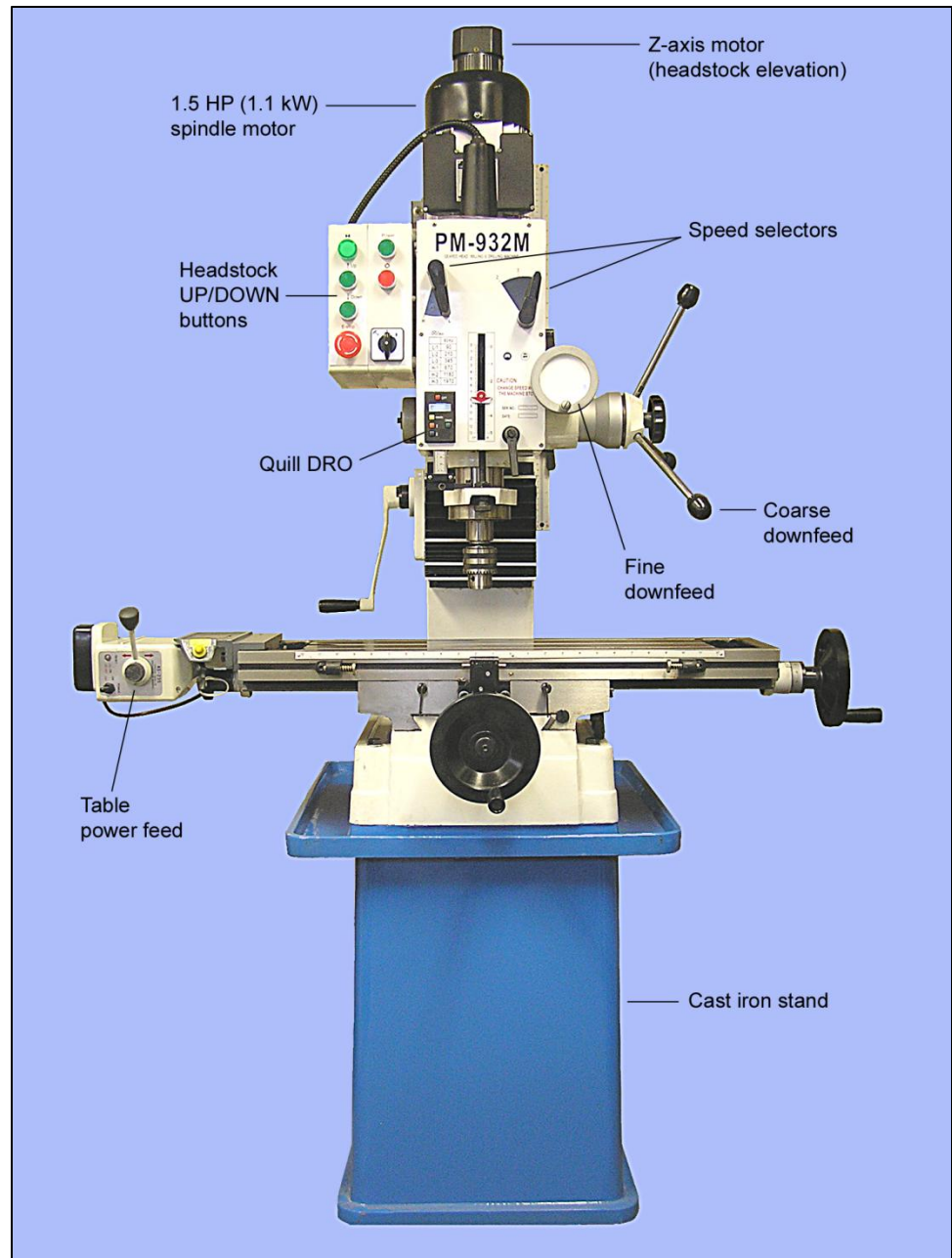


**Model PM-932M**

# Heavy duty milling machine

6-speed gear head  
Powered table (X axis)  
Powered headstock (Z axis)  
Quill DRO & depth stop  
Total weight 1000 lbs  
Cast iron stand



Quality Machine Tools, LLC  
701 Parkway View Drive  
Pittsburgh, PA 15205

**Precision Matthews**

Quality Machine Tools, LLC



## New installation?

***After uncrating the mill, please pay attention to the following:***

- Read the installation instructions at the BACK of this manual.
- 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. **Remove** the hand crank, and set it aside.
- Lifting gear – sling, hoist or forklift – must be rated for at least 1500 lb.
- **Working location** of the mill must allow:
  1. Full left-right travel of the table
  2. Access to the back of the column (Z axis leadscrew maintenance)
  3. Headroom for the Z-axis motor
- Power requirement is 220V, 60Hz, 1 $\phi$ , 15A circuit protection (spindle motor 8.6A, 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.
  2. The Z-axis (headstock) and X-axis (table) motors are safely situated, **not** installed in their working locations. Don't let them dangle on the cables!
  3. There are no clamps or locks on moving parts.
  4. The gearbox contains oil – check the sight glass at right of the headstock.
  5. The gear levers are set for the lowest speed: Hi-Lo to L, 2-3-1 to 1.
  6. The gears are fully engaged – hand-rotate (jiggle) the spindle forward and back while applying light pressure on each gear lever, listening for the click as the gears engage.



This manual contains essential safety advice on the proper setup, operation, maintenance, and service of the PM-932M 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 from negligence, improper training, machine modifications or misuse.

This manual describes PM-932M machines as shipped from January 2014. 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**. Your feedback is welcomed!

# Section 1 INTRODUCTION

## MODEL 932M Milling Machine features and specifications

### General information

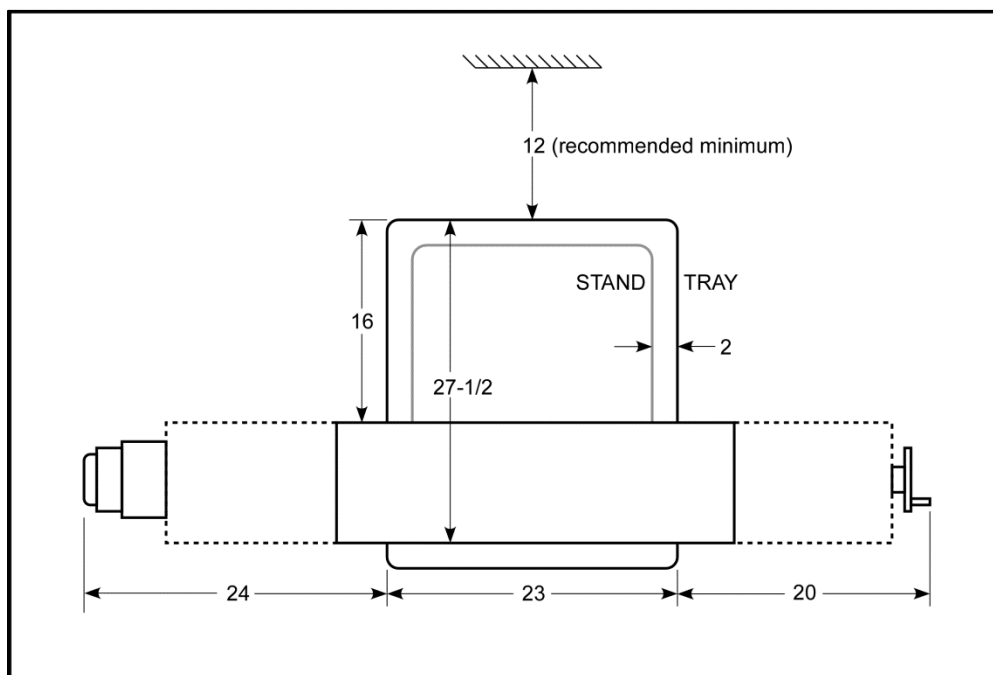
The 932M is a robust "square column" mill designed for day-in, day-out use in the busy model shop. With an all-up weight of 1000 lbs it can handle far more than the typical small machine, including end mills up to 1-1/4" and face mills up to 3". For precise control of cutter depth there is a worm-driven quill downfeed with graduated dial and DRO, completely independent of headstock up/down position.

The reversible spindle runs in high-quality (ISO355) tapered-roller bearings enclosed in a 3" diameter quill with coarse and fine downfeed options. An oil-filled gearbox provides 6 spindle speeds from 90 to 1970 rpm. Features of the headstock include choice of manual or powered elevation on dovetailed ways, 90° – 0° – 90° tilt, and a quill depth stop for drilling operations. The 31.5" x 9.5" table is powered in the X axis by a variable-speed dc motor. Table movement in both X and Y axes is along scraped dovetailed ways.

### Supplied accessories

- R8 drill chuck arbor and 1/2" (13mm) keyed chuck
- 22-24mm open-end wrench
- 14 mm vise keys (2)
- R8 shell mill keyed arbor, 1" diameter, M10 threaded hole

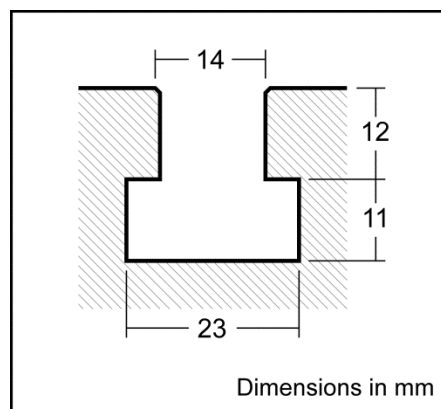
### Floor plan



These are minimum space requirements for full motion of the table.

<b>Dimensions</b>	
Weight, including cast iron stand	990 lb
Size	W 49-1/2" x D 34-1/2" x H 75-1/4"
Stand footprint	Approx. W 18-1/2" x D 27"
<b>Electrical</b>	
Power requirement	220V, 60Hz, 1 $\phi$ , 15A breaker
Full load current	8.6A, spindle motor only
Power cord	14 AWG x 6 ft
<b>Motors</b>	
Main (spindle)	Cap-start induction, 1.5 HP, 1725 rpm
X-axis (table traverse)	DC gear motor, 1A
Z-axis gear motor (elevation)	Cap-start induction, 120W
<b>Headstock</b>	
Vertical travel (Z-axis)	13.5 in.
Left-right tilt	90° – 0° – 90°
<b>Spindle</b>	
Speeds (rpm)	90, 210, 345, 670, 1180, 1970
Internal taper	R8
Top end	6 splines, 28 mm OD
Quill travel	5 in.
Spindle to table	18 in. max
Spindle centerline to column face	10 in.
Drawbar	7/16 x 20, 18 mm wrench
<b>Table</b>	
Size	W 31.5 in. x D 9.5 in. x H 1.6 in.
Surface height	Approx. 35" from floor
Maximum load	220 lb
Leadscrews	Acme, inch pitch, 10 tpi
Front-back travel (Y-axis)	7.9 in.
Traverse (X-axis)	19.5 in.
T-slots (3)	14 mm wide, 80 mm centers

**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, 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 220V power from the mill before making adjustments, changing tooling, or servicing. For routine mechanical work, only, disconnect by pressing the RED power button on the control panel. Before opening the control panel, disconnect by unplugging the power cord from the 220V outlet.
- 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 2 USING THE MILL

### FRONT PANEL CONTROLS

- Connect the mill to a 220Vac source.
- Press the green **Power** button to energize the main contactor in the control box. The power lamp, top left, should light, indicating that power is available to all motors.
- Press the **○** button to disconnect power from the three motors.
- The **E-stop** button, bottom left, has the same effect as the **○** button, but it should be used only for its intended purpose – **emergency disconnect**. The E-stop button is not momentary; once in, it stays in until twisted clockwise.
- The **Up** and **Down** buttons control the Z-axis motor (head elevation).
- The main motor (spindle drive) is controlled by the rotary switch at bottom right. **F** = Forward, **S** = Stop, and **R** = Reverse.



Figure 2-1 Electrical controls and gear levers

### SPINDLE SPEEDS

This is a gear-head machine with a constant speed motor and a two-stage gearbox providing a choice of six spindle speeds. The first stage (**H-L**) selects the speed **range**, high or low, and the second stage (**2-3-1**) selects a specific speed within that range.

- **Before switching on the spindle motor**, be sure that both stages are properly engaged. Hand-rotate (jiggle) the spindle forward and back while applying light pressure on each shift lever, listening for the click as the gears engage.



