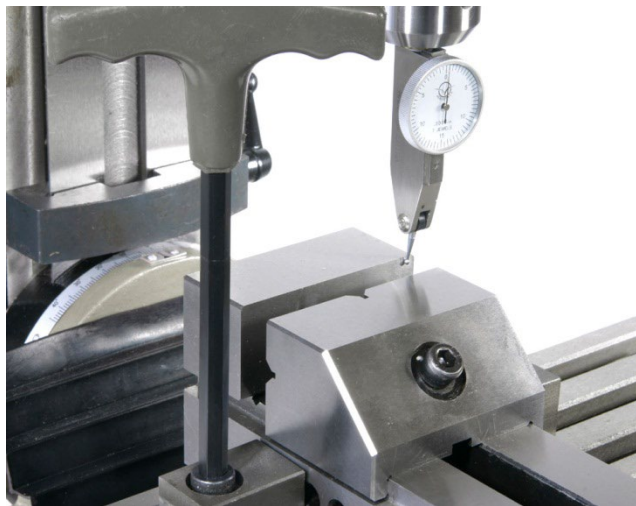
### *Squaring a Vise*

When you mount a vise on the mill table, it is important that it be mounted square to the table. If your vise is not square to the table, you will not be able to produce accurate work.

The vise is usually mounted with the long axis of the vise perpendicular to the long axis of the table. Thus, the jaws are parallel to the X-axis of the mill.

#### **To square a vise on the table:**

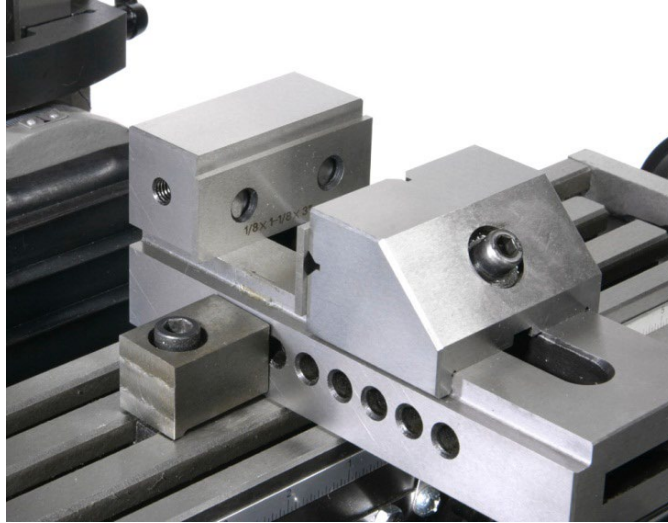
1. Mount the vise on the table and snug, but don't tighten, the mounting bolts.
2. Open the vise jaws at least 1".
3. Put the 3/8" diameter post on the top dovetail of a dial test indicator.
4. Put the dial test indicator post in a drill chuck, end mill holder, or collet in the mill's spindle with the dial facing front.
5. Move the X, Y, and Z-axis controls so the point of the dial test indicator is between, and about 1/8" below, the top of the vise jaws.
6. Move the X-axis so the dial test indicator's point is about 1/16" inside of one end of the vise jaws.



7. Move the Y-axis so that the dial test indicator's point contacts the fixed jaw of the vise. Continue moving the Y-axis to zero the dial test indicator.
8. Move the X-axis so that the dial test indicator's point wipes across the width of the fixed jaw of the vise.
9. Take a reading when the point of the dial test indicator reaches the far end of the vise jaw.
10. Move the Z-axis to raise the dial test indicator so that the point is above the vise jaws.
11. Tap the vise with a dead-blow hammer to rotate it in the appropriate direction to reduce the reading on the dial test indicator.
12. Repeat steps 5 through 11 until the reading on the dial test indicator is acceptable to you. You should be able to reduce the reading to 0.001" or less, then tighten the mounting bolts.

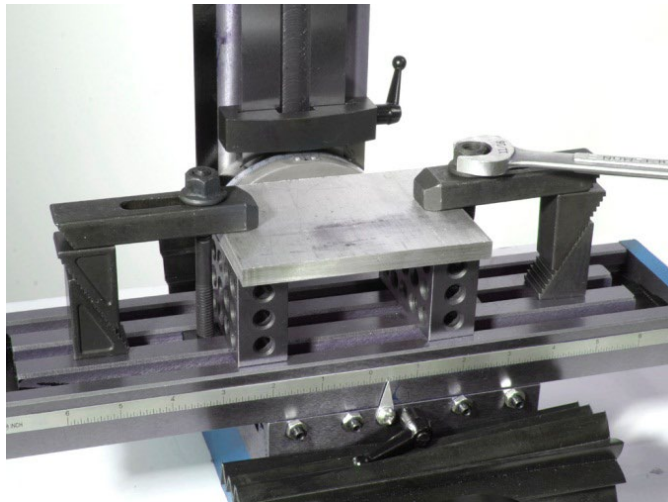
## *Using Parallels*

Precision parallels are used to raise the workpiece off the bed of the vise to a position where you can mill the top surface. Parallels come in sets of graduated heights. Choose a pair of parallels that position the top surface of the work above the top of the vise jaws, while keeping enough material between the jaws of the vise for effective clamping.



## *Clamping with a Clamping Kit*

The clamping kit is the "multi-purpose tool" of the milling machine. Use it to clamp large workpieces, fixtures, and even vises to the mill table. Additionally, add 1-2-3 blocks to the mix as they can be used to hold workpieces up off the table, mount workpieces, and to set-up work perpendicular to the mill table.



When clamping with step blocks and clamp bars, the end of the clamp bar on the step block should be just a little higher than the end on the workpiece. This ensures that the end of the clamp bar contacts the workpiece. The stud should be located as close to the workpiece as possible so that most of the clamping force is exerted on the workpiece and not the step block.



## *Finding the Edge of a Workpiece*

Once your work is secured on the table, the next step is to locate the edge of the work so you can zero the X- and Y-axis dials.

Most engineering drawings show dimensions from two perpendicular edges of the workpiece. These are the two edges that you should "find" or locate, as you zero the X- and Y-axis dials.

The goal is to set the X- and Y-axis dials to zero with the centerline of the spindle directly over the respective edge of the workpiece. Then all movements of the workpiece relative to the spindle are referenced to these two edges.



1. To find the left edge of a workpiece:
2. Put the solid body of an edge finder in a collet or drill chuck in the mill's spindle.
3. Offset the movable end of the edge finder so that it is not concentric with the body.
4. Move the edge finder so that it is clear of the workpiece beyond the left edge.
5. Lower the mill's head so that the smaller diameter section of the movable end of the edge finder is next to the workpiece.
6. Turn the mill on and adjust the speed control to about half of full speed
7. With the edge finder spinning, it is obvious that the movable end of the edge finder is not concentric with the body.
8. Slowly turn the X-axis handwheel clockwise to move the table to the left. As the workpiece approaches the edge finder it first forces the movable end to become more concentric with the body.
9. When the movable end of the edge finder is almost perfectly concentric with the body it will suddenly jump to one side and stay there.
10. The point at which the movable end of the edge finder jumps to one side is the point you are looking for. Stop turning the X-axis handwheel at this point.
11. Turn the spindle off.
12. Raise the mill's head so that the edge finder is completely above the workpiece.
13. Set the X-axis dial to zero as a reference point for the next step.
14. Turn the X-axis handwheel clockwise 0.100". The HiTorque bench mill dials have 100 divisions, so one full turn of the handwheel will yield 0.100". (The movable end of the edge finder is 0.200" in diameter, so you are moving the distance from the center of the edge finder to the edge of the workpiece.)

15. Zero the X-axis dial and zero out the DRO display X-axis if desired.
16. Note the location of the pointer relative to the X-axis scale across the front of the table. This is the zero point for your X-axis movements.

Chris' Tip: Edge finders have maximum spindle speed ranges. Always check your finder's vendor specifications to ascertain an optimal speed range. Spinning an edge finder too fast can damage the product.

## Drilling

There are several ways to locate the position at which you want to drill a hole. You can use your layout tools to scribe crossed lines at the hole location, and then use a wiggler to align the mill's spindle over the intersection of the scribed lines.

