HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

Mechanical Service Manual 96-0283C RevC English June 2007

- This content is for illustrative purposes.
- Historic machine Service Manuals are posted here to provide information for Haas machine owners.
- Publications are intended for use only with machines built at the time of original publication.
- As machine designs change the content of these publications can become obsolete.
- You should not do mechanical or electrical machine repairs or service procedures unless you are qualified and knowledgeable about the processes.
- Only authorized personnel with the proper training and certification should do many repair procedures.

**WARNING: Some mechanical and electrical service procedures can be extremely dangerous or life-threatening.
Know your skill level and abilities.**

All information herein is provided as a courtesy for Haas machine owners for reference and illustrative purposes only. Haas Automation cannot be held responsible for repairs you perform. Only those services and repairs that are provided by authorized Haas Factory Outlet distributors are guaranteed.

Only an authorized Haas Factory Outlet distributor should service or repair a Haas machine that is protected by the original factory warranty. Servicing by any other party automatically voids the factory warranty.

Before You Begin:

Use Common Sense
Many problems are easily overcome by correctly evaluating the situation. All machine operations are composed of a program, tools, and tooling. All three must be looked at before determining the fault. If a bored hole is chattering because of an overextended tool, do not expect the machine to correct the fault. Do not suspect machine accuracy if the vise bends the part. Do not claim hole mis-positioning if a center-drill is not used.

Find the Problem First
Many mechanics tear into things before they understand the problem, hoping that it will appear as they go. We know this as more than half of all warranty returned parts are in good working order. If the spindle doesn't turn, remember that the spindle is connected to the gear box, which is connected to the spindle motor, which is driven by the spindle drive, which is connected to the I/O Board, which is driven by the MOCON, which is driven by the processor. The moral here is don't replace the spindle drive if the belt is broken. Find the problem first; don't just replace the easiest part to get to.

Don't Tinker with the Machine
There are hundreds of parameters, wires, switches, etc., that you can change in this machine. Don't start randomly changing parts and parameters. Remember, there is a good chance that if you change something, you will incorrectly install it or break something else in the process. Consider for a moment changing the processor's board. First, you have to download all parameters, remove a dozen connectors, replace the board, reconnect and reload, and if you make one mistake or bend one tiny pin, it won't work. You always need to consider the risk of accidentally damaging the machine anytime you work on it. It is cheap insurance to double-check a suspect part before physically changing it. The less work you do on the machine the better.

This manual presents information for Horizontal machines, Lathes, and Vertical machines:

Horiz is used to indicate Horizontal machines.

Lathe is used to indicate Lathes.

Vert is used to indicate Vertical machines.

VIBRATION

Vibration is a subjective evaluation, which makes it difficult to determine, in mild cases, if there is an actual problem. In obvious cases, it is a matter of determining the source. Vibrations need to be distinguished from noise such as a bad bearing. Assuming that vibrations would be something that could be felt by putting your hand on the spindle covers or spindle ring, a dial indicator may help prove this. This crude method is to take a dial indicator on a magnetic base extended 10 inches between the table and spindle housing and observe the reading of the indicator. A reading of more than .001" would indicate excessive vibration. The two common sources of noise are the spindle and axis drives. Most complaints about vibration, accuracy, and finish can be attributed to incorrect machining practices such as poor quality or damaged tooling, incorrect speeds or feeds, or poor fixturing. Before concluding that the machine is not working properly, ensure that good machining practices are used. These symptoms will not occur individually (Ex. A machine with backlash may vibrate heavily, yielding a bad finish.) Put all of the symptoms together to arrive at an accurate picture of the problem.

Machine vibrates while spindle is on and is not cutting. Sometimes only at specific RPM.
• If the spindle alone causes vibration of the machine, it is usually caused by the belt/pulley drive system or on a lathe, the chuck jaws may not be centered correctly.

Machine vibrates while jogging the axis with the hand wheel/jog handle.
• The Haas control uses very high gain acceleration curves. This vibration as you jog is simply the axis motors quickly trying to follow the jog handle divisions. If this is a problem, try using a smaller division on the handle. You will notice the vibration more at individual clicks than when you are turning the handle faster; this is normal.

Machine vibrates excessively in a cut
• This can be caused by a number of factors. Generally, the least rigid element of a cut is the tool as it is the smallest part. Any cutter will vibrate if pushed beyond its tensile strength. In order to eliminate the machine as the source of the problem, check the spindle and the backlash of the axes as described in the following sections. Once machining practices have been eliminated as the source of vibration, observe the machine as it cuts and in dry run. Move the axes (individually) without the spindle turning and then run the spindle without moving the axes. Isolate whether the vibration comes from the spindle head or from an axis.

Accuracy

Poor accuracy must be verified before performing any maintenance. Check the following:

• Ensure that the machine has been sufficiently warmed up before cutting parts. This will eliminate mispositioning errors caused by thermal growth of the ballscrews (see "Thermal Growth" section).

• Do not use a wiggler test indicator for linear dimensions. They measure in an arc and have sine/cosine errors over larger distances.

• Do not use magnetic bases as accurate test stops. High accel/decel of the axis can cause movement.

• Do not attach magnetic base/test points to the sheet metal of the machine.

• Do not mount the magnetic base on the spindle dogs (mills).

• Do not check for accuracy/repeatability using an indicator with a long extension.

• Ensure that test indicators and stops are absolutely rigid and mounted to machined casting surfaces (e.g. spindle head casting, spindle nose, or the table).

• Do not rapid to position when checking accuracy. The indicator may get bumped and give an inaccurate reading. For best results, feed to position at 5-10 inches per minute.

• Check a suspected error with another indicator or method for verification.

• Ensure that the indicator is parallel to the axis being checked to avoid tangential reading errors.

• Center drill holes before using longer drills if accuracy is questioned.

• Once machining practices have been eliminated as the source of the problem, determine specifically what the machine is doing wrong.

Mills

Machine will not interpolate a round hole.
• Check that the machine is level (see Installation instruction).

• Check for backlash ("Ball Screw Removal section and Reference manual).

Bored holes do not go straight through the workpiece.
• Check that the machine is level (see Reference manual).

• Check for squareness in the Z axis.

Machine bores holes out-of-round.
• Check that the machine is level (see Reference manual).

• Check the sweep of the machine (see "Draw Bar Replacement" section).

Bored holes are out of round or out of position.
• Check for thermal growth of the ball screw (see "Thermal Growth" section).

• The spindle is not parallel to the Z-axis. Check sweep of the machine ("Draw Bar Replacement").

Machine mis-positions holes.
• Check for thermal growth of the ball screw (see "Thermal Growth" section).

• Check that the machine is level (see Reference manual).

• Check for backlash (see Reference manual).

• Check the squareness of the X-axis to the Y-axis.

Machine leaves large steps when using a shell mill.
• Check that the machine is level (see Reference manual).

• Check the sweep of the machine (see "Draw Bar Replacement" section).

