Models PM-935, PM-949, PM-1054

Precision knee-type milling machines

Choice of **TV** (variable speed) and **TS** (step pulley) versions
Choice of table size: 9 x 35 inch; 9 x 49 inch; 10 x 54 inch
3 HP 220 Vac single-phase or three-phase motor

Above: PM-935TS knee mill with 9 x 35 inch table, 8-speed step pulley drive and 3Ø motor (option)

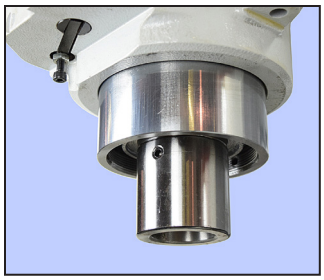
Right: PM-935TV; similar specifications except 1Ø motor (option), and variable speed drive in place of step pulleys

These mills are manufactured in Taiwan

PRECISION MATTHEWS

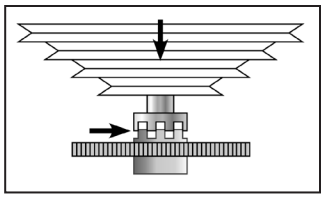
FAQ

R8 collets won't go into the spindle



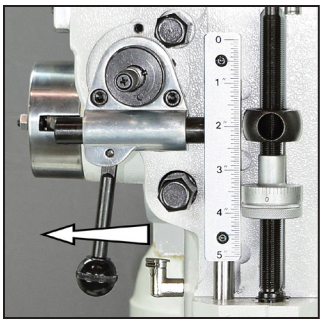
The collet locating screw could be in too far. Back it out a little, procedure in Section 4.

Rattling noise when changing from LO to HI (TS only)



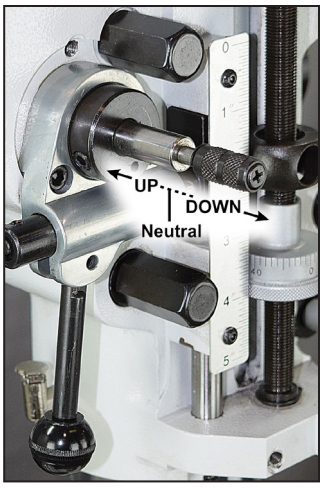
When the motor was turned on the step-pulley spindle teeth were not fully meshed with the main spindle teeth. See "Changing Speed on TS mills" in Section 3.

The quill doesn't move when the fine hand-wheel is turned



Auto feed disengaged?
Quill unlocked?
Feed direction plunger Neutral?
Move the feed lever (arrowed) to the left.

Quill auto-feed goes the wrong way



Check the feed direction plunger.

This manual contains essential safety advice on the proper setup, operation, maintenance, and service of PM-935 Series milling machines. 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. 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-935 Series machines as shipped from December 2016. There may be detail differences between your specific machine and the information given here (with little or no impact on functionality). Please email us if you have questions about any aspect of the manual or your machine (see our website www.precisionmatthews.com for support addresses). Your feedback is welcomed!

Section 1 FEATURES & SPECIFICATIONS

PM-935TS & PM-935TV
PM-949TS & PM-949TV
PM-1054TS & PM-1054TV

PM-935 SERIES MILLING MACHINES

These are top-quality knee-type mills designed to satisfy the most demanding user. Three table sizes are available: 9 x 35 ins, 9 x 49 ins and 10 x 54 ins. All three machines have identical head components, with a choice of two drive systems: 1. **TS** 4-step pulleys, with back gear, 8 speeds from 80 to 2720 rpm; 2. **TV** Mechanically variable, with back gear, speed range 70 to 4200 rpm. Both TS and TV versions come with a 3 HP motor, choice of single phase or three phase. Excluding optional accessories, the machines range in weight from 1500 lb to 3000 lb.

Dimensions in inches
(unless otherwise stated)

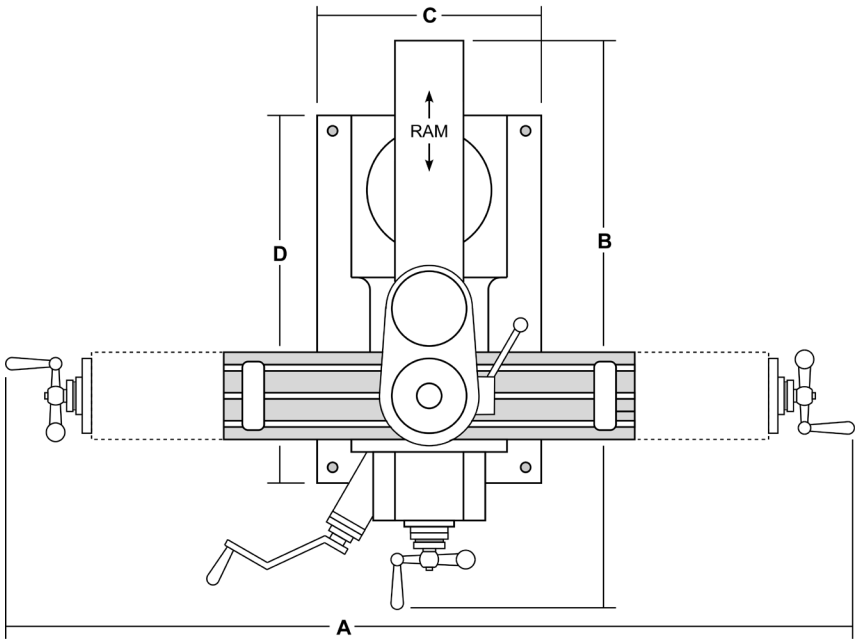
Floor plan ref.		PM-935	PM-949	PM-1054
	Table length	35	49	54
	Table depth	9	9	10
	! Overall height: TS version	66	75	76
	! Overall height: TV version	68	77	78
A	Overall width (table fully L to fully R)	76	98	107
B min	Depth, ram forward (normal ops)	48	53	60
B max	Depth, ram fully retracted	60	70	77
C	Base footprint: width, left to right	19	23	23
D	Base footprint: depth, front to back	32	36	38
	X axis travel	24.0	33.9	36.0
	Y axis travel	12.0	13.0	15.0
	Z axis travel	15.0	16.1	16.9
	Spindle nose to table surface (min)		2.0	
	max	16.9	18.1	18.9
	!! Spindle centerline to Z ways (min)	5.0	6.3	5.5
	max	17.7	19.3	26.0
	!!! Ram travel	12.2	13.8	20.0
	Quill travel		5.0	
	Quill diameter		3.375	
	Left/right head tilt		±90°	
	Forward/backward head tilt		±45°	
	Approximate net weight (lb)	1500	2500	3000

! Overall height: Add approximately 10 in. for 3-phase motor, 13 in. for 1-phase motor

!! Z-ways means the front surface of the vertical (knee) dovetails

!!! For everyday use the practical range of ram motion is slightly less than these max numbers

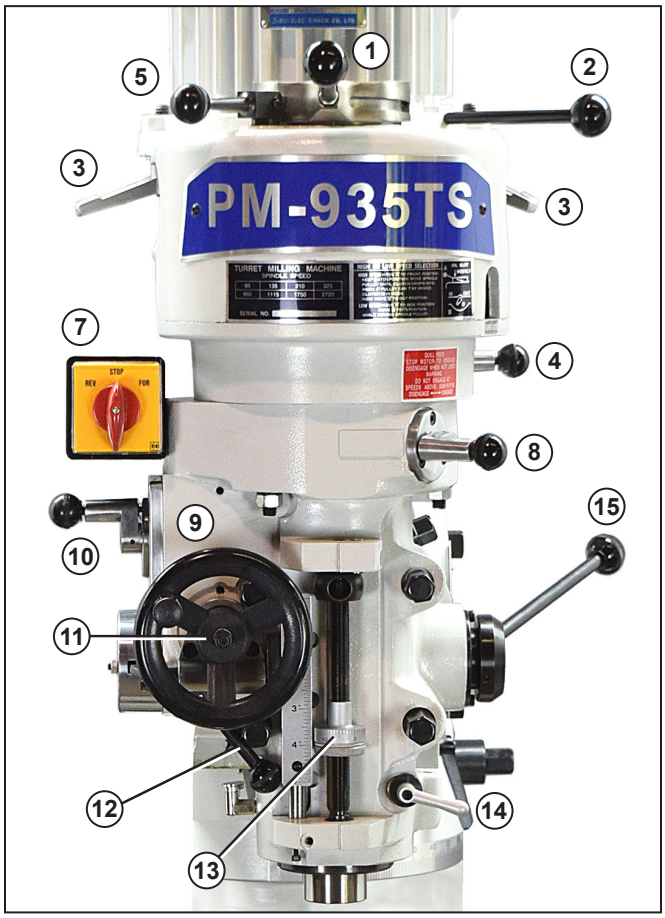
T-slot dimensions
PM-935 Series T-slots are nominally 16 mm = 0.630 in. wide, compatible with Bridgeport® sized 5/8 in. T-nuts, 1/2 in. diameter threaded studs, T-bolts, etc.

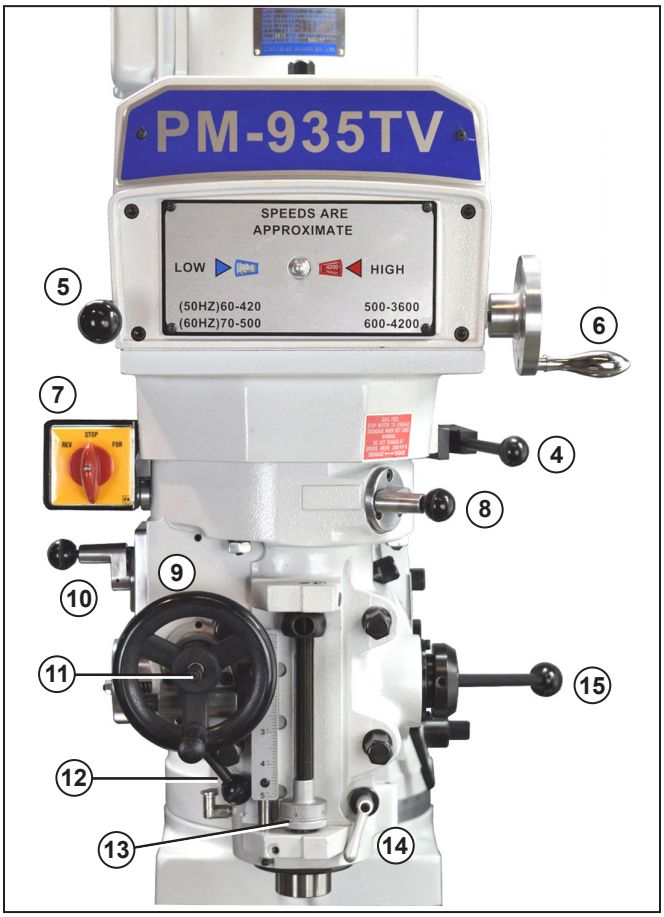


PM-935 Series floor plan

SUMMARY OF FEATURES

- Full-featured head with auto (powered) quill feed
- Headstock tilt ± 90º left-right, ± 45º forward-backward
- 360º swiveling turret, with adjustable ram
- Hardened and ground ways and table
- Turcite B way coating for smooth X and Y motion
- High precision inch-pitch lead screws (5 TPI)
- Ground, hard chrome-plated quill, honed quill bore
- 3-step auto quill feed: 0.0015”, 0.003” and 0.006” per spindle revolution
- Precision spindle: high quality angle-contact bearings, runout less than ± 0.0001”
- Head pulleys balanced for smooth operation
- One-shot lubrication
- Genuine Meehanite iron castings





TS and TV Series compared

TS and TV mills differ only in their drive systems — 4-step pulleys with Vee belt (TS), continuously variable drive (TV). Both versions have dual speed ranges: 1. Direct drive for high speed; 2. Through an intermediate back gear for low speed.

1. Spindle HI/LO cam lever (TS)
2. Motor handle (TS)
3. Motor lock lever (TS)
4. Back gear selector
5. Spindle brake
6. Spindle speed control (TV)
7. Motor switch
8. Quill auto feed ON/OFF
9. Quill fine feed handwheel
10. Quill auto feed rate selector
11. Quill auto feed direction plunger
12. Quill auto feed lever
13. Micrometer depth stop
14. Quill lock
15. Quill manual feed handle

! This manual contains essential safety advice on the proper setup, operation, maintenance, and service of PM-935 Series knee mills. Failure to read, understand and follow the manual may result in property damage or serious personal injury.

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Information in this manual relates to PM-935 Series mills as shipped from June 2016. There may be detail differences between your specific machine and the information given here (with little or no impact on functionality). If you have questions about any aspect of the manual or your machine, please email us at admin@machinetoolonline.com. Your feedback is welcomed.

Section 2 INSTALLATION

Do not move the table, saddle, knee — or any other movable part — until everything has been thoroughly cleaned and lubricated, see below

Cleanup

Finished metal surfaces such as the ways and table are protected in shipping by grease and/or paper. After uncrating the mill, clean the finished surfaces using a plastic paint scraper, disposable rags, and a light oil such as WD-40.

Reverse the hand cranks, if they were installed inside out for shipping (or they may have been shipped loose).

Preliminary oiling

Before cranking the table, knee, saddle and ram into position for hoisting, apply oil to the ways using the one-shot oiler — a couple of pump strokes should be sufficient. Crank the table, knee and saddle through at least one end-stop to end-stop cycle. If the lube reservoir is empty, replenish with Mobil Vactra No. 2 or equivalent (see Section 4, Maintenance).

Moving the head

If it is necessary to swivel the head for hoisting purposes, partially loosen the four head mounting bolts, Figure 2-1, ***while supporting the head*** to prevent sudden movement. Continue supporting the head while using a wrench on hex head #1, Figure 2-2, to crank the head to the desired position. Tighten the bolts in the diagonal sequence, Figure 2-1, first pass at 25 lb-ft torque, second pass at 50 lb-ft. Over-tightening can distort the head, causing the quill to bind.

To tilt the head to the front or back, loosen the three bolts arrowed in Figure 2-2, then turn hex head #2 while supporting the head.

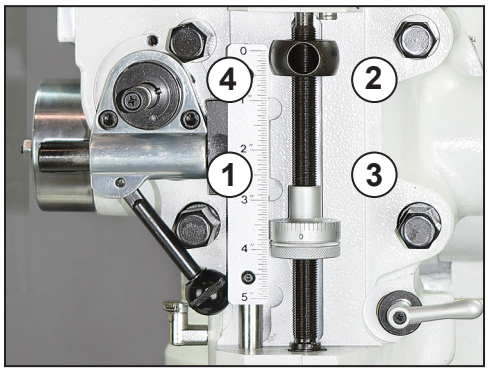


Figure 2-1 **Head mounting bolts**
The numbers indicate the correct (diagonal) tightening sequence.

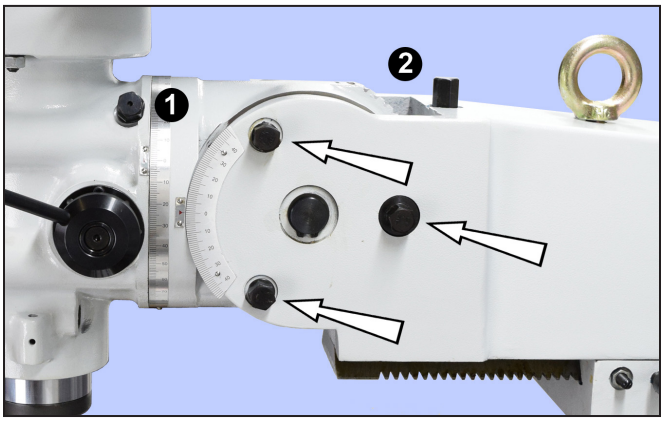


Figure 2-2 **Head swivel & head tilt worm drives**
Use a hex wrench to crank the head clockwise/counter-clockwise (1), or tilt the head forward and back (2). Support the head manually while turning to ease pressure on the worms.

Sight preparation

The floor must be capable of rigidly supporting a weight of at least 1 ton (935), or 2 tons (949 and 1054). If possible, secure the mill to the floor with anchor bolts. Alternatively, use pads and leveling screws installed in threaded holes in the machine base (pads and screws are available from your machine supplier).

If the machine is to be bolted down, be sure that all four corners of the base are ***solidly*** in contact with the floor ***after the machine has been leveled***, see below. Use metal shims to correct if necessary.