**Allow the spindle to stop completely before shifting gears**

### Spindle speeds (rpm)

L-1	90
L-2	210
L-3	345
H-1	670
H-2	1180
H-3	1970



**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. The drawbar is threaded into the R-8 device by a few turns of the upper nut, which is solidly pinned to the bar. With sufficient length of the thread engaged, run the lower nut down as far as it will go, then tighten it using two wrenches, 17 mm upper, 19 mm lower (or 11/16" and 3/4"). To keep the spindle from turning too freely in this procedure, select a low speed such as **L-1**. Another way of tightening the lower nut is to hold the spindle using a 6-spline wrench, nominal size 28 mm.



To remove the R-8 device, loosen the lower nut one half turn or less, then tap the top of the drawbar with a brass or dead-blow hammer to unseat the taper. Unscrew the drawbar by turning the upper nut with one hand while **supporting** the R-8 device with the other hand. Why? Because tables, vises and workpieces can be damaged by falling tools and drill chucks.

## 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, Figure 2-3. If the mill is not equipped with digital readouts (DROs), the table can be accurately positioned by counting whole turns and divisions, bearing in mind **leadscrew backlash**. This means that table motion must always be in the same direction up to the point of reference, then on to the desired location. For example:

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 2-2 **Spindle and drawbar**

Both nuts on the drawbar are 19 mm or 3/4". The spindle can be held using a 28 mm spline wrench (not supplied). The gearbox is vented through the metal elbow, right, and clear plastic tube.

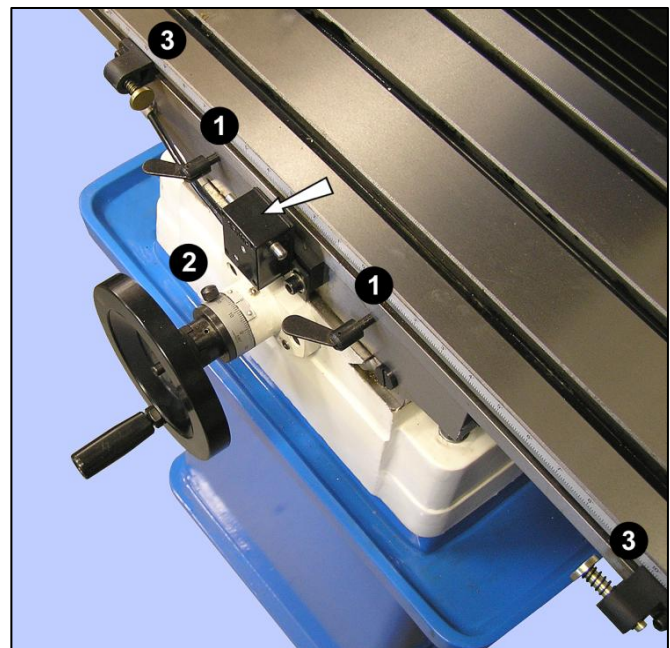
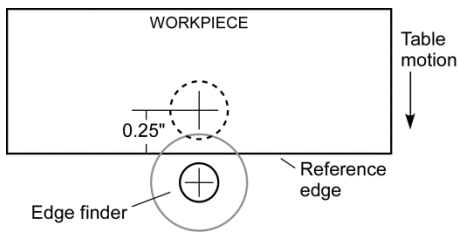


Figure 2-3 **Y-axis handwheel, X-axis locks & limit switch**

In the limit switch assembly, arrowed, there are separate microswitches, left and right, actuated by adjustable spring-cushioned stop blocks (3).



1. Install an edge-finder in collet or chuck (a tip diameter of 0.2" is assumed).
2. Lock the X-axis by tightening both leaf-screws, Figure 2-3 (1).
3. If the reference edge is 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. With the spindle running, lower the quill as necessary, then bring the table **forward** (counter-clockwise), stopping at the point where the edge-finder just makes contact. Stop the spindle.
5. Loosen the thumbscrew on the Y-axis dial, Figure 2-3 (2), zero the dial, then re-tighten the screw.
6. Raise the quill, then rotate the handwheel one **exact** full turn counter-clockwise (0.1") to bring the reference edge to the spindle centerline.
7. 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.



**Be sure to loosen the X-axis lock screws before moving the table, especially under power**

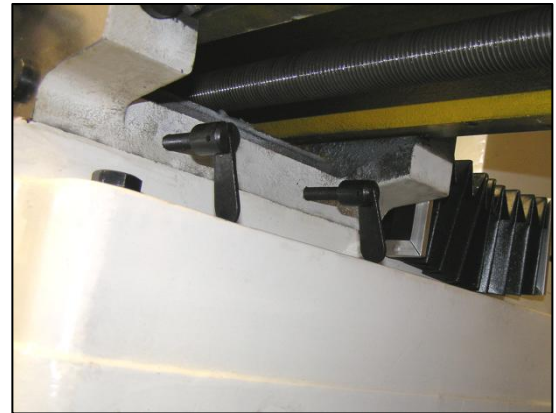


Figure 2-4 Y-axis locks

## X-AXIS POWER FEED

### Power lamp

The power lamp, a small LED on the right-facing surface, lights when the Power switch is on.


### Direction lever



**Before setting the lever to L or R, make sure the X-axis locks are FREE, and the speed control is fully COUNTER CLOCKWISE**

Press the Rapid Traverse button (momentary type) to drive the table rapidly in the direction set by the L-R lever.

### Reset button

If the power feed unit draws more than 3.5 amps for more than 10 seconds, the overload switch will cut power and the reset button will pop out. Press the  button on the main control box to

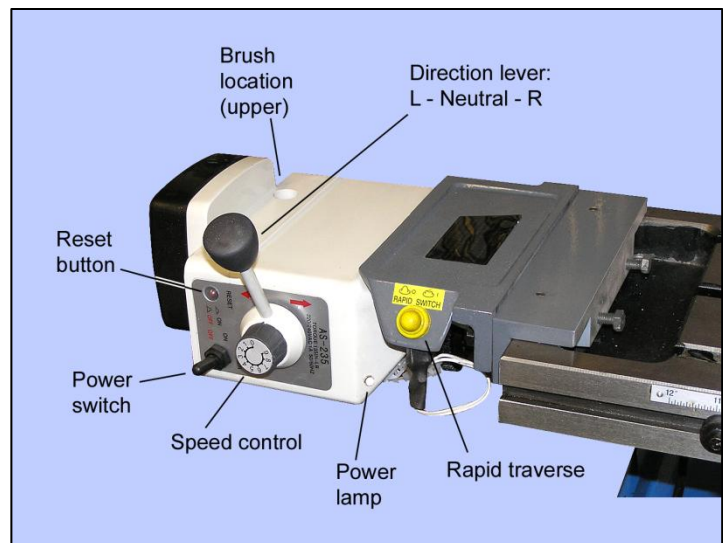


Figure 2-5 X-axis power feed



disconnect power. Investigate and resolve power feed problems – such as X-axis locks not free, or gears too tightly engaged (see Section 6, Installation). Allow a cooling interval, press the reset button, then restore power.

### Limit switch

Stop blocks on the front surface of the table can be independently set to limit travel to left and right, Figure 2-3 (3). To reposition a stop block, loosen its attachment screw, then tap it if needed to free the square nut in the dovetail slot. (Slot dimensions: 10° sides, 0.3" deep, width tapers from approx. 0.5" to 0.4".)

### QUILL DOWNFEED

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

In the drilling mode, coarse feed, the mill functions like a standard drill press – pull the upper lever toward you to lower the quill. For milling operations the lever hub is disengaged, and the quill is controlled by the fine downfeed handwheel. The quill is locked by the lever to the right of the depth stop, Figure 2-7.

#### Coarse feed (Figure 2-6)

For drilling operations, loosen knob (4), allowing the lever hub to rotate independently of sleeve (3). If desired, set the depth stop, Figure 2-7.

#### Fine feed (Figure 2-6)

For milling operations calling for precise, repeatable control of tool depth, tighten knob (4) to engage the tapered face of hub (1) with the internal taper on sleeve (3). Tighten the Z-axis locks, Figure 2-8.

Rotate the fine control knob (2) to raise or lower the quill. Before switching to fine control, it is usually a good idea to run the depth stop up to the top. 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 2-7. Use the locking lever to hold the quill firmly in position.

If division-counting, be aware of backlash in the worm drive. This means that the handwheel must always be **turning in the same direction** throughout the entire process, from setting a reference level to subsequent cutting passes at specific depths – see the backlash discussion in "Moving the table", above. Using the DRO – which has no backlash issues – is less laborious, but remember that the quill is **spring-loaded**. This calls for care when releasing the quill locking lever prior to repositioning the quill downward. If the fine control knob has been allowed to disengage (backed off counter clockwise), the quill

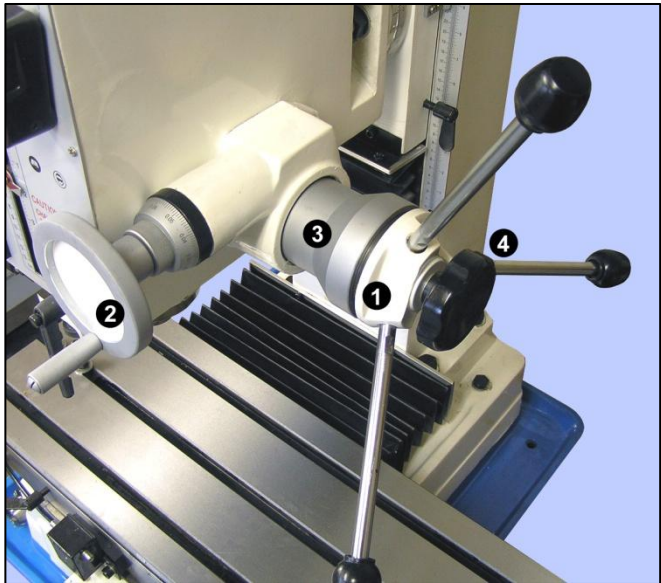


Figure 2-6 Quill downfeed controls

The lever hub (1) is full-time connected to the quill pinion. The fine control knob (2) is connected by a worm gear to the sleeve (3), and is free to rotate – doing nothing to the quill – if not meshed with lever hub (1).

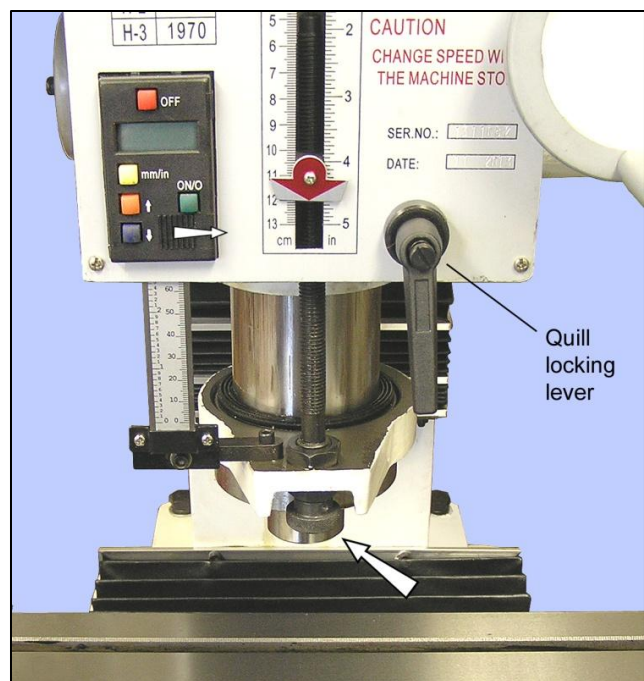


Figure 2-7 DRO, depth stop and quill locking lever

Set the depth stop by rotating the knurled knob, arrowed. For milling operations, lock the quill before making a cut.

will jump up by 0.01" or more. To avoid this, make sure the fine control is ***firmly clockwise***, lightly loading the quill rack, before releasing the locking lever.

## 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.



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

Replace the battery by sliding the cover (small arrow) to the right. For longer battery life use a 1.5V silver oxide battery, SR44 or equivalent.

## HEADSTOCK ELEVATION (Z-AXIS)

See page 6 for the Z-axis motor controls. Use the scale right of the headstock for rough positioning, Figure 2-8.