You can use an edge finder to locate two edges of the workpiece, and then use the X- and Y-axis handwheels and dials to locate the correct location.



Once you find the location, start the hole with a center drill or spotting drill. These specialized drills have relatively large diameter shanks to prevent bending or wobbling as you start the hole. This ensures that the hole is located directly below the center of the spindle.

Next, drill a pilot hole about 1/8" in diameter (but not larger than the final size you need).

Finally, drill to the final drill size you need. You can drill the final hole size as long as two conditions are met. First, the web of the drill (the short straight section at the very tip of the drill) must fit into the pilot hole. Second, the drill must not be too large for the bench mill to drive. If power is an issue, use smaller drills to reach the final diameter in steps.

## Milling

You can use collets or end mill holders to hold end mills. The world is split about 50/50 on which is better. We will give you the arguments for both sides and let you decide.

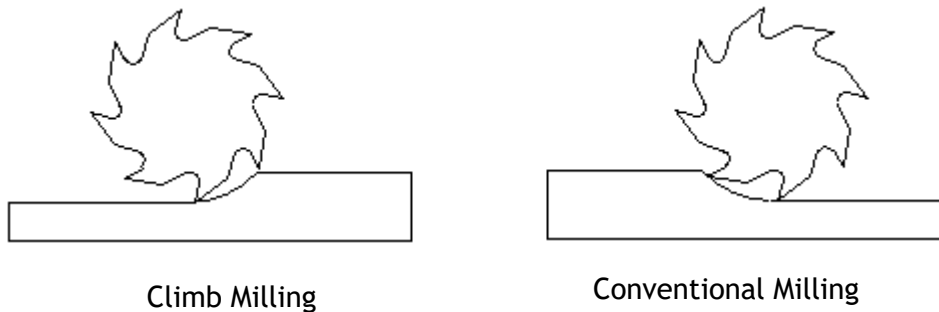
	
<b>Collets</b>	<b>End Mill Holders</b>
Collets are shorter than end mill holders and so give you more vertical work area.	End mill holders are longer than collets and so let you reach nearer the bench mill's table.
Collets grip the end mill all the way around and so provide a better grip.	End mill holders have a setscrew that bears on the flat on the shank of the end mill and so ensure that the end mill cannot slip.
Collets are more concentric than end mill holders because they grip all the way around the end mill's shank.	Because they fit the end mill closely, end mill holders ensure concentricity.
Collets are less expensive than end mill holders and so can be replaced when they wear out.	End mill holders are more robust than collets and are less prone to wear out.
To loosen the collet enough to remove the end mill, about two turns of the drawbar wrench will work. However, if loosen it too much, the collet and end mill may fall out and you must busy one hand to prevent this.	It is easier to replace an end mill in an end mill holder because the end mill holder can remain in the spindle.

Whether you choose end mill holders or collets, they are used to hold an end mill in the spindle of the bench mill.

End mills are called that because they cut on the end, as well as on the periphery. Earlier milling cutters used in horizontal milling machines only cut on the periphery. This makes end mills versatile. You can mill the sides of a workpiece, the top surface of a workpiece, and even cut slots and holes in a workpiece.



## *Climb Milling Versus Conventional Milling*



Depending on the direction in which you move the workpiece against the end mill you are either climb milling or conventional milling. As shown in the illustration above, you are climb milling when the end mill turns as to climb the slope made by cutting.

Climb milling has several advantages and is often recommended for modern milling machines. The flutes dig in to material with a climbing action, and the workpiece and rotation of the cutter are going in the same direction. With this forward stroke the tooth starts with a full chip and pushes the workpiece down against the table or holding device. This requires less machine power, the cutter does not dull as soon, and a better surface finish is produced.

However, climb milling requires a very rigid milling machine with virtually no backlash. Because the workpiece and the milling cutter are moving in the same direction, the milling cutter tends to pull the workpiece away from the driving device if there is any backlash. This can overload the cutter and stall the machine. Or it can simply leave a poor surface finish.

On light mills like the bench mill, use conventional milling for all but the lightest cuts. Then, take your final cut of one or two thousandths of an inch using climb milling for the best surface finish.

## *Plunge Milling*

Plunge milling is the same action as drilling but using a center cutting end mill instead of a drill. This is how you start a slot that does not extend to the edge of the workpiece.

Some end mills are center cutting. This means that one of the cutting edges on the end of the end mill extends across the center of the end mill so that there is a cutting edge for the full diameter of the end of the end mill.

Non-center cutting end mills have cutting edges on the end, but they do not extend to the center. These end mills will cut on the end and can be used for slotting and surfacing, but you cannot plunge a non-center cutting end mill straight down into the workpiece.

## *Milling Slots*

Milling slots is the signature operation for a vertical milling machine. For example, to make a belt-adjustment slot, you plunge mill through the workpiece at one end of the slot, mill the length of the slot and raise the end mill at the other end.

But of course, life is not as simple as this. You may or may not be able to remove all the material in one pass. If the workpiece is thick you might need to make multiple passes along the length of the slot, lowering the end mill between passes.

And, if you use an end mill where the diameter of the end mill is the same as the width of the slot, you are conventional milling on one side of the slot and climb milling on the other. You will see markedly different surface finishes on the two sides of the slot. But since slots usually need to provide some clearance for the bolt that will go through them, the solution is easy. Use an end mill the same size as the bolt, then take a few cleanup passes to widen the slot slightly wider than the end mill diameter. Your final passes should be climb-milling passes on each side of the slot.

## *Surfacing*

Surfacing is used to square a workpiece and to provide a good-looking surface as well as to change the size of a workpiece.

If you are trying to make a good-looking surface, use as large a diameter cutter as is practical. While a fly cutter can surface a large area in one pass. It is prudent to use a smaller diameter cutter, such as an indexable end mill for surfacing.

## Common Accessories

You will soon find that the purchase of a mill is just an initial step. There are many tools and accessories that you will need to get full use from your mill. The following are some common accessories used with the bench mill.

### End Mills

End mills are the most used cutters on bench milling machines, and the most common end mills are 2 flute and 4 flute varieties. The fewer the flutes, the greater amount of material can be cut away without causing issues with chip removal.

Conventional wisdom is that 2 flute end mills are used on non-ferrous metals such as aluminum, while 4 flute end mills are used on steel and brass. Here is a short comparison of the two types.



**2 Flute end mills**



**4 Flute end mills**

End mills with 2 flutes are used on aluminum because aluminum is easy to machine, and you can take big cuts. These end mills provide a lot of room between the flutes for the big chips produced when making heavy cuts. But on a bench mill, you are probably not as concerned about maximizing production, and thus you are not taking the same big cuts that a production shop might.

End mills with 4 flutes can produce a slightly better finish at the same cutting speeds because there are twice as many cutting edges, each taking off half as much material. But again, if you are not trying to maximize production, you can simply slow the feed rate with a two-flute end mill for the same effect.

End mills are also classed as "center cutting" or "non-center cutting." With a center cutting end mill, you can plunge the end mill into the work as you would a drill. This is important if you are cutting a slot that does not extend to the edge of the part. Center cutting end mills are easy to identify. If the flutes meet in the middle of the end of the end mill, it is a center cutting end mill. In some cases, one of the flutes will be longer, reaching right to the center. If the flutes stop short of the center, leaving a space with no flutes in the center, it is a non-center cutting end mill. Virtually all 2 flute end mills are center cutting end mills. Currently, most of the 4 flute end mills are center cutting.

The 6-piece end mill sets we sell are economical starter sets. Because all the end mills in the set have 3/8" shanks, you only need one end mill holder or collet to use the entire set.

## Work Holding

There are two main ways to hold work on a mill's table: with a vise or by clamping the workpiece to the table. In our experience, most work can be held in a vise. But from time to time there is a large or odd-shaped workpiece that must be clamped to the table.

### Vises

There is a range of different types of vises that you can use on a bench mill.