Lifting the mill

See Figures 2-3 and 2-4 for alternatives. Go slow! Check for balance as the mill is clearing the pallet or floor. It may be necessary move the head for clearance, and/or to adjust the knee, table and ram for balance.

Leveling

Check for clearance around the mill before settling on its final location. Using a precision machinist's level check the table lengthwise (X) and crosswise (Y), shimming as necessary under the base, or adjusting the leveling screws.

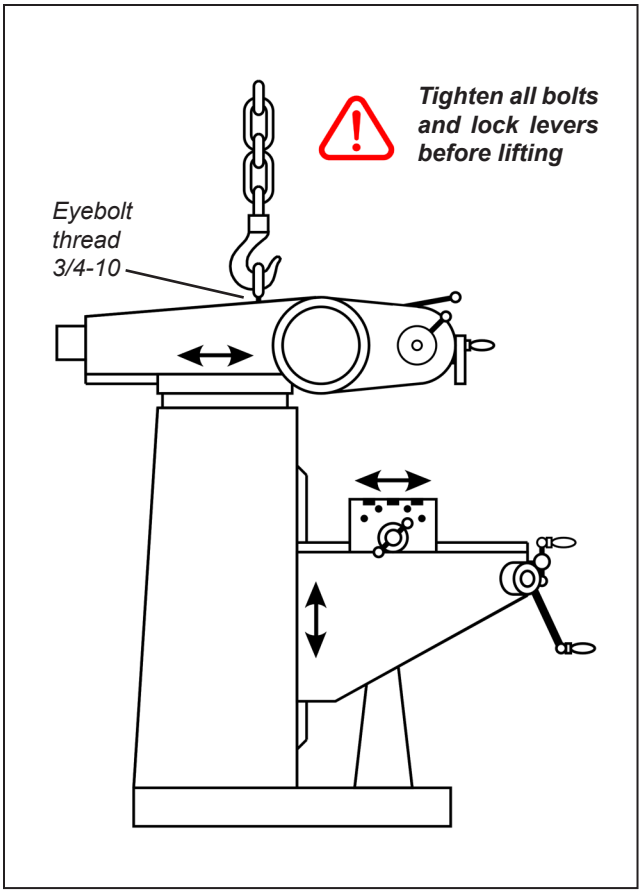


Figure 2-3 **Hoisting by eyebolt**
The head is shown here swiveled 90° counter-clockwise.

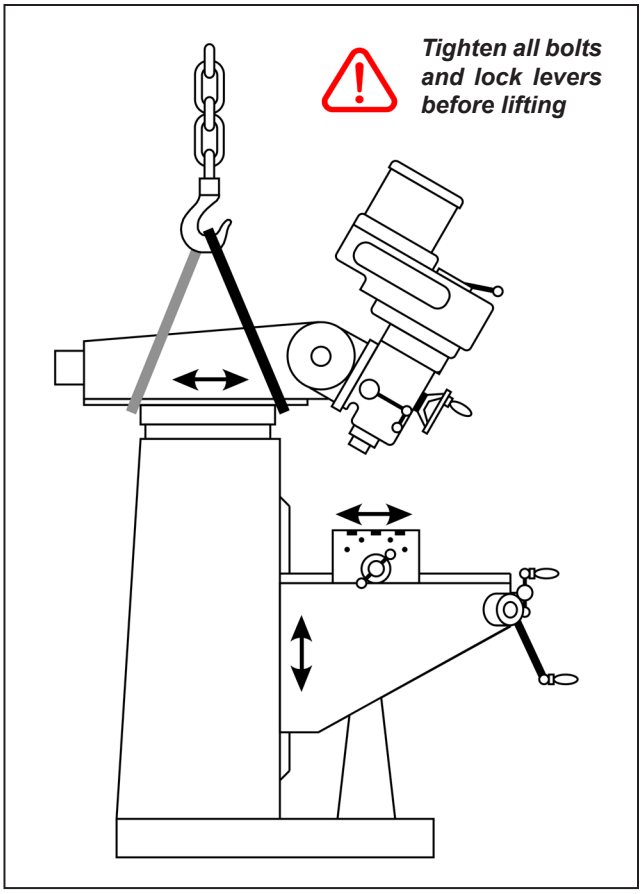


Figure 2-4 **Hoisting by slings**
Move the ram in or out as necessary. Protect the ram ways with padding. Tilt the head forward for clearance if needed.

Power hook-up

- Before running the machine, be sure that the spindle and quill are ***properly lubricated***, see Section 4.
- Remove any clamps or other temporary items that might interfere with normal operation of the machine.
- Check the available power supply for compatibility with the motor.
- Check for correct spindle rotation. With the motor switch set to FWD and the SPEED RANGE selector set to HI, the spindle should rotate clockwise when viewed from the top of the machine (single-phase motors are pre-wired that way). Three-phase motors can be reversed by phase swapping.
- Some users prefer the FWD rotation to be clockwise when the back gear selector is set to LO. This calls for re-wiring if the motor is single-phase.

Everyday precautions

- This machine is intended for use 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, toolholder(s) and machine ways are secure before commencing operations.
- Use moderation: **light** cuts, **low** spindle speeds and **slow** table motion give better, safer results than “hogging”.
- Don’t try to stop a moving spindle by hand – allow it to stop on its own.
- Disconnect 220 Vac power from the mill before maintenance operations such as oiling or adjustments.
- Maintain the machine with care – check lubrication and adjustments daily before use.
- Clean the machine routinely – remove chips by brush or vacuum, not compressed air (which can force debris into the ways).

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

Section 3 USING THE MILL

MOVING THE TABLE

Left-right movement of the table is said to be the X-axis (a.k.a. “longitudinal” or “traverse”). Front-back movement is the Y-axis, sometimes called “cross travel”.

Each axis has a leadscrew with handwheel and micrometer collar with 0.001” divisions, 0.1” per revolution, Figure 3-1. 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 when approaching the point of reference, then onward by a specified amount to the desired location, see “X & Y axis positioning”, later in this section.

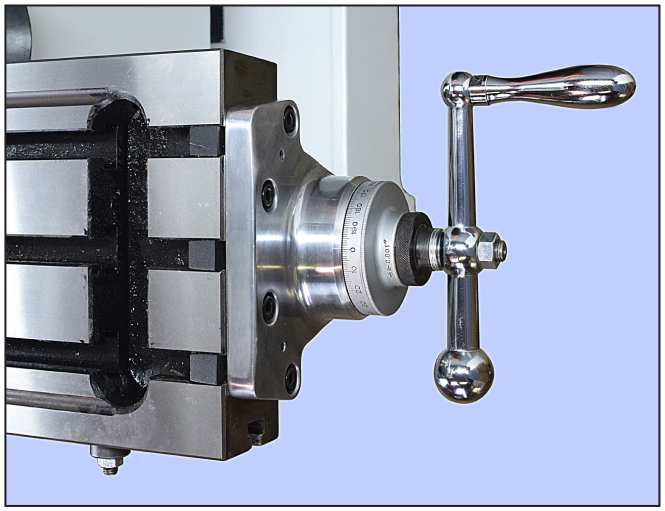


Figure 3-1 **Example leadscrew handle & micrometer dial**
The micrometer dial is resettable. It is locked to the leadscrew by a knurled collar. Loosen the collar to rotate the dial to a desired setting, then re-tighten.

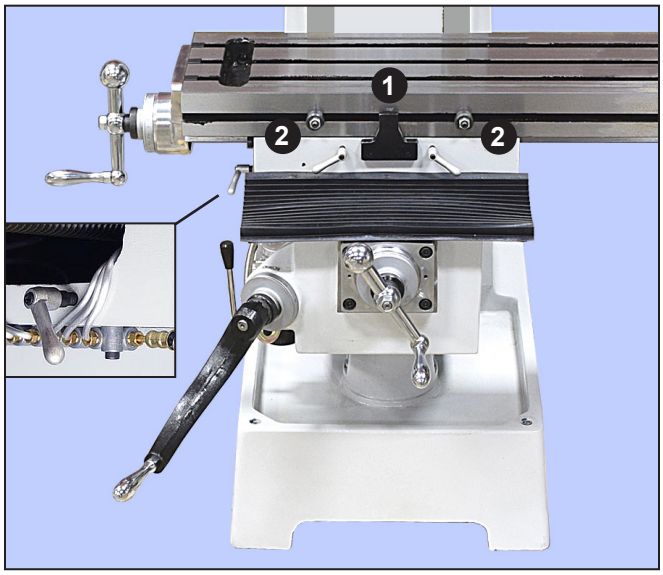


Figure 3-2 **Table stops & locking levers**
The center bracket (1) and adjustable stops (2) allow the table to be traversed to exact end points in repetitive operations (hand-powered only). Two locking levers are provided for the X axis, either side of the center bracket, one lever only for the Y axis (inset).

Be sure to loosen the lock levers before moving the table, especially under power (if so equipped)

POSITIONING THE KNEE

A micrometer collar graduated in 0.001" divisions allows the knee elevation to be accurately set when adjusted by hand, Figure 3-3.

If the mill is not equipped with a Z-axis digital readout (DRO), the knee can be accurately positioned by counting whole turns and divisions. To eliminate the effect of backlash, motion of the knee must always be in the same direction when approaching the point of reference, then onward by a specified amount to the desired location.

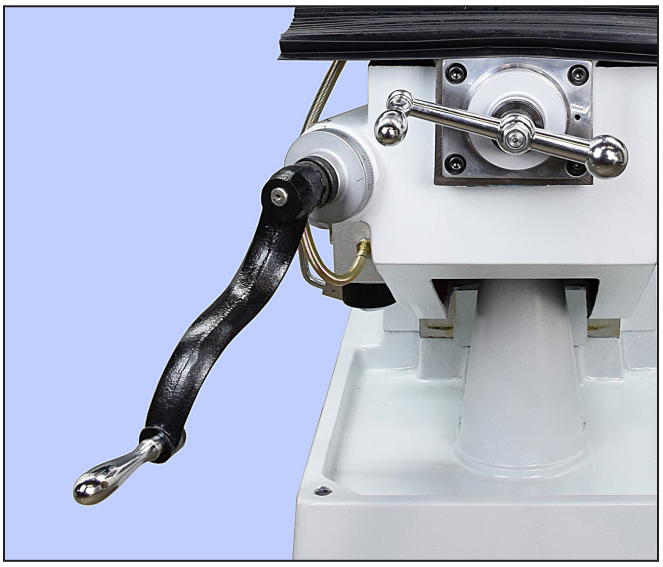


Figure 3-3 **Knee crank**

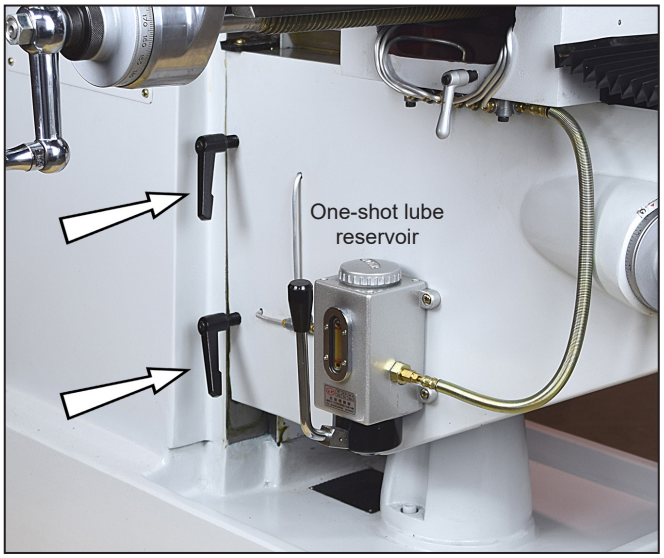


Figure 3-4 **Knee locking levers** *(arrowed)*

TILTING THE HEAD

Precision Matthews TS and TV knee mills have two-way adjustable heads. They can be swiveled ±90º clockwise/counter-clockwise, and tilted ±45º forward/ backward. Worm drive adjusters are provided for both axes, Figure 3-5, which also shows the three clamping bolts for front to back tilt. Clamping bolts for the other axis are shown in Figure 3-6.

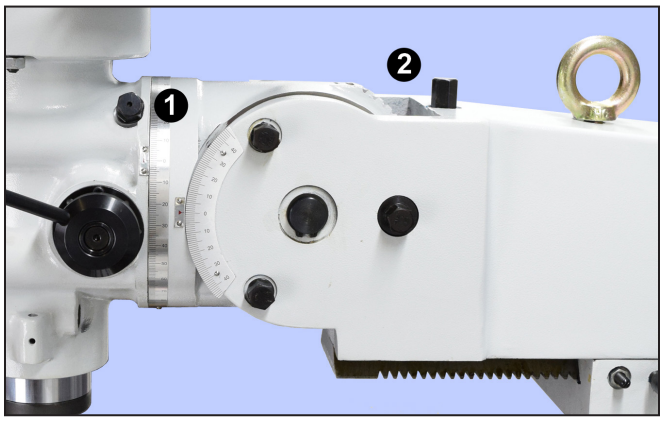


Figure 3-5 **Head swivel & head tilt worm drives**
Support the head manually while turning to ease pressure on the worm drives! *Use a hex wrench to crank the head clockwise/counter-clockwise (1), or tilt the head forward and back (2).*

The headstock is top heavy, so test for moveability as you carefully loosen the bolts. To prevent damage when cranking the worms, the head should be supported manually until the bolts are re-tightened. Be especially careful if the head has not been moved before, because the paint seal may let go without warning.

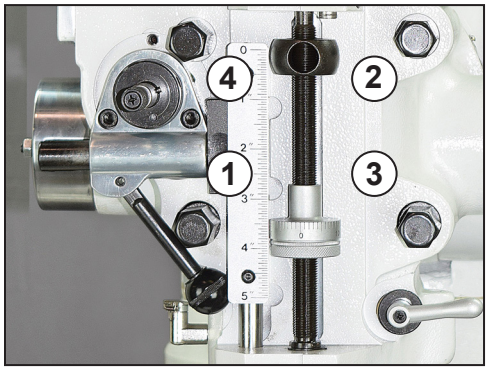


Figure 3-6 **Head mounting bolts**
The numbers indicate the correct (diagonal) tightening sequence.

Set the headstock to the desired angle by reference to the tilt scales, then re-tighten the bolts. For the clockwise/counter-clockwise axis, re-tighten in a diagonal sequence, Figure 3-6, first pass at 25 lb-ft torque, second pass at 50 lb-ft. (Over-tightening can distort the head, causing the quill to bind.) Use the same torque settings on the other tilt axis.

The tilt scales are good only to approximately ± 0.25º, so a more accurate means of angle measurement will be needed if the project calls for a precise offset or, for everyday milling and drilling, true vertical in both axes. This is done by tramming the head, described later in this section. [Because tramming is a time consuming process, most machinists look first for other ways of handling the project instead of moving the head.]

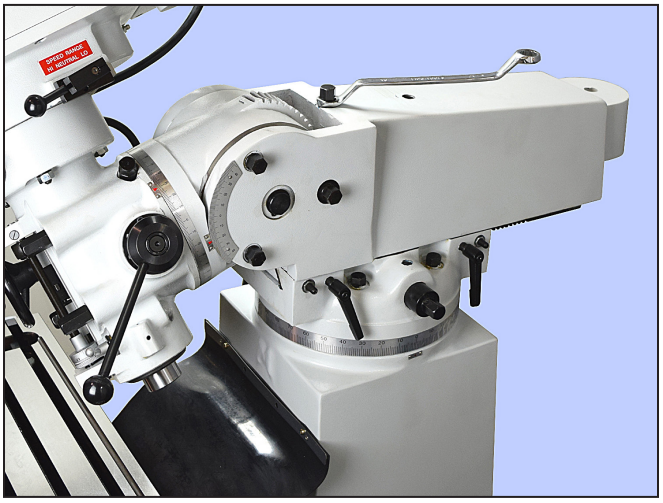


Figure 3-7 **Head tilt**
In this photo the head is tilted 20º forward and 30º counter-clockwise.

MOVING THE RAM & TURRET

In everyday use the turret is usually fixed at 0º, Figure 3-8. Although its angle scale is limited to ± 90º, the turret can be rotated a full 360º around the vertical axis. After re-positioning the turret, make sure the turret bolts are fully tightened.