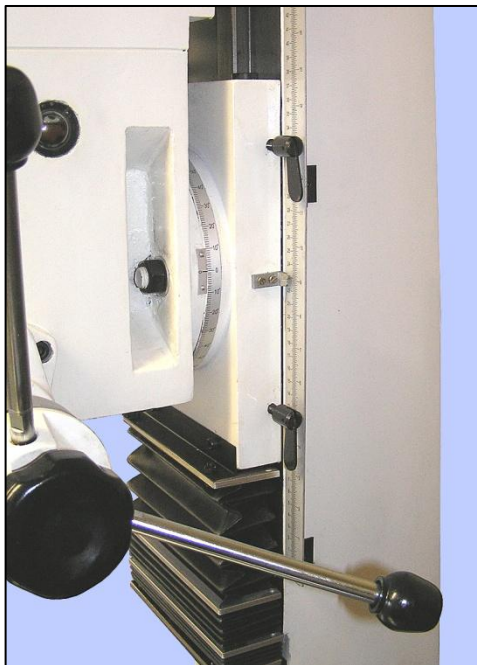


Figure 2-8  
Z-axis scale and locking screws



Figure 2-9  
Hand crank



***Be sure to loosen the Z-axis lock screws before moving the headstock.***



***Remove the crank handle before moving the headstock under power.***

## Hand crank

Use the hand crank, Figure 2-9, only for occasional small adjustments, then ***remove it and set it aside.***

## 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. The 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 (see below). 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.

If power tapping bear in mind that reversing is not instantaneous, so be careful tapping blind holes. Be sure the quill locking lever is free, and start trial work with the lowest spindle speed, **L-1**.

### Turning the spindle by hand

One way to reduce the risk of small-tap breakage is to drill the workpiece, then 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.

Turning the spindle by hand is easier if you select **H-3**, but revert to **L-1** if backing out under power.

## 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 set at the factory, and is not adjustable (by everyday methods), but in the other plane the headstock can be set to any angle up to 90° either side of the normal vertical position. [Because re-establishing true vertical (trammig) on any mill is a time consuming process, most machinists look first for other ways of handling the project instead of tilting the head.]

The headstock is secured by three nuts spaced 120° apart, one underneath and one either side, Figure 2-11. The headstock is top-heavy, and may swing suddenly to either side unless a **helper is on hand** to restrain it. Using a 24 mm wrench, 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.)

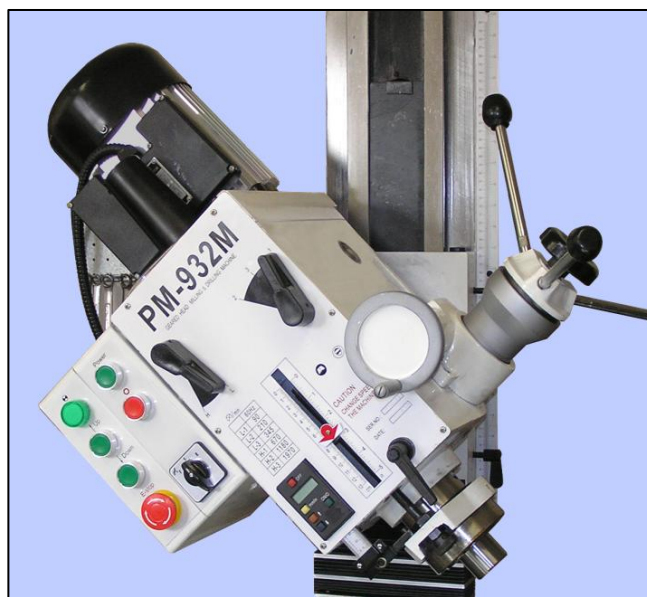


Figure 2-10 Headstock tilted 45° counter clockwise



Set the headstock to the desired angle by reference to the tilt scale, then re-tighten the nuts. Bear in mind that this is good only to **approximately  $\pm 0.25^\circ$** , so a more accurate means of angle measurement will be needed if the project calls for precise tilting.

### Tramming the headstock

"Tram", short for trammel, means accurate alignment – in this case adjusting the headstock tilt to bring the spindle to precisely  $90^\circ$  relative to the table. 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.

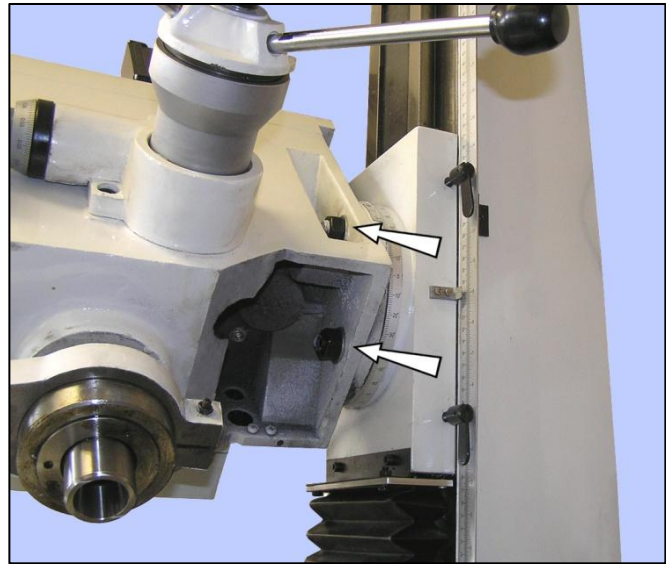


Figure 2-11 Headstock nuts (two of three)

Figure 2-12 shows a typical shop-made holder; it has a threaded arbor allowing the choice of two radius arms, 6 and 10 inches measured from spindle centerline to indicator tip. A collet is used to hold the arbor, in this case  $5/8$ " 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 re-establishing tram:

1. Disconnect power.
2. Set the headstock to the approximate zero degree position on the tilt scale, then tighten the three nuts enough to avoid unexpected headstock movement.
3. Remove the vise and clean the table surface.
4. Set a 1-2-3 block (or other precision-ground block) on the table under the indicator probe.
5. Switch on the DRO.
6. Lower the spindle using fine downfeed to give a half-scale indicator reading (exact location isn't important, but remember the reading).
7. Note both the dial indicator and DRO readings, then back off the fine downfeed at least a couple of turns to avoid collision when sweeping.
8. Set the spindle drive to **H-3** (this will allow the indicator holder to sweep easily from side to side).
9. Reposition the 1-2-3 block to the opposite location on the table.

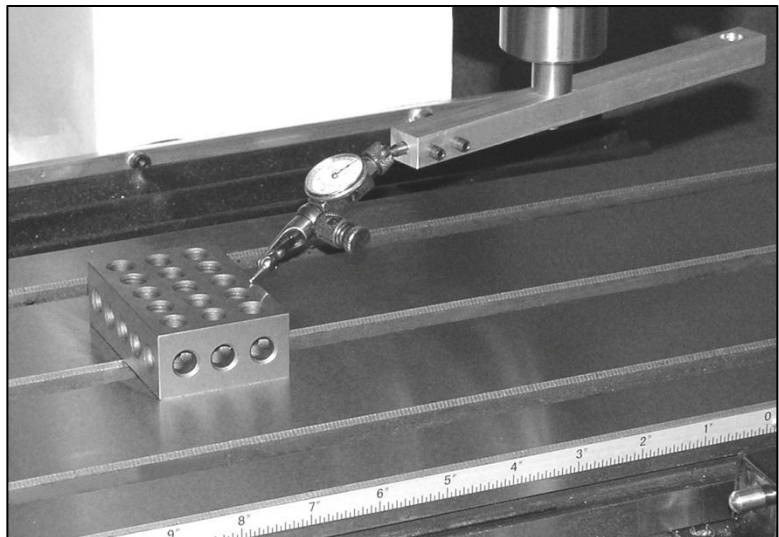


Figure 2-12 Sweeping holder for dial indicator

This example shows a rectangular section aluminum bar with threaded holes allowing the choice of two sweep diameters, 6" and 10", measured from spindle centerline to indicator tip. The smaller sweep can be used for front-to-back tramming, also left-to-right as here. For more sensitive left-to-right tramming, use the larger sweep.

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 (7).

If the headstock is perfectly trammed – highly unlikely at the first shot – the DRO reading should be as in step (7). 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 hand-slap to a rap with a soft-face dead-blow mallet).

Repeat steps (4) 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  $\pm 0.001$ " on a radius of 5 or 6 inches.

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 shimming the column-to-base interface. This is a two-person procedure, requiring an engine hoist or some other means of un-weighting the headstock (see Section 6, Installation).

## INSTALLING A VISE

The mill is shipped with two hardened vise keys, Figure 2-13, that fit snugly in the 14 mm T-slots and many 4" precision vises (but not all: some 4" vises come with 16 mm key slots). Before installing the keys, check their fit in the T-slots. If necessary, ease the fit using a **few strokes** of a fine stone or diamond hone – the objective is a tight fit, but not so tight it takes more than reasonable effort to lift the vise clear of the table.

The other objective is a setup that allows the vise to be removed and replaced routinely, yet be accurate enough for general machining without the need for indicating every time.

A typical setup for indicating is shown in Figure 2-14.

**Make sure** that the spindle does **not rotate** throughout the procedure. There is no spindle lock, but you can set the gears for the lowest spindle speed (L-1), then apply light spring pressure if necessary to the splined upper portion of the spindle (not shown). 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 (say). Lock the Y-axis.

Note the reading at one end of the bar, then traverse to the other end. Note the discrepancy between the two readings. Ideally, the two should be identical. 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)

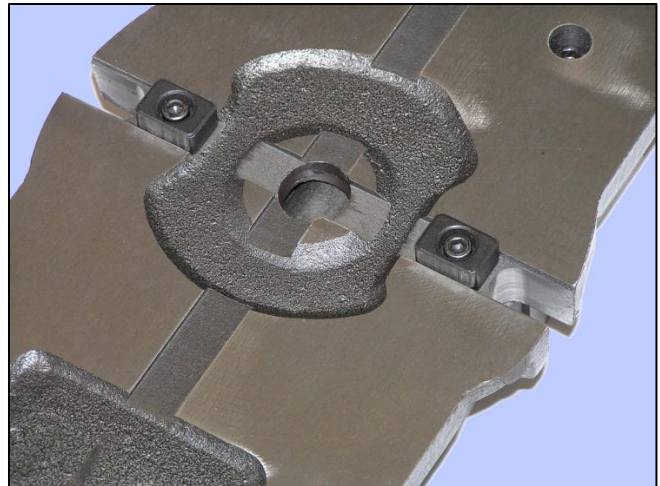


Figure 2-13 **Vise keys installed on X-axis**  
The keys can also be installed on the long axis.

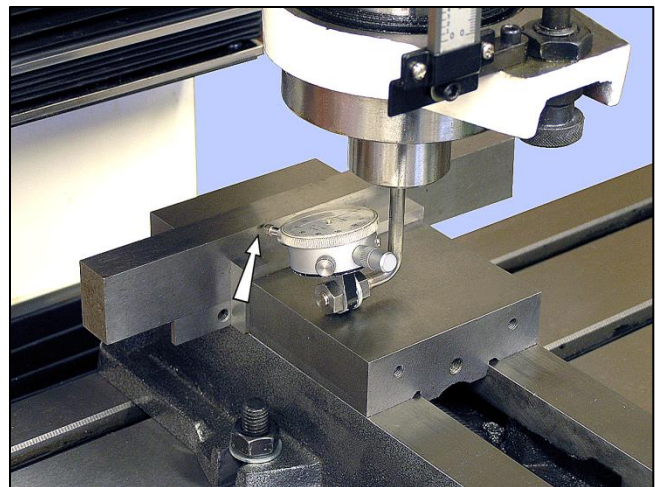


Figure 2-14 **Indicating the vise**  
The tip of a standard dial indicator, arrowed, rides along the side face of a ground reference bar.

behind the fixed jaw, Figure 2-15. There is no "right" deviation; what is acceptable depends on the project.

### 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. Then, 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.

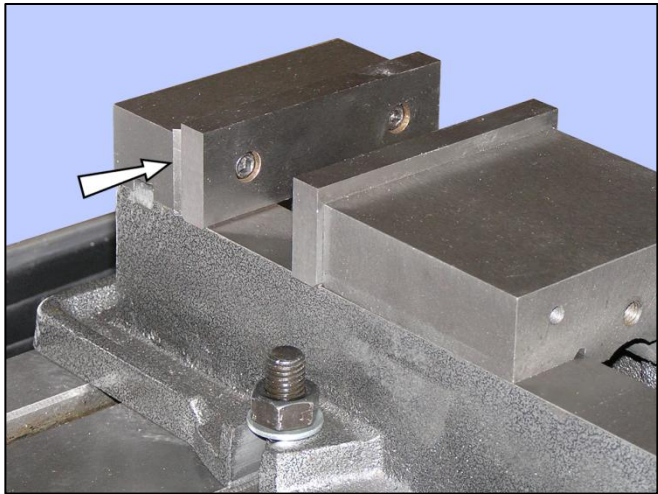


Figure 2-15 **Shimming the fixed jaw**

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



## Section 3 MAINTENANCE



***Unplug the 220V power cord before any maintenance operation!***

### Lubrication

Oils are classified according to their viscosity. There are several viscosity indexes, the main ones being ISO (International Standards Organization) and SAE (Society of Automotive Engineers). SAE adds another complication with different indexes for engine and gear oils, further sub-divided into lists with and without the suffix W, meaning "multigrade". Mistaking SAE engine oil for gear oil can be an issue; for instance, SAE 20 engine oil has about the same viscosity as SAE 80 gear oil, both roughly equivalent to just one number on the ISO scale, ISO 68.

