

## Model PM 25MV-BD

1 HP (750W) brushless dc motor, speed range (VFD) 50 to 2500 rpm

120Vac single phase power

Quiet belt drive, no gears

Quill DRO for precise downfeed measurement

Square column design, heavy cast iron construction

Options: welded steel stand/cabinet, 3-axis DRO

Weight (including stand) 325 lb



**PM 25MV-BD with optional 3-axis DRO**



**PM 25MV-BD with optional stand/cabinet**

## PM 25MV-BD

### FAQ



**My mill doesn't run**

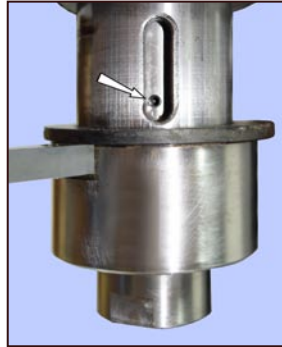


120 Vac power connected? E-Stop button out? Fuse good?

The CHIP GUARD switch may be open. Close the guard.



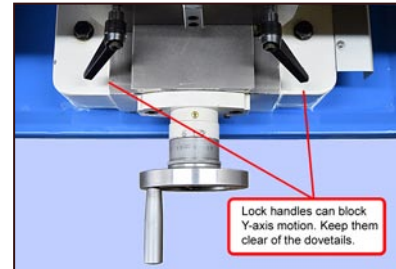
**R8 collets won't go into the spindle**



The collet locating screw could be in too far. Back it out a little.



**The table won't go back to the column**



The X-axis (table) lock handles could be the problem. Swing them up to clear.

This manual contains essential safety advice on the proper setup, operation, maintenance, and service of the PM 25MV-BD milling machine. Failure to read, understand and follow the manual may result in property damage or serious personal injury.

There are many alternative ways to install and use a mill. As the owner of the mill you are solely responsible for its proper installation and safe use. Consider the material contained in this manual to be advisory only. Precision Matthews, LLC cannot be held liable for injury or property damage during installation or use, or from negligence, improper training, machine modifications or misuse.

This manual describes PM 25MV-BD machines as shipped from February 2016. There may be detail differences between your specific machine and the information given here (with little or no impact on functionality). If you have questions about any aspect of the manual or your machine, please call **412-787-2876** (east coast time), or email us at [admin@machinetoolonline.com](mailto:admin@machinetoolonline.com). Your feedback is welcomed!

# Section 1 INSTALLATION



**THESE ARE THE MAIN POINTS TO WATCH OUT FOR!**  
*But read the following pages for more information*

- Handling the mill is at least a two-man job.
- Hand-crank the headstock down until the spindle nose is just clear of the table.
- Lifting gear – sling, hoist or forklift – must be rated for at least 500 lb.
- 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, 1 $\phi$ , 20A circuit protection (spindle motor 14A full load).
- Extension cord not recommended; if no alternative, use 12 AWG not longer than 20 ft.
- Before connecting power 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 potentiometer is set for the lowest speed.

## Setting up the mill

The PM 25MV-BD is shipped in two packing cases, one for the machine and tray (and optional 3-axis DRO), one for the stand. The following procedure makes use of an engine hoist, minimum weight rating 500 lb.

1. Prepare the working location, bench or optional stand.

### **Highly recommended**

Bolt the bench or stand firmly to the floor. Check working clearances, Section 1.

2. Remove the packing case from the pallet, Figure 1-1. Install the largest of the four handles on the headstock handwheel (top of column on right). Install the three smaller handles on the X-axis and Y-axis handwheels.
3. Release the Y and Z axis locks. Check that the mill's center of gravity is as far down and back as possible by cranking both Y and Z handwheels..
4. Tape cloth padding to the underside of the tilt collar.
5. Run a sling under the padding, taking care not to damage the Z-axis locking handle and the cooling fins on the electrical box, Figure 1-2.
6. Hook the sling to the hoist. Slowly lift the mill, controlling any tendency for it to swing as it clears the pallet.
7. Roll the mill into position over the tray, then lower it into place, Figure 1-3.
9. Secure the mill to the bench or stand. If this is a stand installation, use the four bolts M12 bolts supplied (the bolt locations are threaded.) Use lock + plain washers in all locations.



Figure 1-1 Mill ready for lifting

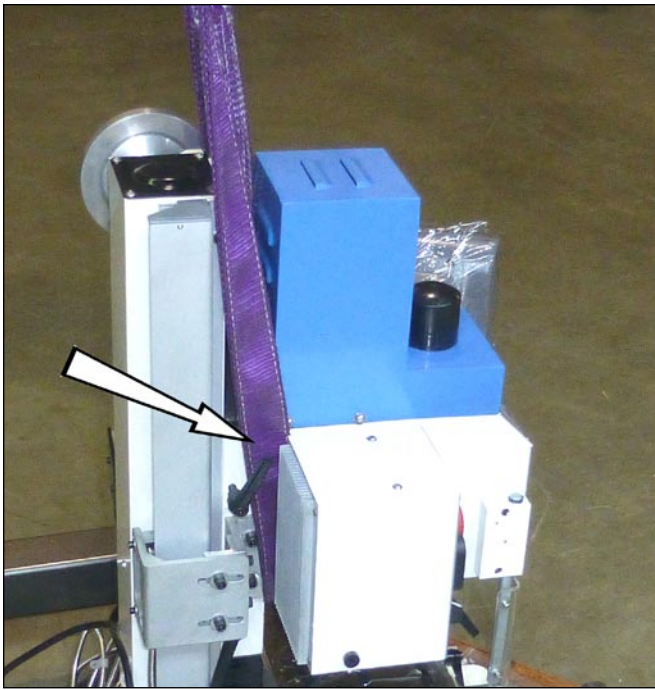


Figure 1-2 Sling position

### Assembly and cleanup

Unfinished metal surfaces may be protected in shipping by thick grease and/or paper. Carefully remove these using a plastic paint scraper, disposable rags and a light-oil type degreaser such as WD-40.

Level the mill using the table surface for reference, shimming under the tray if necessary. Oil the ways and leadscrews (if accessible).

### Initial checks

**Read Section 3 if unsure about any item in the following**

1. Check that no chuck or collet is installed; there are no clamps or locks on moving parts, and; the speed potentiometer is at its lowest setting, fully ccw.
2. Remove the blue motor cover. Make sure the belt is set for low speed (belt running on the larger spindle pulley.) If not, re-position the belt, Figure 3-2. Replace the motor cover.
  1. Connect 120 Vac power.
  2. Be sure the E-Stop (Emergency) button has not been pushed in (it pops out when twisted clockwise).
  3. Press the Power button. The power lamp and the tach display should light.



Figure 1-3 Lowering the mill into position

4. Check the emergency function by pressing the E-Stop button. The power lamp should go out, de-energizing the contactor circuit, disabling all electrics.

***If this doesn't happen, the E-stop function is defective, and needs attention.***

5. Reset (twist) the E-Stop button to restore power.
6. Check that the chip guard switch disconnects power when the guard is swung out.

### Test run procedure

**! DO NOT LEAVE THE MACHINE UNATTENDED DURING THIS PROCEDURE**

1. Select Forward (F) spindle direction. The tachometer should display approximately 50 rpm.
2. Rotate the speed potentiometer cw for a speed of about 200 rpm. Run the spindle at that speed for a few minutes, then progressively increase the speed to the max (about 1250 rpm), pausing for a minute or two at each 200 rpm increment.
3. Repeat step (2) with the spindle reversed (R).
4. Set the belt for high speed, then repeat steps (2) and (3).

The machine should now be ready for normal operations.



# Section 1 FEATURES & SPECIFICATIONS

## MODEL PM 25MV-BD Milling Machine

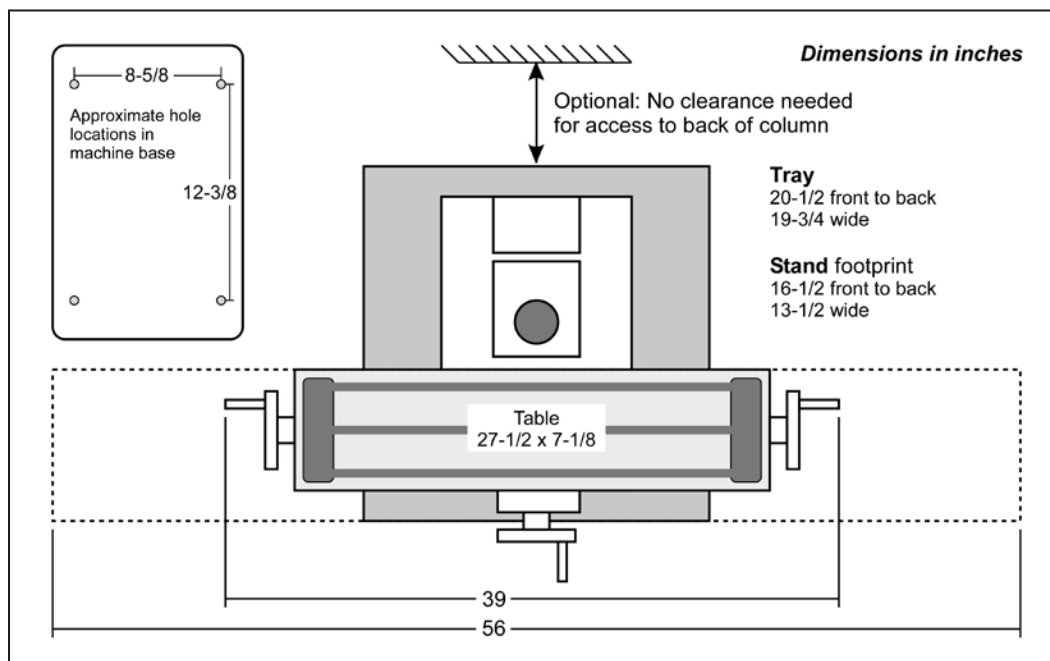
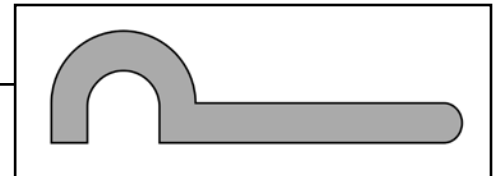
### General information

The PM 25MV-BD is a robust “square column” mill with R8 spindle and continuously-variable spindle speed up to 2500 rpm. It is designed for day-in, day-out use in the model shop. With an all-up weight of 275 lbs it can handle far more than the typical small machine. For precise control of cutter depth there is a worm-driven quill downfeed with graduated dial and DRO, completely independent of headstock up/down position.

