Models PM-727M & PM-727V
Precision milling machines

**PM-727M** 6-speed gear head (6 set speeds)
**PM-727V** 6-speed gear head (6 speed ranges, infinitely adjustable speed in each range)

110Vac power
Quill DRO for precise downfeed measurement
Square column design, dovetail ways
Heavy cast iron construction
Optional steel stand & cabinet
Weight including stand 575 lbs

Model PM-727M (ac induction motor)
FAQ

My mill doesn’t run at all

R8 collets won’t go into the spindle

110 Vac power connected? Power lamp lit? (Press the Power push-button lens)
E-Stop button in? (pop it out by twisting firmly to the right.)
Fuse good?

PM-727M shown above.
The PM-727V panel, left, is labeled differently
(727V Forward = 727M Left, Reverse = Right).

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

This manual contains essential safety advice on the proper setup, operation, maintenance, and service of the PM-727M and PM-727V mills. 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 milling machine. As the owner of the machine you are solely responsible for its proper installation and safe use. Consider the material contained in this manual to be advisory only. Quality Machine Tools, 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-727 machines as shipped from January 2015. 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 email us at service@precisionmatthews.com. Your feedback is welcomed.
New installation?

These are the points to watch out for!

But read the whole manual for specifics

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

- Handling the mill is at least a two-man job.
- Read the installation instructions, Section 2 of this manual.
- Handling the mill is at least a two-man job.
- Lower the center of gravity by cranking 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 1000 lb.

Working location of the mill must allow:

1. Full left-right travel of the table.
2. Access to the back of the column for Z-axis leadscrew maintenance (if against a wall, make sure it can be moved if access is required).

- Power requirement is 110V, 60Hz, 1φ, 20A circuit protection.
- 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. No chuck or collet is installed, and the drawbar 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, 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.
Section 1  FEATURES & SPECIFICATIONS

MODEL PM-727M and PM-727V MILLING MACHINES

General information
These are robust “square column” mills designed for use in the model shop. With an all-up weight of almost 600 lbs (including the optional stand), they 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 main difference between M and V models is the motor — single speed ac (induction type) for PM-727M, variable speed (brushless dc) for the PM-727V. The V model offers a significantly wider speed range than the M model, 40-3000 rpm vs. 115-1700 rpm.

The reversible spindle runs in high-quality tapered-roller bearings enclosed in a 2-1/2” diameter quill with coarse and fine downfeed options. In the PM-727M an oil-filled gearbox provides 6 spindle speeds from 115 to 1700 rpm. The same gearbox in the PM-727V provides 6 speed ranges from 40-190 to 1800-3000 rpm. Ground dovetailed ways for table and headstock ensure smooth, precise motion in all three axes (X = table left/right, 15 in.  Y = table front/back, 8-1/2 in.  Z = headstock up/down, 16 in.). The headstock can be tilted 90 degrees clockwise and counter-clockwise from the vertical.

Approximate T-slot dimensions
Dimensions in inches

Stand footprint:
21-1/4 x 12-1/2

Optional: clearance for access to
Z-axis leadscrew (headstock)

Dimensions in mm

Working clearances – space requirements
for full motion of the table
### Model PM-727M and PM-727V specifications

<table>
<thead>
<tr>
<th>Dimensions</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Weight, including optional stand</td>
<td>575 lb net (475 lb without stand)</td>
</tr>
<tr>
<td>Size, assembled on stand</td>
<td>W 40 in. x D 26-1/2 in. x H 70 in.</td>
</tr>
<tr>
<td>Stand footprint</td>
<td>W 14-1/2 in. x D 21-1/4 in.</td>
</tr>
<tr>
<td>Tray</td>
<td>W 23-1/4 in. x D 26-1/4 in.</td>
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</table>