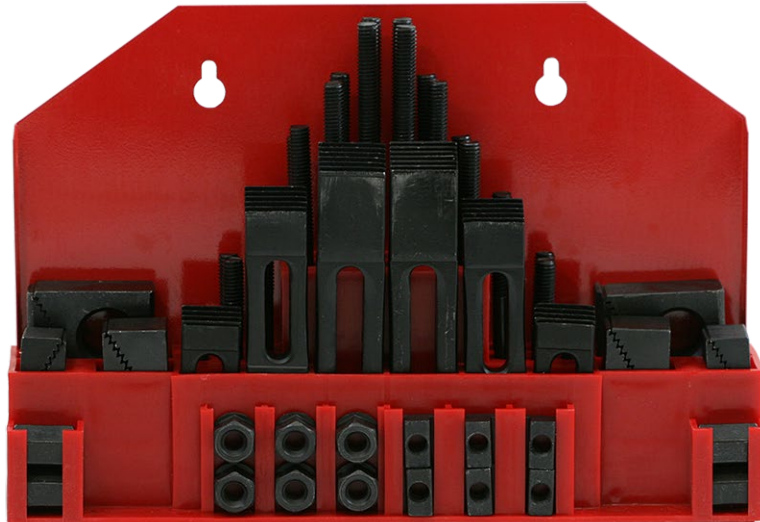


Choose a vise that will handle the work you do. You don't need a 3" vise if the parts you make are a half inch long. While you can usually put small parts in a large vise, it is more convenient to use an appropriately sized vise.

Vise jaws are often too deep for the work being held. In general, you want the top of the workpiece to extend above the top of the vise jaws. To fill the gap from the bottom of the workpiece to the "ways" of the vise, you use parallels. Parallels are strips of metal that have been carefully ground so that the top and bottom edges are parallel with very tight tolerances. They usually come in matched pairs. Place one parallel adjacent to each jaw in the vise and place the workpiece so it rests on the parallels.

## Clamping Kits and Accessories

Clamping kits and their accessories, including 1-2-3 blocks, are the "Erector Sets" of work holding. Use the various pieces of the clamping kit as you see fit to hold a workpiece to the bench mill's table.



In many cases, you need to lift the workpiece off the table, either because the mill spindle won't reach it or because of a projection on the bottom of the workpiece. 1-2-3 blocks are precision ground to be flat and parallel. Use them as spacers to lift the workpiece. You can also use them as an angle plate by bolting a workpiece to the side of the 1-2-3 block and then clamping the 1-2-3 block to the mill table.

## Setup Tools

Once you have your workpiece mounted on the bench mill, you are ready to start cutting metal. Except for one thing, you don't know where the cutting tool is in relation to the workpiece. Edge finders and center finders help you determine the relationship between the cutting tool and the workpiece.



Edge finders locate the edge of the workpiece. Center finders locate the center of existing holes. Wigglers locate the intersection of scribed lines on the workpiece.