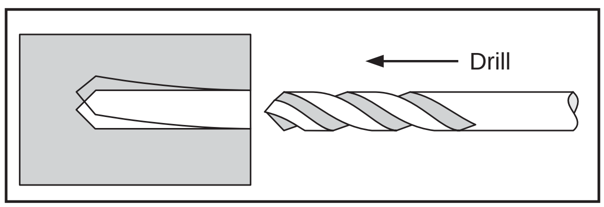
• Cutter diameter too large for depth of cut.

Boring depth inaccurate.
• Check for thermal growth of the ballscrew (see "Thermal Growth" section).

• Check the hydraulic counterbalance system. Check for: abnormal noises from counterbalance system, oil leaks (esp. at fittings and at filter at top of cylinder), bound cylinder.

Lathes

Diameters are out of round
• Check that tooling and machining practices are correct. Bores will be out of round due to tool deflection much more frequently than due to spindle bearing problems.



Diameters are incorrect in X-axis
• Ensure the tool probe is set up correctly (settings, etc.).

• Ensure tool offsets are correct. Note that the coordinate system (FANUC, YASNAC, HAAS) must be selected before setting tools.

• Ensure Parameter 254, Spindle Center, is set correctly.

• Check for thermal growth of the X-axis ballscrew (see “Thermal Growth” section).

Center holes are malformed
• Ensure tooling is tight.

• Ensure Parameter 254, Spindle Center, is set correctly.

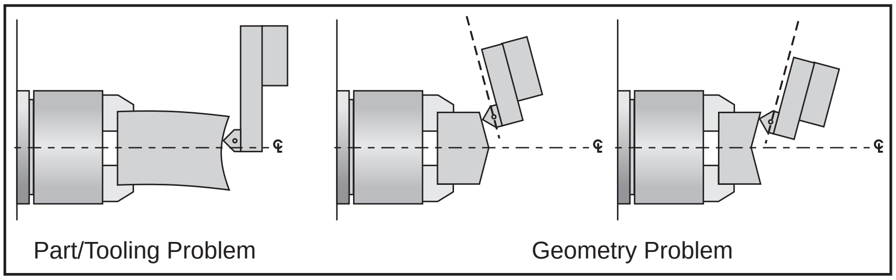
• Check spindle to turret pocket alignment. It may be out of alignment due to a crash or misadjustment.

• Check for thermal growth of the X-axis ballscrew (see “Thermal Growth” section).

Part faces are conical
• Wedge may be out of alignment due to a crash.

• Check tooling setup. Turning long, unsupported parts may cause conical part faces.

• Check for thermal growth of the ballscrews (see Thermal Growth” section).

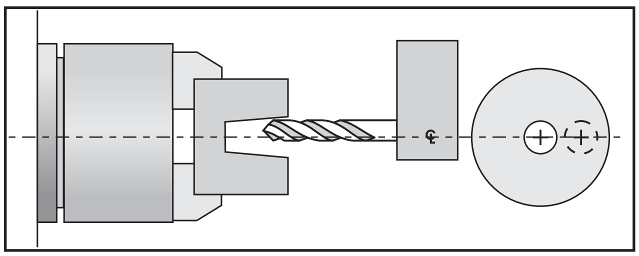


Bores are tapered

• Check that tooling and machining practices are correct. Bores will be tapered if the tooling is inappropriate, the speeds and feeds are incorrect, or coolant is not getting to the cutting tool.

• Although it is rare, the spindle may be out of alignment due to a crash.

• Check that the turret face is parallel with X-axis.



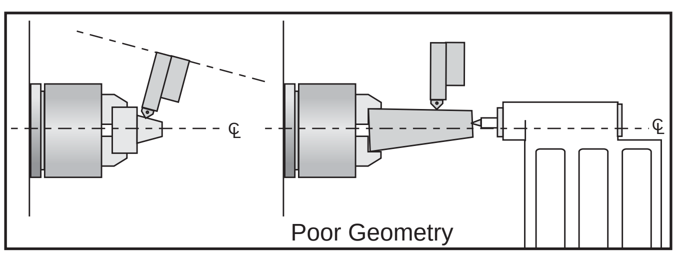
Outside diameter (O.D.) is tapered

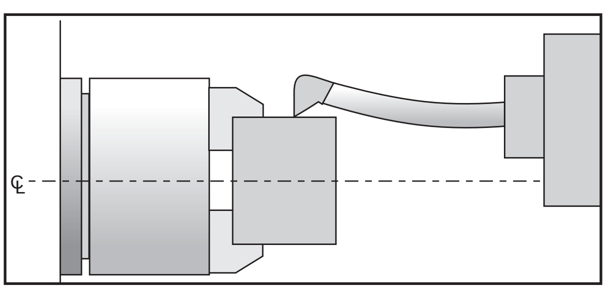
• Check tooling setup. Turning long, unsupported parts can cause a tapered O.D.

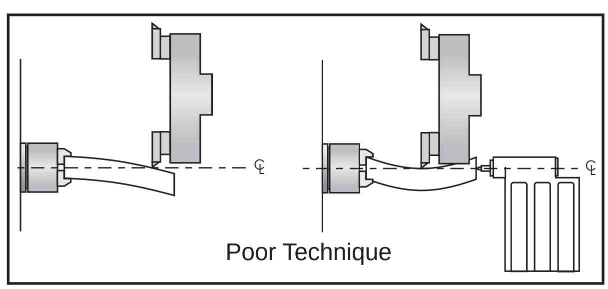
• Check tailstock setup. Excessive hold pressure on the tailstock can distort parts.

• Spindle to Z-axis may be out of alignment (not parallel).

• Program around it. Reduce depth of final rough cut and finish pass to reduce part deflection.





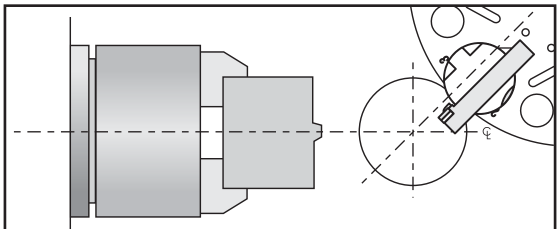


Material left after facing a part

• Ensure tooling is correct.

• Ensure turret is aligned to X-axis travel.

• Ensure Parameter 254, Spindle Center, is set correctly.



Material Left After Facing Part

FINISH

Machining yields a poor finish

• Check for backlash ("Ball Screw Removal and Installation" section).

• Check the condition of the tooling and the spindle.

Vertical & Horizontal Machines

• Check for gearbox vibration.

• Check for spindle failure.

• Check the condition of the axis/servo motors.

• Check that the machine is level (see Reference manual).

Lathes

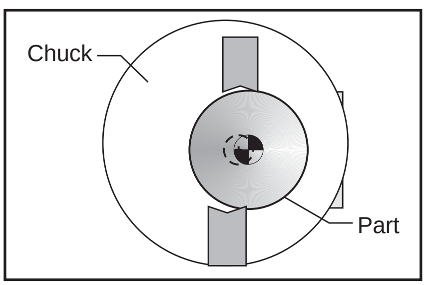
• Check turret alignment.

• Ensure turret is clamped.

• Ensure tooling is tight.

• Check tooling for chatter or lack of rigidity.

• Check the balance of the chuck, part, and fixture.