<table>
<thead>
<tr>
<th>Electrical</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Power requirement</td>
<td>120V, 60 Hz, 1 phase</td>
</tr>
<tr>
<td>Spindle motor PM-727M</td>
<td>Cap-start induction, 900W (1.2 HP), 1720 rpm</td>
</tr>
<tr>
<td>Spindle motor PM-727V</td>
<td>Brushless dc, 1125W (1.5 HP), variable speed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Headstock</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Vertical travel</td>
<td>16 in.</td>
</tr>
<tr>
<td>Left-right tilt</td>
<td>90° - 0° - 90°</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spindle</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PM-727M Spindle speed, rpm</td>
<td>115, 220, 320, 600, 1120, 1700</td>
</tr>
<tr>
<td>Internal taper</td>
<td>R8</td>
</tr>
<tr>
<td>Top end</td>
<td>6 splines, 22 mm OD</td>
</tr>
<tr>
<td>Quill travel</td>
<td>3 in.</td>
</tr>
<tr>
<td>Quill diameter</td>
<td>2-1/2 in.</td>
</tr>
<tr>
<td>Spindle nose to table</td>
<td>2-1/2&quot; to 18-1/4 in.</td>
</tr>
<tr>
<td>Spindle centerline to front face of column</td>
<td>7-3/4 in.</td>
</tr>
<tr>
<td>Drawbar</td>
<td>7/16 - 20, 16 mm wrench</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>W 27-1/2 in. x D 7-1/4 in.</td>
</tr>
<tr>
<td>Surface height over floor</td>
<td>Approx 36 in.</td>
</tr>
<tr>
<td>Maximum load, centered</td>
<td>200 lb</td>
</tr>
<tr>
<td>Leadscrews</td>
<td>Acme, inch pitch, 10 tpi</td>
</tr>
<tr>
<td>Left-right travel (X-axis)</td>
<td>15 in.</td>
</tr>
<tr>
<td>Front-back travel (Y-axis)</td>
<td>8-1/2 in.</td>
</tr>
<tr>
<td>T-slots (3)</td>
<td>12 mm wide, 63 mm centerlines</td>
</tr>
</tbody>
</table>

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**ABOUT THIS MANUAL ...**

It was written before the PM-727V became available. Unless otherwise noted, all descriptions, suggestions and instructions apply equally to both PM-727M and PM-727V machines. They are identical in all respects other than the motor, single speed for the M model, variable for the V.
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 110V 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 2  INSTALLATION

SETTING UP THE MILL
The PM-727M is shipped in two packing cases, one for the machine, one for the optional stand. The following procedure makes use of an engine hoist, minimum weight rating 1000 lb.

If this is a stand installation, move the stand to the mill’s working location. Make sure the back of the column will be accessible for lubrication (working clearances, Section 1).

1. Un-crate the mill. Remove the drill chuck, if fitted.
2. Lower the center of gravity by cranking the headstock down.
3. Tape cloth padding to the underside of the tilt collar.
4. Run a sling under the padding.
5. Hook the sling to the hoist, but do not lift before completing the next step.
6. Place a wood stretcher under the headstock to hold the sling away from the capacitor housing, Figure 2-1.
7. Slowly lift the mill, controlling any tendency for it to swing as it clears the pallet.
8. Roll the mill to its working location, then lower it into place, Figure 2-2.
9. Secure the mill to the bench or stand. If this is a stand installation, use the four bolts supplied. The front two bolt locations are threaded. Use lock washers and nuts for the back two.
10. Level the mill using the table surface for reference, shimming as necessary.

Assembly & 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 such as WD-40.

Oil the ways and leadscrews. Check the headstock sight glass for oil level.

If necessary, install the X-axis handwheels.

Initial checks

Read Section 3 if unsure about any item

1. Connect 110 Vac power.
2. Be sure the E-Stop (Emergency) button is not pushed in (it pops out when twisted clockwise).
3. If the power lamp is unlit, press the Power button.
The power lamp should light.

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. Restore power by twisting the E-Stop button *firmly clockwise*.

Test run procedure

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

1. Gear levers set to L and 1 (115 rpm)? Gears fully engaged? Speed control fully counter clockwise, PM-727V only.
2. Test the spindle motor by pressing the Left and Right motor switches in turn.
3. Run the spindle at 115 rpm for a few minutes, then stop.
4. 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.

The machine should now be ready for normal operations.

**Optional**

After a few hours of run time you may wish to drain the gearbox to flush out any residue from the manufacturing process. Refill the gearbox with the oil recommended in Section 4.

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**PM-727V USERS PLEASE NOTE ...**

**SPEED RANGES (rpm)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>L1</td>
<td>40-190</td>
</tr>
<tr>
<td>L2</td>
<td>180-380</td>
</tr>
<tr>
<td>L3</td>
<td>350-560</td>
</tr>
<tr>
<td>H1</td>
<td>550-1000</td>
</tr>
<tr>
<td>H2</td>
<td>980-1860</td>
</tr>
<tr>
<td>H3</td>
<td>1800-3000</td>
</tr>
</tbody>
</table>

**Not shown in Section 5:**

- Spindle speed is transmitted to the tachometer on the control panel by a sensor located adjacent to spindle.
- The electrical schematic does not show the PM-727V variable speed drive. This replaces entirely the motor and motor switching circuit shown in the schematic.