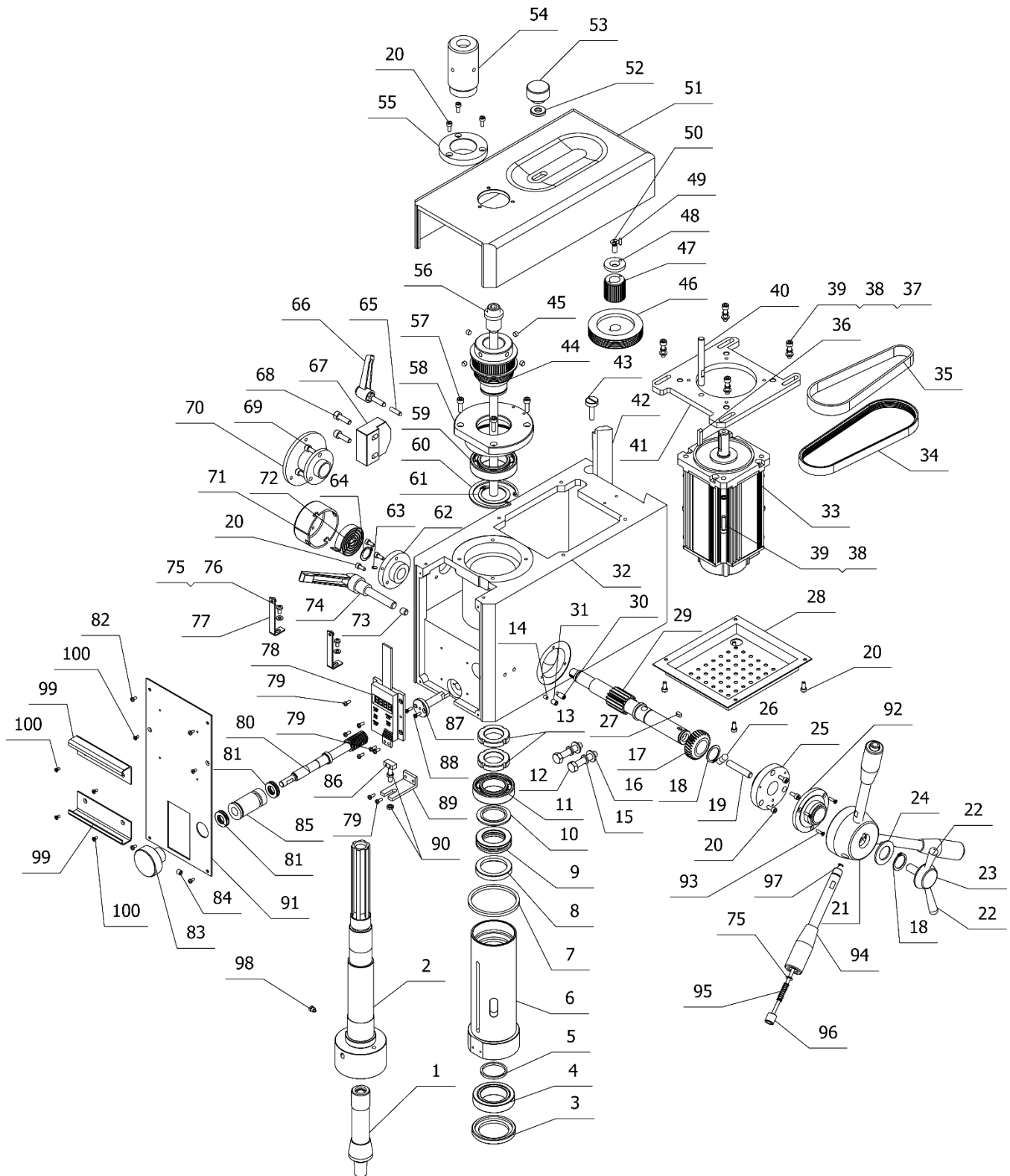
## Troubleshooting

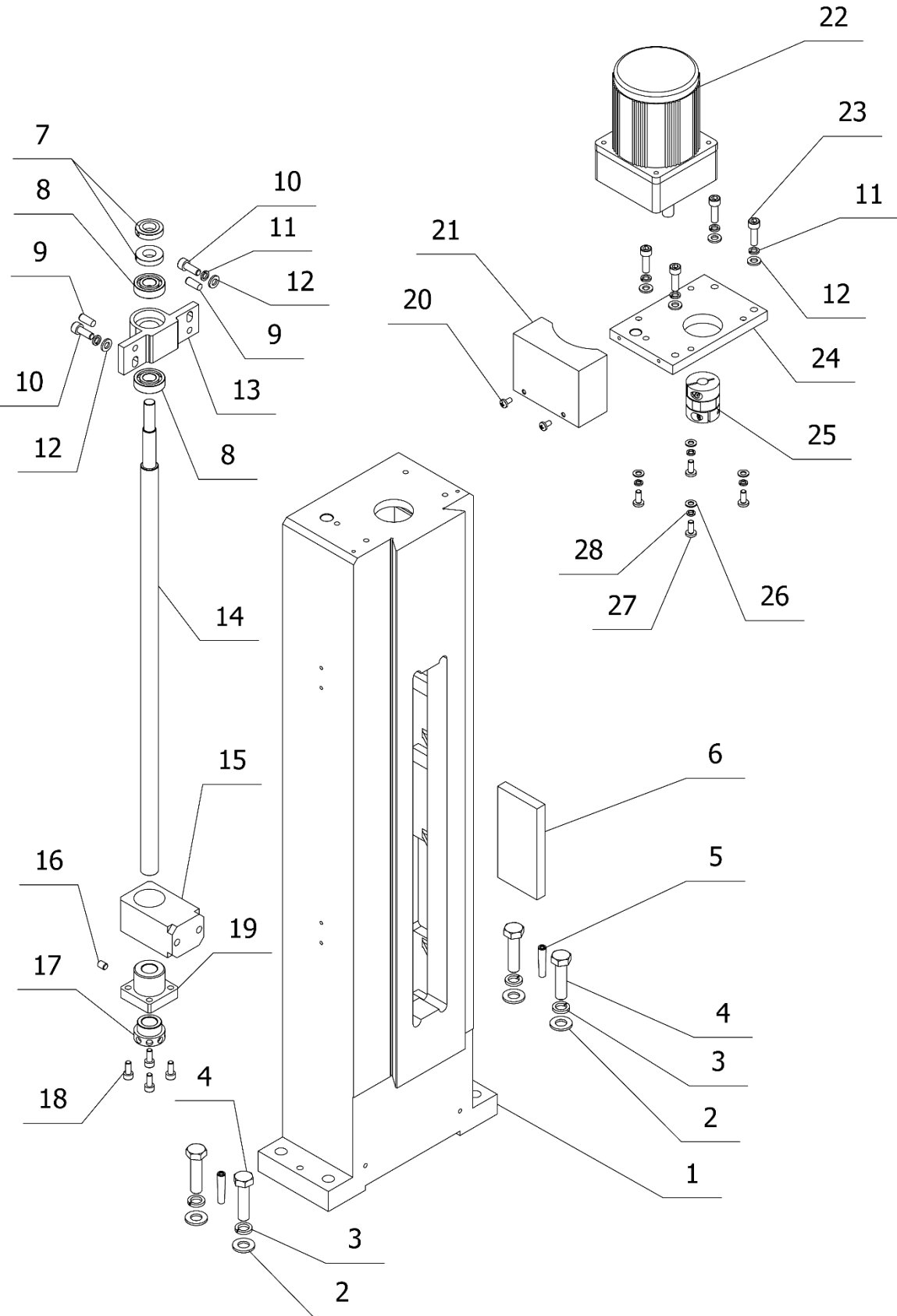
Symptom	Possible Cause	Possible Solution
No Power to machine	Problems with power supply/outlets Machine fuse Spindle Lock engaged	Check circuit breakers/voltage/connections. Replace machine fuse (understand cause) Disengage spindle lock
Motor does not start	Wrong voltage Loose or broken circuit to motor Potentiometer Motor	Check voltage from power supply. Check loosened/disconnected motor connections. Check Potentiometer Check motor
Fuse or circuit breaker Issues	Wire or plug short circuit. Circuit board short circuit. Power supply, fuse, or circuit breaker problem.	Check wires and plugs for damage. Check loosened/disconnected connections. Check voltage from power supply.
Motor overheating	Motor overload Bearing problem Air circulation is restricted	Reduce load on motor. Check bearings. Ensure smooth circulation of air
hand wheel of is too loose	Hand wheel nut loosened. Gib Adjustment off	Tighten the hand wheel. Adjust the gibs
The machine makes constant noise	1. Gear or bearing issue 2. Motor issue.	Replace damaged gear or bearings. Replace motor
During operation, the machine stops	Metal cut too deep Wrong speed or feed speed Cutting tool damage Gear/bearing damaged Motor damaged	Reduce size/depth of cut. Choose the right speed. Replacement cutting tool Replacement gear/bearing Replacement motor
Finish surface difference	Speed or feed speed error. Wrong cutting tool or broken	Adjust the speed or feed. Change the cutting tool
Difficult to move X/Y/Z-axis	Locking levers/Quill Lock engaged Debris on guide rail Drying of guideway	Unlock locking levers. Clean debris from machine Apply Lubricating oil
T-slot nut is difficult to fix	T-slot nut defect or damaged T-slot channel size error	Replace T-slot nut. Confirm T-slot channel size on table
Quill DRO	Improper Reading Dead Battery	Clean DRO Scale Replace Battery