THERMAL GROWTH

A possible source of accuracy and positioning errors is thermal growth of ballscrews. As the machine warms up, ballscrews expand in all linear axes, causing accuracy and positioning errors (or inaccurate boring depths for vertical and horizontal machines). This is especially critical in jobs that require high accuracy, machining multiple parts in one setup, or machining one part with multiple setups.

NOTE: On machines with ***linear scales***, thermal growth will not affect machine positioning or accuracy. However, it is recommended that the machine be warmed up before cutting parts. The ballscrew always expands ***away*** from the motor end. Thermal growth in a lathe ballscrew will be more noticeable in the X-axis, since errors will be doubled when cutting a diameter.

Verify Thermal Growth

There are a number of ways to verify the problem. The following procedure will verify thermal growth of the X-axis (reverse-anchored for lathes) ballscrew in a machine that has not been warmed up:

1. Home the machine. In MDI mode, press Posit and Page Down to the Oper page.
2. Jog to an offset location on the table (example: X-15.0" Y-8.0" for vert & horiz). Select the X-axis and press the Origin key to zero it. Select the Y-axis for mills and zero it.
3. Press the Offset button, then scroll down to G110 (or any unused offset). Cursor to X and press Part Zero Set once to set X0, then press again to set Y0. Press Z Face Meas once for a lathe.
4. Enter the following program. It will start at the new zero position, rapid 10 inches in the X direction, feed the final .25 inches at 10 inches/min., and then repeat the X movement.

```
G00  G110 X0 Y0;
X10.0;
G01 X10.25 F10. ;
M99;
```

5. In order to set up the indicator, run the program in Single Block mode, and stop it when X is at 10.25" (or end of its set travel for Lathes). **Mills:** Set the magnetic base on the table, with the indicator tip touching the spindle housing in the X-axis for vert & horiz. **Lathes:** Set it on the spindle retainer ring or other rigid surface, with the indicator tip touching the turret in the X-axis, and zero it.
6. Exit Single Block mode, and run the program for a few minutes. Enter Single Block mode again, stop the program when X is at 10.25" for vert & horiz or at the beginning of its travel for lathes, and take a final reading on the indicator. A difference in the X position indicates a thermal growth problem.

NOTE: Ensure indicator setup is correct as described in "Accuracy" section. Setup errors are commonly mistaken for thermal growth.

7. A similar program can be written to test for thermal growth in the Y- and Z-axes, if necessary.

Solutions

Since there are many variables that affect thermal growth, such as the ambient temperature of the shop and program feed rates, it is difficult to give one solution for all problems.

Thermal growth problems can generally be eliminated by running a warm-up program for approximately 20 minutes before machining parts. The most effective warm-up is to run the current program, at an offset Z position before the part for lathes, or above the part or table, with the spindle "cutting air" for vert & horiz. This allows ball screws to warm up to the correct temperature and stabilize. Once at temperature, ball screws won't expand any further, unless allowed to cool down. A warm-up program should be run after each time the machine is left idle.

Compensation for Thermal Growth

During normal operation, small inaccuracies in the work pieces may develop due to thermal expansion of the ball screws. Ball screws are made of steel which expands at the rate of 11 millionths of an inch per degree C.

The Haas control contains built-in features to electronically correct for ball screw growth. This compensation works by estimating the heating of the screw based on the amount of travel over the length of the screw and is measured from the motor. Adjustments can be made to the settings as needed. The user can fine-tune this compensation up to plus or minus 30% with the use of settings 158, 159 and 160. If the part size is too big, decrease the amount of compensation for the appropriate axis. For example, increasing the value in Setting 158, “X Screw Thermal Comp%”, can increase the amount of thermal compensation.

Recommended Torque Values for Machine Fasteners - The following chart should be used as a reference guide when replacing way covers/head covers for torquing machine fasteners where specified.

DIAMETER	TORQUE
8-32	30 in-lb
1/4 - 20	15 ft-lb
5/16 - 18	30 ft-lb
3/8 - 16	50 ft-lb
M10 - 100	50 ft-lb
M12 - 65	100 ft-lb
1/2 - 13	80 ft-lb
3/4 - 10	275 ft-lb
1 - 8	450 ft-lb

Way Covers/Head Covers

X-Axis Way Cover Removal (Horiz)

Left/Right Way Cover Removal

1. Jog the X-axis to the center of travel and Power Off the machine.
2. Remove the SHCS that fasten the way covers to the table and remove the SHCS that fasten the way covers to the outside casting.

Y-Axis Way Cover Removal (Horiz)

Removal - Upper

1. Jog the X-axis to the center of travel and the Y-axis all the way down.
2. Power Off the machine.
3. Remove the BHCS that fasten the way cover to the spindle head and the vertical guides to the column.
4. Remove the top way cover.

Install the way cover in the reverse order above; however, make sure that all necessary gaskets and sealants are replaced and repaired as necessary.

Removal - Lower

1. Jog the X-axis to the center of travel and the Y-axis all the way up.
2. Power Off the machine.
3. Remove the three (3) BHCS that fasten the way cover to the spindle head.
4. Remove the seven (7) BHCS on each side that fasten the vertical guides to the column.
5. Remove the lower way cover.

Install way covers in the reverse order above; however, make sure that all necessary gaskets and sealants are replaced and repaired as necessary.

Z-Axis Way Cover (Horiz)

There are two parts to the Z-axis way cover; the side closest to the spindle and the part on the other side of the receiver (i.e. EC-400); farthest from the spindle

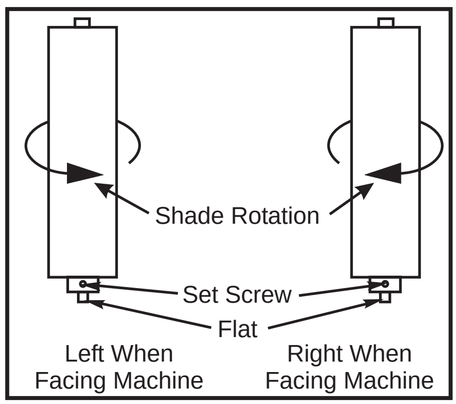
Jog the Z-axis to a position that gains the most access to the way cover to be removed. Horizontal mills with pallet changers: if the way cover closest to the load station, or farthest from the spindle needs to be replaced, rotate the H-frame 45°.

Power off the machine and remove the way cover bolts from each side of the cover.

The replacement cover is installed like the old one was removed. Ensure that a new gasket and sealant are used with the screws to properly fasten the way cover.

MDC/EC-300 Shade-Style Way Cover Adjustment

The front of the column on either side of the spindle is covered by heavy shades, kept taut by spring loaded canisters. If the shades should need adjusting, refer to the following procedure.