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**Allow the spindle to stop completely before shifting gears**
Section 3 USING THE MILL

FRONT PANEL CONTROLS
Connect the mill to a 110Vac outlet. Press the Power lamp switch, top center Figure 3-1, to energize the control circuit (the lamp should light). This is a latching switch – press once to energize, press again to de-energize.

The E-stop button, bottom right, is in series with the Power switch. Like the Power switch, 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.

![Motor controls, gear shifters & DRO](Figure 3-1)

The spindle drive motor is controlled by the three push buttons:
- **Left** = Forward (cw, looking down, used for most milling/drilling operations)
- **Right** = Reverse (ccw, looking down)
- **Off** = Stop

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 (L-H) selects the speed range, high or low; the second stage (1-3-2) selects a specific speed within that range.

![Spindle & drawbar (arrowed)](Figure 3-2)

When installing or removing R8 tooling, set the spindle speed to L1 for the best braking action. Alternatively, an adjustable wrench can be used to grip the flats on the bottom end of the spindle.

**To install**: Hand-thread the drawbar into the R-8 device until the washer, arrowed in Figure 3-2, is seated on the

<table>
<thead>
<tr>
<th>Stage</th>
<th>Speed (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-1</td>
<td>115</td>
</tr>
<tr>
<td>L-2</td>
<td>220</td>
</tr>
<tr>
<td>L-3</td>
<td>320</td>
</tr>
<tr>
<td>H-1</td>
<td>600</td>
</tr>
<tr>
<td>H-2</td>
<td>1120</td>
</tr>
<tr>
<td>H-3</td>
<td>1700</td>
</tr>
</tbody>
</table>

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**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!**
splined spindle. **Fully tighten** the drawbar.

**To remove:** Protect the table under the spindle with rags or scrap wood. Loosen the drawbar one half turn or less — holding the spindle with a wrench if necessary — then tap the top of the drawbar with a brass or dead-blow hammer to unseat the taper. Unscrew the drawbar with one hand while **supporting** the R-8 device with the other hand.

**Why support the R-8 item?** Because the table, vises and workpiece can be damaged by falling tools and drill chucks. The cutting tool itself can also be damaged in the same way.

**Replace the drawbar cap to protect bearings and spline**

**MOVING THE TABLE**

Left-right movement of the table is usually said to be on the X-axis (a.k.a. “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, Figure 3-3. 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 “Spindle Positioning by Counting Divisions” later in this section.

**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 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, Figure 3-1.**

**Always lock the quill when milling**
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 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, Figure 3-1.

**Coarse feed** (Figure 3-5)
For drilling operations, loosen knob (4), allowing the lever hub to rotate independently of sleeve (3).

**Fine feed** (Figure 3-5)
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 clamps, Figure 3-7.

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.

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 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.

X & Y-AXIS POSITIONING BY COUNTING DIVISIONS

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

**Why not use the lock?** On vertical mills of this type, 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.

**NOTE:** This does not apply to operations calling for precise depth control, such as milling. For such operations the quill is locked to maintain a given depth of cut.

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**Figure 3-6 Spindle positioning example**

In Figure 3-6 a hole is to be drilled 0.25” on the Y-axis relative to the **front edge** of a workpiece in a vise, or otherwise clamped to the table.

1. Install an edge-finder in collet or chuck (a tip diameter of 0.2” is assumed).
2. Clamp the X-axis by tightening both levers, Figure 3-3.
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 back-wards (toward the column).
4. Engage the fine downfeed, Figure 3-5.
5. With the spindle running, lower the quill as necessary using the fine downfeed handwheel; 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 movement, zero the 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 exactly 0.25” behind the reference edge.
HEADSTOCK ELEVATION (Z-AXIS)
The headstock is elevated by a hand crank on the left side of the column, Figure 3-1. For milling operations the headstock is usually locked in position by tightening the clamp levers, Figure 3-7.

The spindle must come to a stop before reversing

TAPPING 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 in steel. 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.

Switch off the DRO when not in use!