The reversible spindle runs in high-quality tapered-roller bearings enclosed in a 2.4” diameter quill with coarse (“drilling”) and fine (“milling”) downfeed options.. It is powered by a 1 HP (750 W) brushless dc motor. Spindle speed is continuously variable from 50 to 1250 rpm, low range, and 100 to 2500 rpm, high range. This is a “gearless” design with two-step pulleys on motor and spindle coupled by a long-life ribbed belt. Precision ground dovetailed ways for table and headstock ensure smooth, precise motion in all three axes: X = left/right motion of table, 20-1/2 in. Y = front/back motion of table, 7 in. Z = headstock up/down, 13 in. Note: DRO installation may limit these numbers. The headstock can be tilted 90° clockwise and counter-clockwise from the vertical.

### Supplied accessories (separate toolbox)

- Spindle lock C-wrench
- 4 handles: 3 (small) for X and Y motion, 1 (large) for headstock
- 10 mm T-bolts/nuts, 2 sets, for vise hold-down
- 3 double-end wrenches: 8-10 mm, 13-16 mm, 17-19 mm
- Hex socket wrenches: 2.5, 3, 4, 5, 6 mm
- Flat blade and Phillips screwdrivers
- Oiler



### Working clearances – space requirements for full motion of the table

## PM25MV-BD SPECIFICATIONS

### Dimensions

Approximate weight:

Machine only	275 lb net, 320 lb shipping
Welded steel stand	50 lb net, 54 lb shipping
Size, including stand	W 39 in. x D 20-1/2 in. x H 68-1/2 in.
Stand footprint	W 13-1/2 in. x D 16-1/2 in.
Tray	W 19-3/4 in. x D 20-1/2 in.

### Electrical

Power requirement	120V, 60 Hz, single phase
Spindle motor	Brushless dc, 750W (1 HP)
Full load current	14A

### Headstock

Vertical travel*	13 in.
Left-right tilt	90 degrees clockwise/counter-clockwise

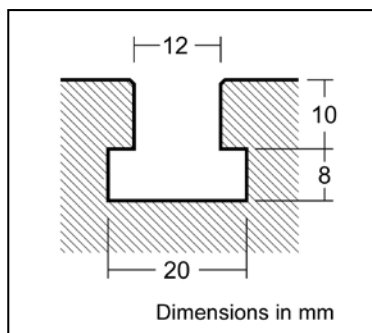
### Spindle

Speeds (rpm)	Low range 50 to 1250, High range 100 to 2500
Internal taper	R8
Quill travel	2 in.
Quill diameter	2.36 in.
Spindle nose to table	2 in. min, 12 in. max
Spindle centerline to front face of column	6 in. to pleated cover (uncovered, 7 in.)
Drawbar	7/16 - 20, 8 mm wrench

### Table

Size	W 27-1/2 in. x D 7-1/8 in.
Surface height over mounting surface	Approx 7 in.
Surface height over floor, if on stand	Approx 38-1/2 in.
Maximum load	200 lb, table centered, less if overhanging
Leadscrews	Acme, inch pitch, 10 tpi
Left-right travel (X-axis)*	20-1/2 in.
Front-back travel (Y-axis)*	7 in.
T-slots (3)	12 mm wide, 63 mm (2-1/2 in.) centerlines

\* DRO installation may limit these numbers



**T-slot dimensions**



## Everyday precautions

- This machine is designed for milling and drilling operations by experienced users familiar with metal-working hazards.
- Untrained or unsupervised operators risk serious injury.
- Wear ANSI-approved full-face or eye protection at all times when using the machine (everyday eyeglasses are not reliable protection against flying particles).
- Wear proper apparel and non-slip footwear – be sure to prevent hair, clothing or jewelry from becoming entangled in moving parts. Gloves – including tight-fitting disposables – can be hazardous!
- Be sure the work area is properly lit.
- Never leave chuck keys, wrenches or other loose tools on the machine.
- Be sure the workpiece and machine ways are secure before commencing milling or drilling – hold-downs and/or vise fully tightened, X-Y-Z axes locked, cutting tool secured.
- Use moderation: **light** cuts, **low** spindle speeds and **slow** table motion give better, safer results than “hogging”.
- Don’t try to stop a moving spindle by hand – allow it to stop on its own.
- Disconnect 120V power from the mill before maintenance operations such as oiling or adjustments.
- Maintain the machine with care – check lubrication and adjustments daily before use.
- Clean the machine routinely – remove chips by brush or vacuum, not compressed air (which can force debris into the ways).

***No list of precautions can cover everything.  
You cannot be too careful!***

## Section 3 USING THE MILL

### MOTOR CONTROLS

**Before doing anything, check the installation instructions in Section 1**

Connect the mill to a 120Vac outlet.

Press and release the green Power **ON** button to energize the control circuit; the tachometer should light. This is a self-latching circuit – when the **ON** button is released, a contactor in the electrical box maintains power until released by the red **OFF** button (also a momentary switch).

- The round orange E-stop button, right, is in series with the **OFF** button. Like the **OFF** button it de-energizes the control circuit completely, but it should be used only for its intended purpose – emergency disconnect. Once the E-stop button is pushed in, it stays in until twisted clockwise to release.
- Also in series with the Power and E-stop buttons is a micro-switch actuated by the acrylic Chip Guard in front of the spindle. The motor will not run if the chip guard is open.
- The spindle motor is controlled by a three position switch, Forward/Stop/Reverse, and a continuously-variable speed pot.

**F** = Forward (cw, looking down, used for most milling and drilling)

**O** = Stop

**R** = Reverse (ccw, looking down)



Figure 3-1 **Spindle motor controls**  
Also shown, arrowed, is the quill locking lever

### SPINDLE SPEEDS

The PM 25MV-BD is a belt-driven machine with two speed ranges, (**L**) 50-1250 rpm and (**H**) 100-2500 rpm.

To select a speed range, disconnect power, then remove the blue motor cover (4 screws). With a 4 mm hex key loosen the socket head screws on each side of the motor, then swing the motor forward to free the belt, Figure 3-2. Make sure that the ribbed belt is properly engaged with the selected pair of grooved pulleys, then re-tighten. Before powering up, rotate the spindle by hand to check tracking and tightness of the belt. Do not over-tighten – aim for  $\pm 1/4$ " slack between the motor and spindle pulleys.



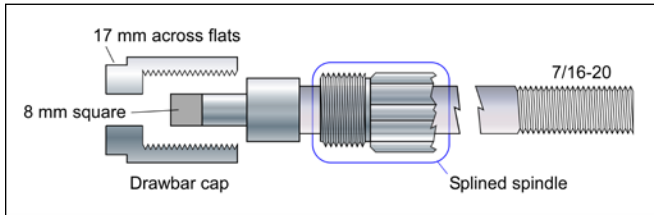
Figure 3-2 **Belt adjustment**

**!** **Excessive cutter noise, chatter, poor finish and tool wear are often the result of too high a feed rate, and/or too high a spindle speed. If unsure, go slow!**



## INSTALLING AND REMOVING TOOLING

The spindle and drawbar are designed for R-8 taper collets, drill chucks and other arbors with the standard 7/16"-20 internal thread.



Two tools are required to install or remove R8 tooling: an 8 mm wrench for the square drawbar nut, and the supplied C-wrench which engages in flats at the bottom end of the spindle.

### Install tooling

Install the R-8 device, then hand-thread the drawbar into it until the shoulder on the drawbar bottoms on the splined spindle, diagram above (on the machine this is concealed by the drawbar cap, Figure 3-2). Lock the spindle with the C-wrench while at the same fully tightening the drawbar with an 8 mm wrench. [Do **NOT** try to lock the spindle using the flats on the drawbar cap; this is screwed onto the spindle to secure the return spring cup.]



**R8 tooling is located in the spindle bore by a set screw. If it is difficult or impossible to insert the R8 device, chances are the set screw is in too far. Rotate the spindle by hand to expose the screw, Figure 3-3, then back it out a fraction of a turn using a 2.5 mm hex wrench.**

**Hand rotate the spindle again to check that the screw clears the inside surface of the quill.**

### Remove tooling

Protect the table, vise or workpiece under the spindle with rags or scrap wood. **Why?** Because they can easily be damaged by falling tools and drill chucks. The cutting tool itself can also be damaged in the same way.

Lock the spindle with the C-wrench, loosen the drawbar one half turn or less, just enough to unseat the taper, then tap the top of the drawbar with a brass or dead-blow hammer to. Unscrew the drawbar with one hand while supporting the R-8 device with the other hand.



**Replace the drawbar cap to protect bearings and splines.**

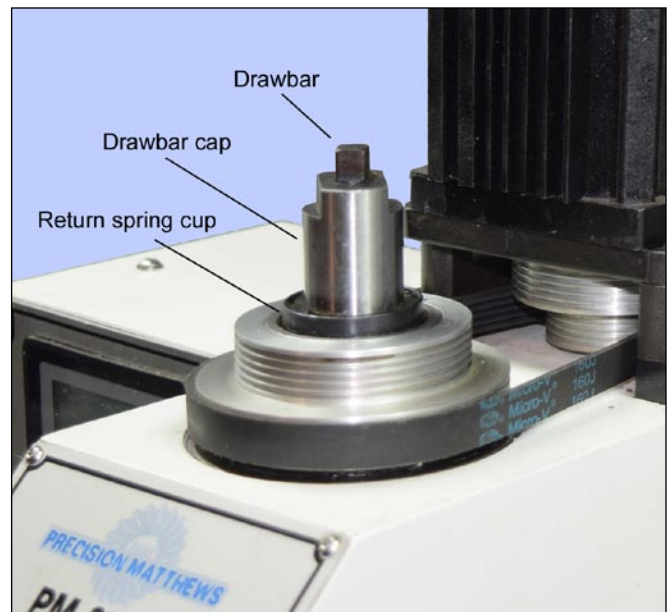


Figure 3-2 Two-step belt drive

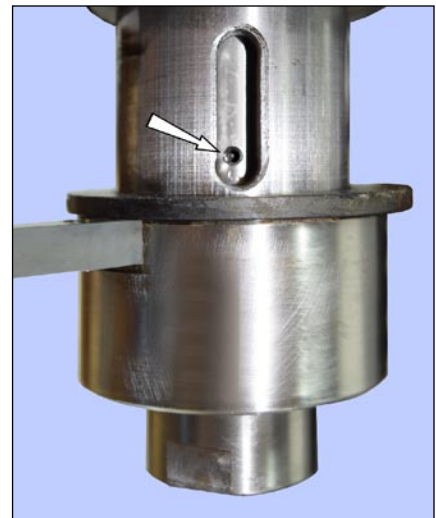


Figure 3-3 Collet set screw

## MOVING THE TABLE

Conventionally, left-right movement of the table is said to be along the X-axis (also called “longitudinal travel” or “traversing”). Front-back movement is on the Y-axis, sometimes called “cross travel”.