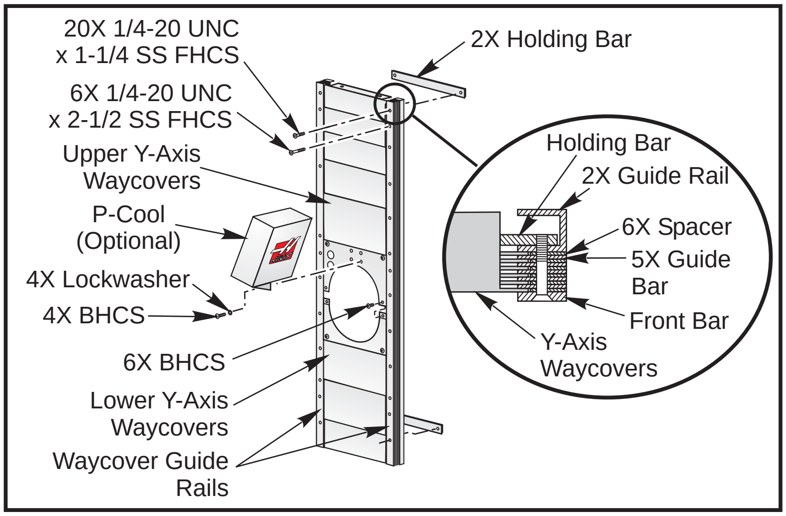


1. Clamp the shaft at the flat with clamping pliers or other such clamping device to hold the shaft when adjusting of the spring tension.
2. Loosen the set screw so that the spring tension may be adjusted.
3. Rotate the shaft one complete revolution against the force of the spring (counterclockwise for the left canister and clockwise for the right canister). Retighten the set screw.
4. Check the tension of the shade. Repeat this process as needed for proper tension one revolution at a time. Do not overtighten the spring.

EC-300 Y-Axis Way Cover Adjustment

Upper Way Cover - Removal

1. Handle jog the X-axis to center of travel. Handle jog the Y-axis to its lowest position.
2. Power Off the machine.
3. Remove the twenty six (26) FHCS that attach the vertical guides to the way cover.
4. Remove the six BHCS that the attach the upper way cover to the spindle head and the lower way cover.



Upper Way Cover - Installation

1. Install the four SHCS at the top of the way cover. Slide it up and down to ensure it moves freely.
2. Slide the way cover down until the bottom flange goes under the spindle head cover and fasten it with four BHCS.
3. Fasten the left and right vertical guides using FHCS.

Lower Y-Axis Way Cover - Removal

1. Handle jog the X-axis to center of travel. Handle jog the Y-axis up fully.
2. Power Off the machine.
3. Remove the SHCS that attach the left and right vertical guides and remove.
4. Remove the four FHCS that attach the top of the lower Y-axis way cover to the spindle head casting. Collapse the way cover down fully.
5. Remove the way cover from the bottom.

Lower Y-Axis Way Cover - Installation

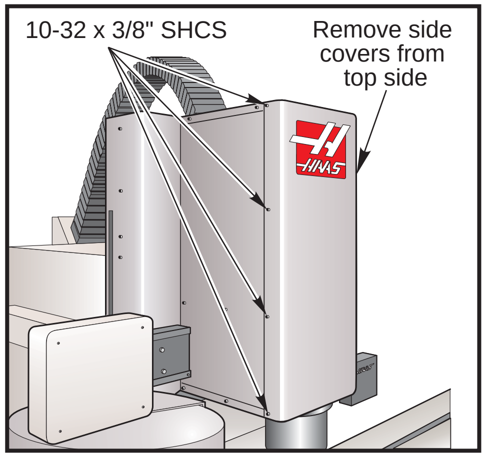
1. Install the four SHCS at the bottom of the way cover, and tighten evenly.
2. Slide the bottom of the way cover up and down to ensure it moves freely.
3. Slide the top flange of the way cover under the spindle head cover plate and fasten it to the spindle head cover and upper way cover using four BHCS.
4. Replace the left and right vertical guides using BHCS.

Head Covers Removal/Installation (Vert)

Removal

NOTE: This procedure is for the VF-3/4. However, the procedure varies only slightly for other models.

50 Taper machines: Before removing the head cover, remove the fan assembly and disconnect the tool release and fan electrical connectors.



VF-3/4 Head Covers

1. Zero return (Zero Ret) all axes, then Handle Jog to center X- and Y-axes under spindle. Protect table surface with a piece of cardboard.
2. Remove the top and rear covers.
3. Pull the front cover from the bottom until you can disconnect the tool release cable (quick disconnect), then remove the cover. Remove the side covers. Jog Z-axis as necessary to make screw removal easier.

Installation

1. Protect table surface with a piece of cardboard. Replace each side cover from the top. Jog the Z-axis as necessary to make access to screws easier.
2. Reconnect the tool release cable, if equipped, then replace the front cover from the bottom. Replace the rear cover and top cover.

Tool Release Piston (TRP) Assembly

Please read this section in its entirety before attempting to replace the tool release piston assembly.

Overview

The tool release piston is actuated by air during a tool change. It forces the tool drawbar down against the spring stack, releasing the tool and allowing another tool to be inserted. Normally the piston is in the upper, retracted position.

As the piston finishes its downward stroke a hole in the side of the tool release shaft comes clear of the cylinder housing and is exposed to the compressed air within the cylinder. The air flows down through the shaft to the tool release nut at the lower end of the shaft. This nut presses on the end of the tool drawbar and the air flows through a central hole to blow any chips out of the tapered area of the spindle shaft.

The spring retainer captures the compression spring that returns the tool change piston and shaft to the normal position when the air is released from the cylinder. The upper and lower limit switches are actuated by the spring retainer. The position of these switches is monitored by the computer control system during a tool change cycle.

There are different tool release pistons for 40 and 50 taper spindles. In addition, the tool change pistons have different subassemblies that will need to be adjusted, or may need replacing. **The section(s) that follow the Spindle TRP Installation instructions must be completed as well or serious damage to the machine could result.**

Tool Clamp/Unclamp

The tool release drawbar is clamped by spring pressure. Air pressure is used to release the tool clamp. When the tool is unclamped, air is directed down the center of the spindle to clear the taper of water, oil, or chips. Tool unclamp can be commanded from the keyboard, and the button on the side of the spindle head. However, these buttons only operate in MDI or Jog modes.

Tool Clamp/Unclamp Air Solenoids

A single solenoid controls the air pressure to release the tool clamp (relay K15). When the relay is activated, 115V AC is applied to the solenoid, which applies air pressure to release the tool. Relay K15 is on the I/O PCB, and circuit breaker CB4 will interrupt power to this solenoid.

Tool Clamp/Unclamp Sense Switches

There are two switches located on the tool release piston assembly that are used to sense the position of the tool clamping mechanism. They are both normally closed. One will open at the clamped position and the other will open at the unclamped position. When both switches are closed, it indicates that the drawbar is between positions.

A tool change operation will wait until the unclamped switch is sensed before the Z-axis or tool changer arm moves, releasing the tool. This prevents any possibility of damaging the machine. The diagnostic display can be used to display the status of the relay outputs and the switch inputs. The Precharge and TSC system applies low air pressure and releases the clamped switch.