### Recommended lubricants

Gearbox: ISO 68, such as SAE 80W90 auto gear oil, or Mobil DTE Heavy/Medium circulating oil (about 3 qts.)

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

Power feed (visible gears), quill rack and pinion, Z-axis helical 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

Assuming a clean environment – free from abrasive particles and 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.

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.



***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.***

### Gearbox drain and refill

1. Run the mill a few minutes to warm the oil if necessary.
2. Remove the sheet metal cover from the underside of the headstock (four 5 mm screws).
3. Place a 1-gallon or larger drain pan under the headstock.
4. Using a 6 mm hex wrench remove the drain plug, Figure 3-1.
5. Allow the oil to drain completely, then replace the drain plug.
6. Remove the fill plug, Figure 3-2, then add just a few ounces of oil.
7. When satisfied that the headstock is oil-tight, add oil to the halfway mark on the sight glass (about 3 qts total).
8. Replace the fill plug.
9. Replace the sheet metal cover, unless going on to service the quill rack and pinion, below.

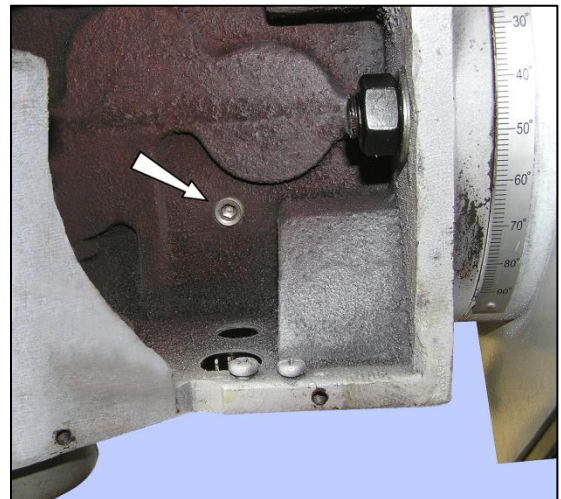
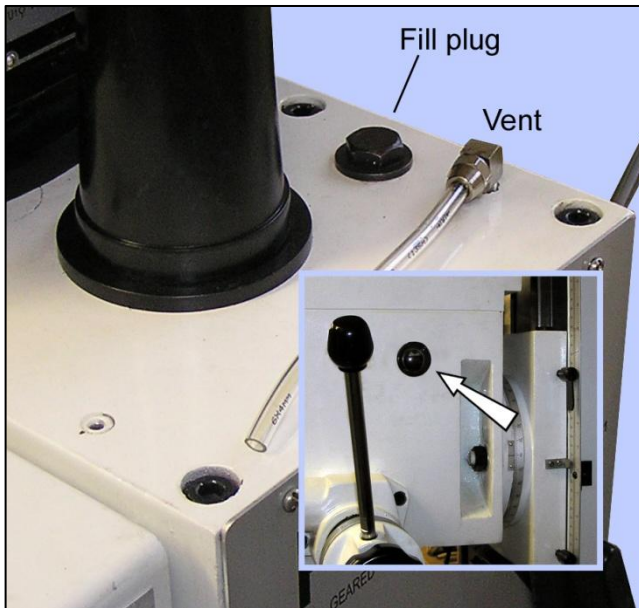
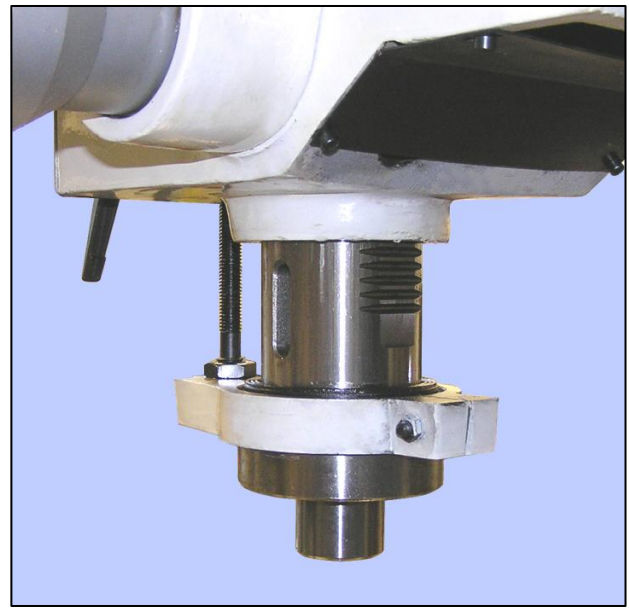


Figure 3-1 Gearbox drain plug



**Figure 3-2 Gearbox fill plug and sight glass (inset)**  
The vent is open to the atmosphere to prevent the development of anaerobic organisms in the oil. The attached tube prevents spillage at high clockwise tilt angles.



**Figure 3-3 Quill rack**

### Quill rack and pinion

Lower and lock the quill, Figure 3-3. Remove the sheet metal cover from the underside of the headstock (four 5 mm screws). 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. Apply grease to the gear teeth, then replace the sheet metal cover.

### Spindle bearings

The spindle runs on sealed, pre-lubricated roller bearings requiring no routine attention.

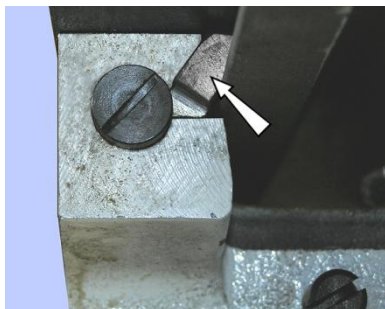
### Maintenance

#### Gib adjustment

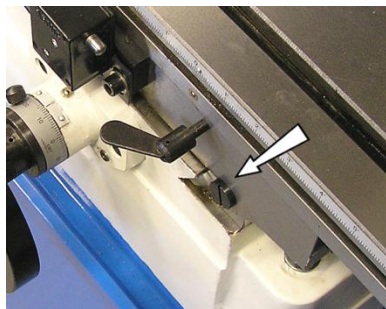
Gibs on the X, Y and Z axes control the fit of the mating dovetailed surfaces. They are gently-tapered lengths of ground cast iron located by opposing screws at each end. Adjusting them is a trial and error process that takes time and patience. Aim for the best compromise of rigidity and reasonably free table movement. Too tight means accelerated wear on the ways, leadscrews and feed motors (X and Z axes only). Too free means workpiece instability, inaccuracies and chatter.



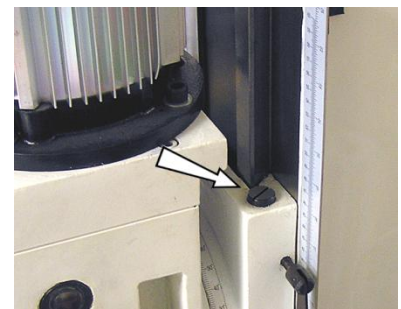
***BOTH screw heads must be tight against the gib ends. If you loosen one, tighten the other. Remove the pleated way covers for access to the back of the Y gib and bottom of the Z gib.***



**Figure 3-4 X-axis gib, right end**



**Figure 3-5 Y-axis gib, front end**



**Figure 3-6 Z-axis gib, top end**

### Leadscrew backlash correction

When alternating between clockwise and counter clockwise rotation of the X or Y leadscrews, the handwheel moves freely but the table stays put. This is backlash, a feature of all leadscrews other than the precision variety 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.

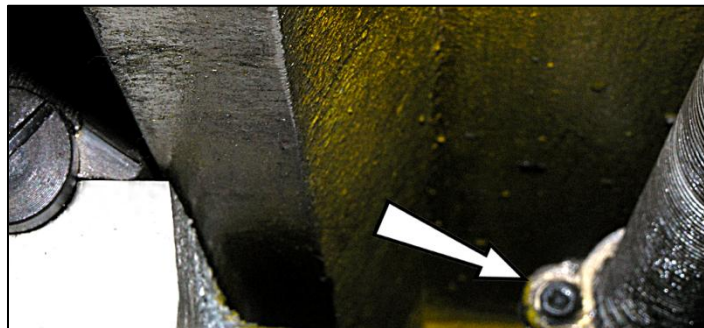


Figure 3-7 X-axis leadscrew nut

Excessive backlash can be corrected by compressing the leadscrew nut, Figure 3-7. To adjust the nut a long-handled 4 mm hex wrench is required, ideally one with an extra-thick shank to minimize flexing. The corresponding leadscrew nut for the Y-axis is underneath the machine, accessible when a side panel has been removed from the stand.

### Downfeed return spring tension

The quill should automatically retract when the coarse downfeed levers are released following a drilling operation. If not, the return spring may need to be re-tensioned – but first check for other issues such as obstructions or lack of lubrication.



***Take extra care when working on the spring – it can unwind violently if not properly controlled.***

A pin in the headstock casting engages in one of 6 notches on the rim of the cup-shaped spring housing. Spring tension is adjusted by disengaging the housing, see below, then rotating and re-engaging it at the desired tension – clockwise to reduce, counter-clockwise to increase.

To adjust the tension:

1. Wear heavy-duty leather gloves for hand protection
2. Loosen one half turn, but ***do not remove***, the M6 socket head screw holding the spring housing in place.
3. While holding the housing ***firmly to stop rotation***, loosen the M6 screw to the point where the housing can just be disengaged from the pin.
4. Step the housing round to the next notch, then run in the M6 screw by hand to secure the housing. Test for tension.
5. Repeat as necessary, then ***fully tighten*** the retaining screw.

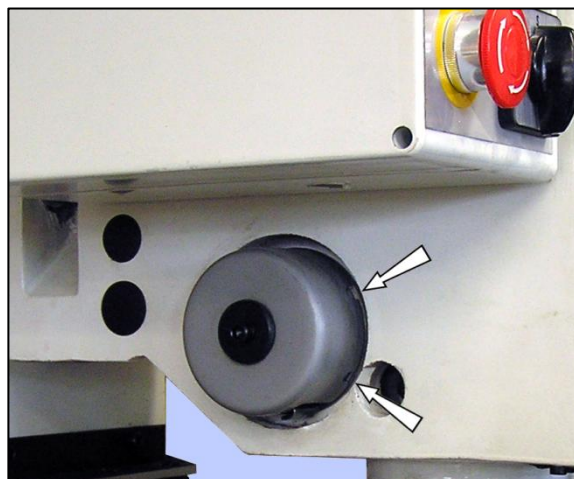


Figure 3-8 Return spring housing

Notches in the rim, arrowed, allow 6 radial settings.