The headstock is secured by three nuts spaced 120 degrees apart, one underneath and one either side, Figure 3-8. The headstock is top-heavy, and may swing suddenly to either side unless a helper is on hand to restrain it. Using an 18 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
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, exaggerated in Figure 3-10.

Figure 3-9 Headstock tilted 45° counter clockwise

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 3-10 Head tilt can affect surface flatness

Figure 3-11 Sweep holder for dial indicator
The holder is 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.

Figure 3-11 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 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. Set the spindle drive to H-3 (this will allow the indicator holder to sweep easily from side to side).
4. 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.

– 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 retighten the nuts. The tilt scale was carefully installed in manufacture, and is good to within ± 1 degree. A more accurate means of angle measurement will be needed if the project calls for greater precision.
5. 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.

6. Set a 1-2-3 block (or other precision-ground block) on the table under the indicator probe.

7. Switch on the DRO.

8. Using the fine downfeed lower the spindle to give an indicator reading of about half-scale.

9. 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.

10. Reposition the 1-2-3 block to the opposite location on the table.

11. 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 (9). 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 (8) through (11) until satisfied with the tram, tightening the nuts as you go. There is no “right” tram; the acceptable difference in side-to-side readings depends on project specs. As a starting point, aim for ± 0.001” on 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 by one of two methods:

1. Shimming between the dovetailed base 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 2, Installation).

**INSTALLING & INDICATING A VISE**

For routine milling operations the workpiece is held in a precision vise. For the PM 727M a 4” vise is most suitable. “Indicating” means checking the alignment of the fixed (back) vise jaw relative to the axis of table motion.

Install the T-bolts 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).

A typical setup for indicating is shown in Figure 3-14. There is no spindle lock, but you need to **make sure that the spindle does not rotate** throughout the procedure. It helps to set the gears for the lowest spindle speed (L-1). Take up any backlash by pushing against the indicator holder. 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 at the tightly-clamped side of the vise, then lock the Y-axis.

Note the indicator reading, then watch the indicator as you traverse the table slowly toward the loosely clamped side. Ideally, there should be no discrepancy between the indicator readings at the two ends — unlikely at the first attempt. Return the table to the starting point, then repeat the process, 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.

**Figure 3-14 Indicating the vise**

The tip of a standard dial indicator, arrowed, rides along the face of a ground reference bar.
There is no “right” setup for a vise, but as a starting point aim for an indicator difference of no more than ± 0.001” over the width of the jaw.

**VISE KEYS**

Most precision vises come with key slots on the underside machined exactly parallel to the fixed jaw. Key slots, Figure 3-15, can be a great time saver. Properly installed they allow the vise to be removed and replaced routinely, accurately enough for general machining **without the need for indicating every time.**

![Keys installed on X-axis of vise](image)

*Figure 3-15  Keys installed on X-axis of vise
On most vises the keys can also be installed on the long axis*

Most 4” vises have either 14 mm or 16 mm slots, calling for shop-made T-shape adapter keys as Figure 3-16. 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. The objective is allow the vise to be removed and replaced routinely, accurately enough for general machining **without the need for indicating every time.**

Case hardening of the keys is recommended, with final fitting using a fine stone or diamond stone.

![Shop-made vise key](image)

*Figure 3-16  Shop-made vise key
Dimensions in millimeters*
Section 4  MAINTENANCE

Unplug the 110V power cord before any maintenance operation!

LUBRICATION
ISO and SAE are the main indexes of viscosity. ISO has a “one number” scale, but SAE uses different indexes for engine and gear oils (there is also the suffix W, meaning multigrade). SAE 20 engine oil has about the same viscosity as SAE 80 gear oil, both roughly equivalent to ISO 68.

Recommended lubricants
Gearbox: ISO 68, such as SAE 80W90 auto gear oil, or Mobil DTE Heavy/Medium circulating oil (about 2 qts.)

Ball oilers: ISO 68 oil, such as Mobil Vactra No. 2, or equivalent

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

Quill rack and pinion, Z-axis gears: light general purpose grease, NLGI No. 2, or equivalent

X and Y leadscrews: ISO 68 oil, such as Mobil Vactra No. 2, or equivalent

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

GENERAL OILING
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.

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.

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.

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.