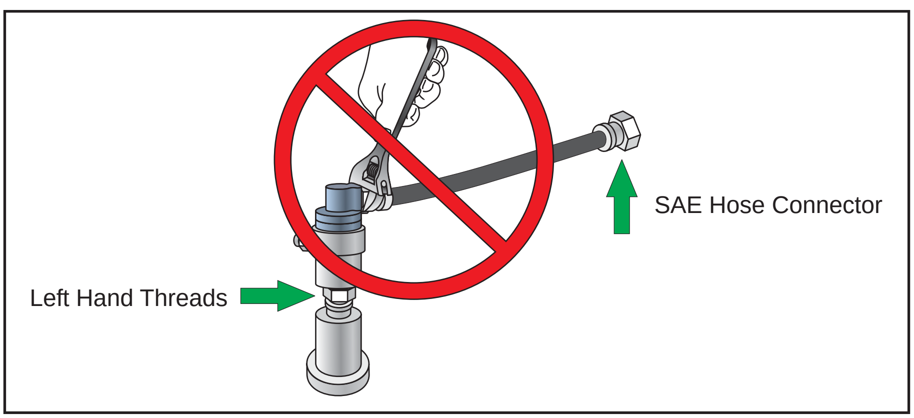
Remote Tool Unclamp Switch

The Remote Tool Unclamp switch is mounted on the side of the cover to the spindle head. It operates the same as the button on the keyboard. It must be held for ½ second before the tool will be released and the tool will remain released for ½ second after the button is released.

Spindle TRP Removal

1. For TSC equipped machines, place a toolholder in the spindle.
2. Remove cover panels from headstock area in accordance with "Head Covers Removal and Installation".
3. For 50 Taper TSC equipped machines the coolant union and extension tube must be removed before proceeding. **They both have left handed threads.**

CAUTION: Do not remove pipe connectors from the coolant union! Removing any pipe connector from the union will void your warranty on the union. Use wrenches only on the SAE hose connector and the bottom nut of the Coolant Union. See arrows below:



a. Loosen the SAE hose connector at the check valve assembly with a wrench (right arrow in diagram). Do not use a wrench on the pipe connector attached to the coolant union; the union will be damaged and the warranty voided.

b. Carefully cut off the clear plastic drain hose at the side of the coolant union. It is safest to use scissors or snips. Cut it close to the connector, since the hose will be re-used on the replacement union. Do not cut the black coolant hose. (Note that if you are not replacing the union, leave the drain hose attached to the union.)

c. Remove the coolant union from the extension tube (bottom arrow in diagram) using two wrenches (7/8 and 15/16). This is a left-hand thread.

d. Return the coolant union with all pipe thread connectors and black coolant hose **intact** to Haas Automation for warranty. **Removal of any of the pipe connectors from the union will void any claims for warranty.**

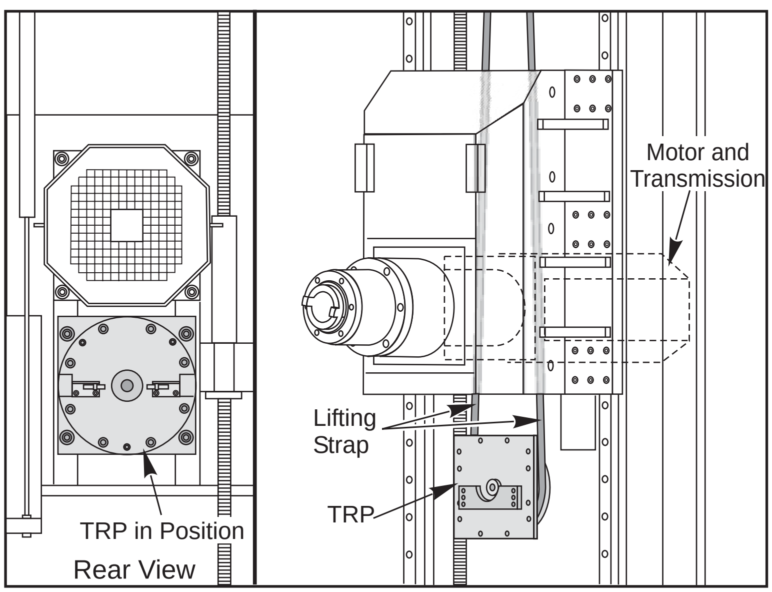
4. Disconnect the air line at the lube/air panel.

5. Disconnect the clamp/unclamp cables (quick disconnect) and the assembly's solenoid wiring located on the solenoid bracket.

6. a. **40 Taper -** Remove the tool release air hose and precharge hose at the fitting shown in the following figure. If machine is equipped with TSC, also remove the coolant hose.

   b. **50 Taper -** Remove the three tool release air hoses.

7. Use a strap and overhead lifting device to hold the TRP in position. Remove the four shoulder screws holding the tool release piston assembly to the head casting. Keep all washers and shims.



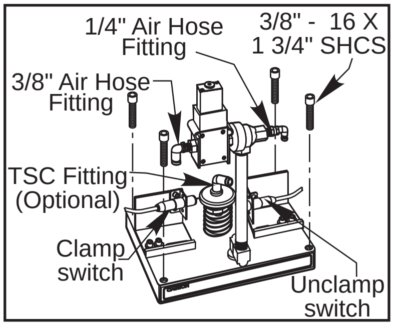
TRP Shown in Position and as it is Lowered

8. Remove entire tool release piston assembly, by sliding it forward then lifting it upward. The assembly is heavy so use great care when removing it.

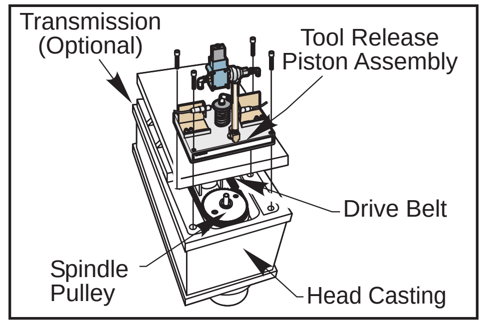
NOTE: Steps 9 and 10 apply only to machines with TSC.

9. Remove the drain and purge lines from the seal housing.

10. Remove the seal housing from the TRP.



Tool Release Piston with Optional TSC Fitting



Mounting Location for Tool Release Piston Assembly

Spindle TRP Installation

The following sections must be completed after installation:

40 Taper

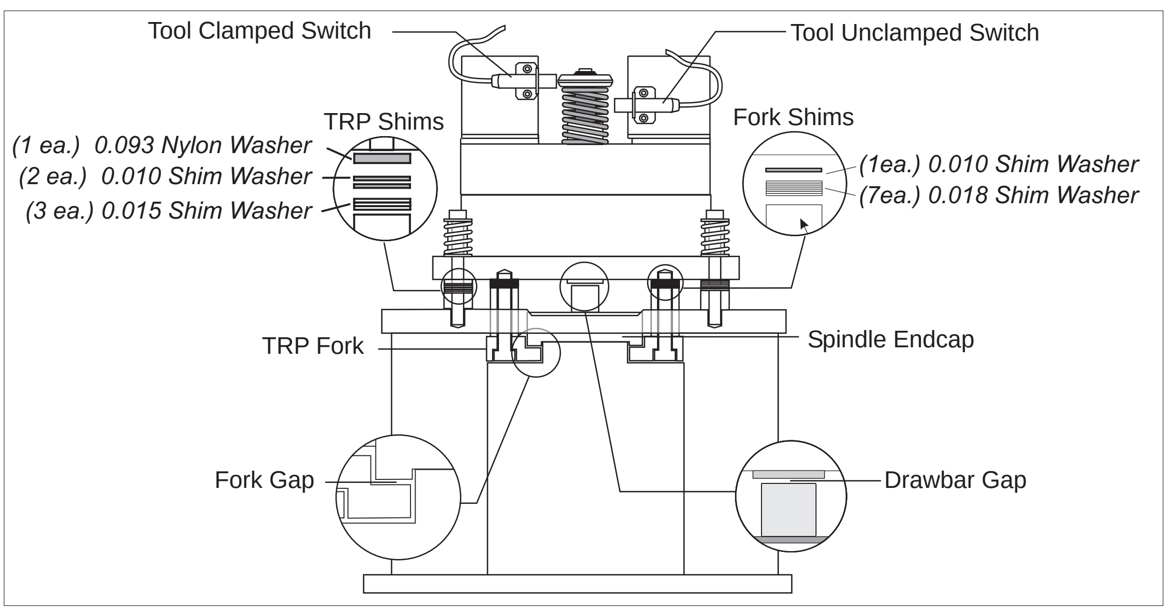
- Set pre-charge
- Adjust the tool clamp/unclamp switches
- Set the drawbar height

50 Taper

- Tool push out adjustment
- Setting TRP switches
- Extension tube Installation (TSC)

1. Ensure drive belt has been properly replaced as described in "Belt Replacement and Tensioning" section.

2. Verify spindle sweep adjustment is correct (as shown in "Drawbar Replacement" section) before proceeding. If not correct, re-shim as necessary.



50 Taper Shim and Spacer Location Diagram

3. Place the TRP on the machine. The TRP will rest on the spindle lift fork.

CAUTION! Be careful of the spindle lift fork. Place the assembly toward the front of the machine before lowering it. The assembly is heavy so use great care when replacing it.

4. Install the 4 bolts, with the shim stock and spacers under the TRP.

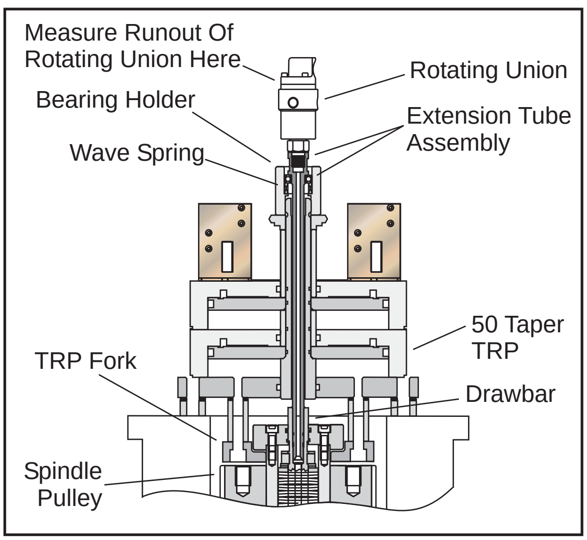
	Part No.	Description	30-0013A (New)	30-0013 (Old Style)
Fork:	(45-0014)	0.010 Shim Washer	1 ea.	None
	(45-0015)	0.018 Shim Washer	7 ea.	5 ea.
TRP:	(45-0019)	0.093 Nylon Washer	1 ea.	1 ea.
Spacers:	(45-0017)	0.010 Shim Washer	2 ea.	2 ea.
	(45-0018)	0.015 Shim Washer	3 ea.	2 ea.

NOTE: TRP Spacers: the nylon washer goes on top of the shims.

5. Reinstall tool release piston assembly loosely if the machine is equipped with TSC. Otherwise tighten the four mounting bolts securely.

6. **50 Taper - I**f the machine is equipped with TSC, re-install the extension tube and rotating union in the following manner. Otherwise, skip this step.

NOTE: If the spindle, drawbar or extension tube has been replaced, the extension tube runout **must** be adjusted.



a) Place a toolholder in the spindle.

b) Insert a 5/8 Allen wrench into the lower end of the piston shaft. Loosen the 1/4-20 screw in the clamp collar on top of the piston shaft. Insert a large flat blade screwdriver into the slot in the clamp collar, and twist the collar off.

c) Screw the bearing holder (20-7655) onto the piston shaft. Tighten using a large wrench or pliers.

d) Wipe clean the hole in the end of the drawbar.

e) Replace the tool release piston.

f) Apply a light layer of molybdenum grease to the inside of the bearing holder. Insert the wave spring (59-0176) into the bearing holder.

g) Lightly grease the o-ring on the end of the extension tube assy (30-1242). Apply blue Loctite to the thread on the end. Insert the extension tube down into the drawbar. Tighten by hand as far as possible **(it has left hand threads).**

h) Block spindle rotation with a bolt, bar or socket inserted into one of the pulley holes. It will stop against the TRP fork.

i) Tighten the extension tube to 15-20 ft-lb. Remove the bolt from the spindle pulley.

j) Install the rotating union. Lightly grease the o-ring. Do not put Loctite on the threads.

1) Thread the coolant union onto the end of the extension tube (it has left hand threads). Do not use Loctite. Tighten the threads snugly using two wrenches.

2) Attach the clear plastic drain hose to the barb connector on the side of the union. Use a hose clamp if one is available. The hose must travel downward (below the union) to drain off collected coolant. The union will be damaged if coolant collects inside the union.

3) Thread the black coolant hose onto the connector on the check valve assembly. Tighten with a wrench. Do not over-tighten!

k) Measure the runout at the top of the rotating union with a dial indicator. Runout should not exceed .006"

l) Check the tool clamp and unclamp switches. They should not have moved.

m) Test run the TSC system to check for leaks before putting the head covers back on.

7. Reconnect the air hoses at the applicable fittings on the tool release piston assembly.
8. Reconnect the clamp/unclamp cables and solenoid wire to the sides of the solenoid bracket.
9. **50 Taper -** Set the main air regulator to 85 PSI and complete Tool push out and TRP switch adjustments.

Steps 10-13 only apply to 40 Taper machines with TSC

10. Connect the 5/32" drain line and 5/32" purge line to the seal housing and install the seal housing on the TRP (use Loctite on the screws). The drain line connector should point toward the rear of the machine.

NOTE: The drain line must run straight through the cable clamp guide on the transmission, and must not interfere with the pulley or belts.

11. Apply precharge pressure several times to allow the seal to center itself with the drawbar. While holding down precharge, tighten the bolts.
12. Install the coolant hose. A wrench must be used, tighten snug. **Do not overtighten!!**
13. Adjust the clamp/unclamp switches in accordance with the appropriate section.

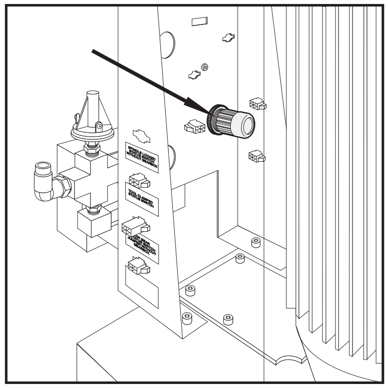
Setting Pre-Charge

Do not perform on machines equipped with Through the Spindle Coolant (TSC). It will damage the machine. Refer to the "Precharge Regulator Adjustment" section and perform those adjustments.