Each axis has a leadscrew with handwheel and graduated dial with 0.001” divisions, 0.1” per revolution. If the mill is not equipped with digital readouts (DROs), the table can be accurately positioned by counting whole turns and divisions, keeping **leadscrew backlash** in mind. This means that table motion must always be in the same direction up to the point of reference, then on to the desired location, see “Positioning by Counting X-Y Divisions”, two pages on.

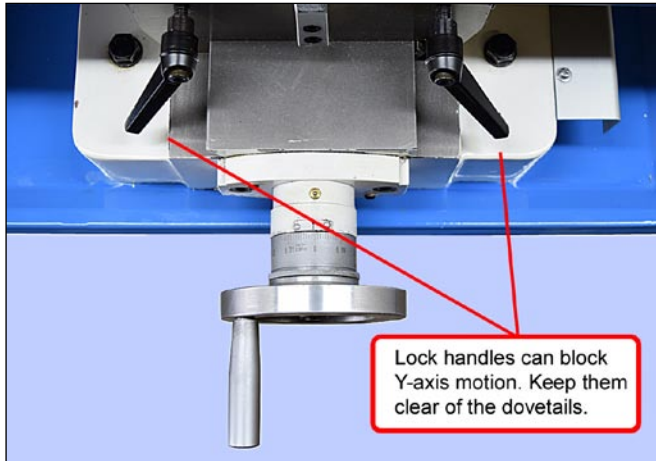


Figure 3-4 X-axis locks

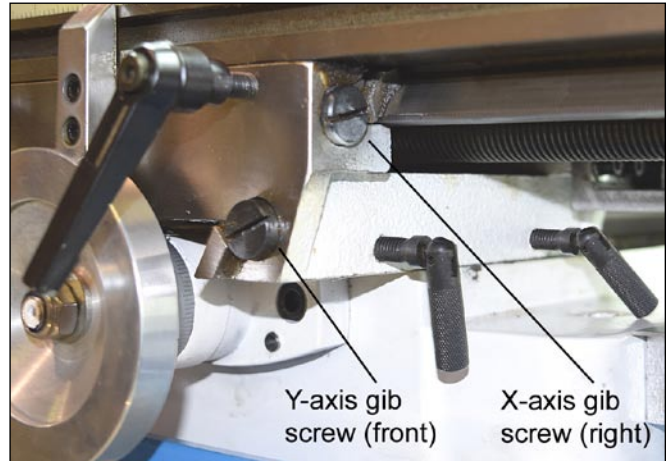


Figure 3-5 Y-axis locks

## RAISING & LOWERING THE HEADSTOCK

The Z-axis crank, Figure 3-6 inset, is at the top right of the column. If the mill has a 3-axis DRO the headstock position is displayed at all times. If not, the headstock can be positioned approximately by reference to a 12” scale on the column. For more precise positioning the crank hub has a graduated dial with 0.001” divisions (be aware of backlash in the bevel gears controlling the Z-axis leadscrew, and also in the leadscrew nut).

When the headstock is at the desired height, lock it in place.

**!** *All milling operations should be done with the quill as fully retracted into the headstock as possible.*

**!** *In operations calling for precise depth control, such as milling, both quill and headstock must be locked to maintain a precise depth of cut.*

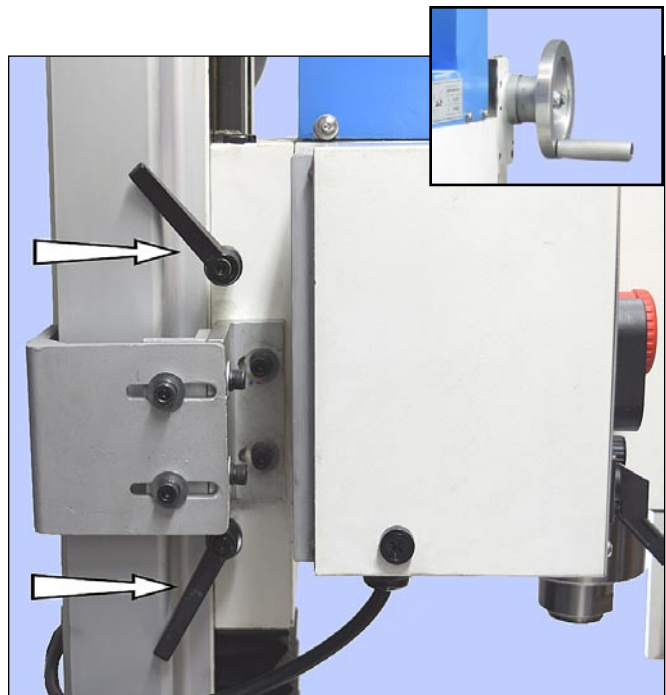


Figure 3-6 Z-axis locks

## QUILL DOWNFEED

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

In the drilling mode, coarse feed, the mill operates like a standard drill press – pull the upper lever toward you to lower the quill. For milling operations the 3-lever hub is disengaged, and the quill is controlled by the fine downfeed handwheel. The quill is locked by a lever on the left of the headstock, see Figure 3-1.

### Coarse feed (Figure 3-7)

For drilling operations, loosen knob (4), allowing the lever hub to rotate independently of sleeve (3).

### Fine feed (Figure 3-7)

For milling operations calling for precise, repeatable control of tool depth, tighten knob (4) to engage hub (1) with the internal taper on sleeve (3). Tighten the Z-axis locks, Figure 3-6.

Rotate the fine control knob (2) to raise or lower the quill. Lower the quill by rotating the fine control knob clockwise, positioning it precisely either by counting divisions on the graduated dial, or by reference to the digital readout (DRO), Figure 3-1. Use the locking lever left of the headstock to hold the quill firmly in position.

**! If you are counting downfeed divisions be aware of backlash in the worm drive.**

The quill DRO – which has no backlash issues – offers a much laborious way of setting tool height, but note that the quill is **spring-loaded**. This calls for care when releasing the quill locking lever. If the fine control knob has been allowed to disengage (backed off counter clockwise), the quill may jump up by 0.01” or more. To avoid this, make sure the fine control has been turned **clockwise** to apply downward pressure on the quill before the locking lever is released.

## DRO

The DRO is in metric mode when switched on. Press the mm/in button to display inches. By pressing and holding the Up arrow (incrementing) or Down arrow (decrementing) the display can be set to a chosen value. The longer the buttons are held down, the faster the change in displayed value. Zero the display at any time by pressing the ON/O button.

Replace the battery by removing the circular cover using a thin coin. For longer battery life use a silver oxide battery, CR2032 or equivalent.

**! Switch off the DRO when not in use!**

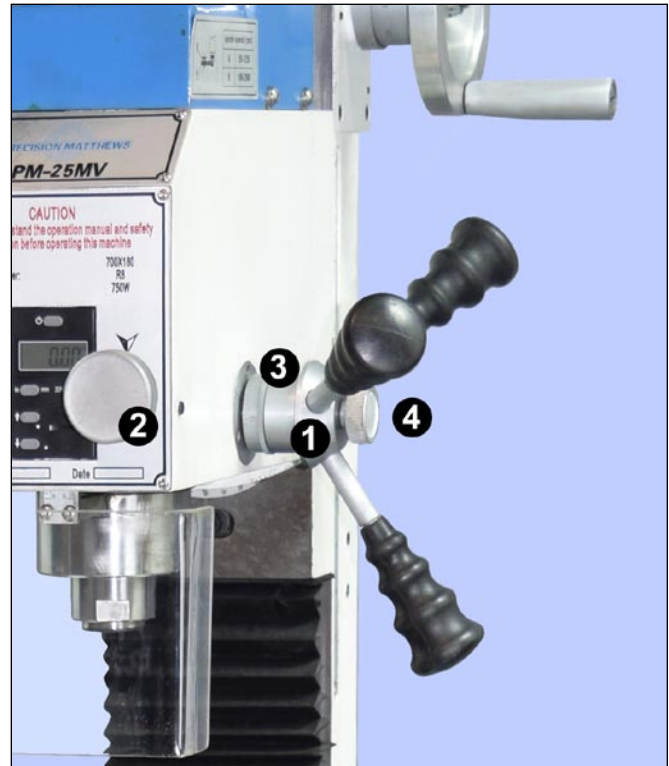


Figure 3-7 Quill downfeed controls

The lever hub (1) is connected at all times to the quill pinion, which engages a rack on the back side of the quill. The fine control knob (2) drives sleeve (3) through a worm gear. If clamp knob (4) is unscrewed, both (2) and (3) rotate freely, doing nothing to the quill. Fine feed is engaged by tightening knob (4) to clamp (3) and (1) together.

## POSITIONING BY COUNTING X / Y DIVISIONS

**!** *For all spindle positioning operations, with or without DROs, avoid using the quill lock.*

**Why?** On practically all vertical mills, including the heavier knee mills, locking the quill may offset the spindle by a few thousandths of an inch. If the edge of the workpiece has been “found” in the quill-locked condition, this will affect placement of holes drilled thereafter. Instead, **lower the quill with the fine downfeed** control. This is worm driven, so it stays where it's put without locking.