GEARBOX DRAIN & REFILL
1. Run the mill a few minutes to warm the oil if necessary.
2. Remove the fill plug on the top surface of the headstock.
3. Place a 1-gallon or larger drain pan under the headstock.
4. Using a 6 mm hex wrench remove the drain plug, Figure 4-1.
5. Allow the oil to drain completely, then replace the drain plug.
6. Remove the fill plug, 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 2 qts total).
8. Replace the fill plug.

Figure 4-1  Gearbox oiling
Drain plug (1), sight glass (2)

QUILL RACK & PINION
Lower and lock the quill, Figure 4-2. Using a stiff flux brush, clean the visible portions of the rack and pinion.
**QUILL RACK & PINION**

Lower and lock the quill, Figure 4-2. 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.

**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.*

**SPINDLE BEARINGS**

The spindle runs on grease-lubricated tapered roller bearings. These should be serviced every 500 hours of running time. Thoroughly clean each bearing assembly then repack with a grease such as Kluber Isoflex (auto shop wheel bearing grease can be substituted in low-load, low rpm operations). Do not over-pack the bearings! Bearing manufacturers recommend that the free volume between inner and outer should be no more than 30% filled with grease. (If smothered with grease, bearings are subject to overheating.)

*Especially during the first 10 hours of running time, check that the spindle runs smoothly, without excessive heat build up (the spindle will run warm when used at high speeds over long periods, but should not be uncomfortably hot). Overheating can be due to excessive grease, see above, or an overtight spanner nut at the upper end of the spindle. Call Precision Matthews for guidance.*

**LEADScrew BACKLASH CORRECTION**

When alternating between clockwise and counter clockwise rotation of the X or Y leadscrews, the handwheel moves freely a few degrees 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.

Excessive backlash can be corrected by compressing the leadscrew nut. For the X-axis this is done by tightening the socket head screw in Figure 4-5. 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, Figure 4-6, is concealed by the solid way cover. It is more difficult to get to because access to the screw is partly blocked by the leadscrew itself.
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 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 knob holding the spring housing in place.
3. While holding the housing firmly to stop rotation, continue to loosen the knob to the point where the housing can just be disengaged from the pin.
4. Step the housing round to the next notch, then tighten the knob to secure the housing. Test for tension.
5. Repeat as necessary, then fully tighten the knob.
Section 5  PARTS

MOTOR CONTROLS

Power  Press once to energize, press again to de-energize.

Left = Spindle Forward = clockwise looking down on mill table

Right = Spindle Reverse = counter-clockwise

Off = Stop motor

E-Stop  Emergency disconnect (stays in until turned counter-clockwise to release)
PM-727M ELECTRICAL SCHEMATIC

This schematic is representational. Point-to-point wiring may differ.
**COLUMN COMPONENTS**

There may be detail differences between this representative drawing and the machine as supplied.

All dimensions in mm
Item quantity: 1 piece unless otherwise stated (…)

<table>
<thead>
<tr>
<th>#</th>
<th>Item Description</th>
<th>#</th>
<th>Item Description</th>
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<th>Item Description</th>
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</thead>
<tbody>
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<td>Column</td>
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<td>Screw: M6 x 20 skt hd (4)</td>
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<td>Screw: M6 x 16 skt hd (3)</td>
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<td>Headstock base</td>
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<td>Key (2)</td>
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<td>3</td>
<td>Screw: M12 x 55 hex hd (3)</td>
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<td>Shaft</td>
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<td>Nut, M14 flange</td>
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<td>4</td>
<td>Washer: 12 (3)</td>
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<td>Retaining ring: 15, ext</td>
<td>30</td>
<td>Cap</td>
</tr>
<tr>
<td>5</td>
<td>Connector</td>
<td>18</td>
<td>Handle</td>
<td>31</td>
<td>Screw: M4 x 8, button hd (3)</td>
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<tr>
<td>6</td>
<td>Screw: M6 x 25 skt hd (3)</td>
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<td>Z-axis crank</td>
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<td>Z-axis leadscrew</td>
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<tr>
<td>7</td>
<td>Washer, lock: 12 (3)</td>
<td>20</td>
<td>Screw: M8 x 12 set</td>
<td>33</td>
<td>Screw: M5 x 8, button hd (4)</td>
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<tr>
<td>8</td>
<td>Nut: M12 hex (3)</td>
<td>21</td>
<td>Taper pin 6 x 18 (2)</td>
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<td>Rear cover</td>
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<td>Gib screw (2)</td>
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<td>24</td>
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<td>Gib</td>
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<td>12</td>
<td>Bush</td>
<td>25</td>
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<td>13</td>
<td>Z-axis crank base</td>
<td>26</td>
<td>Bearing housing</td>
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</table>
There may be detail differences between this representative drawing and the machine as supplied.
## BASE & MILL TABLE COMPONENTS