NOTE: Set the air pressure regulator to 30 PSI on Super Speed machines with an in-line drive and do not set a precharge on 50 Taper machines. For a standard 40 Taper machine (without TSC), use the procedures in step 4.

1. Turn the air pressure regulator to zero (0). The knob must be pulled out to unlock before adjusting. **In-Line drive machines -** Disconnect the air hose from the precharge regulator. Install a test gauge between the regulator and the solenoid. Command the precharge (Macro #1120-1), the pressure should be 30 PSI.

NOTE: At "0" pressure on the precharge regulator, the adjustment knob is out as far as it will turn.



Air Pressure Regulator Adjustment Knob

2. Verify Parameter 149, Precharge DELAY, is set to 300.
3. Execute a tool change. A banging noise will be heard as the tool release piston contacts the drawbar.
4. Turn the air pressure regulator ½ turn in. Execute a tool change and listen for banging noise described in step 3. If it is heard, repeat this step until no noise is heard. There should be no noise with or without a tool in the spindle.

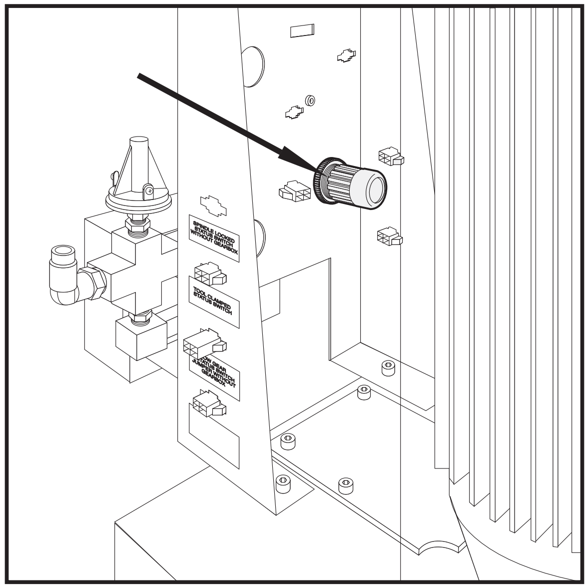
CAUTION! Only increase the pressure to the point where tool changes become obviously quiet. Any further pressure increases are not beneficial. Excessive pressure to the precharge system will cause damage to the tool changer and tooling in the machine.

5. Replace the head covers.

TRP Switch Adjustment

TRP Precharge must be adjusted for Inline Spindles before adjusting the Clamp-Unclamp switches. To adjust the TRP Precharge:

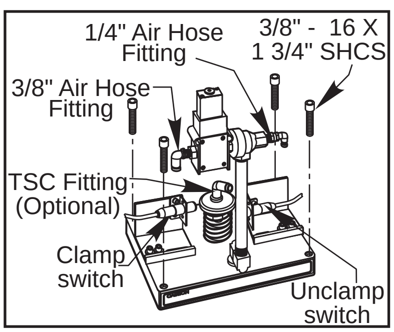
1. Install an inline pressure gauge between the regulator and the check valve.
2. Remove the toolholder from the spindle.
3. Rotate the regulator adjusting knob to the fully out position (turn counter-clockwise).



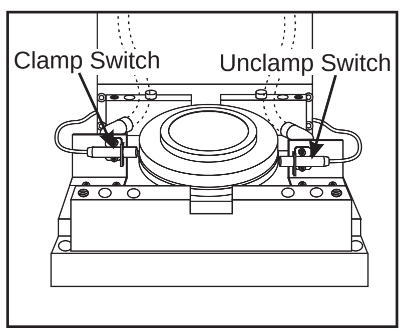
4. Press MDI.
5. Enter #1120=1, and press Cycle Start.
6. Adjust the pressure regulator to 30 PSI and press Reset.
7. Press Cycle Start again to verify that the regulator is set to 30 PSI.
8. Lock the regulator adjusting knob, by pressing it in and remove the inline gauge.

Adjustment Procedure

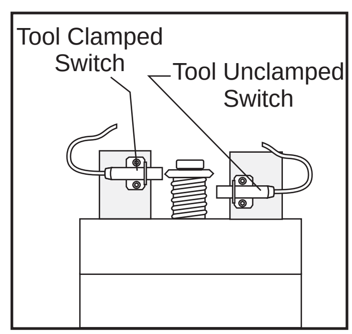
Upon completion of the Tool Release Piston switch adjustment procedure, the switches should indicate that the tool is released from the spindle taper with the tool **0.060”** out of the taper and that the tool is **not** released with the tool **0.050”** out of the taper.



Conventional Spindle Switches



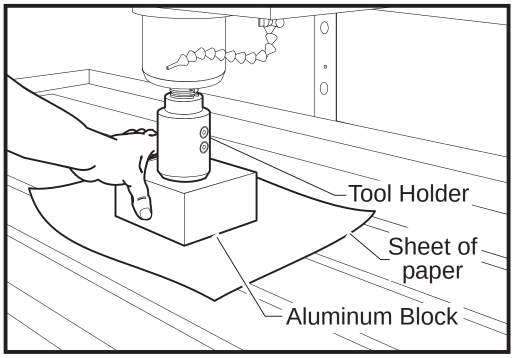
Inline Spindle Drawbar Switches



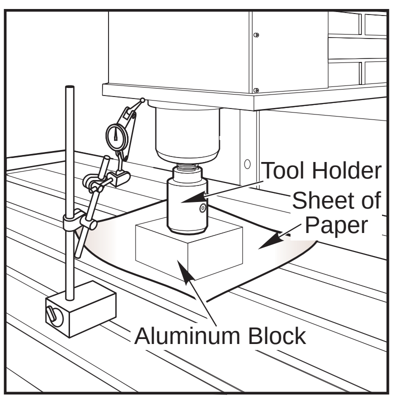
50 Taper Tool Clamp/Unclamp Switches

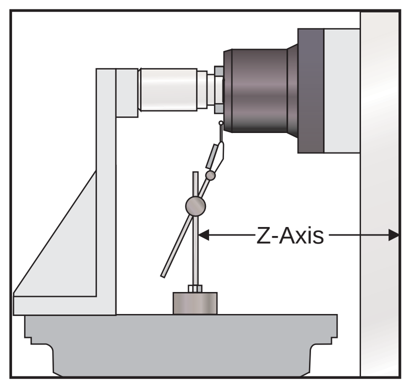
Lower (Unclamp) Switch

1. TRP height must be set properly before adjusting switches. See the “Setting TRP height” section.
2. Press Param/Dgnos until the diagnostic page is displayed. Confirm that DB OPN=0 and DB CLS=1.
3. Place a tool in the spindle and place a machined aluminum block on the table under the toolholder (Vert), or set up a fixture to support an aluminum block for horizontal mills. Be sure to place a clean piece of paper under the block to protect the table, or fixture surface.