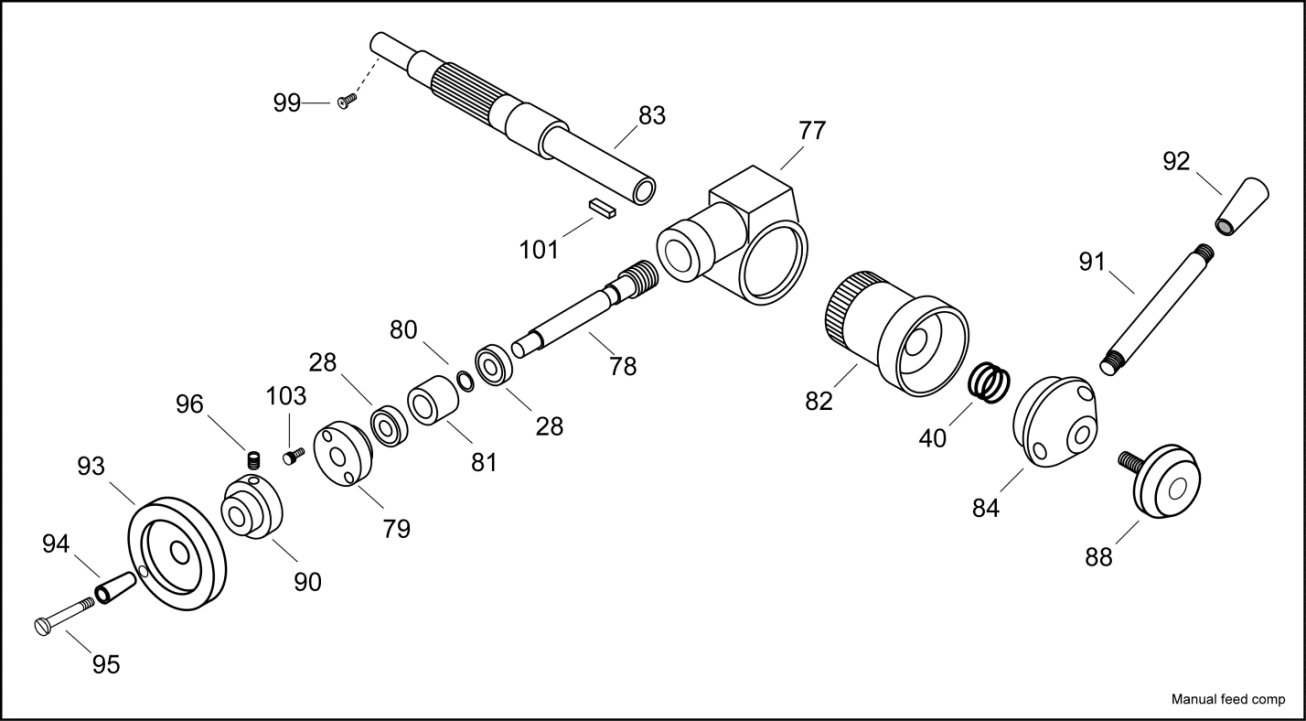
**Power feed (X-axis) brush replacement**

There are two carbon brushes on the power feed motor. If removed for inspection, they should be replaced in the same orientation. Replace both when worn down to about 0.2".

# Section 4 PARTS

## PLEASE NOTE

1. All dimensions are in mm
2. Item quantity 1 piece unless otherwise stated in brackets (...)
3. Standard hardware items are available from multiple sources, and are not given a manufacturer's part number.
4. To order proprietary parts, please give the drawing reference number, together with the manufacturer's part number, and the revision number of this manual (see the v number in the page footer).

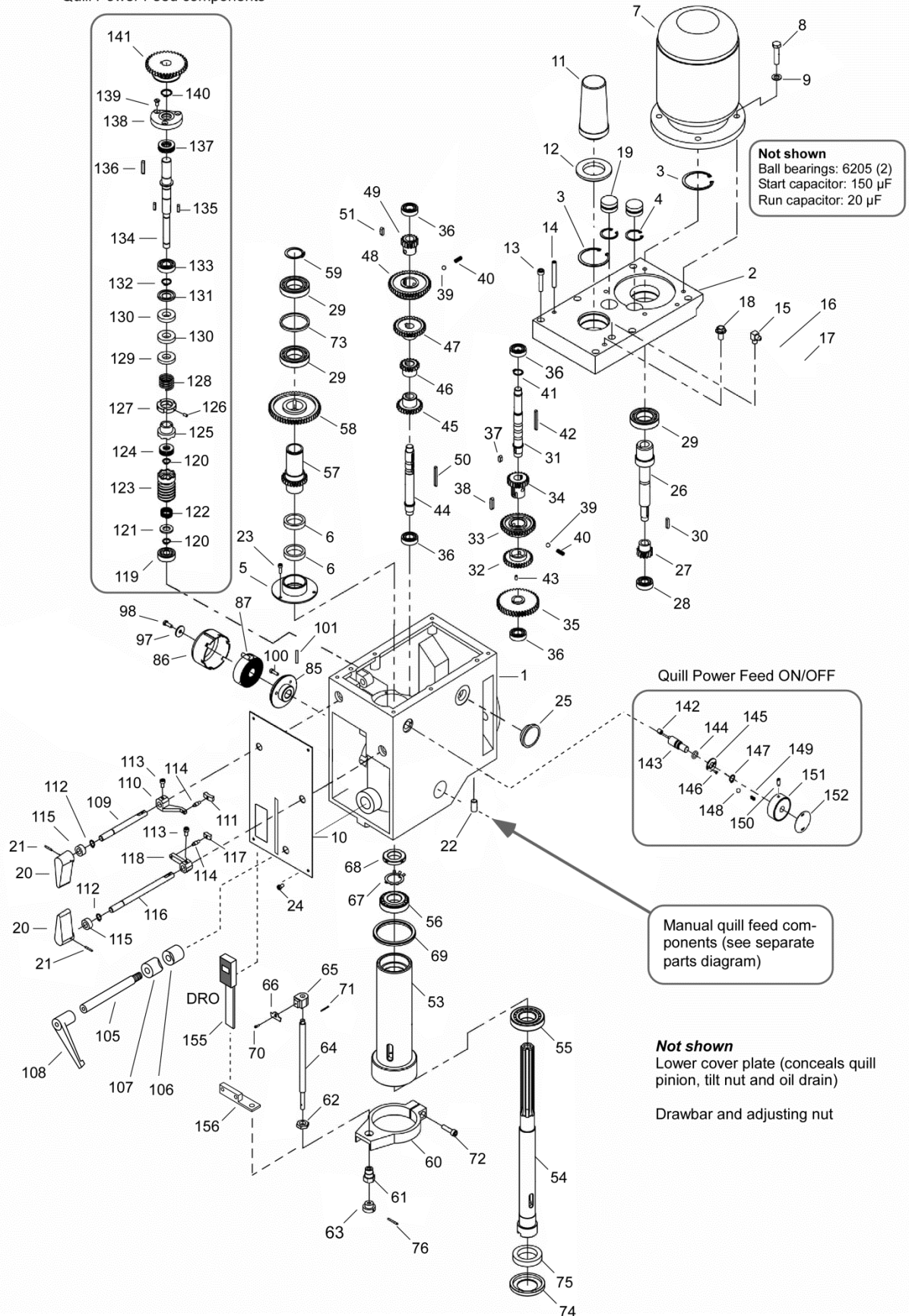


28		Ball bearing: 6003 (2)	82	20016	Fine feed hub (worm gear)	93	20306B	Find downfeed handwheel
40		Spring	83	20117	Pinion shaft	94	20305-1B	Handle
77	20015	Worm gear housing	84	20013	Coarse feed hub	95	20305-2B	Screw: M8 1.25, shoulder
78	20119	Worm shaft	88	20303	Clamp knob	96		Screw: M5
79	20302	End plate	90	20017	Graduated dial	99		Screw: M5 0.8 x 8, Ph
80		Retaining ring: 14, Ext	91	20121B	Lever (3)	101		Key
81	20120	Spacer	92	20301B	Knob: M12 (3)			

## MANUAL QUILL FEED COMPONENTS



# Quill Power Feed components



Head comp

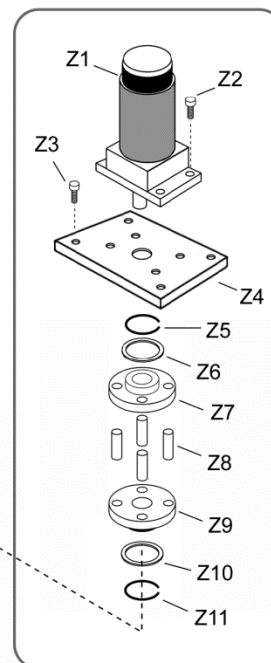


1	20010B	Headstock	37		Key: 6 x 6 x 14	71		Roll pin: 3
2	20011B	Headstock top plate	38		Key: 6 x 6 x 28	72		Screw: M8 1.25 x 30
3		Retaining ring: 62, int (2)	39		Ball: 2 (2)	73	20024B	Spacer
4		Retaining ring: 35, int (2)	40		Spring (2)	74	20133B	Spindle end cap
5	20018B	End cap	41		Retaining ring: 18, ext (2)	75		Spindle seal
6		Quill seal (2)	42		Key: 5 x 5 x 50	76		Roll pin: 3
7		Motor: 1.1 kW (1.5 HP)	43		Screw: set (4)	77 - 84		Manual quill feed components
8		Screw: M8 1.25 x 25, hex	44	20107B	Shaft #3 (idler)	85	20118	Return spring flange
9		Washer	45	20109-B	Gear: 25T	86	20123	Return spring housing
10	20201	Front cover plate	46	20110-2B	Gear: 18T	87	20122	Return spring
11	20304-1B	Drawbar cap	47	20112-B	Gear: 32T	88 - 96		Manual quill feed components
12	20304-2B	Drawbar cap seal	48	20113-B	Gear: 43T	97		Washer
13		Screw: M8 1.25 x 45, skt cap (6)	49		Gear: 16T	98		Screw: M6 1 x 12, skt hd cap
14		Taper pin: 8 x 40	50		Key: 5 x 5 x 50	99		Manual quill feed component
15	20025B	Gearbox vent elbow	51		Key: 6 x 6 x 18	100		Screw: M6 1 x 12, flat (3)
18		Oil fill plug	52			101		Pin: 8 x 20 (2)
19	20020B	Cap plug (2)	53	20019	Quill	105	20124B	Quill lock shaft
20	20307B	Shift lever (2)	54	20104B	Spindle	106	20203B	Quill lock bush (fixed)
21		Roll pin: 3 x 15 (2)	55		Roller bearing: 30207 (I 35/O 72)	107	20202B	Quill lock bush (moving)
22		Oil drain plug	56		Roller bearing: 30206 (I 30/O 62)	108		Quill lock handle
23		Screw: M5 0.8 x 10, ph (3)	57	20114-B	Splined sleeve	109	20125B	Shaft: H-L speed selector
24		Screw: M4 0.7 x 8, skt cap btn (13)	58	20116-B	Gear: 53T	110	20022-1B	H-L rocker arm
25		Sight glass	59		Retaining ring: 35, ext	111	20204-2B	H-L shift fork
26	20105B	Shaft #1 (drive)	60	2012	Quill base	112		Retaining ring: 12, ext (2)
27	20105-1B	Gear: 14T	61	20128	Shoulder nut: M16	113		Screw: M6 1 x 14, cap (2)
28		Ball bearing: 6003 (3)	62	20129	Nut: M16	114	20204-3B	Shift rod (2)
29		Ball bearing: 6007 (3)	63	20130	Depth rod adjustment knob	115		Oil seal (2)
30		Key: 5 x 5 x 25	64	20131	Depth rod	116	20126B	Shaft: 2-3-1 speed selector
31	20106B	Shaft #2 (idler)	65	20021	Depth block	117	20204-1B	2-3-1 shift fork
32	20108-B	Gear: 29T	66	20132	Depth pointer	118	20022-2B	2-3-1 rocker arm
33	20110-1B	Gear: 35T	67		Lock washer	119 - 152		Quill Power Feed components
34	20111-B	Gear: 21T	68		Spanner nut: M30			(separate manual)
35	20106-1B	Gear: 41T	69	20308	Quill seal	155		DRO assembly
36		Ball bearing: 6202 (4)	70		Screw: M4 0.7 x 8	156		DRO bracket