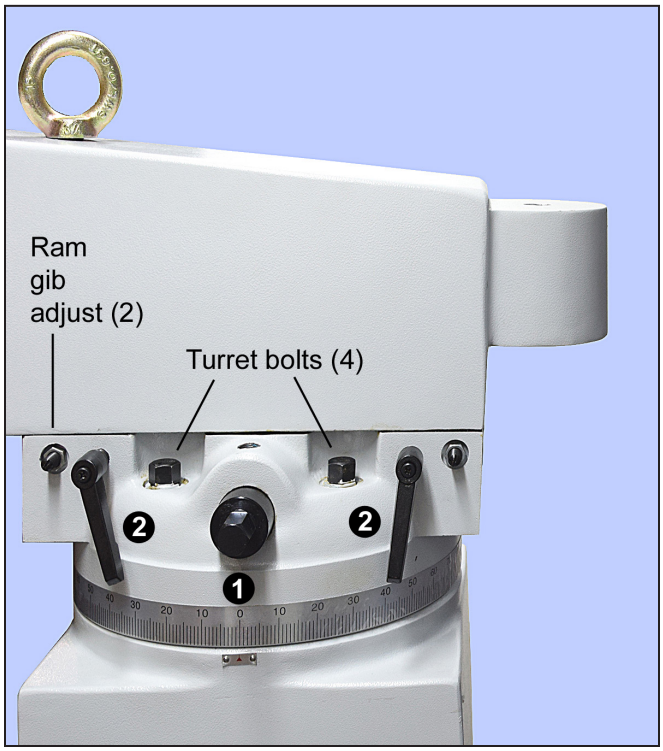


Figure 3-8 **Ram and turret adjustments**
To move the ram forward or backward, release the locking levers (2). Use a 19 mm wrench on pinion shaft (1).

The adjustable ram allows great flexibilty in dealing with various workpiece sizes and shapes. Make sure that the gib strip is tight, and that the dovetails are properly lubricated (the one-shot lube system does not supply the ram).

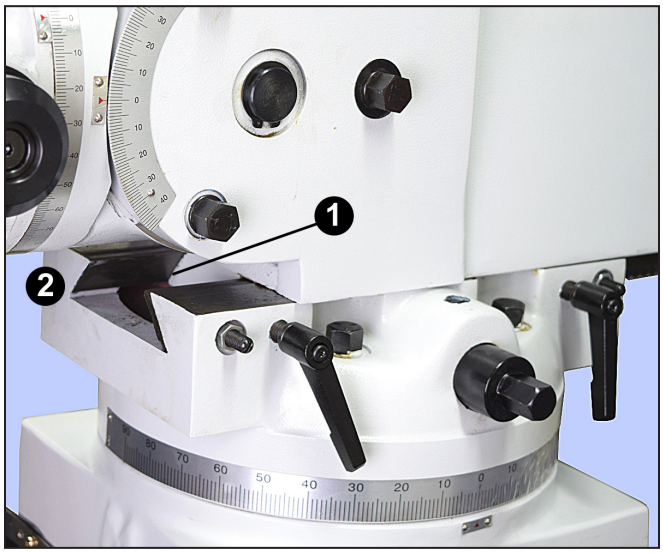


Figure 3-9 **Not-to-exceed point**
When backing the ram, stop when the separation between the forward edges of male and female dovetails, points (1) and (2), is 2-1/2". Go no further. Otherwise, the ram will likely jam and cannot be brought forward unless unweighted by lifting on the eyebolt shown in Figure 3-5.

RUNNING THE SPINDLE

Check lubrication, clamping bolts, locking levers, tooling before powering up

SPINDLE SPEED - TS VERSION

FORWARD spindle rotation is usually said to be clockwise, looking down on the workpiece.

Spindle speed in TS mills is determined by the combination of the ***pulley ratio*** between motor and spindle (four choices), and the spindle-to-motor coupling (two choices). For high speeds the driven 4-step pulley is directly coupled to the spindle. For low speeds the driven pulley is connected to the spindle through a back gear.

	Spindle speed (rpm)
LO Back gear engaged	80
	135
	210
	325
HI Back gear disengaged	660
	1115
	1750
	2720

Key fact ...
The back gear reverses the direction of spindle rotation. If the spindle turns clockwise in the high range when the motor switch is set to FWD, it will turn counter-clockwise in the low range. For clockwise rotation in the low range, set the motor switch to REV.

Some users prefer the alternate choice of FWD = clockwise rotation in low speed. This is arranged by phase swapping at the power input if the motor is three-phase, or by rewiring the motor switch if single-phase.

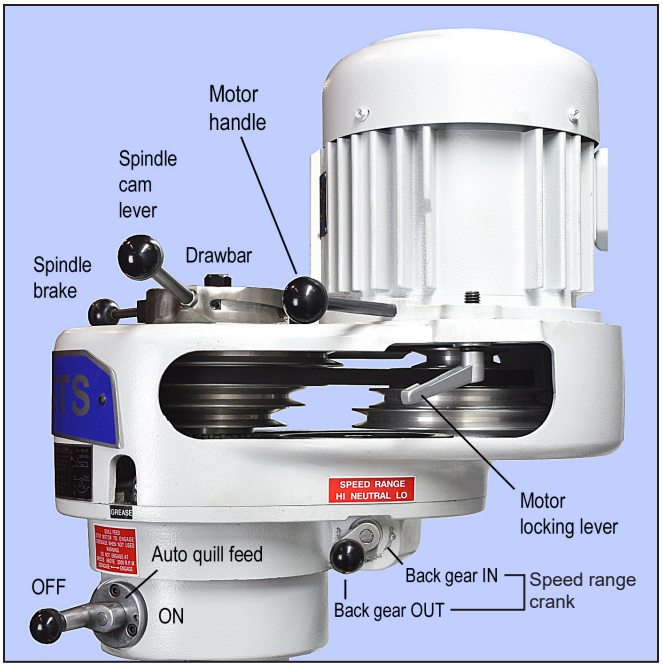


Figure 3-10 **TS drive components**

CHANGING SPEED ON TS MILLS

Make sure the spindle is stopped before ANY speed adjustment

Repositioning the Vee belt
Loosen the motor locking levers, Figure 3-10, then swing the motor forward to de-tension the belt. Reposition the belt, then reverse the procedure.

Engaging/de-engaging the back gear (TS version)

Going from LO to HI is not just the reverse of HI to LO!

HI to LO
1. Move the spindle cam lever to the right (this raises the driven pulley).
2. Move the SPEED RANGE crank to the LO detent position, Figure 3-1. (LO = back gear IN)
3. Run the spindle. Rotation OK? Switch FWD/REV if not.

LO to HI
1. Move the spindle cam lever to the front.
2. Push on the Vee belt, Figure 3-11, until you ***hear*** the clutch dogs engage (signifying that the driven pulley has dropped into position). ***Until that happens don't apply power!***
3. Move the SPEED RANGE lever to the HI detent position. (HI = back gear OUT)
4. Run the spindle. Rotation OK? Switch FWD/REV if not.

Figure 3-11 **Switching from LO to HI range**
One way to make sure the drive system is properly set before switching on the motor is to push back on the belt with fingertips until you hear the clutch engaging.

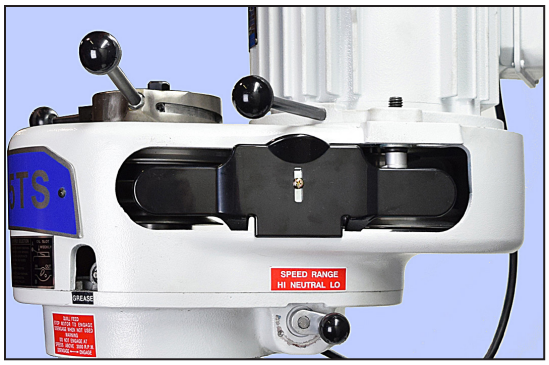


Figure 3-12 **TS belt guard**
The guard is held in place by an adjustable metal clip.

SPINDLE SPEED - TV VERSION

TV mills have a back gear for speed range selection, LO and HI, plus a cone-and-belt drive system delivering continuously variable speeds within each range.

LO speeds: 70 to 500 rpm
HI speeds: 600 to 4200 rpm

CHANGING SPEED ON TV MILLS

! ***Make sure the spindle is STOPPED before changing LO/HI SPEED RANGE (back gear IN/OUT)***

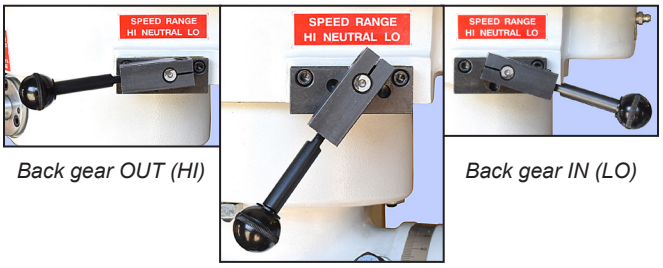
! ***Adjust the speed control handwheel only when the spindle is RUNNING***

Figure 3-13 **TV speed adjustment**
Turn the handwheel only when the spindle is running

Engaging/de-engaging the back gear (TV version)

HI to LO
1. Move the SPEED RANGE lever to the LO detent position, Figure 3-3. (LO = back gear IN). You may need to twist the spindle back and forth by hand for proper engagement.
2. Run the spindle. Rotation OK? Switch FWD/REV if not.

LO to HI
1. Move the SPEED RANGE lever to the HI detent position, Figure 3-14. (HI = back gear OUT). You may need to twist the spindle back and forth by hand for proper engagement.
2. Run the spindle. Rotation OK? Switch FWD/REV if not.



Back gear OUT (HI) *Neutral* *Back gear IN (LO)*

Figure 3-14 **TV back gear engagement**
With the spindle stationary: push the handle inward, then turn it to reposition

INSTALLING & 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. Use the spindle brake to stop the spindle turning when installing or removing tooling, Figure 3-15.

To install a tool, install the R-8 device (collet or arbor) in the spindle bore, then thread the drawbar into it by as many turns as it takes to bottom-out the drawbar head on top of the spindle. (Washers may be required if the device's internal thread is too short, or damaged.) Tighten the drawbar with a 19 mm wrench.

To remove R-8 tooling, loosen the drawbar then tap it 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.***

Keep in mind that the table, vise and workpiece can be damaged by falling tools and drill chucks. The cutting tool itself can also be damaged in the same way.

Figure 3-15 **TS & TV spingle brakes, arrowed**

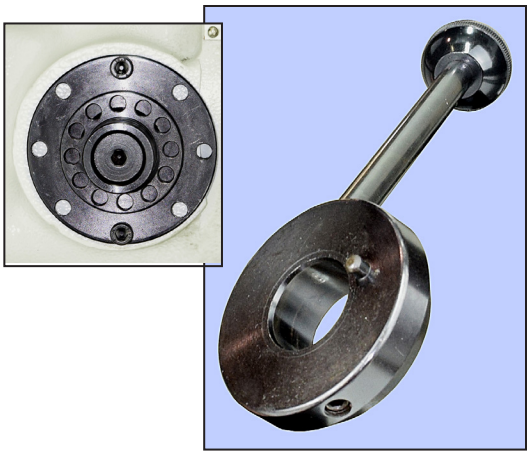


Figure 3-17 **Quill manual feed handle and index plate**

QUILL DOWNFEED

The quill is moved in three different ways: manual ***coarse***, manual ***fine***, and ***powered*** (auto quill feed).

Coarse down feed

In this mode the mill functions like a standard drill press — lower the quill using the quill manual feed handle, Figure 3-16.

Before operating the manual feed handle, unlock the quill. Stop the spindle and disengage the quill auto feed (crank at right of the head).

The feed handle hub, Figure 3-17, is held on the quill pinion shaft by a spring-loaded ball and a detent groove on the outer end of the shaft. A pin on the hub locates in one of 12 holes in an index plate keyed to the shaft.

To reposition the manual feed handle relative to the index plate, slide the hub about 1/4" away from the plate, then re-index the hub to a different location.

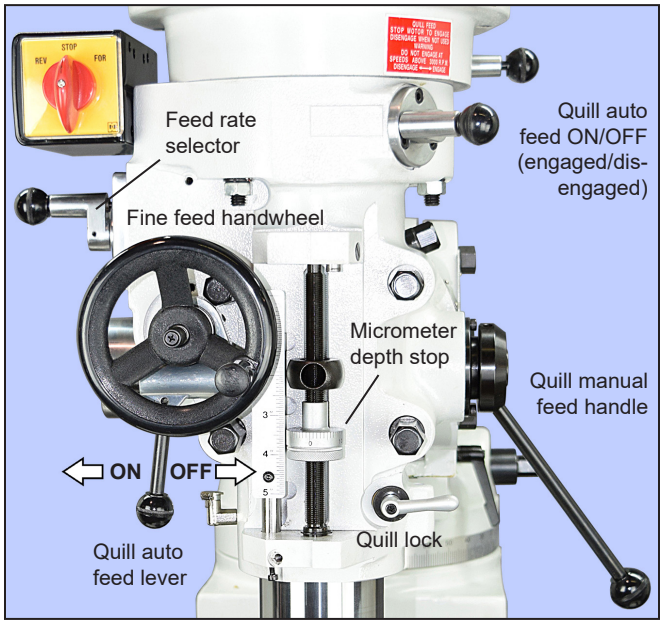


Figure 3-16 **Quill controls**

Fine down feed

For milling operations calling for better control of tool depth, use the fine feed handwheel.

1. With the spindle ***stationary***, disengage the quill auto feed (crank at right of the head).
2. Unlock the quill.
3. Set the quill auto feed direction plunger to neutral (mid position), Figure 3-19.
4. Swing the quill auto feed lever to the left.

The quill is now under handwheel control.

NOTE 1: Clockwise rotation of the handwheel causes the quill to descend.

NOTE 1: The handwheel is often removed for better visibility of the micrometer scale.

NOTE 3: In common with other knee mills there is no indication of down feed amount unless a DRO is installed on the quill. Most users control cutting depth by locking the quill then raising the knee in precise increments.

QUILL AUTO FEED

Do not operate the auto feed system at spindle speeds over 3000 rpm

The auto feed system can be set to drive the quill either up or down at a choice of three speeds, Figure 3-18. A clutch mechanism diasbles the drive when overloaded (as shipped, the clutch is adjusted for a drilling capacity of about 3/8" in mild steel).

Be sure the quill is unlocked before auto feeding

1. Set the micrometer depth as required, Figure 3-16.
2. With the spindle ***stationary***, engage the quill auto feed (crank at right of the head).
3. Select* a feed direction, Figure 3-19. The directions given in this figure apply to the usual spindle direction for drilling, clockwise looking down.
4. Select* a feed rate, Figure 3-18: 0.0015", 0.003" and 0.006" per spindle revolution.
5. Start the auto feed action by pushing the quill auto feed lever to the left, Figure 3-20.

** Feed direction and rate can be changed at any time while the spindle is running.*

Auto feed will terminate when the stop collar reaches the micrometer depth stop, tripping the quill auto feed lever to the right.

The tripping point is accurate only to within ± 0.01". For a more precise end point (± 0.001"), hand feed to a dead stop.