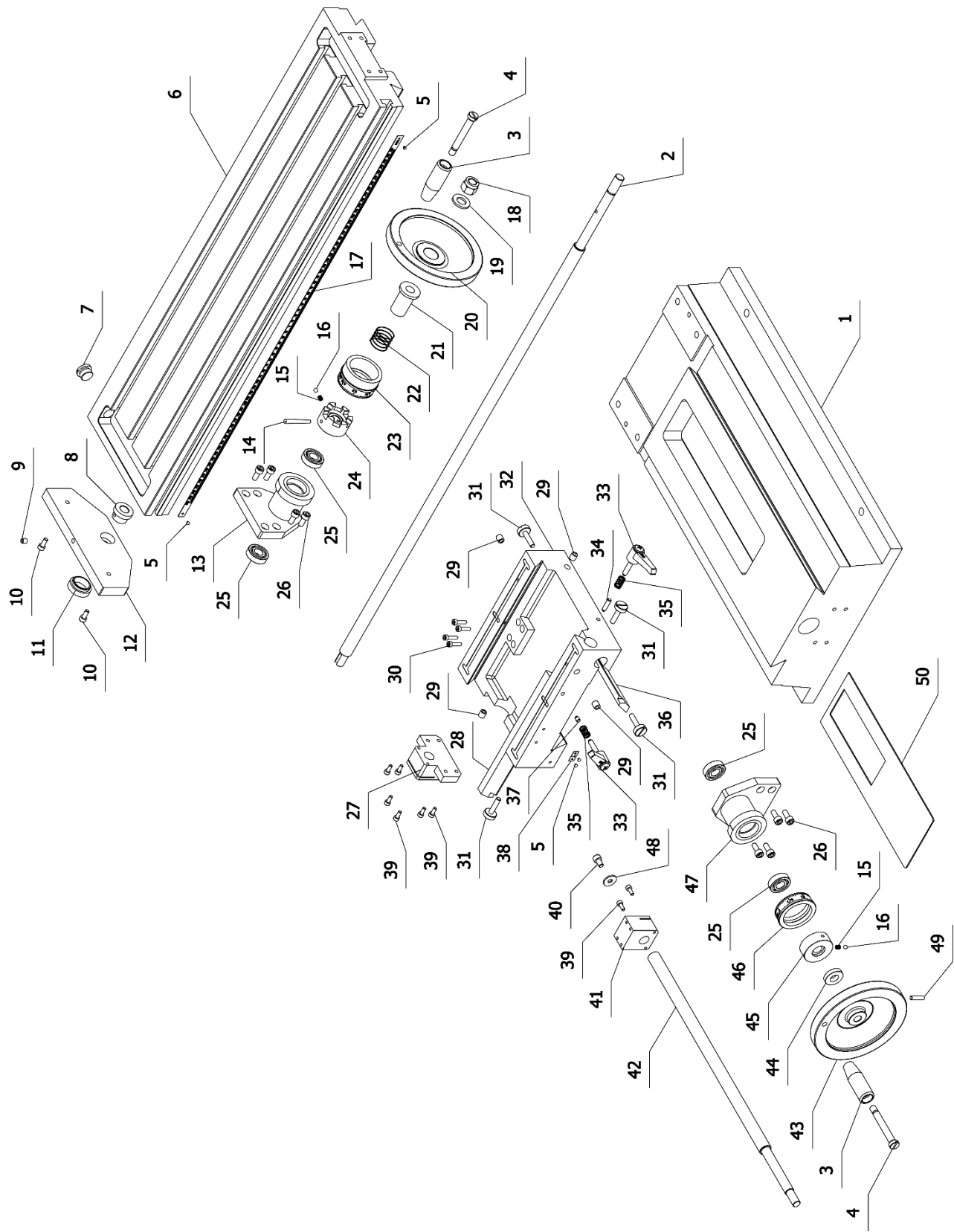


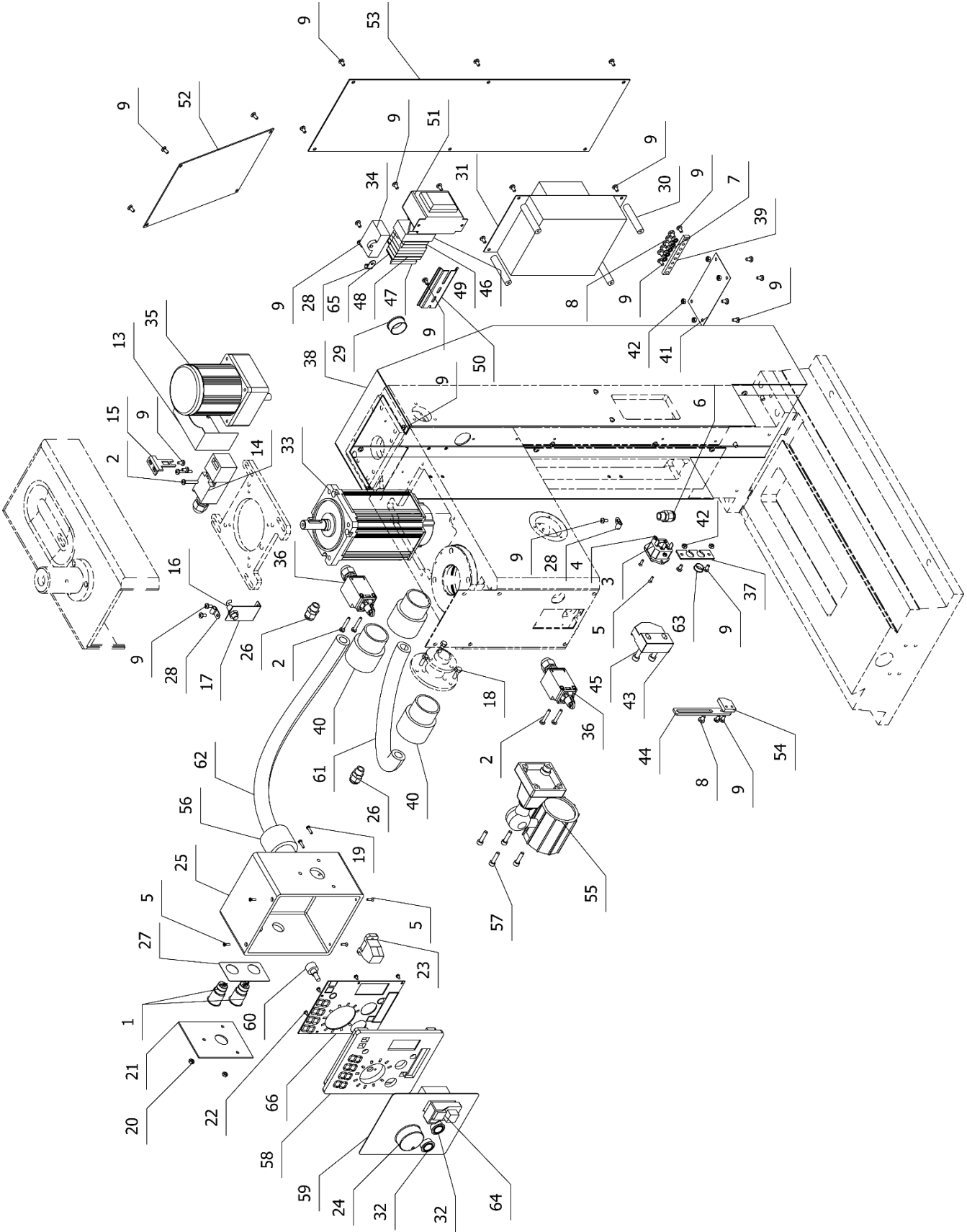
# 6770 Parts Diagrams

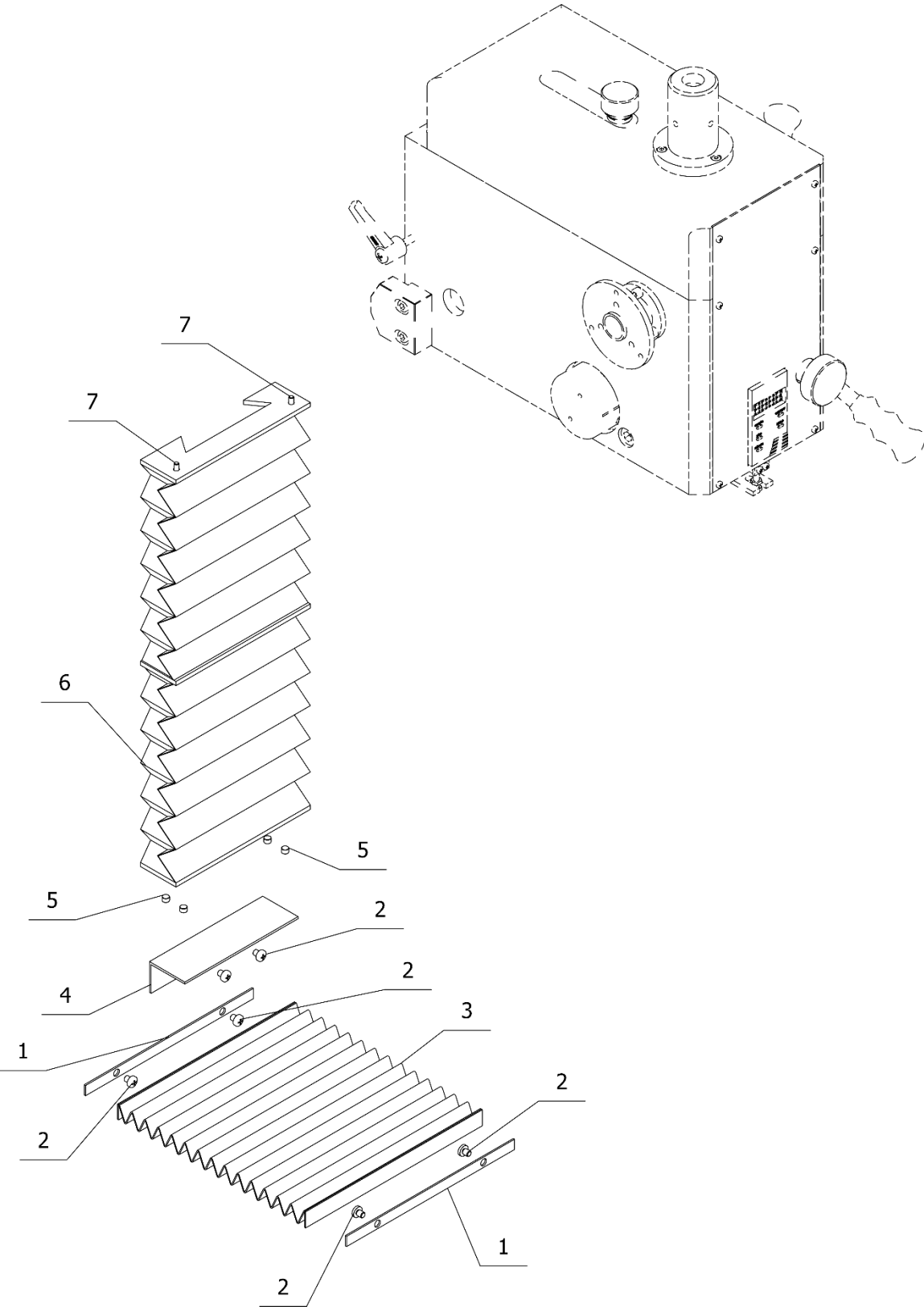
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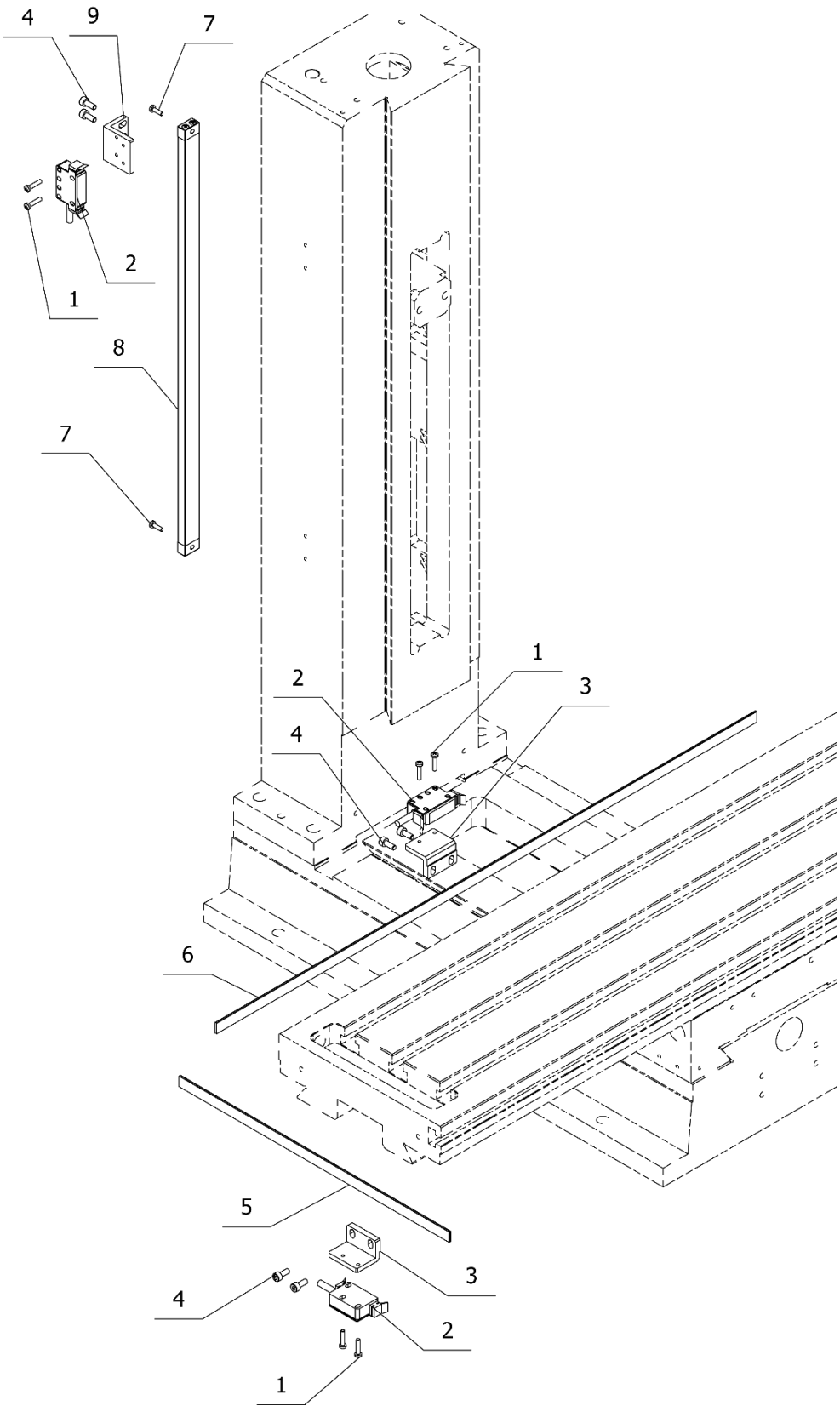