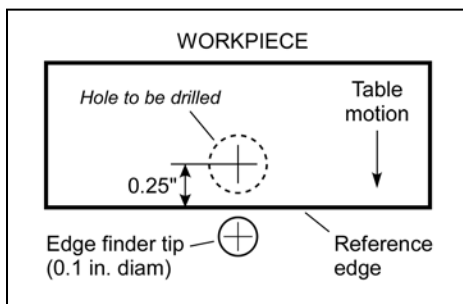


Figure 3-8 Workpiece positioning example

In this illustration a hole is to be drilled exactly 0.25” on the Y-axis relative to the front edge of a workpiece in a vise, or otherwise clamped to the table, Figure 3-8.

1. Install an edge-finder in collet or chuck (a tip diameter of 0.2” is assumed).
2. Lock the X-axis (optional).
3. If the reference edge is already to the back the spindle centerline, do nothing; if not, rotate the Y-axis handwheel clockwise to send the workpiece backwards (toward the column).
4. Engage the fine downfeed, Figure 3-7.
5. With the spindle running, lower the quill as necessary using the fine downfeed control, then bring the table forward (counter-clockwise), stopping at the point where the edge-finder just makes contact (the tip jumps out of line). Stop the spindle.
6. While holding the Y-axis handwheel to prevent rotation, zero the Y dial.
7. Raise the quill, then rotate the handwheel one exact full turn counter-clockwise (0.1”) to bring the reference edge to the spindle centerline.
8. Rotate the handwheel 2-1/2 turns counter-clockwise to bring 50 on the dial opposite the datum; the spindle is now 0.25” to the back of the reference edge.

## THREADING OPERATIONS

When threading a drilled hole it is essential to align the threading tap properly in the bore. The mill is often used for this purpose, ideally with a dedicated (non-slip) tap holder or, for production work, an auto-reverse tapping attachment. A drill chuck can be used instead for sizes up to (say) M6 or 1/4”, beyond which the chuck may not grip tightly enough to avoid slippage. Tapping can be done under power, or by hand turning the chuck. For either method, it is essential to use a tapping fluid. Any cutting oil is better than none, but most users find Castrol's Moly Dee the most reliable for threading in steel.

If power tapping bear in mind that the spindle does not stop instantaneously, so be careful tapping blind holes. Be sure the quill locking lever is free, and start trial

work with the lowest spindle speed.

One way to reduce the risk of small-tap breakage is to use a larger drill than the one typically recommended in the charts for “75% thread depth”. Having drilled the hole, remove the drill from the chuck and replace it with the tap. Lower the quill to engage the tap, at the same time **turning the chuck by hand** while maintaining light pressure on the quill. After a few turns of the chuck to establish alignment of the tap, there are two options:

1. Unscrew the tap by reversing the spindle at the lowest speed, then remove the tap and complete the tapping operation away from the mill.
2. Leave the tap in place, then loosen the chuck. Raise the quill, then use a hand tap holder to complete the job with the workpiece remaining in the machine vise.

## TILTING THE HEADSTOCK

In routine operations the user relies on squareness of the spindle relative to both axes of the table. Front-to-back squareness is set at the factory, and is not adjustable by everyday methods. In the other plane the headstock can be set to any angle up to 90 degrees

either side of the normal vertical position. Because re-establishing true vertical (tramming) on any mill is a time consuming process, most machinists look first for other ways of handling a project instead of tilting the head.

The headstock is secured by three nuts spaced 120



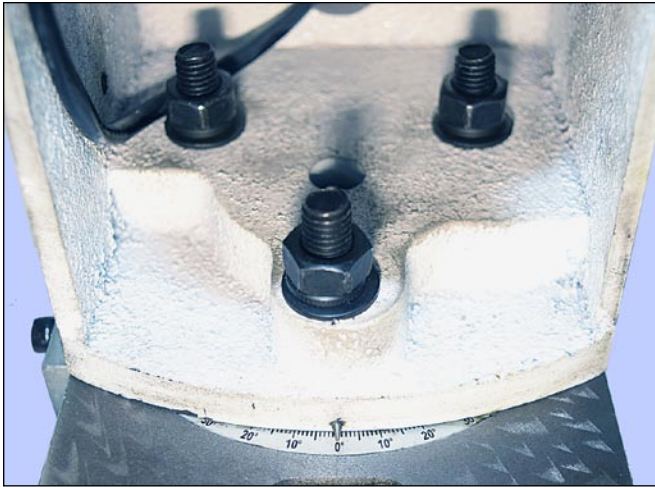


Figure 3-9 **Headstock nuts**

degrees apart, one underneath and one either side, Figure 2-9. The headstock is top-heavy, and may swing suddenly to either side unless a helper is on hand to restrain it. Testing for moveability as you go, carefully loosen the nuts by degrees. Be especially careful if the head has not been moved before – the paint seal may let go without warning. (First-time tilting may also call for unusual effort on the wrench.)

Set the headstock to the desired angle by reference to the tilt scale on the headstock base casting, then re-tighten the nuts. The tilt scale is typically good to within  $\pm 1/4^\circ$ . A more accurate means of angle measurement will be needed if the project calls for greater precision.

## TRAMMING THE HEADSTOCK

As shipped, the mill is set to zero tilt, squared accurately enough for initial out of the box test drillings, etc. For more demanding project work thereafter, the spindle needs to be set at precisely 90 degrees relative to the table, in other words trammed. “Out of tram” may show up as an offset of a few thousandths between entry and exit of a deep hole, or as a scalloped effect when surfacing a workpiece with a large-radius fly cutter, greatly exaggerated in Figure 3-10.

Tramming is done by fine-tuning the headstock tilt angle. Tram is typically checked by attaching a dial indicator to some form of “sweepable” holder installed in the spindle, the aim being to adjust tilt for the same reading on either side of the X axis. The longer the radius arm, the greater the sensitivity.

Figure 3-11 shows a typical shop-made holder; it has a threaded arbor allowing the choice of two radius arms,

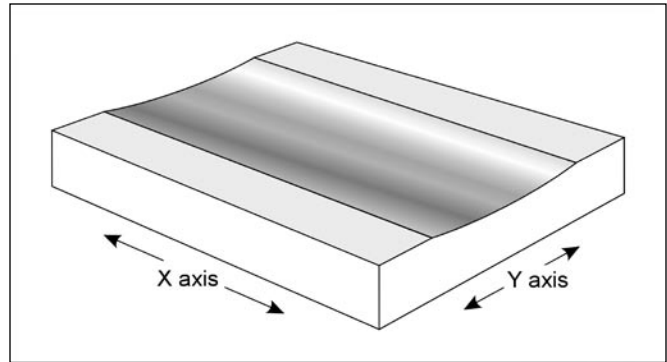


Figure 3-10 **Head tilt can affect surface flatness**

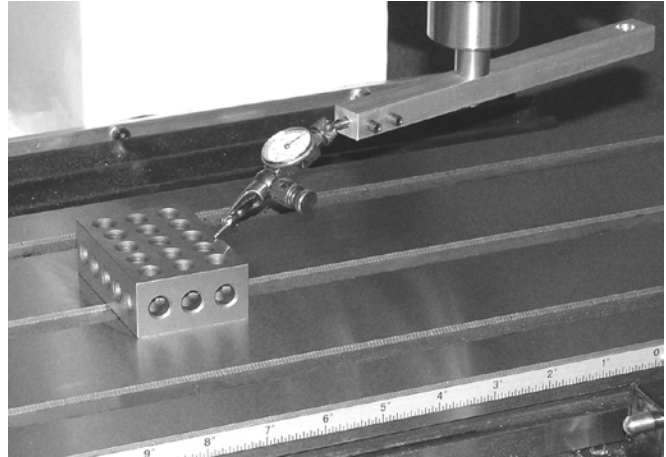


Figure 3-11 **Shop-made indicator holder**

6 and 10 inches measured from spindle centerline to indicator tip. A collet is used to hold the arbor, in this example 5/8" diameter. The dimensions are arbitrary, but note that the indicator must be firmly attached, and the arm rock-solid relative to the indicator spring force (which can be considerable on plunger-type indicators).

A suggested procedure for establishing tram:

1. Disconnect power.
2. Install the dial indicator.
3. If the headstock has been tilted, reset it to the approximate zero degree position on the tilt scale, then tighten the three nuts enough to avoid unexpected headstock movement.
4. Remove the vise, if installed, and clean the table surface. If there are noticeable grooves or dings, flatten the surface with a diamond lap or fine-grit stone.
5. Set a 1-2-3 block (or other precision-ground block) on the table under the indicator probe.
6. Switch on the DRO.
7. Using the fine downfeed lower the spindle to give an indicator reading of about half-scale.
8. Note the dial indicator **and** DRO readings, then back off the fine downfeed at least a couple of turns to



avoid collision when sweeping.

9. Reposition the 1-2-3 block to the opposite location on the table.
10. Swing the indicator holder to the new location, then lower the spindle – fine downfeed again – to give the same dial indicator reading as in step (8).

If the headstock is perfectly trammed – highly unlikely at the first shot – the DRO reading should be as in step (8). If not, loosen the nuts just enough to allow the headstock to be tapped a fraction of a degree in the direction called for, then re-tighten the nuts. The “tap” can be anything from a gentle slap of the hand to a rap with a dead-blow mallet.

Repeat steps (7) through (10) until satisfied with the tram, tightening the nuts as you go. This will likely call for several iterations. There is no “right” tram; the acceptable difference in side-to-side readings depends on project specs. As a starting point, aim for  $\pm 0.001$ ” with a sweep radius of 5 or 6 inches.

**! Tramming calls for patience! Expect to tighten and re-check at least three times (simply tightening the bolts can itself affect the tram).**

A similar procedure may be used to check tram in the Y-axis, front to back. The difference here is that there is that Y-axis tram is established in manufacture, and can be adjusted only by these shop methods:

1. Shimming between the dovetailed Z-axis saddle casting and the headstock itself. It is more likely that the headstock is nodding forward rather than leaning backward, so start with (say) a 2 mil shim in line with the underside (central) headstock nut. This is a temporary fix that will need to be checked if the headstock is tilted again.
2. Shimming between the underside of the column and the main base casting. This is a long-term fix. It is a two-person procedure, requiring an engine hoist or some other means of un-weighting the headstock (see Section 1, Installation).