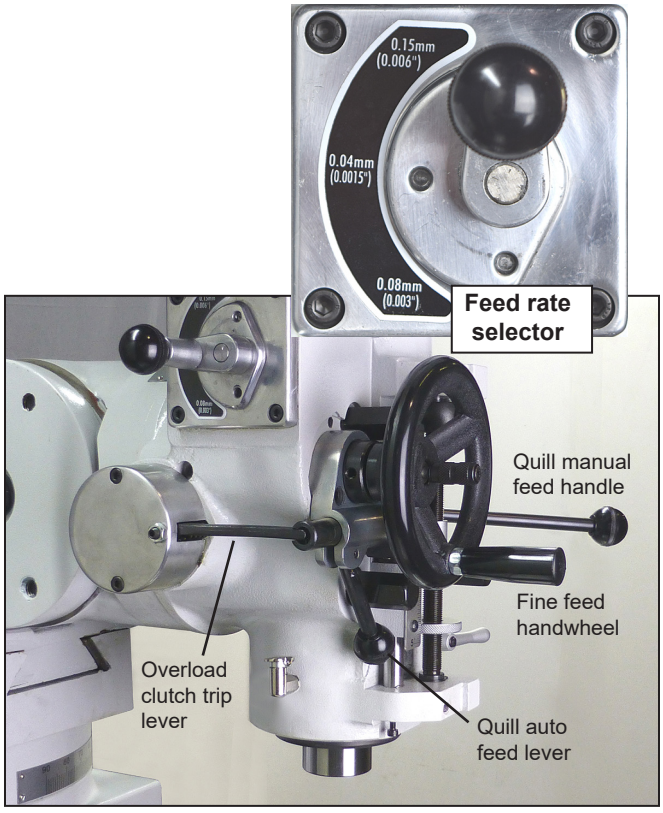


Figure 3-18 **Quill feed components**

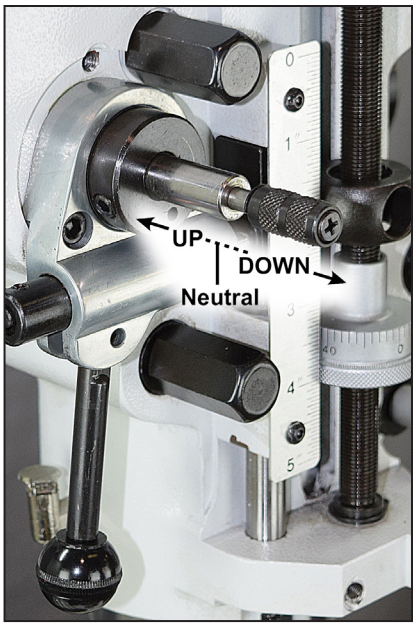
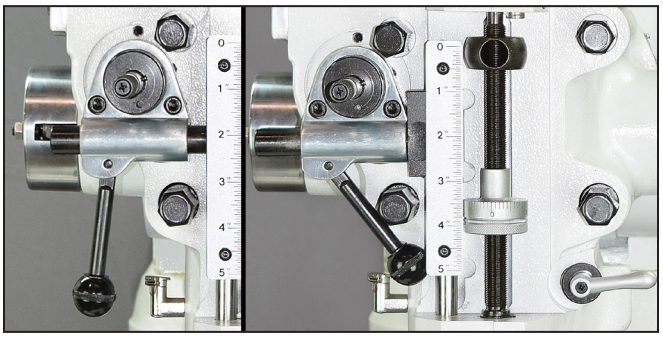
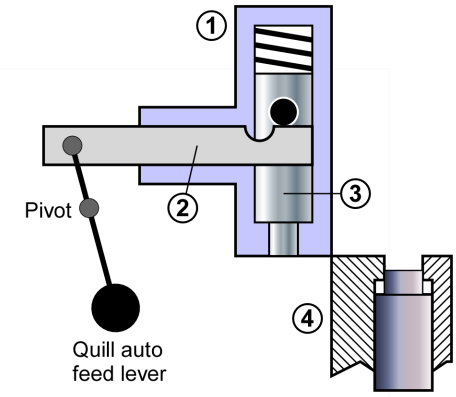


Figure 3-19 **Auto feed direction plunger**
Moving the plunger from fully in to fully out reverses feed direction. The center position is neutral, no down feed. UP and DOWN directions here apply to clockwise spindle rotation — vice-versa for counter-clockwise rotation.



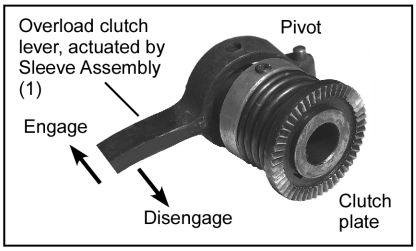
Auto feed ON ***Auto feed OFF***

Figure 3-20 **Activating the quill auto feed**

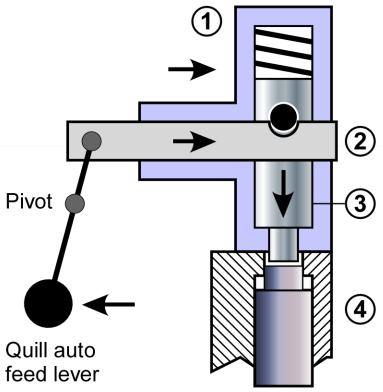


Auto feed OFF

The T-shaped sleeve assembly (1) contains a spring-loaded plunger (3), slotted cross-wise for cam rod (2). In the OFF condition, a cross pin resting on (2) holds (3) up so that its bottom tip is clear of head casting (4).



FEED CLUTCH ASSEMBLY
(located in a housing on the left side of the head)

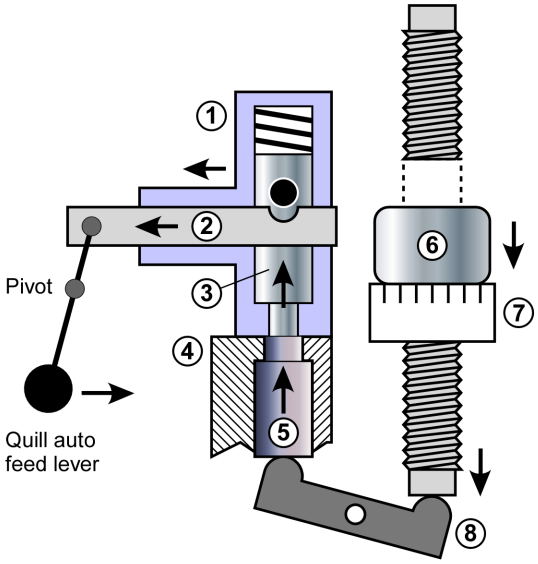


Initiating auto feed

The auto feed lever is moved LEFT, driving both the T-sleeve (1) and cam rod (2) to the right. This causes events A and B to take place at the same time:

A The sleeve assembly connects the power drive by closing the feed clutch and compressing the clutch spring, see above.

B The cross pin drops into the "hook" in (2), locking the bottom tip of plunger (3) in head casting (4).

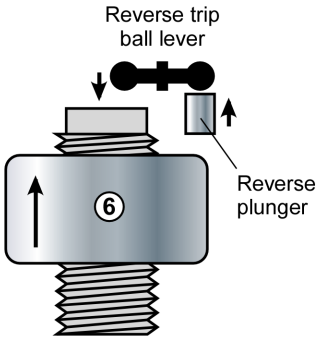


Feed disengagement

The quill stop collar (6) descends, coming into contact with micrometer nut (7).

Pressure on the nut pushes down the threaded stop rod, causing the seesaw trip lever (8) to swing clockwise. This in turn drives the trip push-rod (5) upwards, releasing plunger (3) from the head casting.

The now-released sleeve (1) and cam rod (2) are driven rapidly left by the clutch spring. The clutch opens, stopping the drive. At the same time, cam rod (2) drives the auto feed lever RIGHT to its OFF position.



Reverse feed trip mechanism

If the quill feed is reversed, ascending instead of the usual down-feed, the feed is arrested by a second seesaw, the "reverse trip ball lever". This is a dumb-bell shaped device, pivoting on a shoulder at its mid point. It is activated by the quill stop collar (6) pushing on the reverse plunger.

When this occurs, the ball lever pushes the threaded stop rod down, disengaging the drive in the same way as described above.

Figure 3-21
Auto feed schematic
The auto feed system's many inter-dependent parts are adjusted in manufacture for tripping action and clutch torque. They will not normally need attention. If you are considering any adjustments, please contact Precision Matthews for guidance.

X & Y-AXIS POSITIONING BY COUNTING DIVISIONS

Note: The following procedure shows how to eliminate the leadscrew backlash factor when dead reckoning. This also applies to the knee: when counting divisions on the knee dial, the knee must be traveling in the ***same direction*** when approaching a point of reference, then onward by a specific number of divisions to the desired location.

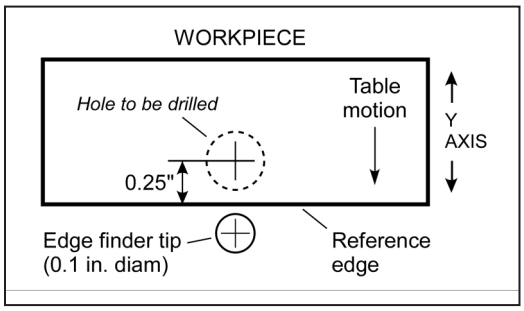


Figure 3-22 **Spindle positioning example**

Figure 3-22 is an example of Y-axis positioning. 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. Lock the X-axis by tightening both levers.
3. If the reference edge is already to the back the spindle centerline, do nothing; if not, rotate the Y-axis handwheel clockwise to send the workpiece backwards (toward the column).
4. Engage the fine downfeed.
5. With the spindle running, lower the quill with the downfeed handwheel to bring the tip of the edge-finder just below the top of the workpiece.
6. 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.
7. While holding the Y-axis handwheel to prevent movement, zero the dial.
8. Raise the quill, then rotate the Y-axis handwheel one exact full turn counter-clockwise (0.1”) to bring the reference edge to the spindle centerline.
9. 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.

TRAMMING THE HEADSTOCK

“Tram”, short for trammel, means accurate alignment — in this case adjusting the headstock tilt to bring the spindle to a known angle — usually 90 degrees — relative to the table. This is essential for routine operations in which the user relies on squareness of the spindle relative to both axes of the table.

Using the tilt scales, Figure 3-5, the head can be zeroed accurately enough for initial out-of-the-box test drillings, etc. For more demanding project work thereafter, the spindle needs to be precisely set at 90 degrees to the table in both axes, 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, highly exaggerated in Figure 3-23.

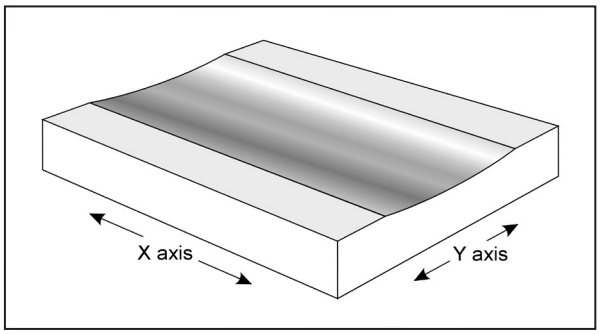


Figure 3-23 **Head tilt can affect workpiece surface flatness**
This shows the effect when fly-cutting if the head is tilted left or right (clockwise/counter-clockwise). Front to back tilt causes a similar scalloping effect in the other axis of the workpiece.

Tramming is the process of 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 3-24 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 a factor with plunger-type indicators).

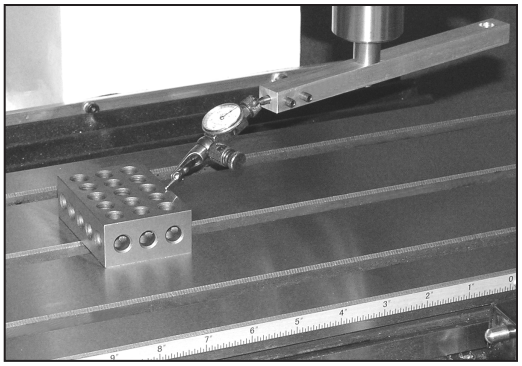


Figure 3-24 **Sweeping holder for dial indicator**
This example shows a rectangular section aluminum bar with threaded holes allowing the choice of two sweep diameters, 6” and 10”, measured from spindle centerline to indicator tip. The smaller sweep can be used for front-to-back tramming, also left-to-right as here. For more sensitive left-to-right tramming, use the larger sweep.

A suggested procedure for establishing tram in the X axis:

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. Raise the knee, or lower the spindle using fine downfeed, to give an approximate half-scale indicator reading.
6. Record the ***exact*** readings on both the dial indicator and the downfeed micrometer collar.
7. Lower the knee or back off the fine downfeed to avoid collision when sweeping.
8. Select the highest spindle speed (this will allow you to sweep the indicator holder easier from side to side).
9. Reposition the 1-2-3 block to the opposite location on the table.
10. Swing the indicator holder to the new location, then lower the spindle – fine downfeed again – to give the same dial indicator and micrometer collar readings as in step (6).

If the headstock is perfectly trammed – highly unlikely at the first shot – the readings should be as in step (6). If not, loosen the 4 head bolts just enough to allow the headstock to be worm-driven a fraction of a degree in the direction called for, then re-tighten the bolts, Figure 2-1.

Repeat steps (5) through (10) until satisfied with the tram, tightening the bolts 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 ± 0.001" on a radius of 5 or 6 inches.

A similar procedure is used to check tram in the Y-axis, front to back.

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

INSTALLING & INDICATING A VISE

For routine milling operations the workpiece is usually held in a precision vise. "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).

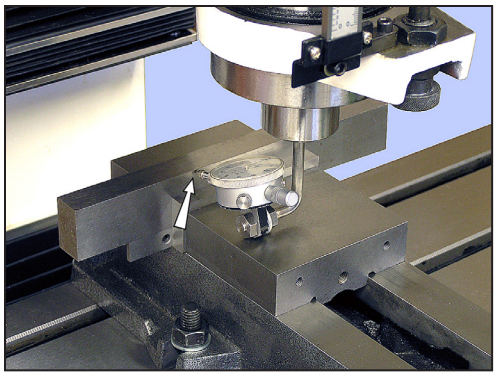


Figure 3-25 **Indicating the vise**
The tip of a standard dial indicator, arrowed, rides on the face of a flat (ground) reference bar.

A typical setup for indicating is shown in Figure 3-25. Use the spindle lock to ***make sure that the spindle does not rotate*** throughout the procedure. The tendency to rotate can also be minimized by selecting the lowest spindle speed, taking 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.

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. Vise keys, Figure 3-26, can be a great time saver. Properly installed they allow the vise to be removed and replaced routinely, accurately enough for most jobs ***without the need for indicating every time.***

Most 4" vises have 14 mm slots, calling for shop-made T-shape adapter keys as Figure 3-27. It is well worth the effort to make these precisely. The T-slots on PM TS and TV mills are nominally 5/8", but check before working on the keys.

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 without effort.

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

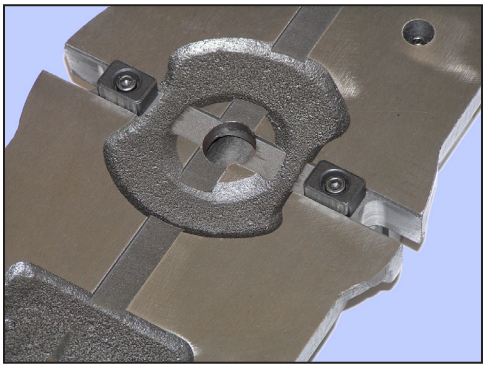
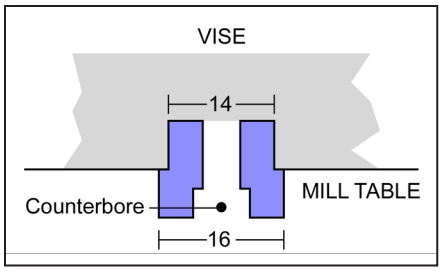


Figure 3-26 **Keys installed on X-axis of vise**
On most vises the keys can also be installed on the long axis



Sample dimensions in mm

Figure 3-27 **Shop-made vise key**

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 often necessary 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 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.

Section 4 MAINTENANCE

Disconnect 220V power before any maintenance operation!

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

OILING PROCEDURE

Assuming a clean environment – no abrasive particles or machining debris – lack of proper lubrication is the main cause of premature wear.

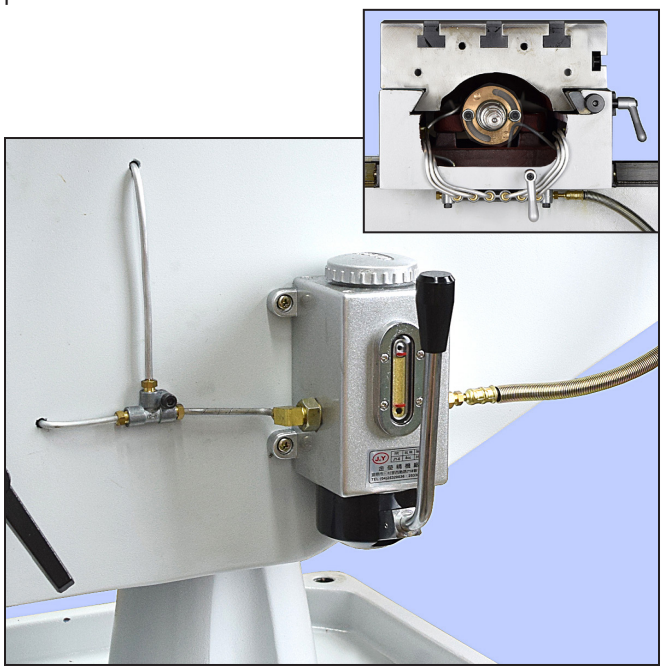


Figure 4-1 **One-shot lube reservoir**
The one-shot system oils the X, Y and Z dovetails. Inset is the left end of the table, bearing removed.