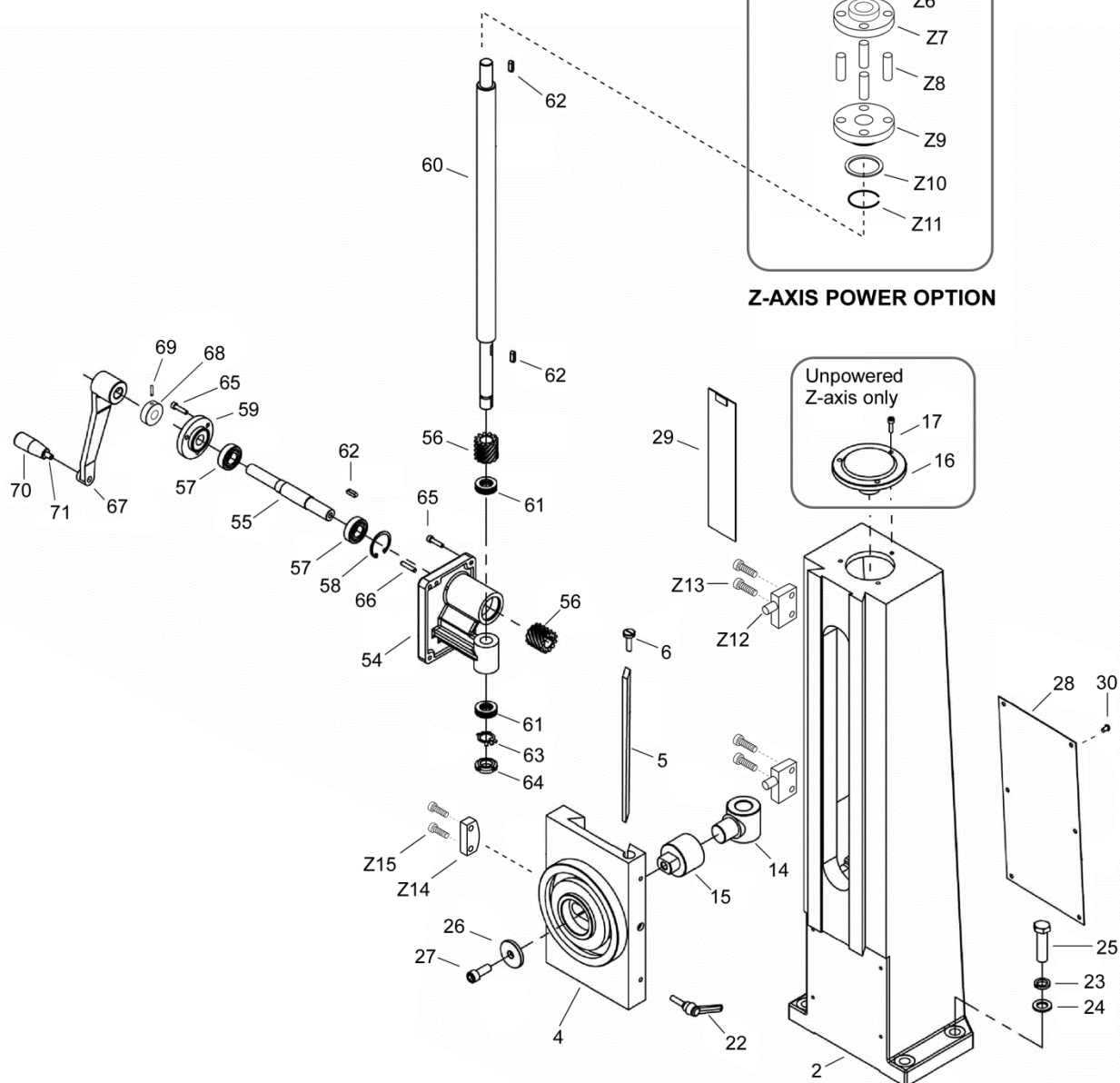
## HEAD COMPONENTS

**Not shown**  
 Ball bearings:  
 6000  
 (10mm ID, 26mm OD)  
 6001  
 (12mm ID, 28mm OD)

**Z-axis power option  
 also includes**  
 Limit switches (2), ref.  
 Z12, limit block ref.  
 Z14, and attachment  
 screws Z13, Z15



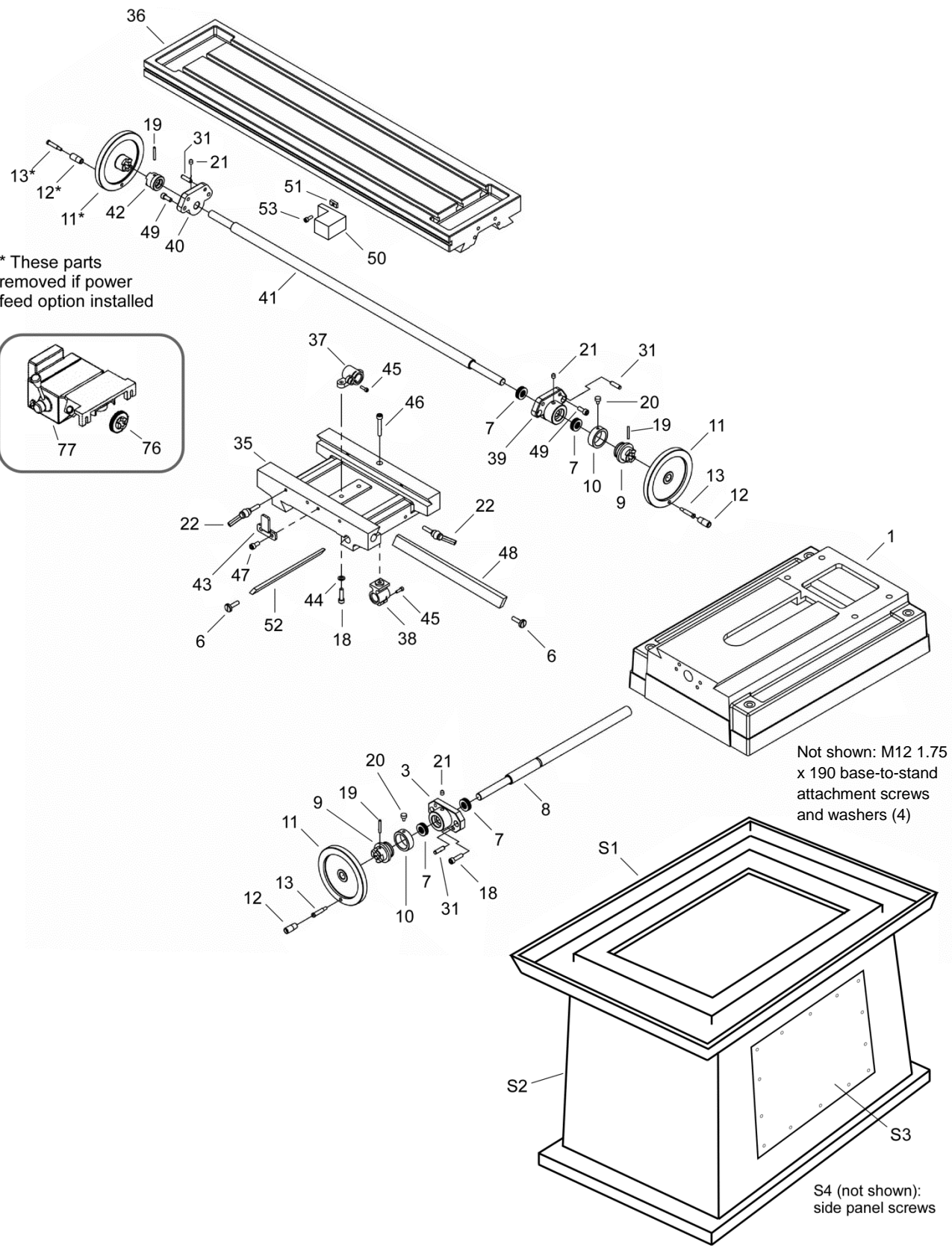
**Z-AXIS POWER OPTION**



Column comp

2	10013	Column	57		Ball bearing: 604 (2)	Z1		Gear motor: 220V, 1φ
4	10016	Headstock base casting	58		Retaining ring: 42, int	Z2		Screw: M8 1.25 x 25 (4)
5	10025	Z-axis gib	59	10015	Flange	Z3		Screw: M8 1.25 x 20 (4)
6	10106	Screw: gib adjustment (2)	60	10116	Z-axis leadscrew	Z4		Motor base (column cap)
14	10024	Z-axis leadscrew nut	61		Thrust bearing 51104 (2)	Z5		Retaining ring: 30, ext
15	10117	Leadscrew nut sleeve	62		Key: 6 x 6 x 20 (3)	Z6		Spacer
22		Locking leaf screw (2)	63		Lock washer	Z7		Top coupler
23		Lock washer: 16	64		Nut: M20 1.5	Z8		Nylon peg (4)
24		Flat washer: 16	65		Screw: M6 1 x 25 (7)	Z9		Bottom coupler
25		Screw: M16 2 x 60	66		Pin: 6 x 30	Z10		Spacer
28	10119	Rear cover	67	10018	Z-axis crank casting	Z11		Retaining ring: 30, ext
29	10124	Sliding cover plate	68		Notched hub	Z12		Limit switch (2)
30		Screw: M6 1 x 8 (6)	69		Roll pin	Z13		Screw: M4 0.7 x 12 (4)
54	10017	Crank gear housing	70		Handle	Z14		Z-axis limit actuator
55	10113	Z-axis crankshaft	71		Screw plus nut: M10	Z15		Screw: M6 1 x 20 (2)
56	20109	Gear: 12T, helical (2)						