All dimensions in mm
Item quantity: 1 piece unless otherwise stated (…)

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<td>1</td>
<td>Base</td>
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<td>Graduated dial (3)</td>
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<td>2</td>
<td>Gib screw (4)</td>
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<td>Dial flange</td>
<td>30</td>
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<tr>
<td>3</td>
<td>X-axis gib</td>
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<td>Screw: M8 x 20 skt hd (2)</td>
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<td>Oiler (3)</td>
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<td>Y-axis leadscrew</td>
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<td>Y-axis gib</td>
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<td>Position indicator block</td>
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<tr>
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<td>Screw: M6 x 25 skt hd (8)</td>
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<td>Handwheel (3)</td>
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<td>Taper pin 6 x 20 (6)</td>
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<tr>
<td>14</td>
<td>Friction spring (3)</td>
<td>28</td>
<td>X-axis leadscrew support flange (L)</td>
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</table>
There may be detail differences between this representative drawing and the machine as supplied.
HEADSTOCK CASE COMPONENTS

All dimensions in mm
Item quantity: 1 piece unless otherwise stated (…)

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<td>Spring housing</td>
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<td>16</td>
<td>Ball, 6.5 (2)</td>
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<td>Washer</td>
<td>63</td>
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<tr>
<td>17</td>
<td>Compression spring (2)</td>
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<td>Knob (M6)</td>
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<td>Spring flange</td>
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<td>Gear shift shaft, 2-3-1 group</td>
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<td>Screw: M4 x 6, button hd (5)</td>
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<td>Screw: M6 x 8, set (2)</td>
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*Missing numbers are either: (1) components not fitted, or; (2) components shown in the Headstock Drive diagram*
There may be detail differences between this representative drawing and the machine as supplied.
# HEADSTOCK DRIVE COMPONENTS

All dimensions in mm  
Item quantity: 1 piece unless otherwise stated (…)

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<td>Ball bearing: 6007 (2)</td>
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<td>7</td>
<td>Gear: 57T</td>
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<td>Splined spindle sleeve, 29T gear</td>
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<td>9</td>
<td>Key</td>
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<td>Oil seal: 20 x 42 x 7 (2)</td>
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<td>Oil seal housing</td>
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**Missing numbers are either: (1) components not fitted, or; (2) components shown in the Headstock Case diagram**
This illustration is typical, not specific to the PM-727M
**SPEED SELECTION EXAMPLES**

---

**Low Range, Lowest Speed**
The H-L pair is in its upper location, engaging the "L" gear with the large spindle gear. The 2-3-1 cluster is in its highest location, engaging the smallest gear (1) with the largest of the bottom three gears of the H-L group.

**High Range, Lowest Speed**
The H-L pair is in its lower location, engaging the "H" gear with the small spindle gear. The 2-3-1 cluster is in its highest location, same as for L-1, left.

---

**High Range, Mid Speed**
The H-L pair is in its lower location, same as for H-1 above right. The 2-3-1 cluster is in its lowest location, engaging its mid-speed gear (2) with the mid-speed gear of the H-L group.

**High Range, Highest Speed**
The H-L pair is in its lower location, same as for H-2, left. The 2-3-1 cluster is in its center location, engaging its largest gear (3) with the smallest gear of the H-L group.
QUILL FEED COMPONENTS

All dimensions in mm
Item quantity: 1 piece unless otherwise stated (…)

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<td>Quill pinion shaft</td>
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<tr>
<td>2</td>
<td>Gear housing</td>
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<td>Dial bush</td>
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<td>Worm assembly</td>
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<td>Graduated dial</td>
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<td>Ball bearing: 6200 (2)</td>
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<td>Screw: M4 x 7, skt hd (3)</td>
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<td>Handle</td>
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<td>Friction spring</td>
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<tr>
<td>7</td>
<td>Handwheel</td>
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<td>Grip (3)</td>
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<td>8</td>
<td>Screw: M6 x 8, set</td>
<td>16</td>
<td>Lever (3)</td>
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There may be detail differences between this representative drawing and the machine as supplied.