Before starting a work session, lubricate the X and Y dovetails by operating the one-shot lube system, Figure 4-1. The recommended oil for this is ISO68, Mobil Vactra No. 2 or equivalent. (Don't overdo the lube action — one or two pump strokes will usually be enough.) Distribute the oil evenly by running the table full travel in both axes. Also check the following:

1. X & Y axis leadscrews: ISO68 oil, Vactra No. 2 or equivalent. Apply by brush. Distribute the oil evenly by running the table full travel in both axes.
2. Z axis leadscrew, Figure 4-2: NLGI No. 2 grease. Apply by brush.Distribute the grease evenly by running the knee up/down full travel.
3. Ram dovetails, Figure 4-3 (not lubricated by the one-shot system): ISO68 oil, Vactra No. 2 or equivalent. Apply by brush.
4. Quill: A few drops of ISO 32 (10W oil) in the oil cup, Figure 4-4.
5. Quill rack and pinion, Figure 4-5. Fully lower and lock the quill. Using a stiff flux brush, clean the visible portions of the rack. Apply by brush NLGI No. 2 grease. Raise and lower the quill a few times to distribute the grease.
6. Back gear, Figures 4-6: Use a grease gun to apply NLGI No. 2.

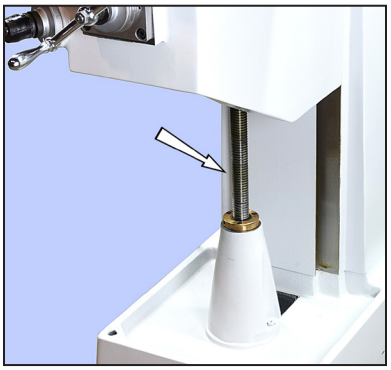


Figure 4-2 **Z-axis leadscrew**

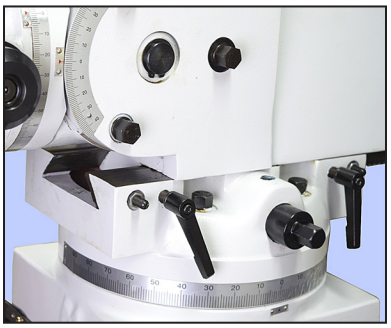


Figure 4-3 **Ram dovetails**

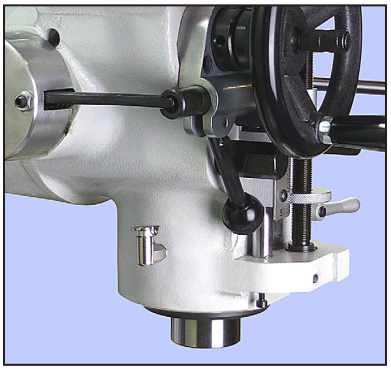


Figure 4-4 **Quill oilcup**

Figure 4-5 **Quill rack**

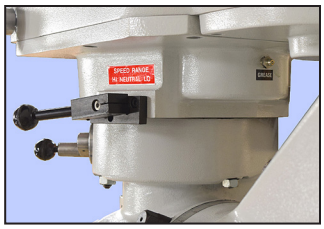


Figure 4-6 **Back gear grease nipple**
TS models, left, TV models, right

COLLET LOCATING SCREW

R8 devices are located in the spindle by a special set screw that protrudes less than 3/32" beyond the inner wall of the quill. This may or may not be locked in place by a second, outer, set screw. If your R8 devices meet spec, but consistently bind when inserted, the inner screw may be in too far.

For access to the set screw(s), lock the quill, then loosen the locking set screw in Figure 4-7. With a pin wrench or needle-nosed pliers, Figure 4-8, remove the spindle nose-piece — ***LEFT HAND*** thread. The collet locating screw should now be visible below the quill, Figure 4-9. Adjust the screw depth using a ball-end hex wrench (the screw may be too close to the quill rim for a standard wrench).

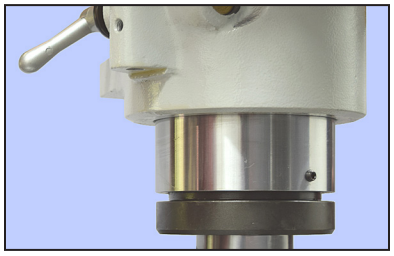


Figure 4-7 **Spindle nose-piece lock screw**

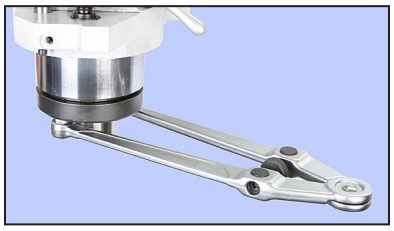


Figure 4-8 **Removing the nose-piece**

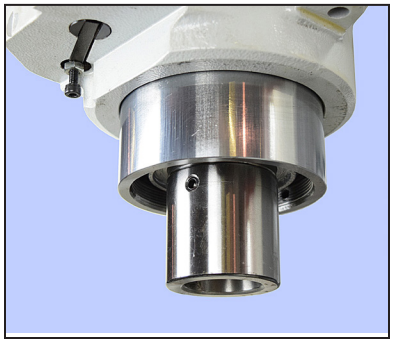


Figure 4-9 **Collet locating screw(s)**

DOWNFEED RETURN SPRING TENSION

The quill should automatically retract when the manual feed lever is released following a drilling operation. If it fails to retract, the return spring may need to be re-tensioned — but first check for other issued such as obstructions or lack of lubrication.

Fully raise the quill. Remove the feed handle, lock the quill, then remove the two 5 mm screws securing the pinion shaft index plate, Figure 4-10. (Some pressure should be felt when the second screw is loosened; if not, the spring may be broken, or detached from the shaft - Call us for guidance.)

Allow the index plate to rotate to its neutral setting — spring fully relieved. Using a pin wrench or needle-nosed pliers, rotate the index plate clockwise 90° from neutral, then re-attach. With the feed handle in place, check the return spring force. If insufficient, try one or two additional 45° rotations.

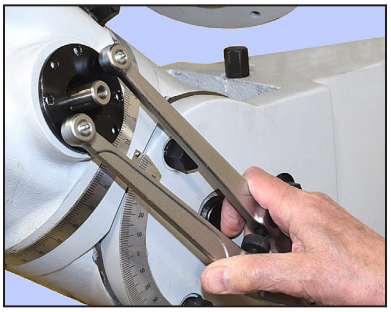


Figure 4-10 **Quill index shaft index plate**

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 held in place by opposing screws at each end. Adjusting them is a trial and error process that takes time and patience. Aim for the best compromise between firmness and reasonably free table movement. Too tight means accelerated wear on the ways, leadscrews and feed motors, if installed. Too free means workpiece instability, inaccuracies and chatter.

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

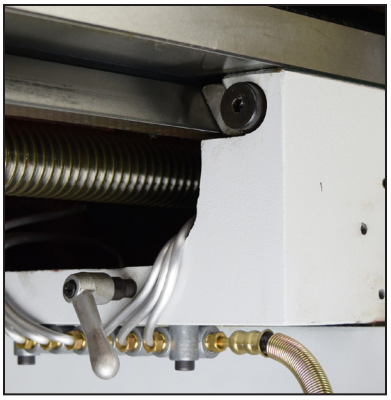


Figure 4-11 **Table (X axis) gib screw, left side**

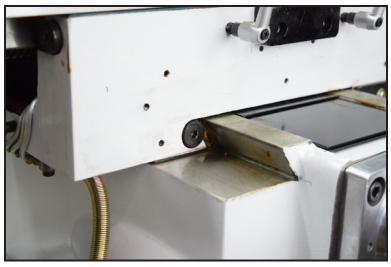


Figure 4-12 **Saddle (Y axis) gib, front**

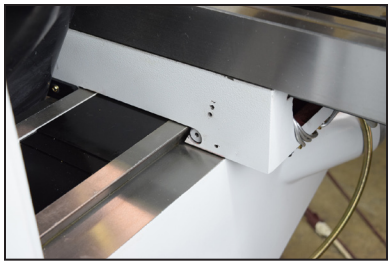


Figure 4-13 **Saddle gib, rear, chip guard removed**

Figure 4-14 **Knee (Z axis) gib, topside**

Figure 4-15 **Knee gib, underside**

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 standard leadscrews. 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.

Each leadscrew nut comprises two internally-threaded components, one fixed, the other adjustable. Backlash is corrected by rotating the adjustable nut shown in Figures 4-16, 4-17 and 4-18. Clockwise or counter-clockwise rotation of the nut has a similar effect in reducing backlash. Adjust backlash by rotating the nut finger tight, then re-tighten the two socket head screws.

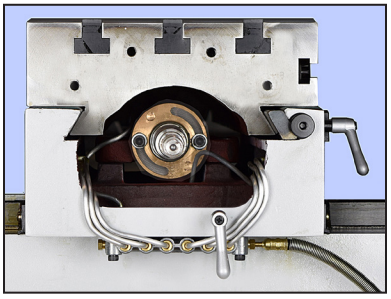


Figure 4-16 **Table (X axis) backlash adjuster**

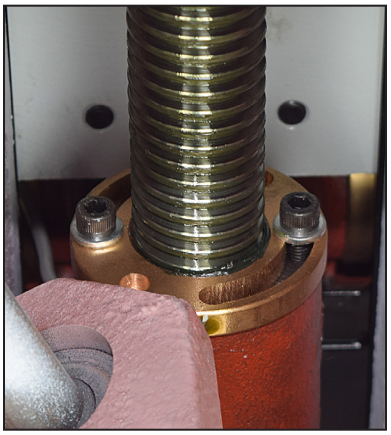


Figure 4-17 **Saddle (Y axis) backlash adjuster, underside view**

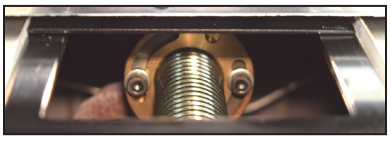


Figure 4-18 **Saddle backlash adjuster, topside view**

CUTTING FLUID RESERVOIR

The hollow base casting, Figure 4-19, is intended to accommodate a user-supplied circulating pump, and also to serve as a reservoir for cutting fluid. Returning fluid is filtered by a perforated plate, Figure 4-20. If you use water-miscible (emulsified) cutting fluid, bear in mind that the ratio of product to water is important — too much water causes excessive corrosion and other problems. Check the mix from time to time using a refractometer. If this is not available, make up a small batch according to the product directions, then replace with a fresh batch when the old one becomes unusable due to reduced performance, oil/water separation, or bad odor.

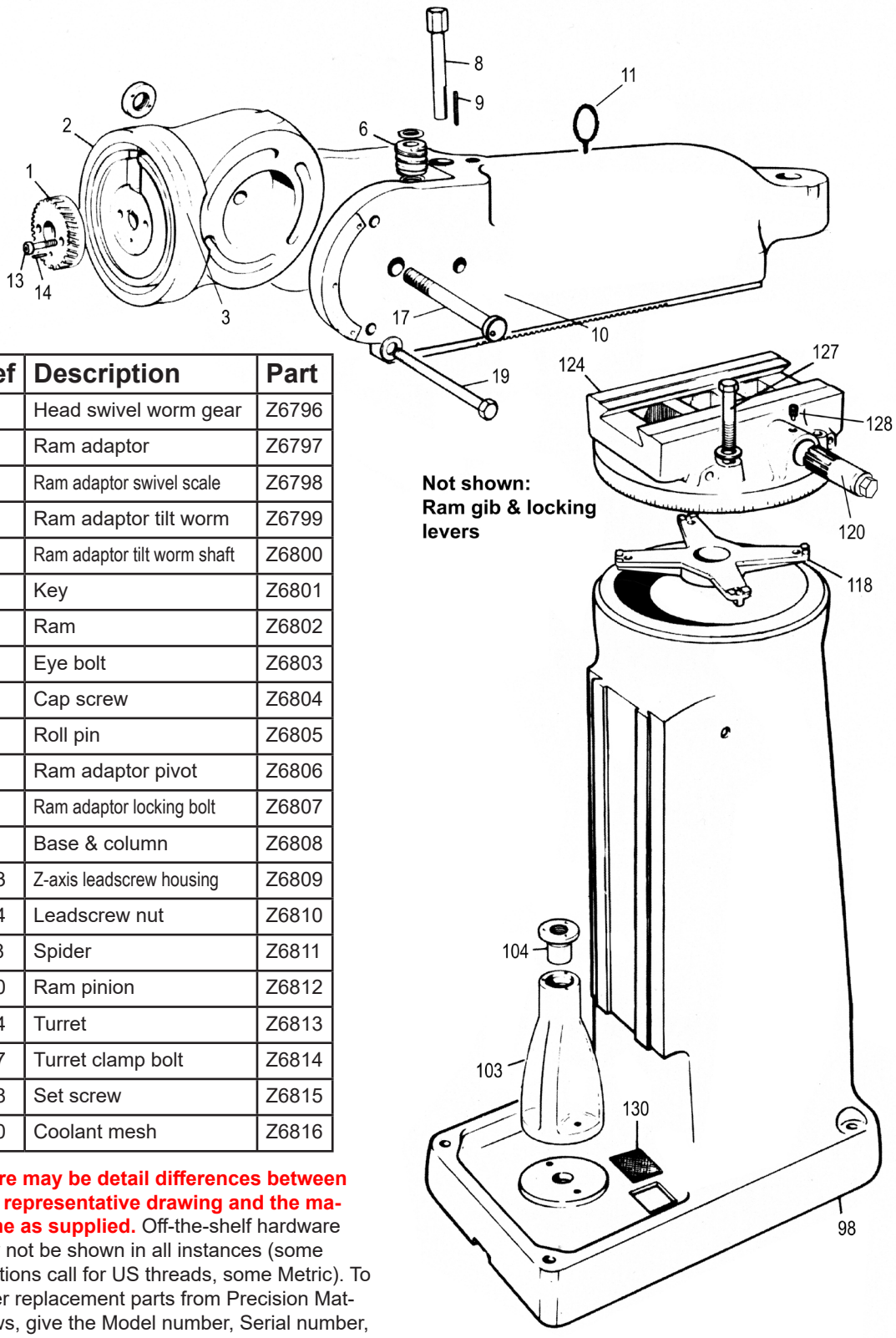
Disposal of used cutting fluid can be a problem. It is about 95% water, so its volume can be drastically reduced by evaporation in an open tank. The residue may then be handled like any other waste oil.