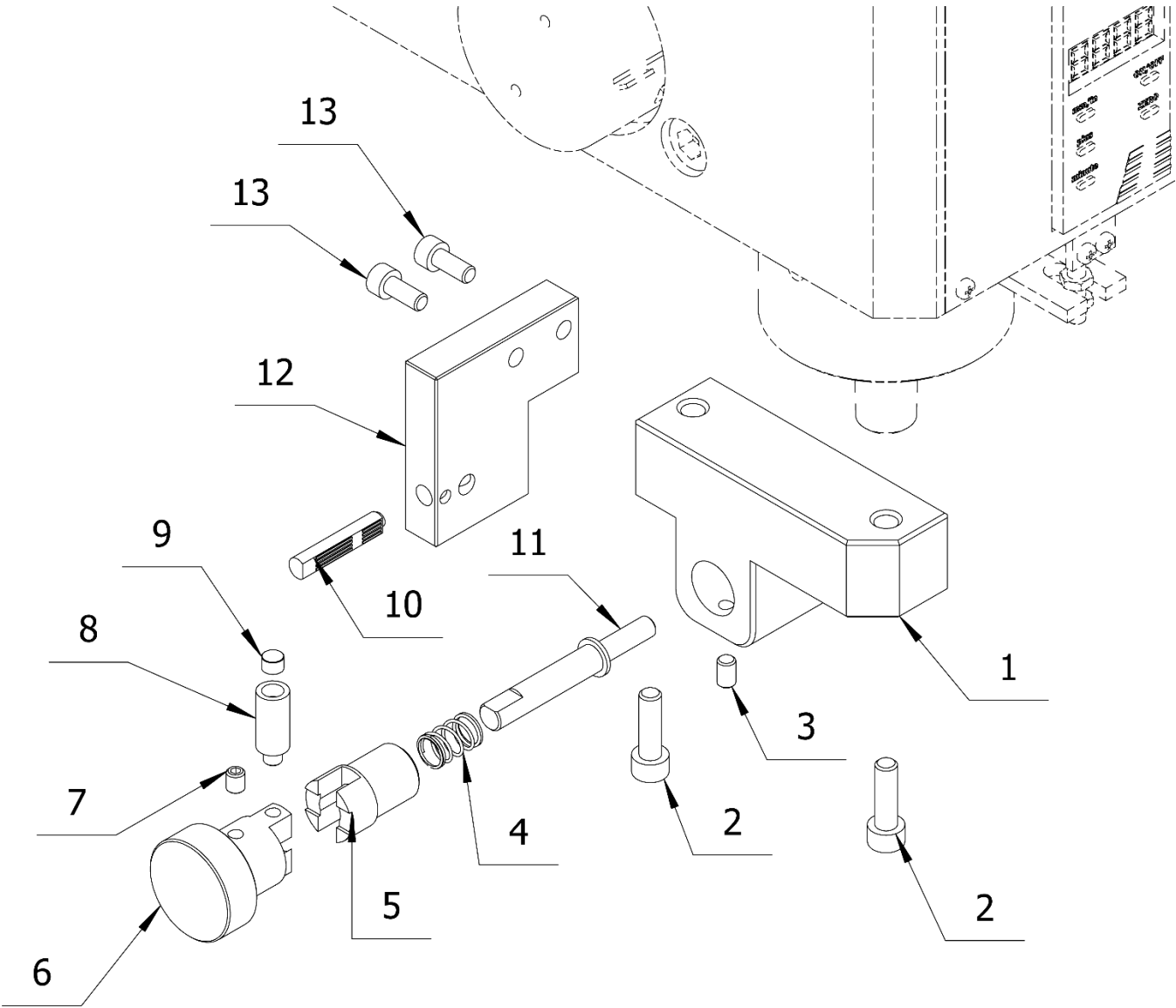




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## 6770 Parts List

Item	Description	Qty
A001	Drill Chuck Arbor, R8 to 33JT	1
A002	R8 Spindle	1
A003	Lower Oil Seal	1
A004	Bearing, Tapered Roller HR32907J	1
A005	Spacer, Top Spindle Bearing	1
A006	Spindle Sleeve	1
A007	Spacer, Spindle Sleeve	1
A008	Upper Oil Seal	1
A009	Bearing, Thrust 51106	1
A010	Spacer, Bottom Spindle Bearing	1
A011	Bearing, 6006-2RS	1
A012	Cap Screw, M8x40, Hex Head	2
A013	Nut, Spindle M27x1.5	2
A014	Block, Pressing	1
A015	Washer, M8 Lock	2
A016	Washer, M8 Flat	2
A017	Gear, Bevel, Quill	1
A018	Retaining Ring, M20 External	2
A019	Shaft, Quill Lock	1
A020	Cap Screw, M4x10, Socket Head	13
A021	Pivot, Quill Pinion	1
A022	Handle, Locking Lever	2
A023	Locking Lever	1
A024	Spacer, Z-Axis Coarse Feed	1
A025	Retainer, Quill Pinion Right	1
A026	Ball, M8	3
A027	Key, 4x8 mm	1
A028	Cover, Bottom	1
A029	Pinion, Quill	1
A030	Set Screw, M6x14 Socket Dog Point	1
A031	Set Screw, M6x8 Socket Flat Point	1
A032	Housing, Spindle	1
A033	Motor, 1000 Watt Brushless	1
A034	Poly V-belt	1