## INSTALLING A VISE

For routine milling operations the workpiece is held in a precision vise. For the PM 25MV-BD a 4” vise is most suitable, ideally one with slots on the underside machined exactly parallel to the fixed jaw. An ideal vise would have 12 mm slots, in which case simple parallel-side keys would match both the vise and the table T-slots. This would allow the vise to be removed and replaced routinely, accurately enough for general machining **without the need for indicating** every time.

Unfortunately, most precision 4” vises come with either 14 mm or 16 mm slots, calling for T-shape adapter keys as Figure 3-12, not commercially available. It is well worth the effort to make these precisely. Aim for a snug fit in both vise and table, but not so tight that it takes more than reasonable effort to lift the vise clear of the table. Case hardening is recommended, with final fitting using a fine stone or diamond hone.

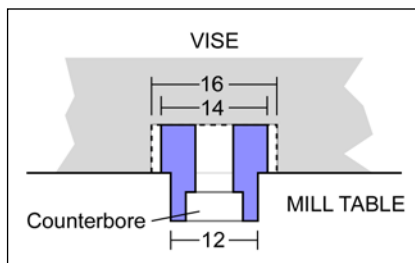


Figure 3-12 **Shop-made vise key**  
Dimensions in millimeters

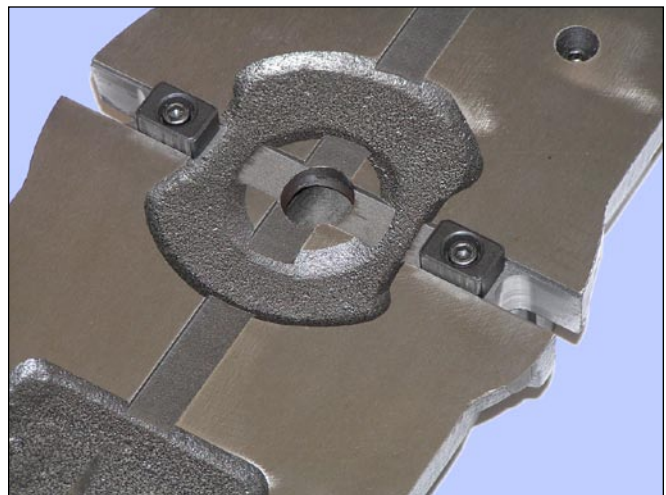


Figure 3-13 **Vise keys installed on X-axis**  
On most vises the keys can also be installed on the long axis.

## INDICATING A VISE

“Indicating” means checking the alignment of the vise jaws (or any vertical surface) relative to the axis of table motion.

A typical setup for indicating is shown in Figure 3-14. **Make sure that the spindle does not rotate** throughout the procedure. There is no spindle lock, so some form of shop-made clamp is desirable. Set the indicator tip against the upper edge of a precision reference bar or, if not available, use the front face of the fixed jaw of the vise instead (check for dings, hone if necessary). Adjust the Y-axis to pre-load the indicator to mid range, then lock the Y-axis.

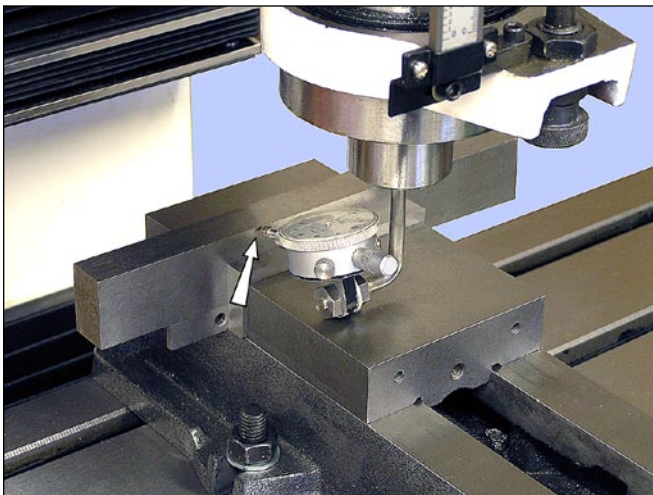


Figure 3-14 **Indicating the vise**

The tip of a standard dial indicator, arrowed, rides along the side face of a ground reference bar.

In the following it is assumed that the vise is keyed in place:

Note the reading at one end of the bar, then traverse to the other end. Ideally, there should be no discrepancy

between the readings at the two ends. If the difference is unacceptably large, say more than  $\pm 0.002$ " over the width of the jaw, consider a stainless steel shim (such as feeler gauge stock) behind the fixed jaw, Figure 3-15. There is no “right” deviation; what is acceptable depends on the project.

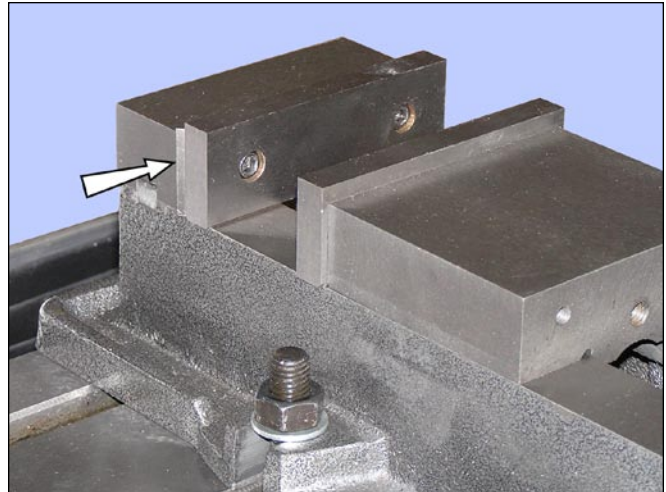


Figure 3-15 **Shimming the fixed jaw**

Do this to correct misalignment between the vise keyways and the jaw.

### Setting up the vise without keys

If shimming is unacceptable, remove the keys and align the vise by eye. With one of the clamp nuts snug, but not tight, tighten the other one just short of fully-tight (but tight enough so the vise won't budge without a definite tap from a dead-blow mallet). Traverse the table slowly, indicating from the tightly clamped end toward the looser end, tapping the vise in as you go. Repeat the process as often as necessary for the desired accuracy, progressively tightening the “looser” nut. Now fully tighten both nuts, and re-check again (tightening a nut can itself introduce significant error). An established routine like this – tight to loose – can save a lot of time.

## Section 4 MAINTENANCE



**Unplug the 120V power cord before any maintenance operation!**



**Remove all machining debris and foreign objects before lubricating ANYTHING! If need be, any oil is better than no oil – but use the recommended lubricants when you can.**

### RECOMMENDED LUBRICANTS

**Ball oilers** (X and Y leadscrews): ISO 32 oil, such as 3-IN-ONE (the “motor oil” version of this brand is heavier, about ISO 68, but it can also be used)

**X, Y and Z axis ways** (dovetails): ISO 68 oil, such as Mobil Vactra No. 2, or equivalent

**Visible gears** such as quill rack and pinion, Z-axis bevel gears: light general purpose grease, NLGI No. 2, or equivalent

**X and Y leadscrews:** ISO 68 oil, such as Vactra No. 2 or 3-IN-ONE Motor Oil

**Z leadscrew:** ISO 68 oil or NLGI No. 2 grease

### GENERAL OILING

Assuming a clean environment – no abrasive particles or machining debris – lack of proper lubrication is the main cause of premature wear. Rotating parts are easy to lubricate, sliding parts are not. Gibs are tightened for

the best compromise between rigidity and slideability, which means practically zero gap between the ways. Take time to understand exactly which are the bearing surfaces on the various dovetail surfaces; this is not obvious – some of the interfaces look like bearing surfaces, but are simply narrow gaps.

Every few hours of operation: 1. Apply the recommended way-oil with a dedicated short-bristle brush such as the type used for applying flux; 2. Use a similar brush to apply oil or grease to the leadscrews; 3. Apply oil to the ball oilers, see below.

#### Ball oilers

Use a pump-type oil can with tip large enough to more than 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.

#### Quill rack and pinion

Lower and lock the quill. 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.

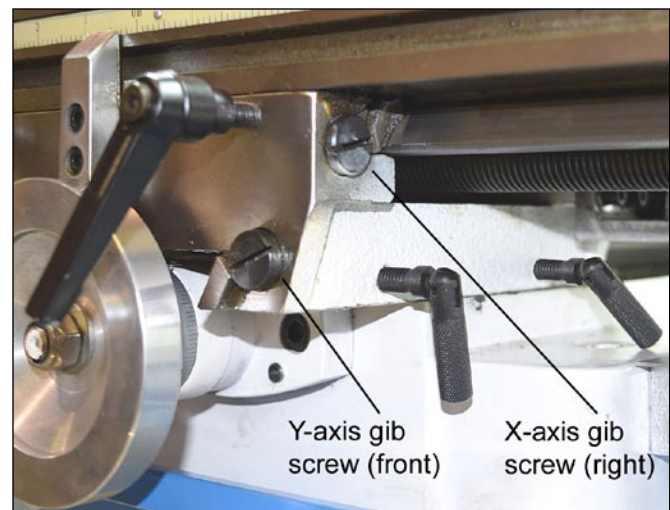
#### Spindle bearings

The spindle runs on sealed, pre-lubricated roller bearings requiring no routine attention. See Servicing Quill and Spindle, two pages on.

### GIB ADJUSTMENT

Gibs on the X, Y and Z axes control the fit of the mating dovetailed surfaces. They are gently-tapered lengths of ground cast iron located by opposing screws at each end. Adjusting them 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.

**Both screw heads** must be tight against the gib ends. If you loosen one, tighten the other. Remove the way covers for access to the back of the Y gib and bottom of the Z gib.



**Figure 4-1 Gib adjustment, X and Y axes**

The back adjustment screw for the Y axis gib is under the solid rubber way cover behind the table. The left adjustment screw for the X axis is in a similar location on the left side of the saddle casting.