Figure 4-19 **Cutting fluid reservoir & pump housing**

Figure 4-20 **Filter**

Section 5 PARTS

BASE, COLUMN, & RAM COMPONENTS Fig 1

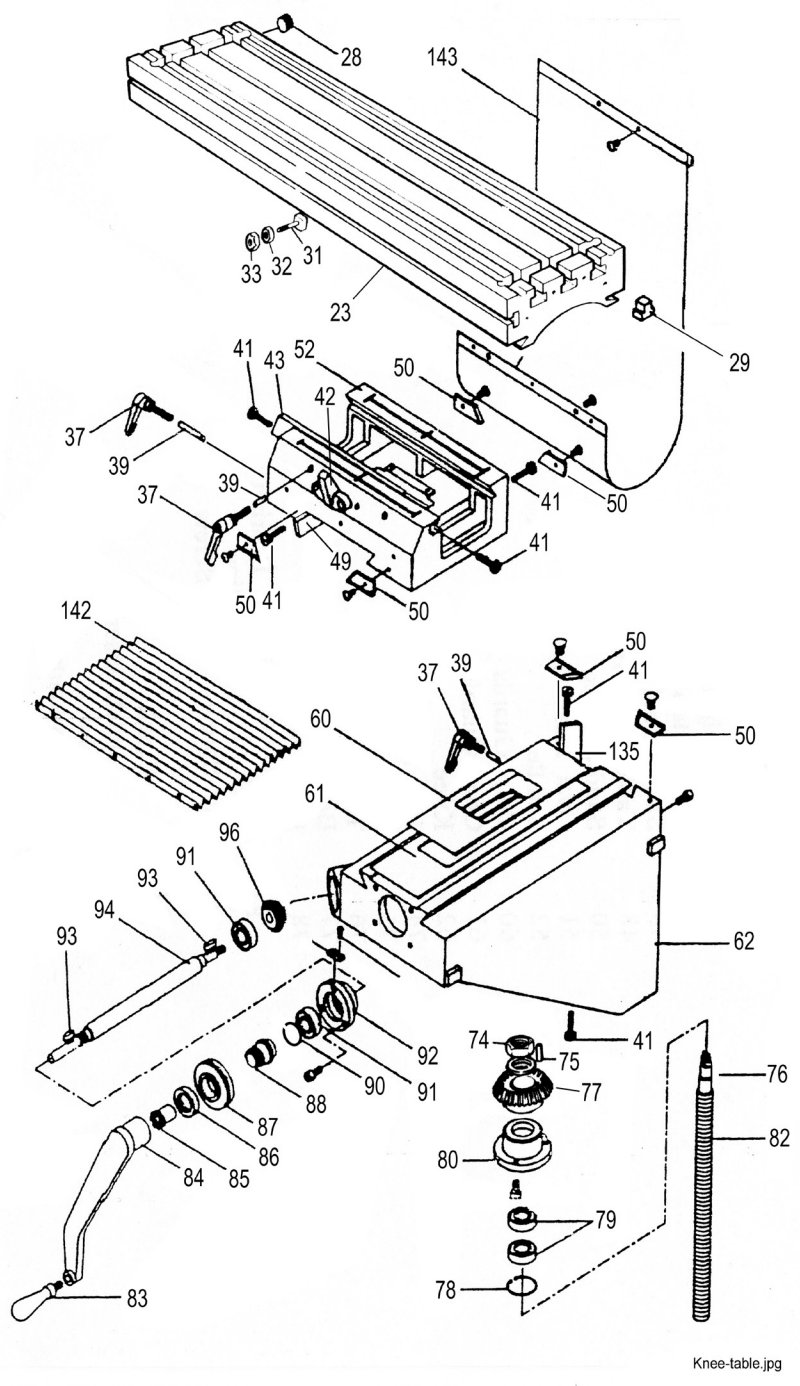


Ref	Description	Part
1	Head swivel worm gear	Z6796
2	Ram adaptor	Z6797
3	Ram adaptor swivel scale	Z6798
6	Ram adaptor tilt worm	Z6799
8	Ram adaptor tilt worm shaft	Z6800
9	Key	Z6801
10	Ram	Z6802
11	Eye bolt	Z6803
13	Cap screw	Z6804
14	Roll pin	Z6805
17	Ram adaptor pivot	Z6806
19	Ram adaptor locking bolt	Z6807
98	Base & column	Z6808
103	Z-axis leadscrew housing	Z6809
104	Leadscrew nut	Z6810
118	Spider	Z6811
120	Ram pinion	Z6812
124	Turret	Z6813
127	Turret clamp bolt	Z6814
128	Set screw	Z6815
130	Coolant mesh	Z6816

There may be detail differences between this representative drawing and the machine as supplied. Off-the-shelf hardware may not be shown in all instances (some locations call for US threads, some Metric). To order replacement parts from Precision Matthews, give the Model number, Serial number, and reference number on this drawing.

KNEE & TABLE COMPONENTS Fig 2

Ref	Description	Part
29	End plug	Z6817
31	Table stop T-bolt	Z6818
32	Table stop bush	Z6819
33	Hex nut	Z6820
37	Lock lever, 935 X and Y	Z6821A
37	935 Z ax, 949 1054 All	Z6821B
39	Push rod, 935 X and Y	Z6822A
39	935 Z ax, 949 1054 All	Z6822B
41	Gib adjust screw	Z6823
42	Table stop bracket	Z6824
43	Table gib	Z6825
49	Saddle (Y-axis) gib	Z6826
50	Wiper (Set, 6 pc) 935T	Z6827A
50	Wiper (Set, 6 pc) 949T	Z6827B
50	Wiper (Set, 6 pc) 1054T	Z6827C
52	Saddle	Z6828
60	Guard plate	Z6829
61	Guard plate	Z6830
62	Knee	Z6831
74	Jam nut	Z6832
75	Key	Z6833
76	Washer	Z6834
77	Bevel gear	Z6835
78	Retaining ring	Z6836
79	Grease-sealed ball bearing	Z6837
80	Bearing flange	Z6838
82	Z-axis leadscrew	Z6839
83	Handle	Z6840
84	Crank	Z6841
85	Crankshaft dog clutch	Z6842
86	Dial lock thimble	Z6843
87	Graduated micrometer dial	Z6844
88	Dial bushing	Z6845
90	Retaining ring	Z6846
91	Grease-sealed bearing	Z6847
92	Bearing flange	Z6848
93	Key	Z6849
94	Elevating shaft, 935T	Z6850A
94	Elevating shaft, 949T	Z6850B
94	Elevating shaft, 1054T	Z6850C



Knee-table.jpg

Ref	Description	Part
96	Bevel gear	Z6851
135	Knee gib	Z6852
142	Way Cover, 935T/949T	Z6853A
142	Way Cover, 1054T	Z6853B
143	Way Cover, Rear	Z6854

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TABLE LEADSCREW COMPONENTS Fig 3

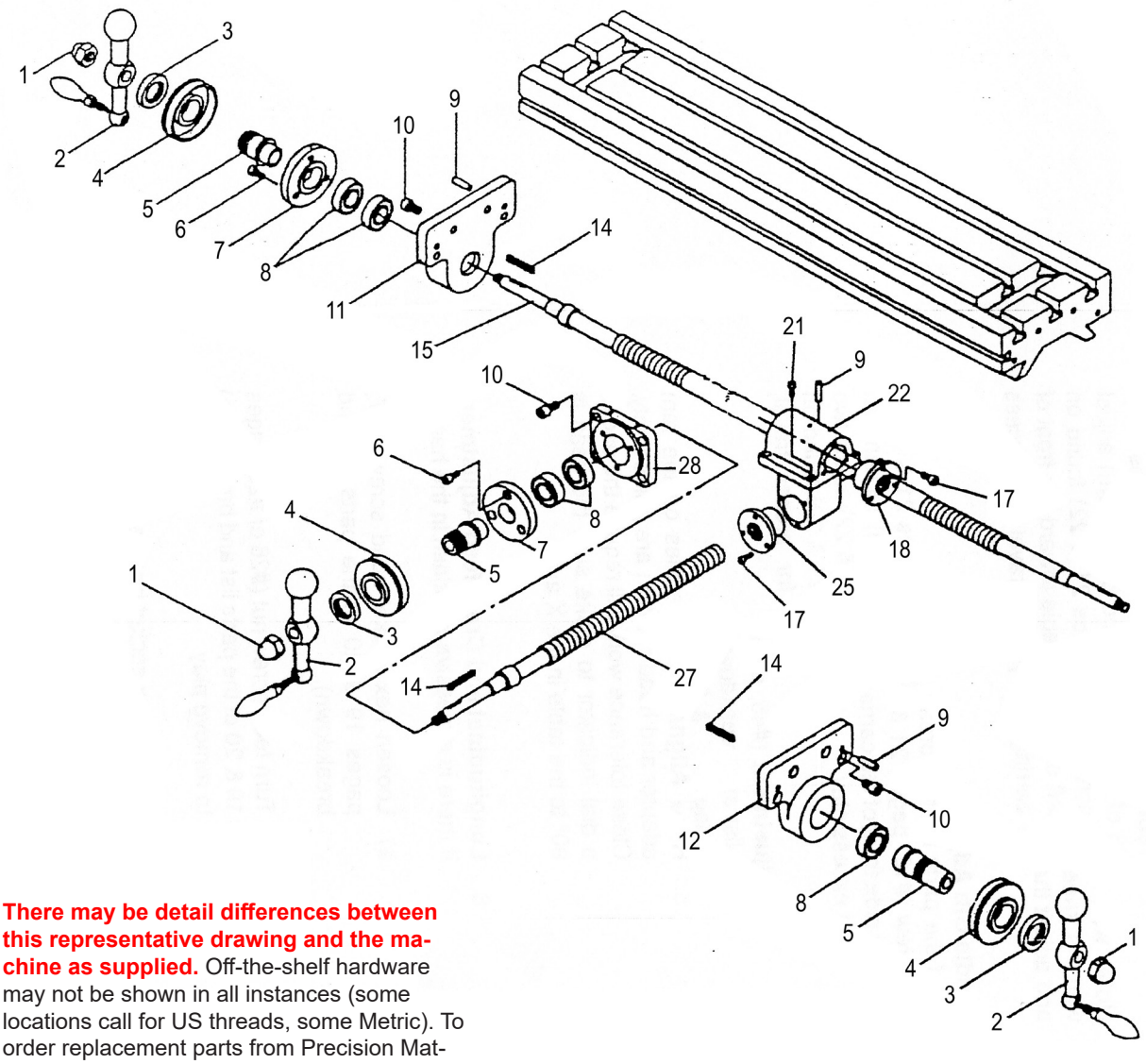

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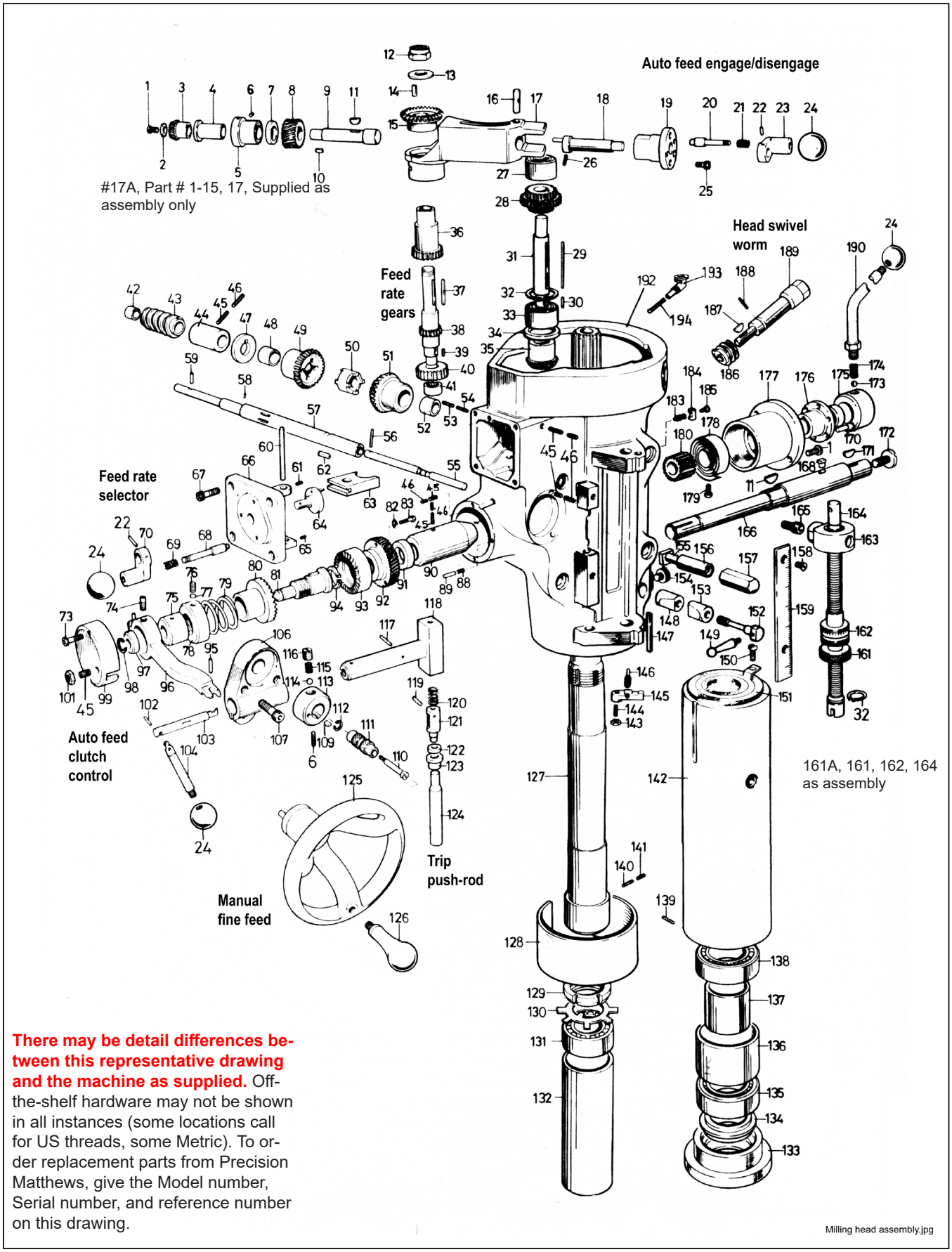
Table leadscrew components.jpg

Ref	Description	Part
1	Jam nut	Z6855
2	Ball crank handle	Z6856
2	Ball crank handle, safety (free spin)	Z6856S
3	Dial locking thimble	Z6857
4	Graduated micrometer dial	Z6858
5	Dial bushing	Z6859
6	Cap screw	Z6860
7	Bearing flange	Z6861
8	Grease-sealed ball bearing	Z6862
9	Dowel pin	Z6863
10	Cap screw	Z6864

Ref	Description	Part
11	Left bearing bracket	Z6865
12	Right bearing bracket	Z6866
14	Key	Z6867
15	X-axis leadscrew 935A, 949B, 1054C	Z6868
17	X-axis nut retaining screw	Z6869
18	X-axis leadscrew nut	Z6870
21	Cap screw	Z6871
22	Leadscrew nut housing	Z6872
25	Y-axis leadscrew nut	Z6873
27	Y-axis leadscrew 935A, 949B, 1054C	Z6874
28	Y-axis bearing bracket	Z6875

MILLING HEAD COMPONENTS Fig 4



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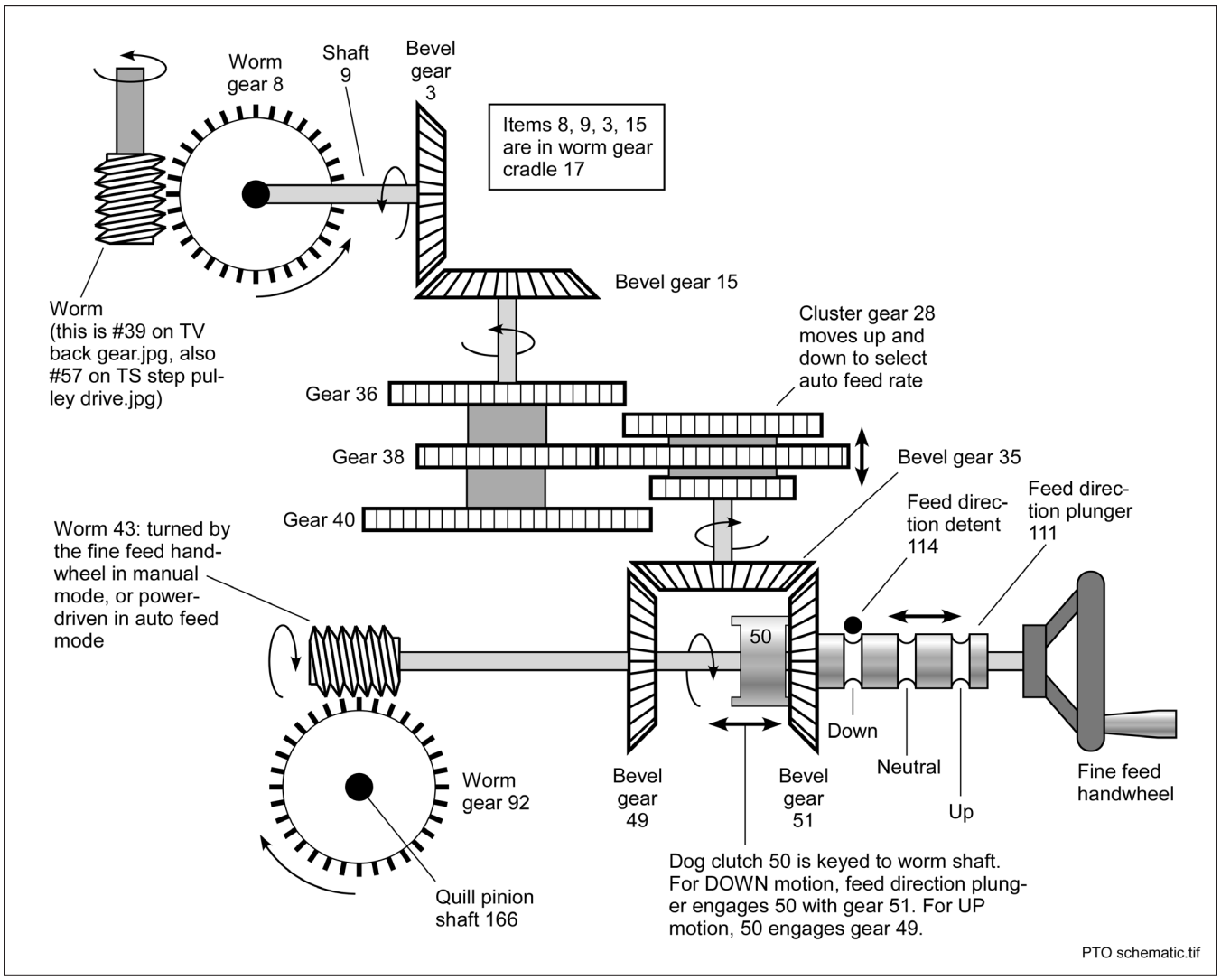
MILLING HEAD COMPONENTS Fig 4