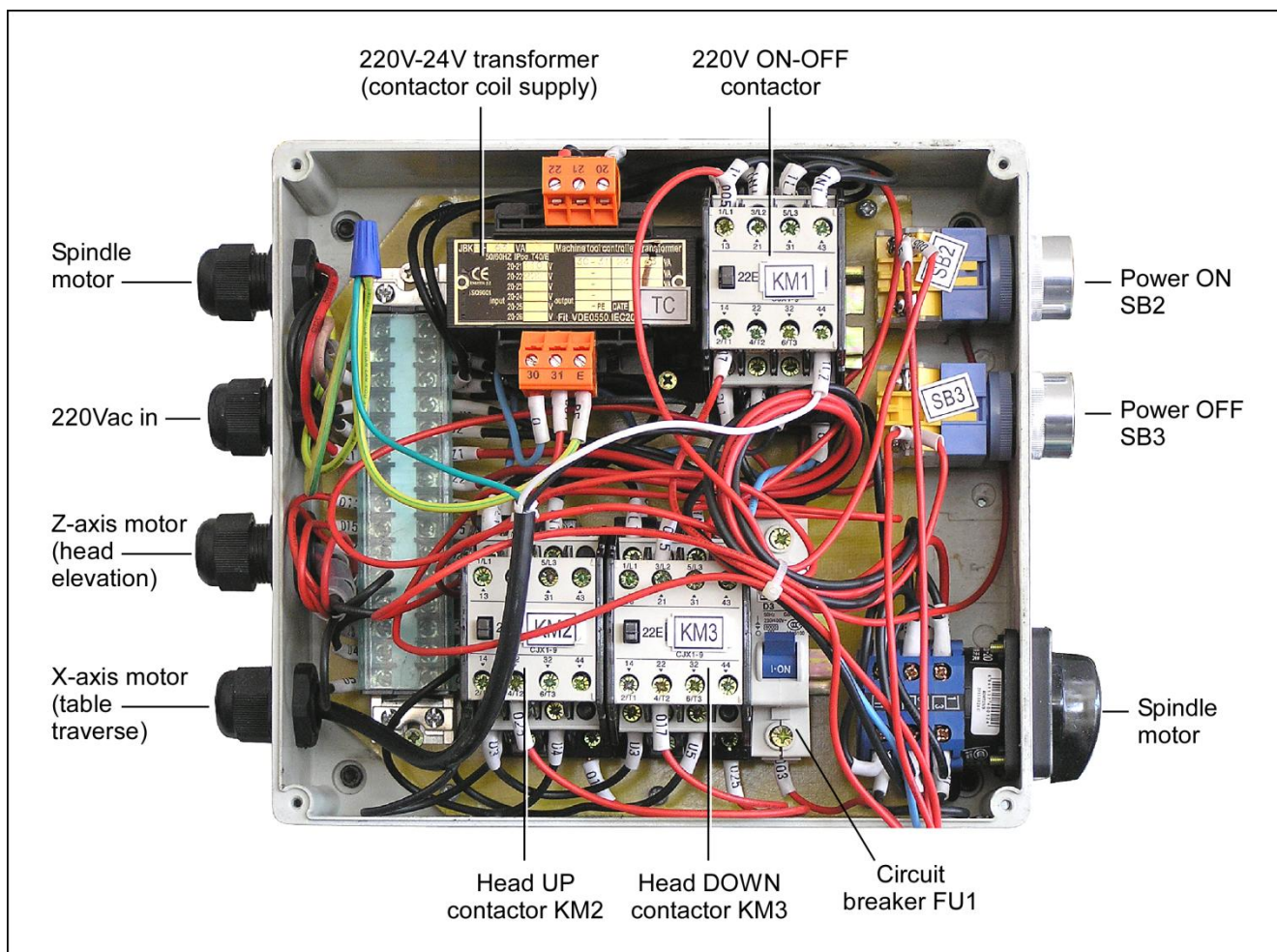
## COLUMN COMPONENTS



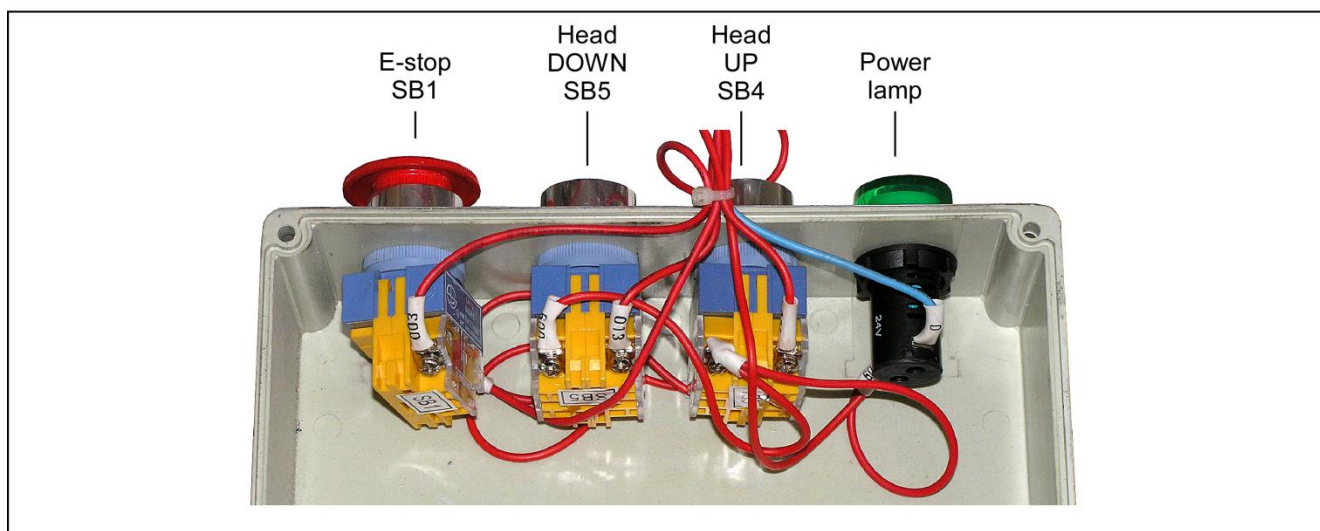
Base-Table-Stand comp

1	10010	Base	21		Oiler (3)	46		Screw: M8 1.25 x 45, Cap
2		Screw: M12 1.75 x 190 (4)	22		Locking leafscrew (4)	47		Screw: M8 1.25 x 12, Cap
3	10021	Y-axis leadscrew flange	31		Pin: 8 x 30 (6)	48	10022	Table gib (X-axis)
6	10106	Screw: gib adjustment (4)	35	10011	Saddle	49		Screw: M5 0.8 x 25, Cap (4)
7		Bearing 51103 (4)	36	10012	Table	50	10108	Movable stop block assembly (2)
8	10104	Y-axis leadscrew	37	10202	X-axis leadscrew nut	51	10109	Nut, M6 special (2)
9	10102	Dial hub (2)	38	10203	Y-axis leadscrew nut	52	10023	Saddle gib (Y-axis)
10	10111	Graduated dial (2)	39	10020	X-axis leadscrew RH flange	53		Screw: M6 1 x 15 (2)
11	10301	Handwheel (2)	40	10019	X-axis leadscrew LH flange	S1		Cast iron tray
12	20305-1B	Handle (2)	41	10103	X-axis leadscrew	S2		Cast iron base
13	20305-2B	Shoulder screw: M8 1.25 x 12 (2)	42	10105	Power feed coupler	S3		Side panel (2)
18		Screw: M8 1.25 x 20, Cap	43		Limit switch assembly	S4		Screw: M6 1 x 8, Ph (28)
19		Pin: 5 x 45 (3)	44		Washer: 8	76		Pinion
20		Screw: M5, knurled (2)	45		Screw: M5 0.8 x 25, Cap (2)	77		Power feed assembly

## BASE, TABLE & STAND COMPONENTS



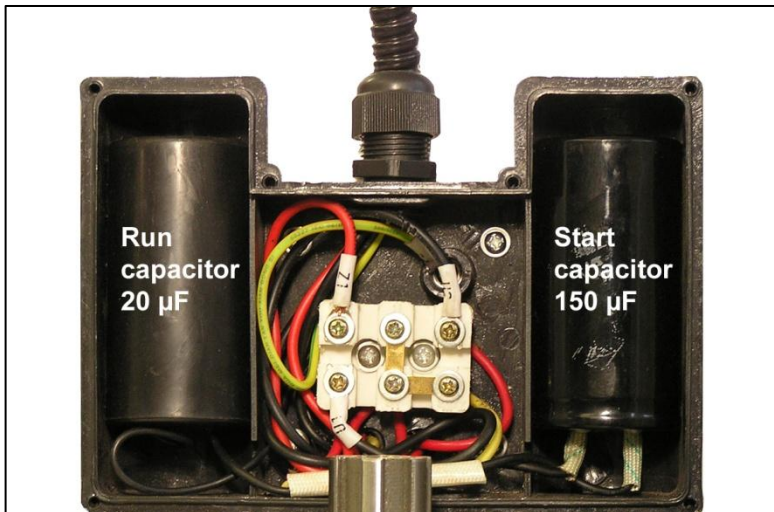
**CONTROL BOX**



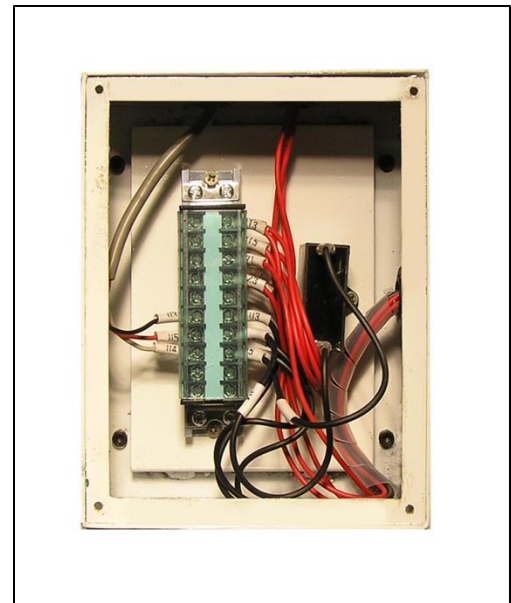
**CONTROL BOX COVER**

## CONTROL BOX COMPONENTS





**SPINDLE MOTOR CAPACITORS**



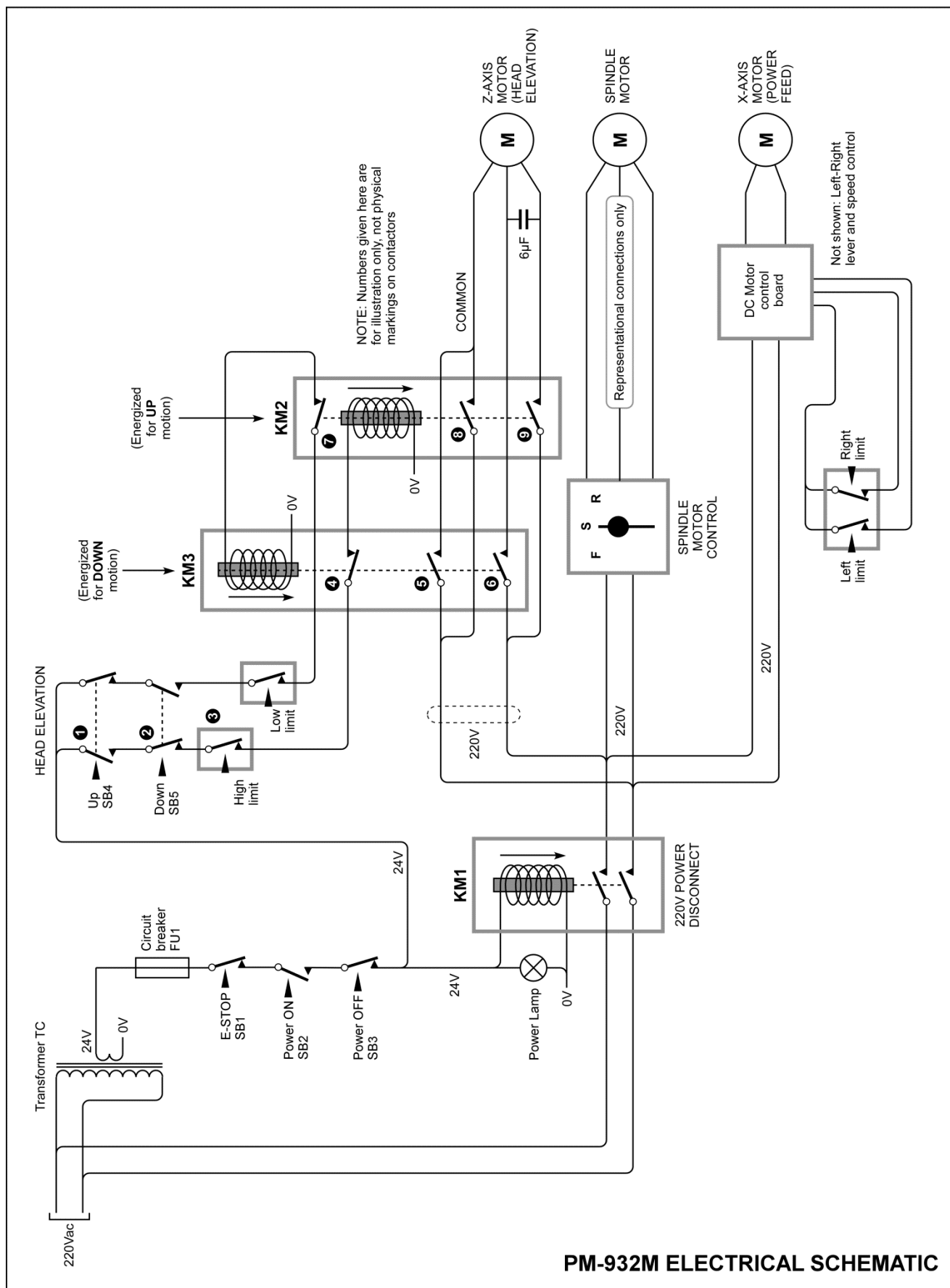
**Z-AXIS MOTOR & LIMIT SWITCH  
WIRING**  
(back of column)

### **Electrical system** (schematic on following page)

- All switch contacts are shown in their "normal" condition (= not actuated).
- The 220V ac supply to all devices except the transformer is switched by contactor KM1.
- The 220V ac input to the transformer is **not** switched.
- All push-buttons (SB) and the solenoids of contactors KM1, KM2 and KM3 are in the 24V ac circuit powered by the transformer.
- The 24V circuit is protected by FU1, a resettable circuit breaker.
- The E-STOP button breaks the 24V ac line, instantly de-energizing all contactors and stopping all machine motion.
- Z-axis contactors KM2 and KM3 together form a latching circuit that positively ensures that UP and DOWN motions cannot be selected at the same time. Example:

SB4 is pressed for UP motion. Contact SB4(1) closes, completing the 24V circuit to KM2 solenoid via SB5(2), high-limit switch (3), and KM3(4). KM2 energizes, opening KM2(7), disabling the DOWN circuit by breaking the 24V line to KM3 solenoid. Contacts KM2(8) and KM2(9) close, powering the Z-axis motor.

- The 6μF capacitor on the Z-axis motor phase-shifts the 220V supply for UP vs. DOWN motion.



## Section 5 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.  
**Remove** the hand crank, and set it aside.
- Lifting gear – sling, hoist or forklift – must be rated for at least 1500 lb.
- Working **location** of the mill must allow:
  1. Full left-right travel of the table
  2. Access to the back of the column (Z axis leadscrew maintenance)
  3. Headroom for the Z-axis motor
- Power requirement is 220V, 60Hz, 1 $\phi$ , 15A circuit protection (spindle motor only, 8.6A 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.
  2. The Z-axis (headstock) and X-axis (table) motors are safely situated, **not** installed in their working locations. Don't let them dangle on the cables!
  3. There are no clamps or locks on moving parts.
  4. The gearbox contains **oil** – check the sight glass at right of the headstock.
  5. The gear levers are set for the lowest speed: Hi-Lo to L, 1-2-3 to 1.
  6. The gears are fully engaged – hand rotate the spindle forward and back while applying light pressure on each lever, listening for the click as gears engage.

## Uncrating the mill

The PM-932M is shipped in two packing cases strapped together, the lower case for the machine, the upper one for the stand. If available, use a forklift to remove the base. If not, an "engine hoist" such as that shown in Figure 5-1 may be used.



Figure 5-1 **One method of removing the upper packing case**

A nylon sling encircles two webbing straps with ratchet tensioners. To bring the hook and chain over the center of the main packing case, the hoist was set to its fullest extension (1 ton max load), and the front wheels were elevated by 6x6 studs on either side of the pallet.

## Setting up the stand

A suggested procedure:

1. Lower the stand packing case onto a dolly or pallet jack.
2. Remove the packing materials, then roll the stand to its working location.
3. Slide the stand off the dolly or pallet jack.