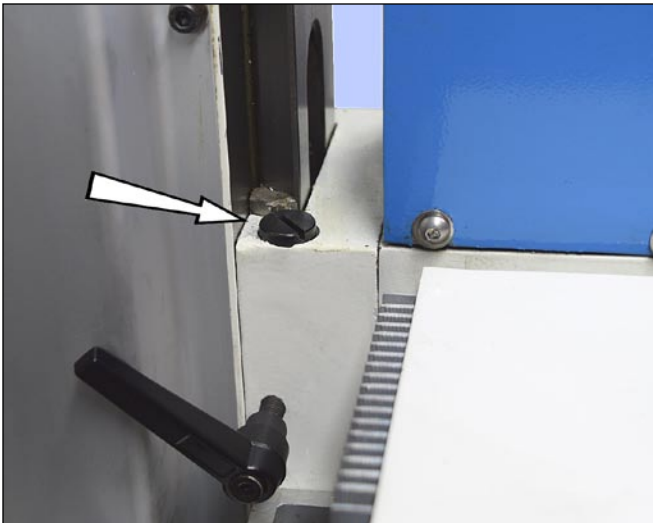


Figure 4-2 **Z-axis gib adjustment, upper screw**  
The lower screw is under the pleated way cover.

## LEADSCREW BACKLASH CORRECTION

When alternating between clockwise and counter clockwise rotation of the X or Y leadscrews, the hand-wheel moves 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 leadscrew split nut. For the X-axis this is done by tightening the socket head screw in Figure 4-3. A long-handled 4 mm hex wrench is required, ideally one with an extra-thick shank to minimize flexing. The corresponding adjustment for the Y-axis is difficult because the split nut and leadscrew are concealed by castings, Figure 4-4. Access to the adjusting screw is possible

only if the entire machine is unbolted from the bench or stand, then: 1. **Lifted** by sling and engine hoist (see Installation, Section 5), or; 2. **Tilted** backward by pivoting on the back edge of the base casting.



**Both options are two-man procedures**

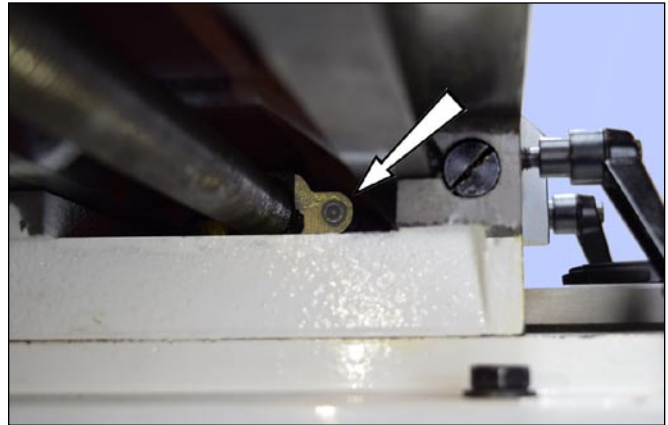


Figure 4-3 **X-axis backlash adjustment**

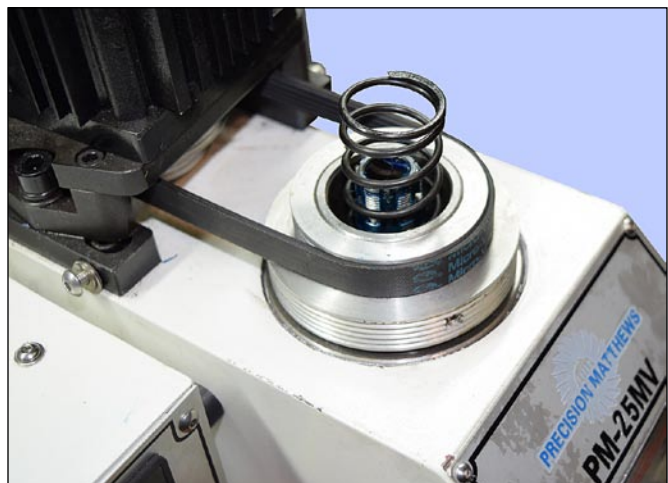


Figure 4-4 **Y-axis backlash adjustment**

## DOWNFEED RETURN SPRING

The quill should automatically retract when the coarse downfeed levers are released following a drilling operation. If it does not, check for binding in the quill lock. The return spring, Figure 4-5, is held by a spring cup which is locked to the spindle by a special C-clip beneath the drawbar cap, Figure 3-2. Spring force is not adjustable.

Figure 4-5 **Quill return spring**



## SERVICING QULL & SPINDLE

In the normal use the quill assembly needs only oiling on its sliding surface. The spindle runs on pre-lubricated roller bearings and should need no attention. If the bearings need to be serviced or replaced, remove the quill/spindle assembly as follows:

1. Remove any installed R8 device from the spindle.
2. Lock the spindle with the C-wrench, then unscrew the drawbar cap (17 mm flats) from the spindle.
3. Remove the drawbar.
4. **IMPORTANT:** Use wood blocks or other means to prevent **unexpected downward movement** of the quill assembly.
5. Press down on the return spring cup while removing the C-Clip, Figure 4-6.
6. Remove the return spring, Figure 4-5.
7. Using a 2.5 mm hex key remove the two button head screws securing the DRO scale and stand-off block to the quill assembly.
8. Remove the wood blocks (4), then remove the quill assembly from the headstock.

**! Do not over-pack the roller bearings with grease. This can cause premature failure of the bearings due to heat build-up.**

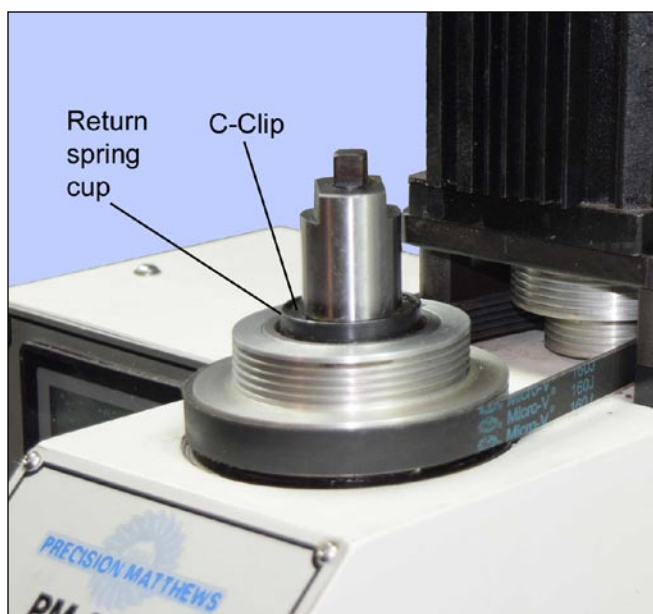


Figure 4-6 Remove drawbar cap for access to the C-Clip

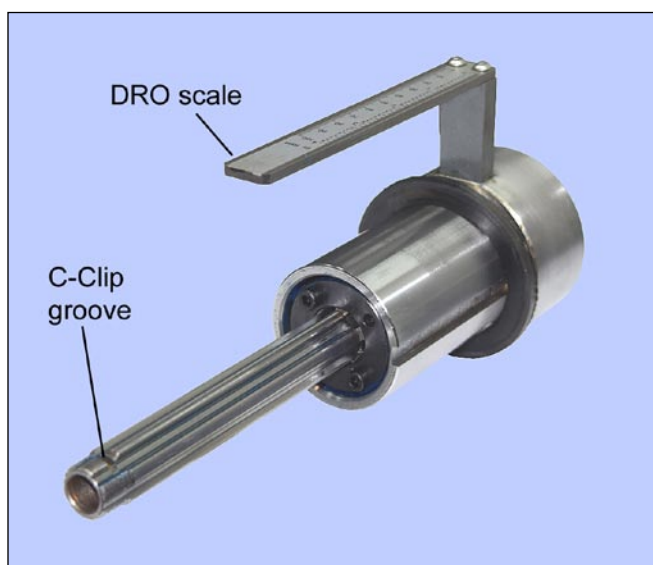
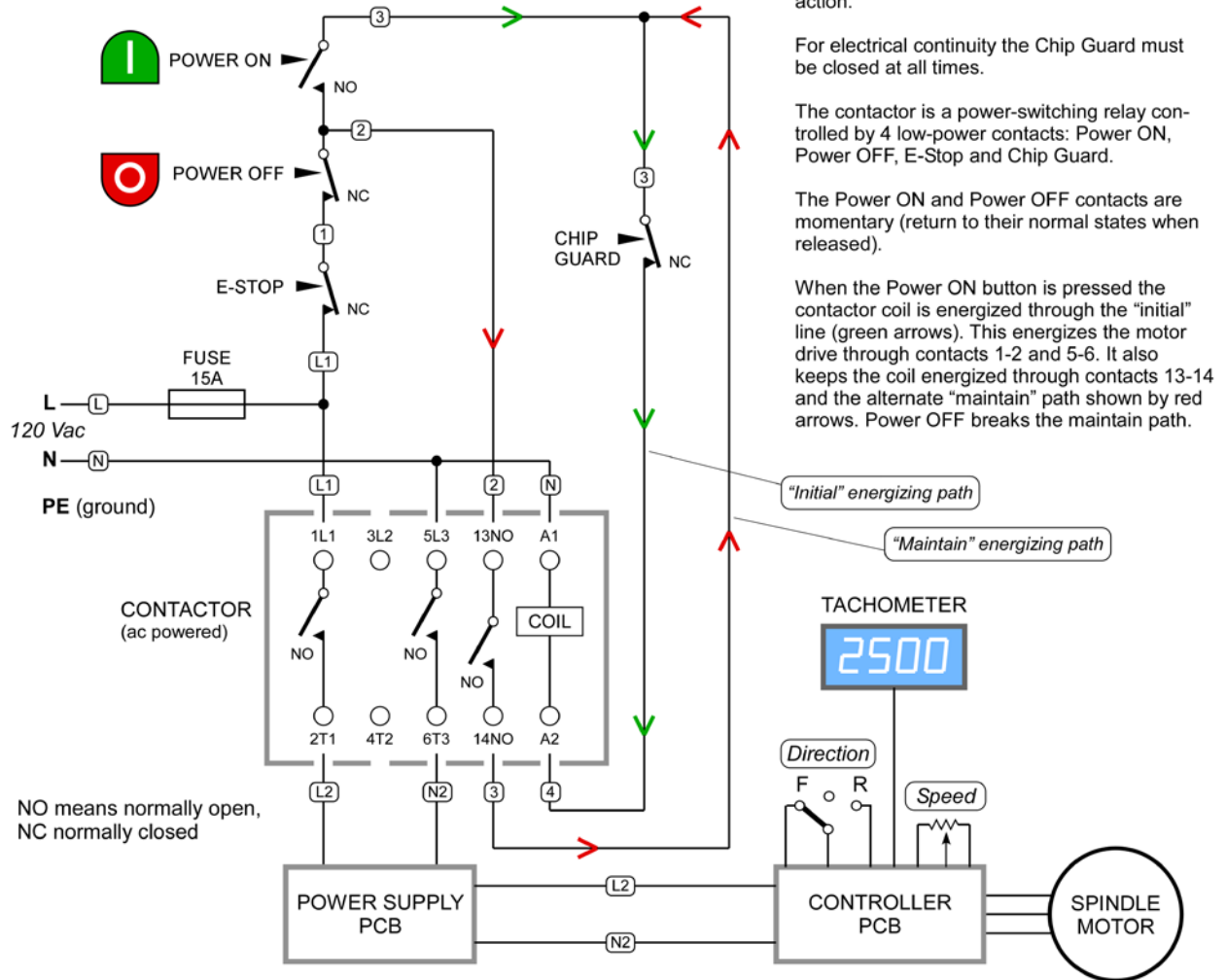