Ref	Description	Part
3	Bevel gear	Z6883
4	Worm gearshaft sleeve	Z6883
5	Worm cradle bushing	Z6883
8	Worm gear	Z6883
9	Worm gearshaft	Z6883
15	Feed rev. bevel gear	Z6883
16	Feed engage pin	Z6882
17	Worm gear cradle	Z6883
17A	Assembly, 1-15, 17	Z6883
18	Cradle Actuator	Z6884
19	Flange	Z6885
20	Shift plunger	Z6886
21	Compression spring	Z6887
23	Shift crank	Z6888
27	Cluster gearshft bearing	Z6889
28	Cluster gear assembly	Z6890
31	Cluster gearshaft	Z6891
32	Retaining ring	Z6892
33	Bevel gear bearing	Z6893
34	Spacer	Z6894
35	Feed rev. bevel gear	Z6895
36	Feed drive gear	Z6896
38	Cluster gear input shaft	Z6897
40	Feed drive gear	Z6898
41	Needle bearing	Z6899
42	Bushing	Z6900
43	Feed worm	Z6901
44	Worm shaft bushing	Z6902
48	Oilite bearing	Z6903
49	Feed rev. bevel gear	Z6904
50	Feed reverse clutch	Z6905
51	Feed rev. bevel gear	Z6906
52	Oilite bearing	Z6907
55	Reverse clutch rod	Z6908
57	Feed worm shaft	Z6909
60	Feed shift rod	Z6910
63	Feed gear shift fork	Z6911
64	Cluster gear shift crank	Z6912
66	Cluster gear cover plate	Z6913
68	Gear shift plunger	Z6914
69	Compression spring	Z6915
70	Shift crank	Z6916
75	Clutch ring	Z6917
77	Brass plug	Z6918
78	Overload clutch locknut	Z6919
79	Clutch spring	Z6920
80	Overload clutch A	Z6921
81	Overload clutch shaft	Z6922
82	Spring washer	Z6923
88	Compression spring	Z6924
89	Overload clutch plunger	Z6925
90	Quill pinion shft bushing	Z6926
91	Spacer	Z6927
92	Feed worm gear	Z6928
93	Overload clutch B	Z6929
96	Overload clutch trip lvr	Z6930
99	Clutch cover	Z6931
103	Cam rod	Z6932
104	Trip handle	Z6933
106	Feed trip base	Z6934
110	Feed reverse stud	Z6935
113	Handwheel boss	Z6936
115	Compression spring	Z6937
116	Clutch spring screw	Z6938
118	Sleeve assembly	Z6939
120	Compression spring	Z6940
121	Trip plunger sleeve	Z6941
122	Plunger bushing	Z6942
123	Plunger bushing	Z6943
124	Trip plunger	Z6944
125	Handwheel (Incl #126)	Z6945
126	Handle (w/#125)	
127	Spindle	Z6947
128	Quill skirt	Z6948
129	Locknut	Z6949
130	Tabbed washer	Z6950
131	Ball bearing	Z6951
132	Spindle sleeve	Z6952
133	Spindle nose piece	Z6953
134	Spindle shield	Z6954
135	Ball bearing	Z6955
136	Bearing spacer - large	Z6956
137	Bearing spacer - small	Z6957
138	Ball bearing	Z6958
140	Set screw, special	Z6959
141	Set screw, special	Z6960
142	Quill	Z6961
145	Feed trip lever	Z6962
146	Trip lever pin	Z6963
148	Quill lock sleeve A	Z6964
149	Quill lock lever	Z6965
152	Quill lock bolt	Z6966
153	Quill lock sleeve B	Z6967
155	Tee bolt	Z6968
156	Tee bolt spacer	Z6969
159	Scale	Z6970
161	Quill stop nut #161A	Z6971
162	Micrometer nut #161A	Z6971
163	Quill stop	Z6973
164	Quill stop screw #161A	Z6971
166	Quill pinion shaft	Z6975
168	Spring pin	Z6976
174	Compression spring	Z6977
175	Handle hub	Z6978
176	Sleeve	Z6979
177	Spring housing	Z6980
178	Clock spring	Z6981
180	Quill pinion	Z6982
183	Reverse trip ball lever	Z6983
184	Reverse trip plunger	Z6984
185	Reverse trip lever screw	Z6985
186	Head swivel worm	Z6986
187	Key	Z7558
189	Worm shaft	Z6987
192	Quill housing	Z6988

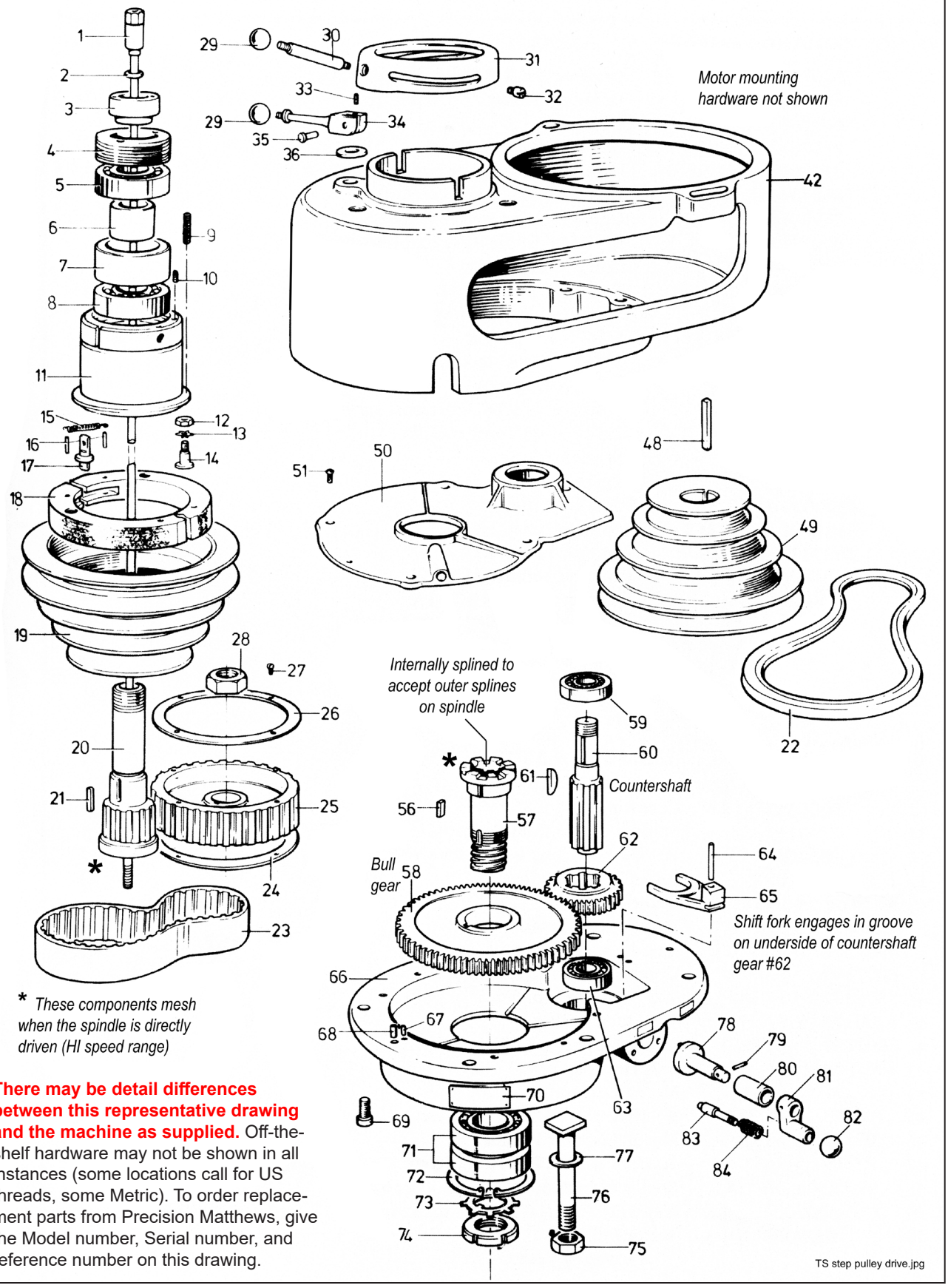
Standard off-the-shelf hardware is omitted from this list. Items listed are unique fabricated or critical parts specific to the TS and TV Series mills.

QUILL AUTO FEED POWER TAKE-OFF SCHEMATIC Fig 5

This drawing shows major components of the drive train, in principle only. It is not to scale. The numbers here refer to Milling head assembly. jpg, previous page.



STEP PULLEY DRIVE COMPONENTS: TS MODELS Fig 6



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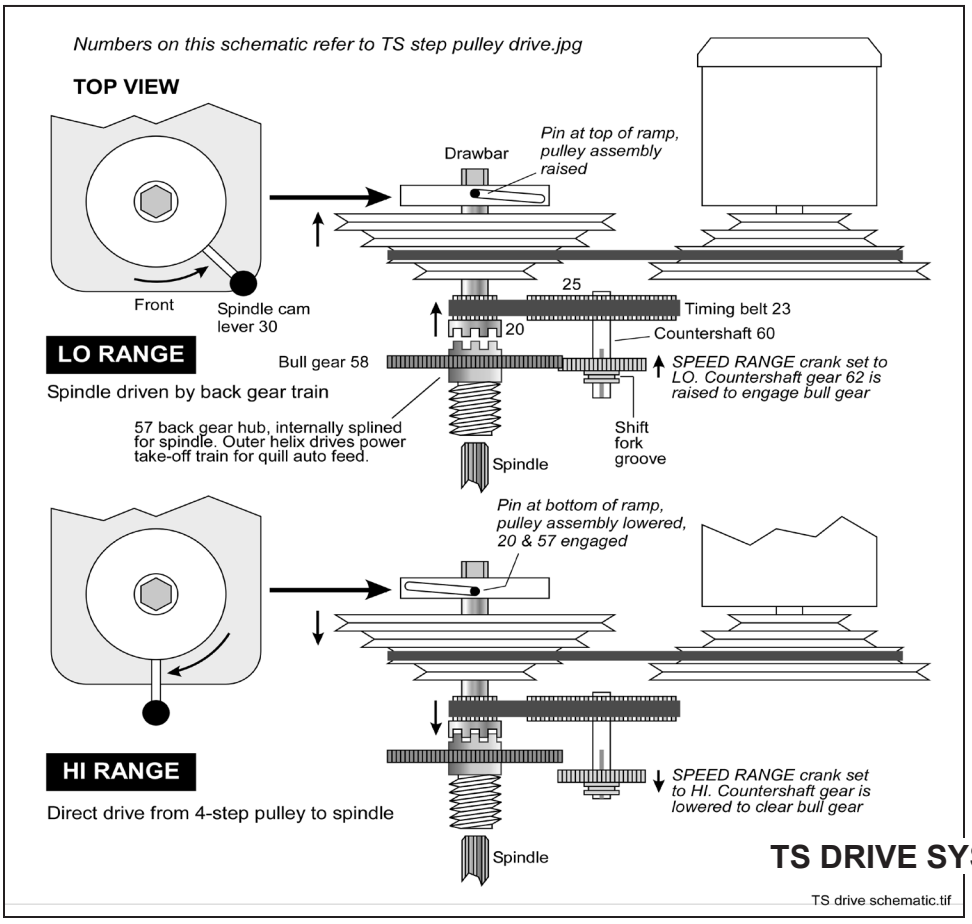
STEP PULLEY DRIVE COMPONENTS: TS MODELS Fig 6

Ref	Description	Part	Ref	Description	Part	Ref	Description	Part
1	Drawbar, 7/16-20 thread	Z6989	23	Timing belt	Z7007	61	Key	Z7025
2	Washer	Z6990	24	Pulley flange	Z7008	62	Countershaft gear	Z7026
3	Upper bearing locknut	Z6991	25	Timing belt pulley	Z7009	63	Ball bearing	Z7027
4	Bearing sleeve locknut	Z6992	26	Pulley flange	Z7010	64	Dowel pin	Z7028
5	Ball bearing	Z6993	30	Spindle HI/LO cam lever	Z7011	65	Countershaft gear shift fork	Z7029
6	Upper bearing spacer - small	Z6994	31	Cam ring	Z7012	66	Back gear housing	Z7030
7	Upper bearing spacer - large	Z6995	32	Cam ring pin	Z7013	67	Dowel pin	Z7031
8	Ball bearing	Z6996	34	Brake handle	Z7014	71	Ball bearing (pair)	Z7032
9	Compression spring	Z6997	35	Brake lock pin	Z7015	72	Retaining ring	Z7033
11	Spindle pulley bearing sleeve	Z6998	42	Drive housing	Z7016	73	Tabbed washer	Z7034
14	Special screw	Z6999	48	Key	Z7017	74	Special locknut	Z7035
15	Extension spring	Z7000	49	Motor pulley	Z7018	75	Hardened hex nut	Z7036
17	Brake lock stud	Z7001	50	Drive housing bottom cover	Z7019	76	Tee bolt	Z7037
18	Brake block	Z7002	56	Key	Z7020	78	Gear shift crankshaft	Z7038
19	Spindle pulley	Z7003	57	Internally splined gear shaft	Z7021	80	Bushing	Z7039
20	Spindle pulley shaft	Z7004	58	Bull gear	Z7022	81	Shift crank	Z7040
21	Key	Z7005	59	Ball bearing	Z7023	83	Plunger	Z7041
22	Vee belt	Z7006	60	Countershaft	Z7024	84	Compression spring	Z7042



TS DRIVE SYSTEM SCHEMATIC Fig 7

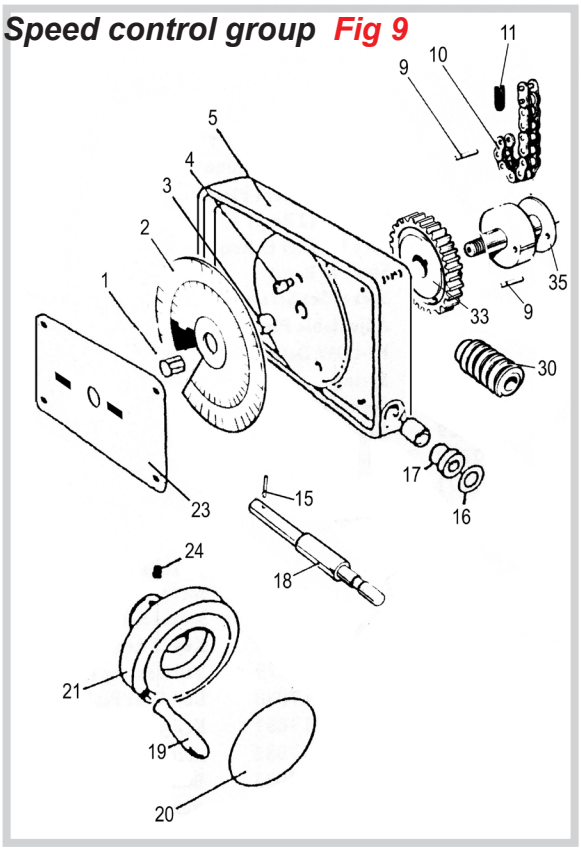
The back gear (LO speed) system is not the same in TS and TV mills!