The stand comprises two iron castings, a hollow casing and a tray. The back side of the casing has holes for piping and wiring to and from a (coolant) pump which may be located within the casing. A coolant drainpipe is provided in the tray casting. Rotate the tray to bring the drain to the back.

Check local codes for "machine tool" fastening requirements. If none is specified, you may wish to install leveling mounts. Use mounts with a 1/2-13 threaded stem, and a load capacity of not less than **400 lb** per mount. Mounts with a smooth underside such as nylon allow minor repositioning even with the mill in place. Thread length should be about 3 inches (longer stems

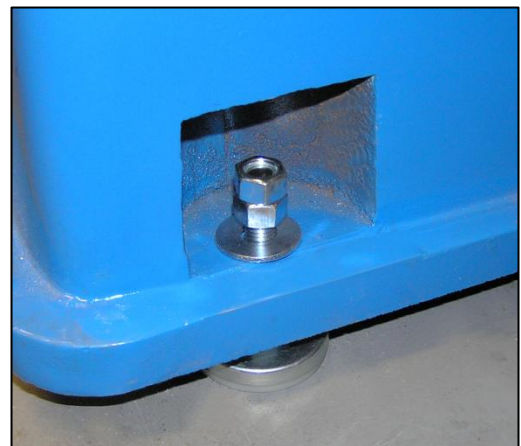


Figure 5-2 **Leveling mounts**

Because the mounting holes are not threaded, a nut and washer are needed on the underside, plus a locknut arrangement on top to prevent rotation when the bottom nut is turned.

won't fit in the pockets).

With the stand in its approximate working location, level it using the rim of the tray casting. Final leveling should be done when the machine is installed and bolted to the stand.

### Timesaving suggestion

The tray casting slides freely on top of the stand. This makes it difficult to keep the holes aligned when the mill is lowered into place. One way to save effort is to install all-thread M12 x 1.75 screws in two diagonally opposite corners with the threads uppermost (for access to the threaded holes in the stand, remove one of the stand side panels). Thread the screws in until they protrude just enough to stop the tray sliding around. Another way to achieve the same result is to tap in two wood dowels from above. The dowels must be sized to allow them to be driven through when the time comes to install the mounting bolts on the mill.

### Preparing the mill

The following assumes an engine hoist will be used. A suggested procedure:

1. With the mill remaining on the shipping pallet, remove all packing materials except for the single sheet under the mill.
2. Check that the headstock (Z-axis) is fully lowered (spindle nose just clear of the table), then run a sling "basket style" under the graduated tilt collar at the back of the headstock. **Caution:** Wrap a soft cloth around the sling to prevent damage to the tilt scale.
3. SLOWLY lift the mill, controlling any tendency for it to swing as it clears the pallet.
4. Remove the shipping pallet, then lower the mill onto a dolly or pallet jack.
5. OPTIONAL STEP: While the mill is near ground level, visually inspect all components – especially those that will be difficult to access once the mill is installed on its stand, see below.

### Initial inspection and cleanup

This is a good time to work on the Z-axis leadscrew and other parts of the column. Remove the column cap (four M8 screws) and the rear cover (six M5 screws). Clean off all grease from the leadscrew nut and hand-crank helical gears. The next step is easier if you first remove the external retaining ring and coupler components from the top of the leadscrew. Cover the leadscrew down to the nut with a taped-up sleeve of polyethylene, then remove all casting and/or machining residue using scrapers, wire brushes and a shop vacuum. Finally, "detail clean" the helical gears using a stiff nylon brush such as a flux applicator. Remove the sleeve from the leadscrew. Re-grease the gears and oil the leadscrew. Reassemble the coupler components, then test-fit the Z-axis motor. **Check for hole alignment** – the leadscrew may have been displaced in shipping, correctable by light pushing and pulling on the coupler at the upper end of the leadscrew. Do not install the motor at this time.

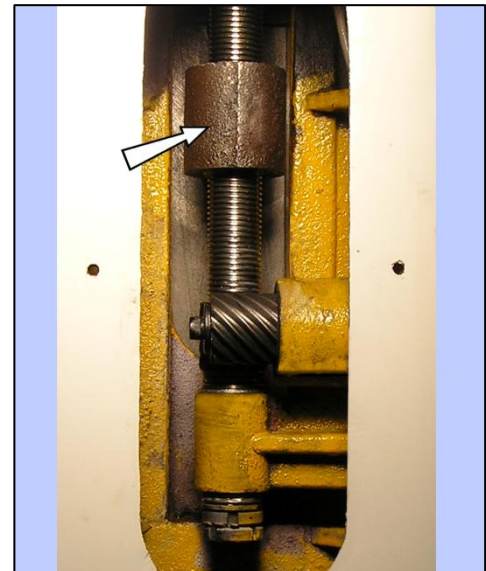


Figure 5-3 **Leadscrew and helical gears**  
The leadscrew nut, arrowed, is attached to the headstock.



## Installing the mill

1. Raise the mill to just clear the stand tray casting, then roll the mill into position.
2. Lower the mill onto the tray using taper drift(s) to align the mounting holes.
3. Remove the two temporary tray-locating screws/dowels, if fitted, then install the four mounting M12 x 190 bolts with washers.

### Moving the mill when attached to the stand

Instead of unbolting the mill, save time by fork-lifting the entire assembly. You will need two 1" diameter steel rods about 40" long. These will span the stand (hole locations arrowed in Figure 5-4) with 8 or 9 inches clear each side of the tray. Be careful with balance – crank the headstock down as far as it will go.



Figure 5-4 **Lowering mill onto stand tray**

The sling, with soft cloth padding, runs under the tilt collar at the back of the headstock. Note the X-axis motor, left, and Z-axis motor, right. These are installed after the mill is bolted down.

## Final assembly and cleanup

Unfinished metal surfaces are protected 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. Install the X axis and Y axis handwheels. **Level** the mill using the table surface for reference. **Oil** the ways and leadscrews.

## Installing the power feed (X-axis) motor

Installing the X-axis power feed motor takes care and attention. The mounting bracket, a casting with two hex-head clamp screws, is pre-installed. On the out-facing surface of the bracket loosely install two hex-head M8 screws with split and plain washers. The motor assembly hooks onto these screws, and is carefully lowered to engage its drive pinion with the larger pinion pre-installed on the X-axis leadscrew. To prevent the gears meshing too tightly, place a greased strip of standard bond paper (about 0.004" thick) between them before **gently** pressing down on the assembly. Tighten the screws, then crank the X handwheel to remove the paper.

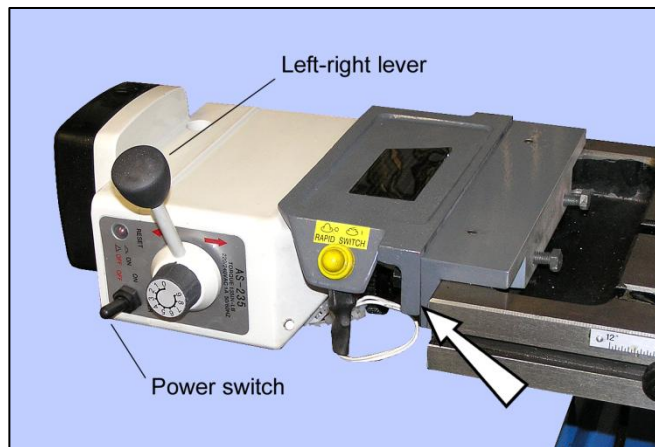


Figure 5-5 **X-axis power feed motor (table traverse)**

Shims on both sides of the bracket, arrowed, may be required to achieve quiet meshing of the gears.



**Do not power the X-axis motor at this time!**

Crank the handwheel a few turns in both directions. If the motor is properly installed, there should be little resistance on the handwheel, and no noise other than what can be expected of straight-cut gears. If other noises are heard, it may be that the motor is slightly tilted down. This may be correctable by tightening the attachment screws. If not, it may be necessary to insert metal shims (say 0.005") between the mounting bracket and motor assembly – location arrowed in photo.

**Installing the head elevation (Z-axis) motor**

Key the gearbox output shaft to the leadscrew coupler, then hand-crank the leadscrew as necessary to align the bolt holes. Install and tighten the four M8 x 25 bolts.



**REMOVE the crank handle before running the motor**

**Power-up procedure**

Depending on the available 220V wall outlet, install a 6-15 or 6-20 plug on the mill power cord. Be sure the green/yellow ground wire is attached (it may be tagged **PE** = Protective Earth).



**Before connecting power be sure that:**

1. The spindle (main) motor switch, lower right of the control panel, is set to S.
2. The Z-axis crank handle is **removed**.
3. There are no clamps or locks on moving parts.
4. The gearbox contains **oil** – check the sight glass at right of the headstock.
5. The gear levers are set for the lowest speed: Hi-Lo to L, 1-2-3 to 1.
6. The gears are fully engaged – hand rotate the spindle forward and back while applying light pressure on each lever, listening for the click as gears engage.

**Test the mill as follows:**

1. Connect power.
2. Be sure the **E-stop** (Emergency) button is not pushed IN (it pops OUT when twisted clockwise).
3. Press the **Power** button. Expect to hear a click from the control box – this is the power contactor energizing. The green power lamp, top left, should light.
4. Check the emergency function by pressing the **E-stop** button. The power lamp should go out, de-energizing the contactor, disabling all electrics.

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

5. Reset the **E-stop** button to restore power.
6. Center the **Left-Right** lever on the X-axis power feed. Rotate the speed control knob fully counter-clockwise, then clockwise about 45 degrees.
7. Switch ON the power feed motor (switch moves right). Test the power traverse function by selecting **Left** traverse, followed by **stop** (center), then **Right**.
8. Check that the limit switch assembly stops motion correctly when actuated by the left and right stop blocks, Section 2, Figure 2-3.



Figure 5-6 **Main controls**

9. **Crank handle removed? Headstock locking screws loosened?** Press and hold the **Up** button to run the headstock up the column. Check that the motor stops as the upper limit switch is actuated, Figure 5-7.
10. Check for no obstructions, then press and hold the **Down** button to run the headstock down to the lower limit.



Expect to hear a click from the control box when the **Up** button is pressed. This is one of the two Z-axis motor contactors energizing. A similar click from the other contactor should be heard when the **Down** button is pressed.

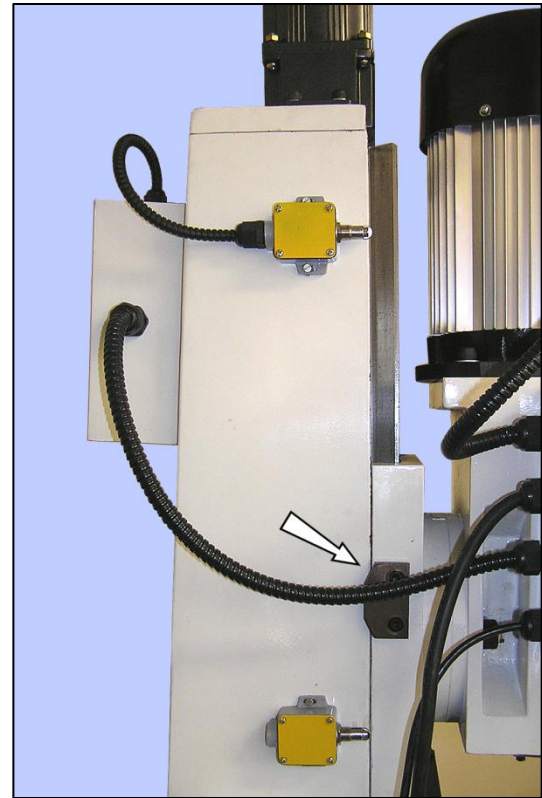


Figure 5-7 **Z-axis (elevation) limit switches**  
These are actuated by the radiused block attached to the headstock, arrowed.

### Test run procedure

DO NOT LEAVE THE MACHINE UNATTENDED DURING THIS PROCEDURE

1. **Gear levers set to L and 1 (90 rpm)? Gears fully engaged?**  
Test the spindle motor by setting the motor switch, lower right, to **F** (forward) and **R** (reverse) in turn.
2. Run the spindle at 90 rpm for a few minutes, then stop.
3. Select each of the available speeds in turn (L-2, L-3, H-1, etc.). Check **gear engagement** each time, then run for a few minutes.

#### OPTIONAL STEP

When the test run is completed, you may wish to drain the oil to flush out any residue from the manufacturing process. This is standard practice in many shops. There are no specific data to support this, but it may result in smoother, quieter running, together with longer service life.

Refill the gearbox with the recommended oil, page 14.

The machine should now be ready for normal operations.