Figure 4-7 Complete DRO scale and quill assembly  
For illustration only: for servicing operations the scale should be detached from the quill and should remain in the DRO case.



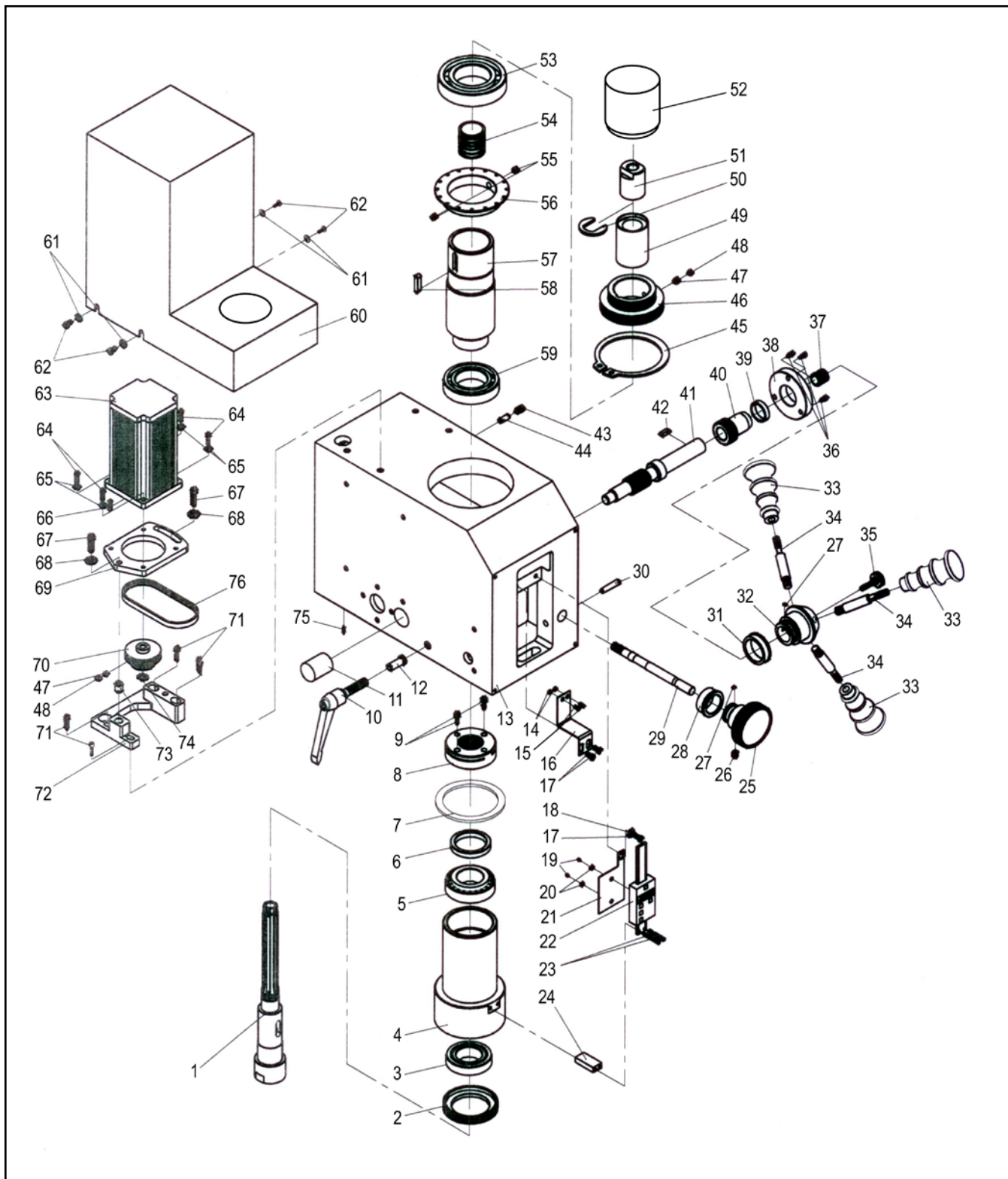
## Section 5 PARTS

*This schematic is representational only. Actual point-to-point wiring may differ.*