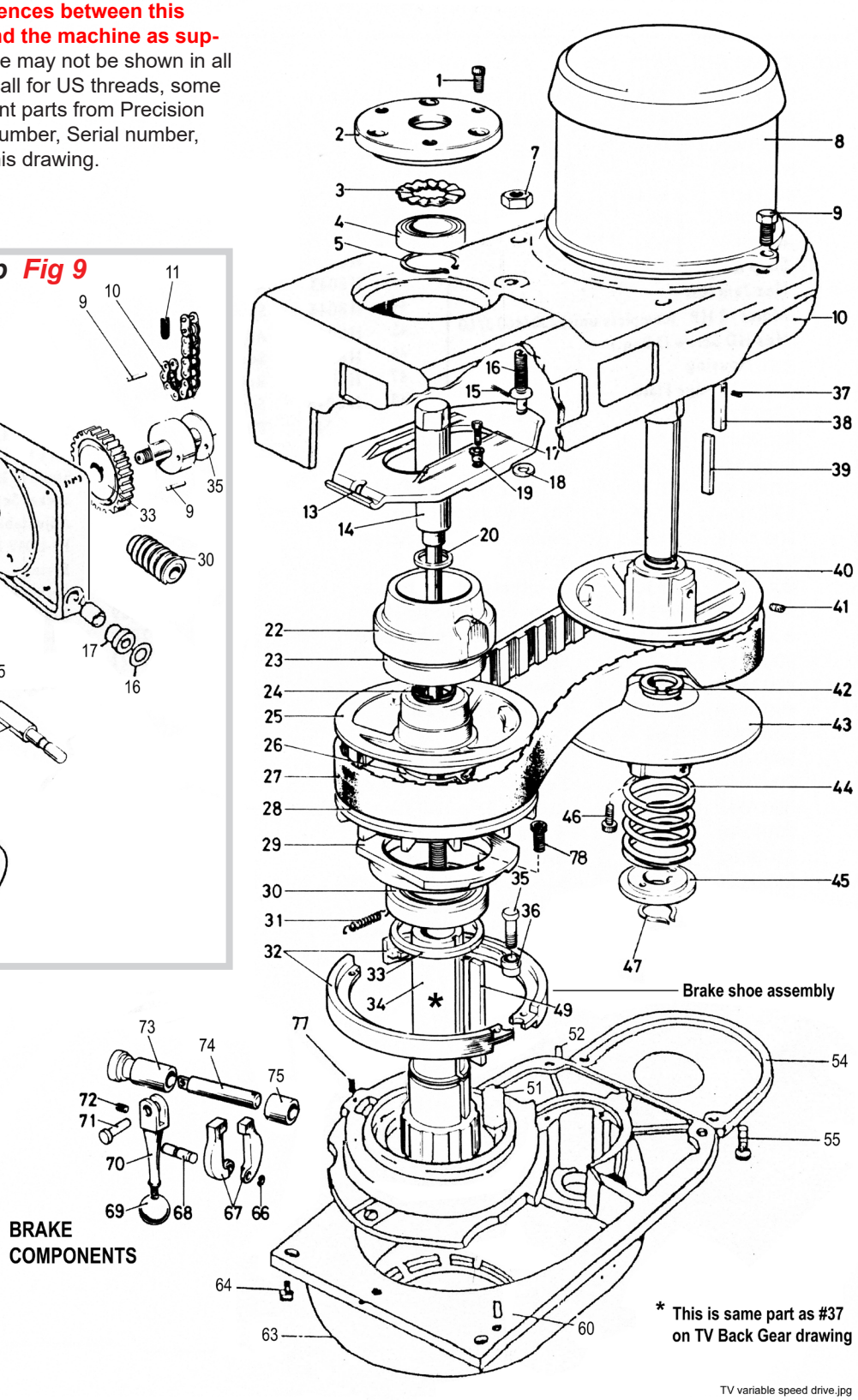
In TS mills the bull gear is fixed, and the countershaft gear is raised to engage.

In TV mills it's the other way around — the countershaft gear is fixed, and the bull gear is lowered to engage.

VARIABLE SPEED DRIVE COMPONENTS: TV MODELS Fig 8

There may be detail differences between this representative drawing and the machine as supplied. Off-the-shelf hardware may not be shown in all instances (some locations call for US threads, some Metric). To order replacement parts from Precision Matthews, give the Model number, Serial number, and reference number on this drawing.





VARIABLE SPEED DRIVE COMPONENTS: TV MODELS Fig 8

Ref	Description	Part
2	Top bearing cap	Z7061
3	Spring washer	Z7062
4	Ball bearing	Z7063
5	Retaining ring	Z7064
10	Drive housing	Z7065
13	Speed change plate	Z7066
14	Drawbar, 7/16-20	Z7067
16	Pivot stud	Z7068
19	Pivot sleeve	Z7069
22	Sliding bearing housing	Z7070
23	Ball bearing	Z7071
24	Plastic insert	Z7072
25	Adjustable cone disc	Z7073
26	Retaining ring	Z7074
27	Drive belt	Z7075
28	Fixed cone disc	Z7076
29	Brake bearing cap	Z7077
30	Ball bearing	Z7078
31	Extension spring (Incl w/Z7080)	
32	Brake shoes (Incl Springs #31)	Z7080
33	Spacer	Z7081
34	Spindle pulley hub	Z7082

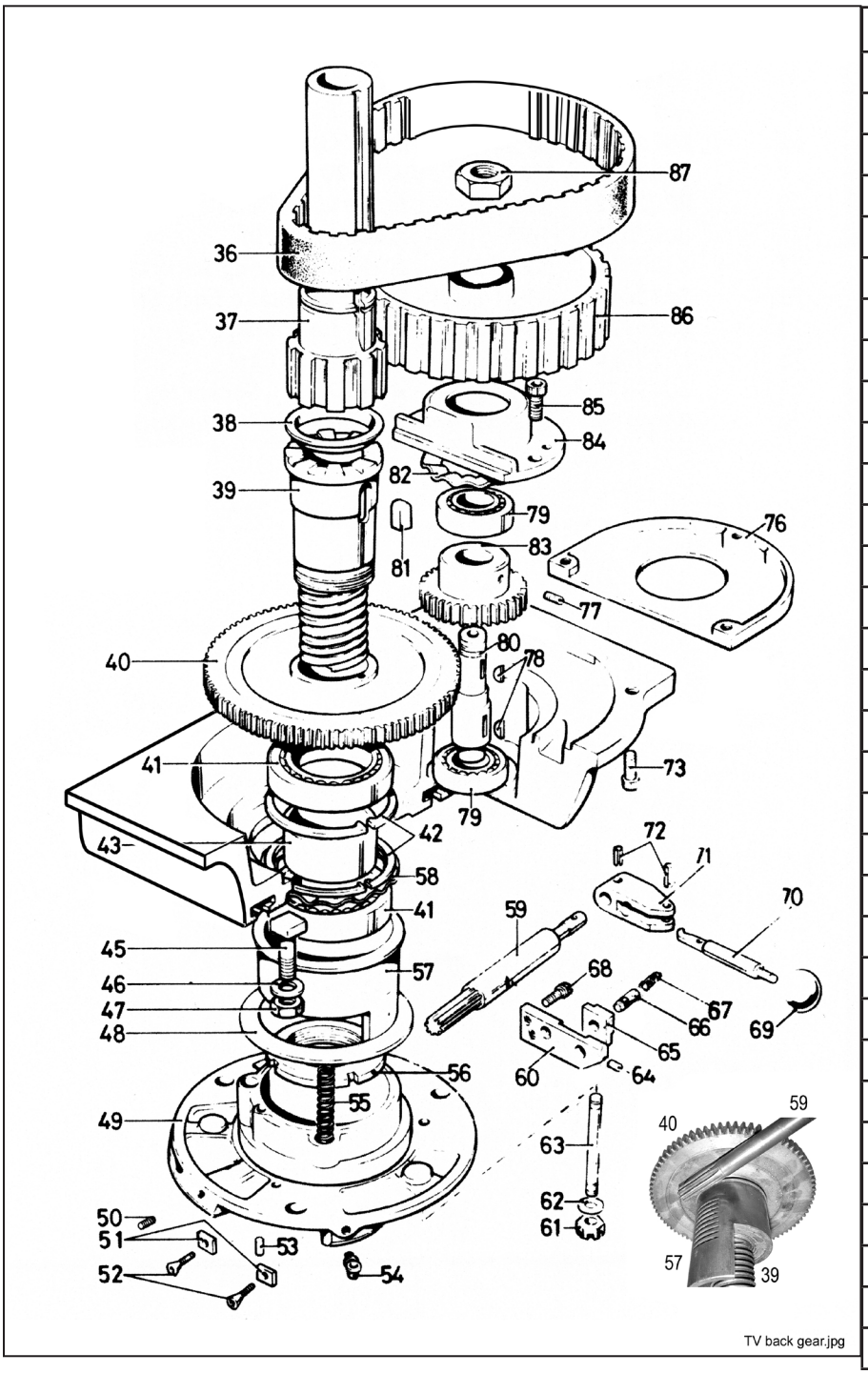
Ref	Description	Part
36	Brake shoe pivot sleeve	Z7083
38	Key	Z7084
39	Key	Z7085
40	Fixed cone disc	Z7086
42	Plastic insert, replaceable insert vari disc	Z7087
43	Adjustable disc (includes one set Z7087)	Z7088
43A	Variable Disc, w/o insert mid 2021 on	Z7088A
44	Compression spring	Z7089
45	Spring flange	Z7090
47	Retaining ring	Z7091
49	Plastic key	Z7092
51	Key	Z7093
52	Taper pin	Z7094
54	Motor pulley cover	Z7095
63	Gear housing	Z7096
66	Retaining ring	Z7097
67	Brake finger pivot stud	Z7098
68	Brake actuating finger	Z7099
70	Brake handle	Z7100
71	Brake lock pin	Z7101
73	Sleeve	Z7102
74	Brake lock shaft	Z7103
75	Bushing	Z7104

VARIABLE SPEED DRIVE COMPONENTS: TV MODELS SPEED CONTROL GROUP Fig 9

Ref	Description	Part
1	Hex nut	Z7043
2	Speed disc	Z7044
3	Bearing	Z7045
4	Set screw	Z7046
5	Speed control housing	Z7047
9	Roll pin Incl w/Z7050	Z7050
10	Speed control chain Incl w/Z7050	Z7050
11	Link (incl. in #10)	Z7050
16	Spring washer	Z7051

Ref	Description	Part
17	Bearing	Z7052
18	Speed control shaft	Z7053
19	Handle, Incl #20 and #21	Z7054
20	Caution plate	Z7054
21	Handwheel	Z7054
23	Faceplate	Z7057
30	Worm	Z7058
33	Worm gear	Z7059
35	Chain drum	Z7060

BACK GEAR COMPONENTS: TV MODELS Fig 10

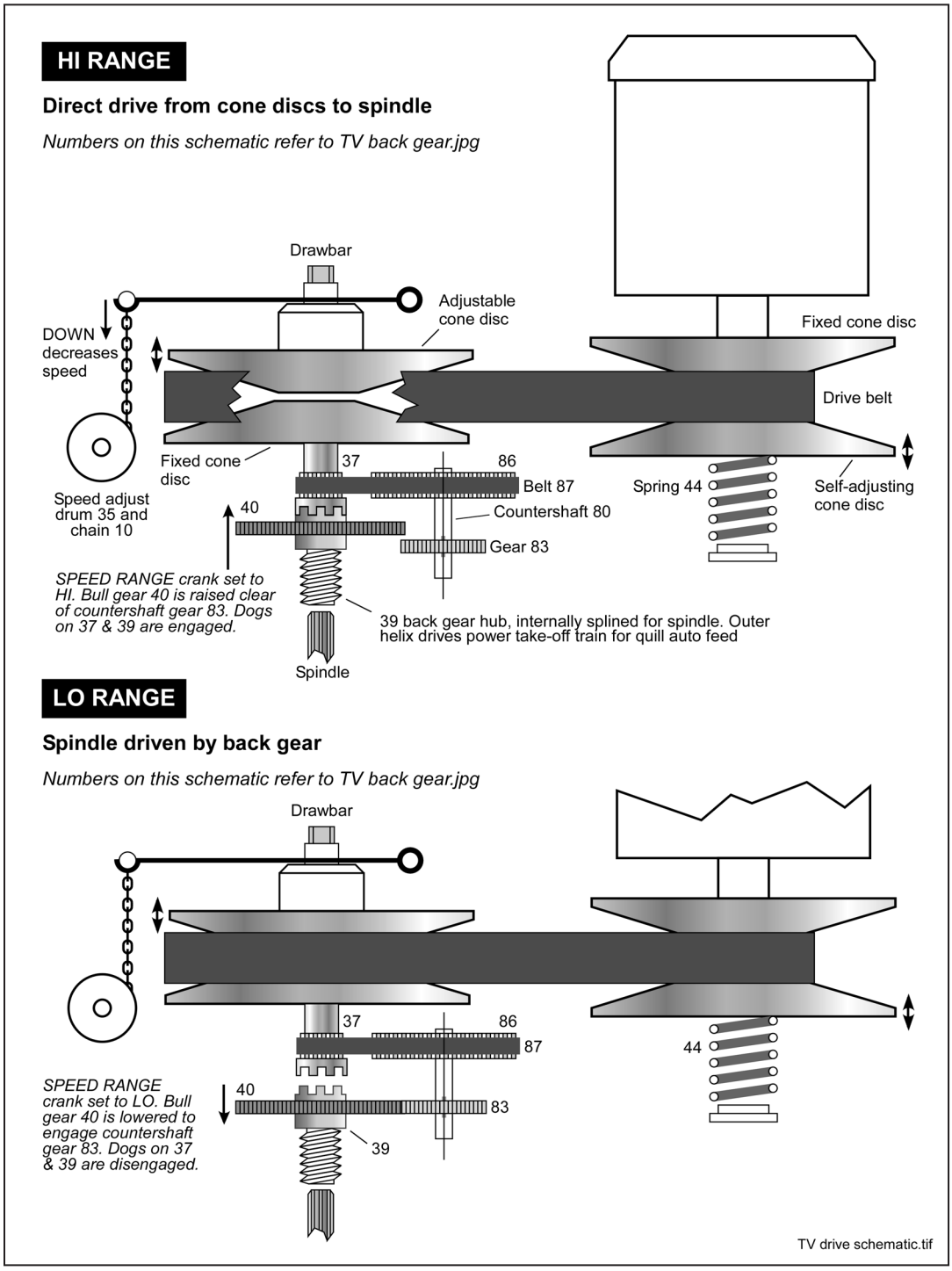


Ref	Description	Part
36	Timing belt	Z7105
37	Spindle pulley hub	Z7106
38	Timing pulley clutch sleeve	Z7107
39	Splined gear hub	Z7108
40	Bull gear	Z7109
41	Ball bearings	Z7110
42	Retaining rings	Z7111
43	Bull gear bearing spacer	Z7112
45	Tee bolt	Z7113
48	Washer	Z7114
49	Clutch bracket	Z7115
55	Compression spring	Z7116
56	Locknut	Z7117
57	Bearing sleeve	Z7118
58	Spring washer	Z7119
59	Pinion shaft (bull gear shift)	Z7120
60	HI/LO detent plate	Z7121
63	Threaded stud	Z7122
65	Adjustable plate	Z7123
66	HI/LO detent plunger	Z7124
67	Compression spring	Z7125
70	HI/LO crank lever	Z7126
71	HI/LO pinion block	Z7127
78	Key	Z7128
79	Ball bearings	Z7129
80	Countershaft	Z7130
81	Key	Z7131
82	Spring washer	Z7132
83	Countershaft gear	Z7133
84	Countershaft bearing flange	Z7134
86	Timing belt pulley	Z7135
87	Jam nut	Z7136

There may be detail differences between this representative drawing and the machine as supplied. Off-the-shelf hardware may not be shown in all instances (some locations call for US threads, some Metric). To order replacement parts from Precision Matthews, give the Model number, Serial number, and reference number on this drawing.

Standard off-the-shelf hardware is omitted from this list. Items listed are unique fabricated or critical parts specific to the TS and TV Series mills.

TV DRIVE SYSTEM SCHEMATIC Fig 11



The back gear (LO speed) system is not the same in TS and TV mills!

In TS mills the bull gear is fixed, and the countershaft gear is raised to engage.

In TV mills it's the other way around — the countershaft gear is fixed, and the bull gear is lowered to engage.