Item	Description	Qty
A035	Belt, Timing	1
A036	Key, 5x25 mm	1
A037	Washer, M5 Flat	4
A038	Washer, M5 Lock	8
A039	Cap Screw, M5x20, Socket Head	8
A040	Stud, Cover Plate Handle	1
A041	Motor Mount	1
A042	Gib, Z-Axis	1
A043	Screw, Gib Adjusting	2
A044	Pulley, Spindle Timing	1
A045	Magnet 6x0	4
A046	Pulley, Multi-V, Motor	1
A047	Pulley, Timing, Motor	1
A048	Washer, Spindle Pulley	1
A049	Pin, 3x10	1
A050	Screw, M6x16 Flat Head Phillips Machine	1
A051	Cover, Spindle Housing	1
A052	Washer, Cover Plate Handle	1
A053	Knob, Cover Plate	1
A054	Cap, Spindle	1
A055	Retainer, Spindle Cap	1
A056	Drawbar	1
A057	Cap Screw, M5x16 Socket Head	4
A058	Retainer, Bearing	1
A059	Bearing, 6007-2RS	1
A060	Retaining Ring, M62 Internal	1
A061	Retaining Ring, M35 External	1
A062	Retainer, Quill Pinion Left	1
A063	Pin, Spring 3x8	1
A064	Retaining Ring, M16 External	1
A065	Pin, Z-Axis Lock	1
A066	Locking Lever, M6	1
A067	Limit Block, Z-Axis Sensor	1
A068	Socket Head Cap Screw M6x20	2

Item	Description	Qty
A070	Mount, Control Box	1
A071	Cover, Clock Spring	1
A072	Spring, Clock	1
A073	Shaft, Quill Lock	1
A074	Cap Screw, M10x25, Socket Head	1
A075	Washer, M4 Flat Black Finish	5
A076	Screw, M4x8 Pan Head Phillips Machine	2
A077	Bracket, Digital Height Gauge	2
A078	Display, Digital Quill Height Gauge	1
A079	Screw, M3x8 Pan Head Phillips Machine	8
A080	Worm Shaft, Z-Axis Find Feed	1
A081	Bearing, Thrust 12x22x5	2
A082	Screw, M3x6 Pan Head Phillips Machine	6
A083	Knob, Z-Axis Fine Feed	1
A084	Set Screw, M6x6 Socket Flat Point	1
A085	Sleeve, Worm Drive	1
A086	Screw, Quill Display Actuator	1
A087	Registration Bracket, Quill Position	1
A088	Screw, M3x10 Flat Head Phillips Machine	2
A089	Bracket, Quill Readout Deluxe	1
A090	Nux, Hex Thin Chamfered M5	2
A091	Front Panel	1
A092	Contact Ring	1
A093	Screw, M3x12 Flat Head Phillips Machine	3
A094	Handle, Rapid Feed	3
A095	Spring, 6 mm x 25 mm	3
A096	Push Button, Reversing	3
A097	Retaining Ring, E-Type M3	3
B01	Column	1
B02	Feed Screw Z-Axis	1
B03	Nut, Z-Axis Locking	1
B04	Nut, Z-Axis Feed Screw	1
B05	Bracket, Lower, Z-Axis Feed Screw	1
B06	Bracket, Z-Axis	1
B07	Pin, M6x16 Tapered	2

Item	Description	Qty
B08	Bearing, 6001-2RS	2
B09	Pin, 6x16 Tapered Threaded	2
B10	Cap Screw, M6x16, Socket Head	2
B11	Washer, M6 Lock	6
B12	Washer, M6 Flat	6
B13	Bracket, Z-Axis	1
B14	Feed Screw, Z-Axis	1
B15	Bracket, Lower, Z-Axis Feed Screw	1
B16	Set Screw, M6x8 Socket Flat Point	1
B17	Nut, Z-Axis Locking	1
B18	Cap Screw, M5x12, Socket Head	4
B19	Base, Z-Axis Feed Screw	1
B20	Screw, M4x8 Pan Head Phillips Machine	2
B21	Cover, Z-Axis Power Lift Motor	1
B22	Motor, Z-Axis Power Lift	1
B23	Cap Screw, M6x20, Socket Head	4
B24	Motor Mount, Z-Axis Power Lift	1
B25	Coupling, Shaft, 10-10-30 mm	1
B26	Washer, M5 Flat	4
B27	Screw, M5x12 Pan Head Phillips Machine	4
B28	Washer, M5 Lock	4
C01	Base	1
C02	Feed Screw, X-Axis	1
C03	Handle, Hand Wheel	2
C04	Screw, Hand Wheel	2
C05	Rivet, M2x4	4
C06	Table	1
C07	Table Plug	1
C08	Bushing, X-Axis Feed Screw	1
C09	Oil Fitting, 6 mm	1
C10	Cap Screw, M5x12, Socket Head	2
C11	Cover, Feed Screw End	1
C12	Retainer, X-Axis Bushing	1
C13	Retainer, X-Axis Screw	2
C14	Pin, 4x40 Tapered	1

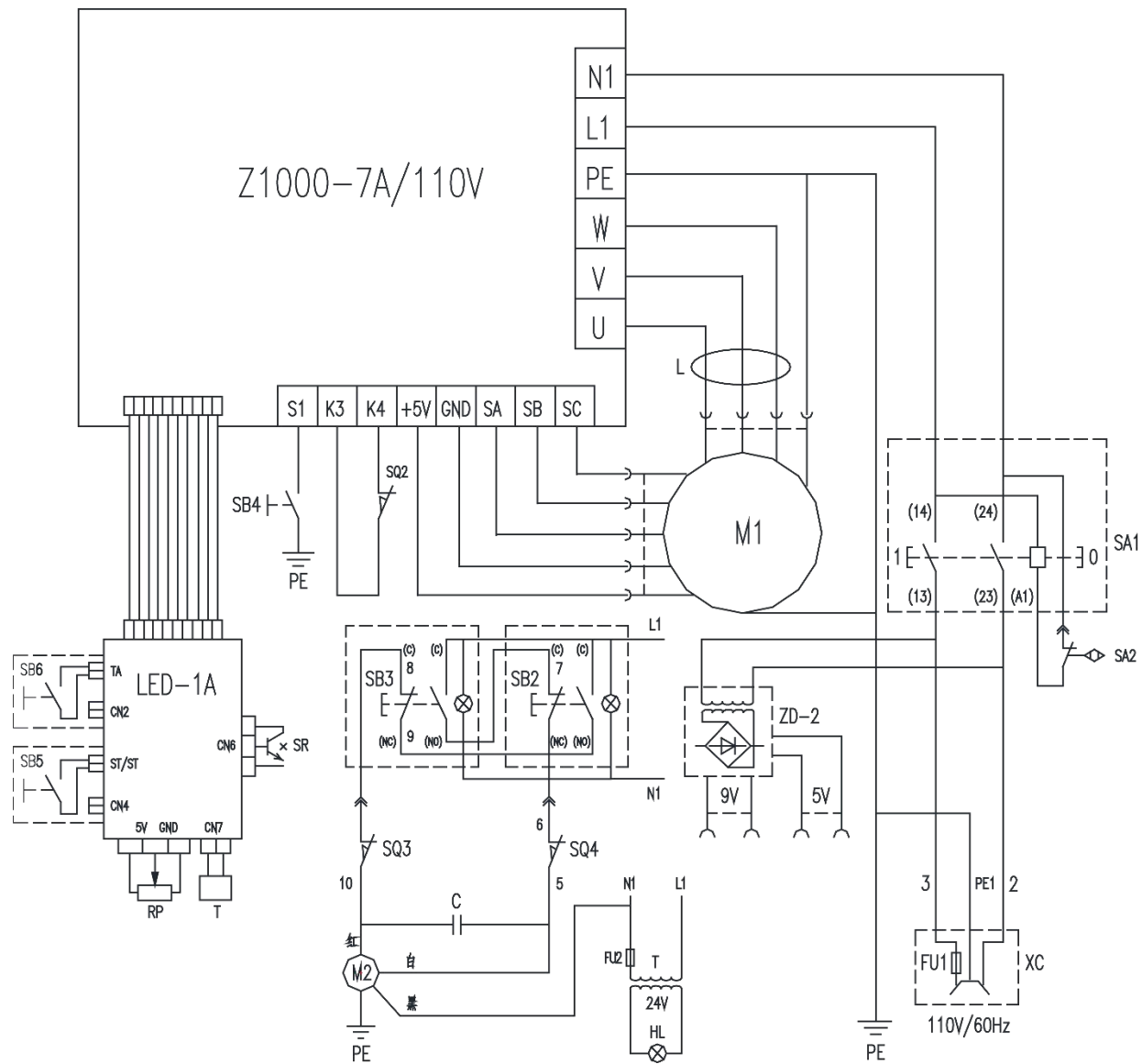
Item	Description	Qty
C15	Spring, 4.65 mm x 9 mm	2
C16	Ball, M5	2
C17	Scale, X-Axis	1
C18	Nut, M12 Nylon Insert Lock	1
C19	Washer, M12 Flat	1
C20	Handwheel, X-Axis	1
C21	Sleeve, X-Axis Handwheel	1
C22	Spring, X-Axis Handwheel	1
C23	Dial, 100 Divisions, X-Axis	1
C24	Clutch, X-Axis Handwheel	1
C25	Bearing, 6001-2RS	4
C26	Cap Screw, M6x14, Socket Head	8
C27	Nut, Feed Screw, X-Axis	1
C28	Gib, X-Axis	1
C29	Oil Fitting, 8 mm	4
C30	Cap Screw, M4x16, Socket Head	4
C31	Screw, Gib Adjusting	4
C32	Saddle	1
C33	Locking Lever, M6	2
C34	Pin, Z-Axis Lock	1
C35	Spring, 9.2 mm x 14 mm	2
C36	Gib, Y-Axis	1
C37	Pin, Locking	1
C38	Label, Position Indicator	1
C39	Cap Screw, M4x10, Socket Head	8
C40	Cap Screw, M6x10 Hex Socket Button	1
C41	Nut, Feed Screw, Y-Axis	1
C42	Feed Screw, Y-Axis	1
C43	Hand Wheel, X and Z-Axis	1
C44	Nut, Z-Axis Drive Locking	1
C45	Spacer, Y-Axis Handwheel	1
C46	Dial, 100 Divisions, Y-Axis	1
C47	Retainer, Y-Axis Screw	2
C48	Washer, M6 Flat Large Diameter	1
C49	Set Screw, M5x20 Socket Flat Point	1
C50	Way Cover Plate	1