**Model PM25MV-BD Electrical schematic**

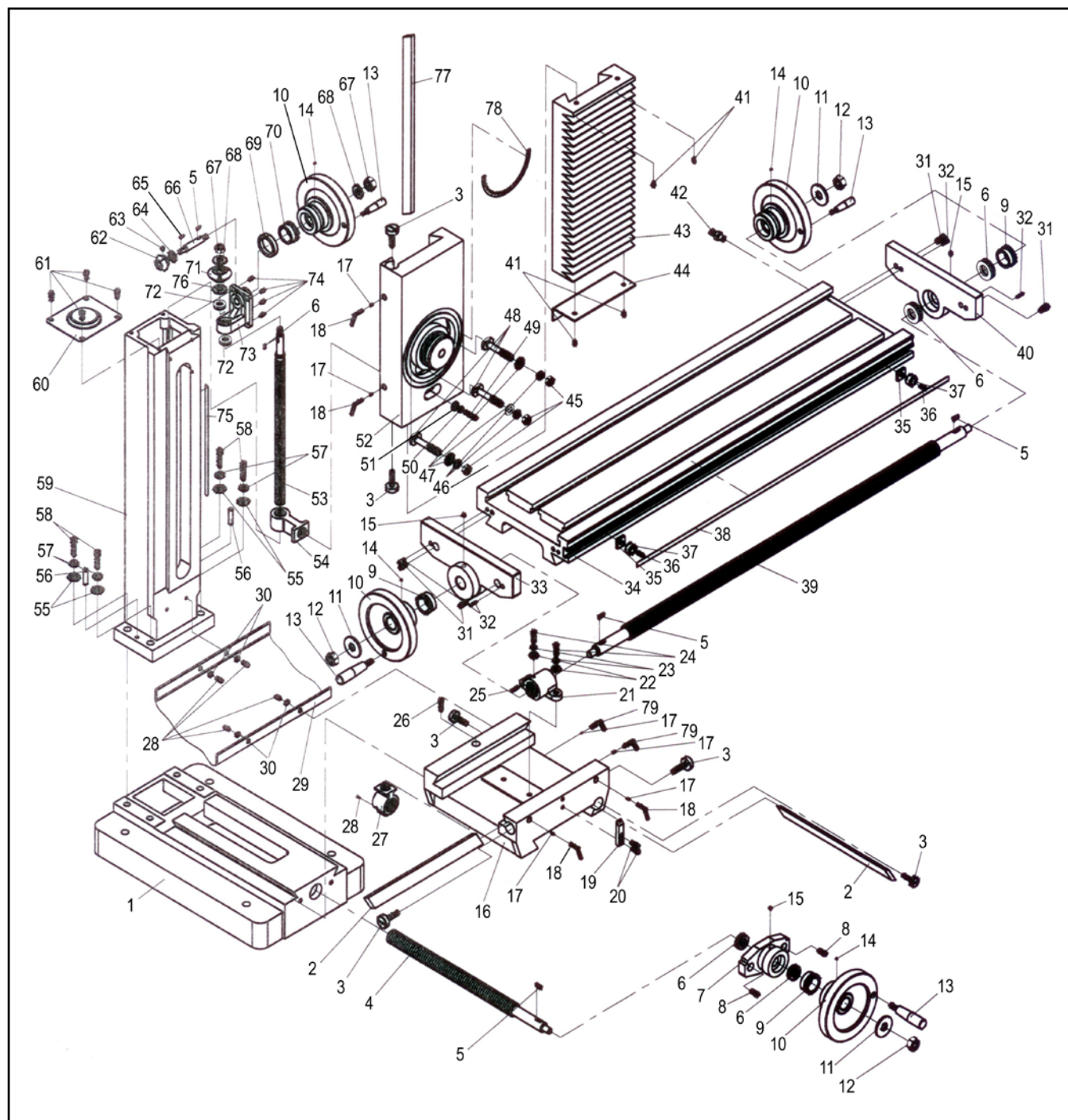
# HEAD COMPONENTS



*Dimensions in millimeters*

	Manufacturer's ref.	Qty.			Manufacturer's ref.	Qty.	
1	WMD25VH-02-003	1	Spindle	39	WMD20V-01-037	1	Sleeve
2	WMD20V-01-001	1	Bearing seal	40	WMD20V-01-023	1	Worm gear
3	GB/T297-94	1	Roller bearing 32007	41	WMD20V-01-024	1	Pinion shaft
4	WMD20V-01-002	1	Quill sleeve	42	GB1096-79	1	Key: 4 x 12
5	GB/T297-94	1	Roller bearing 32005	43	GB78-2000	1	Screw: M6 x 12, set
6	WMD25VB-02-001	1	Spacer	44	GB119-2000	1	Pin: 5 x 10
7	WMD20A-02-007	1	Washer, nitrile	45	GB894.1-86	1	Retaining ring: 45, ext
8	WMD20V-01-041	1		46	WMD20VH-02-006	1	2-step spindle pulley
9	GB70-2000	2	Screw: M5 x 12 skt hd	47	GB/T78-2000	2	Screw: M6 x 8, set
10	JB7270.12-1994	1	Quill lock handle	48	GB/T77-2000	2	Screw: M6 x 6, set
11	WMD20V-01-025	1	Casting plug	49	WMD25VH-02-019	1	Return spring cup
12	WMD20V-01-034	1	Quill guide pin	50	WMD20V-01-008	1	C-clip, spring retainer
13	WMD25VH-02-001	1	Headstock	51	WMD25VH-02-020	1	Drawbar cap
14	GB41-2000	2	Nut: M3	52	WMD20V-01-009	1	Drawbar cover
15	GB/T818-2000	2	Screw: M3 x 8 pan hd	53	GB/T276-94	1	Ball bearing: 6209
16	WMD25VH-02-017	1	DRO bracket	54	WMD20A-02-012	1	Spring, quill return
17	GB/T818-2000	3	Screw: M4 x 10 pan hd	55	GB/T78-2000	2	Screw: M6 x 8, cone pt
18	GB95-85	1	Washer: flat, M4	56	WMD25VH-02-016	1	Tach sensor coil
19	GB70-2000	2	Screw: M4 x 6 pan hd	57	WMD25VH-02-008	1	Splined sleeve
20	GB96-2000	2	Washer: flat, M4, large	58	GB/T1096-79	1	Key: 6 x 25
21	WMD20A-02-006	1	DRO back plate	59	GB/T276-94	1	Ball bearing: 6007-2Z
22	DQ-2	1	DRO assembly	60	WMD25VH-02-015	1	Motor cover
23	GB65-2000	2	Screw: M4 x 55 pan hd	61	GB95-85	4	Washer: flat, M4
24	WMD20V-01-043	1	DRO connector block	62	ISO7380	4	Screw: M4 x 10 pan hd
25	WMD20V-01-030	1	Fine feed knob	63		1	Motor
26	GB71-85	1	Screw: M5 x 8, set	64	GB70-85	4	Screw: M5 x 20 skt hd
27	WM180V-08-10	2	Leaf spring	65	GB95-85	4	Washer: flat, M5
28	WMD20V-01-028	1	Graduated dial, fine	66	GB1096-79	1	Key: 6 x 16
29	WMD20V-01-027	1	Worm spindle	67	GB70-85	2	Screw: M8 x 30 skt hd
30	GB118-2000	1	Pin: taper, 8 x 30	68	GB95-85	2	Washer: flat, M8
31	WMD20V-01-036	1	Graduated dial, coarse	69	WMD25VH-02-018	1	Motor mount, lower
32	WMD20V-01-022	1	Coarse feed hub	70	WMD20VB-02-004A	1	2-step motor pulley
33	WMD20V-01-047	3	Coarse feed handle	71	GB70-85	4	Screw: M6 x 20 skt hd
34	WMD20V-01-046	3	Coarse feed spoke	72	WMD25VH-02-013	1	Motor mount, upper
35	WMD20V-01-021	1	Clamp knob	73	WMD25VH-02-012	1	Bushing
36	GB70-85	3	Screw: M4 x 10 skt hd	74	GB893.1-86		
37	GB/T2089-94	1	Compression spring	75	WMD20V-01-018		
38	WMD20V-01-026	1	Pinion shaft flange	76	406PJ5	1	Ribbed belt

## TABLE, COLUMN & BASE COMPONENTS



*Dimensions in millimeters*

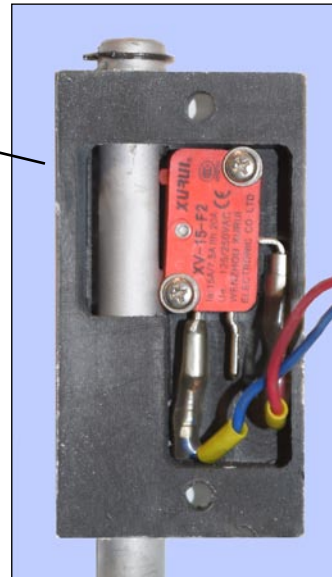
	Manufacturer's ref.	Qty.			Manufacturer's ref.	Qty.	
1	WMD20A-01-001	1	Base	41	GB70-85	4	Screw: M5 x 8 skt hd
2	WMD20A-01-014	2	Gib, Y-axis	42	WMD20V-02-018	1	Hose fitting (coolant)
3	ZAY7025FG-01-032	6	Gib adjust screw	43	WMD20A-01-018	1	Z-axis pleated cover
4	ZAY7025FG-01-020	1	Y-axis leadscrew	44	WMD20A-01-021	1	Support bracket
5	GB1096-79	5	Key: flat, 5 x 16	45	GB41-2000	3	Nut: M10
6	GB301-1995	4	Ball bearing: 51103	46	GB93-87	3	Washer: lock, M10
7	WMD20A-01-007	1	Y-axis support flange	47	GB95-85	3	Washer: plain, M10
8	GB70-85	2	Screw: M8 x 20 skt hd	48	GB37-88	3	T-bolt: M10 x 60
9	ZAY7025FG-01-036	3	Graduated dial	49	GB70-85	1	Screw: M8 x 35
10	WMD20A-01-005	4	Handwheel	50	GB97-86	1	Washer: lock, M 8
11	GB95-85	3	Washer: flat, M10	51	GB95-85	1	Washer: plain, M 8
12	GB6182-2000	3	Locknut: M10	52	WMD20A-01-004	1	Saddle, Z-axis
13	JB7270.5-1994	3	Handle	53	WMD20A-01-008	1	Z-axis leadscrew
14	WMD20V-01-029	4	Leaf spring	54	WMD20A-01-013	1	Z-axis leadscrew nut
15	GB1155-89	3	Oiler: 6	55	GB95-85	4	Washer: plain, M 12
16	WMD20A-01-003	1	Saddle, X-Y	56	GB118-2000	2	Pin: taper, 6 x 35
17	WMD20A-01-017	6	Friction pin	57	GB97-86	4	Washer: lock, M 12
18	HY7310.12-1	4	Lock handle: M8 thread	58	GB70-85	4	Screw: M12 x 60
19	ZAY7025FG-01-041	1	Stop/indicator block	59	WMD20A-01-002	1	Column
20	GB70-85	2	Screw: M5 x 12 skt hd	60	WMD20A-01-023	1	Column cap
21	ZAY7025FG-01-026	1	X-axis leadscrew nut	61	GB70-85	4	Screw: M5 x 8 skt hd
22	GB95-85	2	Washer: flat, M6	62	WMD20A-01-010	1	Bevel gear A
23	GB93-87	2	Washer: lock, M6	63	GB/T78-2000	1	Screw: M6 x 8, set
24	GB70-85	2	Screw: M6 x 20 skt hd	64	WMD20A-01-020	1	Pad
25	GB70-85	1	Screw: M5 x 20 skt hd	65	GB1096-79	1	Key: flat, 4 x 16
26	GB70-85	1	Screw: M6 x 40 skt hd	66	WMD20A-01-012	1	Lifting gear shaft
27	ZAY7025FG-01-019	1	Y-axis leadscrew nut	67	GB6182-2000	1	Locknut: M12
28	GB70-85	5	Screw: M5 x 16 skt hd	68	GB95-85	1	Washer: plain, M 12
29	WMD20A-01-022	1	Y-axis cover stiffener	69	WMD20A-01-024	1	Collar
30	GB95-85	4	Washer: flat, M5	70	WMD20A-01-025	1	Graduated dial
31	GB70-85	4	Screw: M6 x 16 skt hd	71	WMD20A-01-011	1	Bevel gear B
32	GB118-2000	4	Pin: taper, 6 x 25	72	GB301-1995	2	Ball bearing: 51102
33	ZAY7025FG-01-035	1	X-axis support flange: L	73	WMD20A-01-009	1	Z leadscrew bracket
34	ZAY7025FG-01-033	1	Table	74	GB70-85	4	Screw: M5 x 14
35	ZAY7025FG-01-024	2	Nut: square M6	75	WMD20A-01-026	1	Z-axis scale
36	GB70-85	2	Screw: M6 x 12 skt hd	76	WMD20A-01-019	1	Washer
37	ZAY7025FG-01-023	2	Stop collar	77	WMD20A-01-015	1	Gib, Z-axis
38	ZAY7025FG-01-034	1	Table scale	78	WMD20A-01-016	1	Tilt scale
39	ZAY7025FG-01-027	1	X-axis leadscrew	79	ZAY7025FG-01-050	2	Lock handle: swivel, M8
40	ZAY7025FG-01-042	1	X-axis support flange: R				



*Dimensions in millimeters*

This exploded view diagram illustrates the assembly of a door handle. The components are numbered as follows:

- 1**: A small circular cap or pin at the top of the handle.
- 2**: The main rectangular handle body.
- 3**: Two screws used to secure the handle body to the mounting plate.
- 4**: A small pin or screw located on the side of the handle body.
- 5**: A long, thin vertical mounting plate.
- 6**: The door plate or door itself, which the mounting plate is attached to.
- 7**: Two screws used to secure the mounting plate to the door plate.
- 8**: Two additional screws used to secure the mounting plate to the door plate, positioned lower than the ones in group 7.



1	GB894.1-86	1	Circlip	5	WMD20A-03-002	1	D-shape shaft
2	WMD20A-03-001	1	Switch box	6	WMD20A-03-003	1	Shield
3	GB70-85	2	Screw: M5 x 16 skt hd	7	GB96-85	2	Washer: flat, M4
4	GB/T79-2000	1	Screw: M4 x 8, set, spc'l	8	GB70-85	2	Screw: M4 x 14 skt hd