Item	Description	Qty
D01	Power lift up/down button	2
D02	Screw, M4x25 Pan Head Phillips Machine	6
D03	Plug, Power Cord	1
D04	Nut, M3	2
D05	Screw, M3x10 Flat Head Phillips Machine	6
D06	Strain Relief, 12 mm	1
D07	Washer, M5 Lock	5
D08	Screw, M5x8 Pan Head Phillips Machine	8
D09	Screw, M4x8 Pan Head Phillips Machine	44
D13	Cover, Z-Axis Power Lift Motor	1
D14	Switch, Safety, Z-Axis Power Lift	1
D15	Support, Power Lift Sensor Probe	1
D16	Sensor Probe, Z-Axis Power Lift	1
D17	Housing, Power Lift Sensor Probe	1
D18	Cap Screw, M6x16, Hex Head	3
D19	Screw, M3x12 Pan Head Phillips Machine	2
D20	Nut, M4	3
D21	Liner, Electric Box	1
D22	Screw, Tapping M2.9x6.5 Round Head	5
D23	USB Port	1
D24	Knob, Potentiometer	1
D25	Control Box	1
D26	Strain Relief, 12 mm	2
D27	Front Plate, Control Panel	1
D28	Fixed wiring button	3
D29	Wiring Ring, Column Back, SB-26	1
D30	Support Post	4
D31	Motor Controller	1
D32	Button, Start/Stop, with Lamp	2
D33	Motor, 1000 Watt Brushless	1
D34	Capacitor	1
D35	Motor, Z-Axis Power Lift	1
D36	Sensor, Z-Axis Limit	2
D37	Line card bracket	1
D38	Column Back Cover	1

Item	Description	Qty
D39	Grounding Bar	1
D40	Connector, Quick, M40B-AD34.5	3
D41	Screen, Dust	1
D42	Nut, M4	6
D43	Control Box	1
D44	Adjusting rod	1
D45	Cap Screw, M6x20, Socket Head	2
D46	Fuse box	1
D47	Fixture	2
D48	Connecting head	4
D49	Connecting head	2
D50	Guideway	1
D51	Lighting transformer	1
D52	Upper cover plate	1
D53	Lower cover plate	1
D54	Collision block	1
D55	LED Lighting	1
D56	Connector, Quick, Flexible Conduit, 34.5	1
D57	Cap Screw, M5x20, Socket Head	4
D58	Electrical box cover	1
D59	Mirror switch label	1
D60	Potentiometer	1
D61	Flex. Conduit, 21.2 mm	1
D62	Flex. Conduit, 28.5 mm	1
D63	Plug, Wiring, HP Series 13mm	1
D64	Emergency Stop Switch	1
D65	Terminal block	1
D66	LED Light Board	1
D67	DRO Display Mounting Bracket	1
D68	DRO Display	1
D69	DRO Bracket Mounting Screws	2
D70	Fender Washers	2
D71	Small Washers	2
E01	Retainer, Bellows Table	2
E02	Screw, M5x6 Pan Head Phillips Machine	6

Item	Description	Qty
E03	Bellows, Chip Guard	1
E04	Baffle, Way Cover	1
E05	Magnet 6x0	5
E06	Way Cover, Z-Axis	1
E07	Screw, M4x10 Pan Head Phillips Machine	2
F01	Screw, M3x14 Pan Head Phillips Machine	6
F02	DRO Read Head with 9-Pin Connector	3
F03	Bracket, Scale, X & Y-Axis	2
F04	Cap Screw, M4x10, Socket Head	6
F05	Scale, DRO Magnetic 1 Meter	1
F06	Scale, DRO Magnetic 1 Meter	1
F07	Screw, M3x10 Pan Head Phillips Machine	2
F08	Scale, DRO Magnetic 1 Meter	1
F09	Bracket, Scale, Z-Axis	1
F10	DRO Display Mounting Bracket	1
F11	DRO Display	1
F12	DRO Bracket Mounting Screws	2
F13	Fender Washers	2
F01	Screw, M3x14 Pan Head Phillips Machine	6
G01	Bracket, Spindle Lock	1
G02	Cap Screw, M6x20, Socket Head	2
G03	Set Screw, M5x8 Socket Cone Point	1
G04	Spring, 9 mm x 15 mm	1
G05	Bracket, Spindle Lock Shaft	1
G06	Knob, Spindle Lock	1
G07	Set Screw, M5x6 Socket Cone Point	1
G08	Shaft, Spindle Lock Magnet	1
G09	Magnet, 6mm x 4mm	1
G10	Switch, Magnetic, Spindle Lock	1
G11	Shaft, Spindle Lock	1
G12	Bracket, Magnetic Switch, Spindle Lock	1
G13	Cap Screw, M5x12, Socket Head	2

## 6770 Wiring Diagram



Z1000-7: Main control board

LED-1A: Light Board

SA1: Electromagnetic switch

SA2: Magnetic switch

L: Magnetic ring

SR: Tachometer Sensor

M1: Brushless Motor

SB4: Tapping Button

HL: LED Light

T: LED Transformer

ZD-2: DC Power Board

SQ3: Down Limit Switch

SQ4: Up Limit Switch

SB2: Down Button

SB3: Up Button

M2/C: Lifting Motor / Capacitor

FU1: Fuse (20A)

FU2: Fuse (2A)

XC: Socket with Fuse

SB5: Stop Button

SB6: Mill / Tapping Switch Button

SQ2: Microswitch for Head Cover