4. Jog Z-axis until the toolholder is about 0.030” above the aluminum block. Switch to .001” increments. Jog one increment at a time until the toolholder just makes contact with the block (should still be able to move the block). This is the Zero Point. **Do not press** the Tool Release button; it will cause a Z-axis overload.
5. Change Parameter 76, Low Air Pressure, to 99,999. This eliminates a low air pressure alarm.
6. To limit spindle head deflection during this next part of the procedure, the air pressure needs to be reduced to lower the output force of the TRP. Turn the regulator down past 50 PSI, then adjust back up to 60 PSI.
7. Place a 0.0005” test indicator between the table, or fixture and the face of the spindle head to measure axial deflection when the TRP is energized. Press and hold the Tool Release button and check that the block is tight and the head deflection is between 0.002” and 0.004”. If the head deflection is too high, reduce the air pressure. If the head deflection is too low, or there is no deflection, increase the air pressure.





8. Remove the indicator.
9. Press Posit, then Page Up until the Pos-Oper page is displayed. With the Z-axis selected, press Origin to zero the display.
10. Press .01 and jog the Z-axis to 0.060” (away from the block).
11. Press the Tool Release button and hold it in. Adjust the switch in or out toward the spring retainer until the switch changes status (DBOPN=1). The switch should now be indicating that the tool is unclamped and out of the spindle taper.
12. Cycle the tool release several times and confirm that the switch is tripping. Press Param/Dgnos until the Diagnostics page is displayed. Confirm that (DB OPN=1) and (DB CLS=0).
13. Check the adjustment. Jog the Z-axis to 0.050” (from the block) and confirm that (DB OPN=0 when the Tool Release button is pressed.

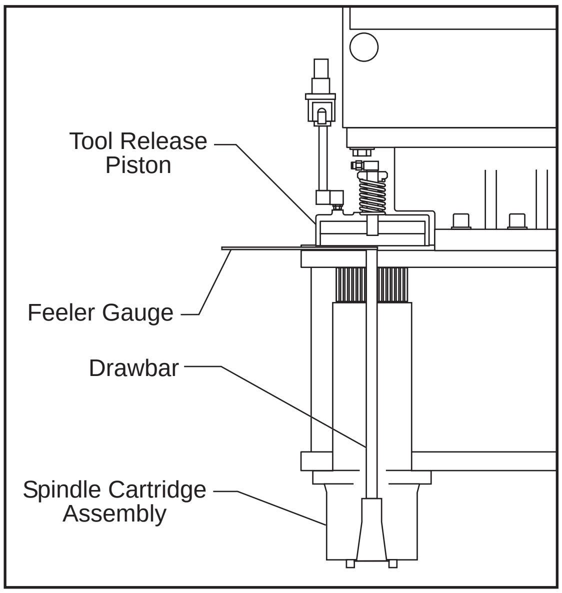
NOTE: The switch must trip (DB OPN=1) at 0.060” and not trip (DB OPN=0) at 0.050”.

14. Adjust and repeat steps 11-13 if necessary.

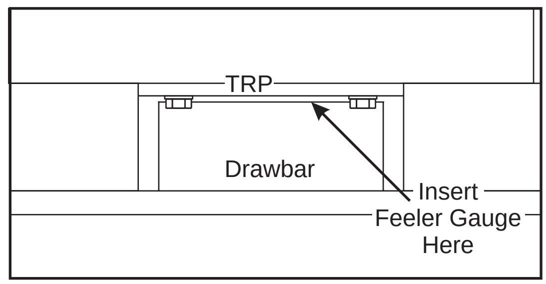
15. Set the pressure regulator back to 85 PSI and set Parameter 76 to 1500.

Upper (Clamp) Switch

1. Remove the tool holder from the spindle.
2. Enter MDI mode, erase any code and enter #1120=1.
3 Start with the upper switch all the way in. Place a 0.020” feeler gauge between the TRP and the drawbar.



Conventional Spindle Switch Adjustment



Inline Spindle Switch Adjustment

4. Press Param/Dgnos until the Diagnostics page is displayed, then press Cycle Start.
5. If DB CLS=0 (Tool Unclamp), the adjustment is complete. If not, adjust the upper switch out until the switch is just un-tripped (DB CLS=0) and continue with the next step.
6. Press Reset. Replace the 0.020” feeler gauge with a 0.040” feeler gauge. (Checking with the 0.040” feeler gauge assures that the switch is not too far out of position. If the switch is all the way in, this check is not necessary.) Press Cycle Start. See that DB CLS=1.
8. Repeat steps 4-7 if necessary. If repetition is not necessary, remove any feeler gauges. The adjustment procedure is complete.

TRP Installation and Adjustment - OM-1A/OM-2A

Upon installation of the TRP, the top of the spindle gear must sit flush with the bottom of the subplate of the TRP casting. If the TRP subplate casting sits above the spindle, add .01” shims as necessary. Connect an air pressure gauge to the TRP Pre-Charge, and adjust the pressure until it reads 6 PSI upon tool release. Insert shoulder bolts and torque to 18 ft-lb.

NOTE: Upon tightening of the fasteners, the TRP must fully return to its original position.

Drawbar Height Adjustment

1. Place a machined aluminum block on the table under the toolholder (with no tool in the spindle). Be sure to place a clean piece of paper under the block to protect the table surface.

2. Jog the Z-axis down until the toolholder is about 0.030” above the aluminum block. Set the clearance from the toolholder to the block to zero by pressing Tool Release, switching to .001” increments, and jogging down one increment at a time. Move the Z-axis, then press Tool Release while feeling for movement of the toolholder (place finger between toolholder and spindle). Repeat process until no movement is felt. This is the zero point.

3. In .01” increments, handle jog the Z-axis to .100” above the block.

4. Press and hold the Tool Release button. Try to move the block. The block should be tight at .100”, and loose at .110”. If the block moves at .100”, repeat the process, jogging the Z-axis down one increment at a time until the block is tight. If the block is tight at .110”, repeat the process, jogging the Z-axis up one increment at a time until the block is loose.

NOTE: The number of increments jogged up or down is equal to the number of shims to add or remove. If the block was tight at .110”, remove shim washers. If the block was loose at .100”, add shim washers.

Shim Washer Addition/Removal

To add or subtract shim washers, remove the TRP assembly.

1. Check tool release tip and drawbar condition and replace damaged parts before setting drawbar height.
2. Remove the tool release bolt.
3. Add or remove the required number of shim washers.
4. Reinstall the tool release bolt.
5. Install the TRP assembly and recheck settings. Adjust as required.

Upper (Clamp) Switch

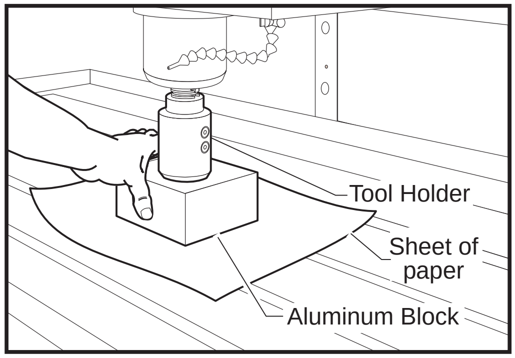
1. Delete everything in MDI mode and write #1120 = 1.
2. Start with the upper switch all the way in.
3. Place a 0.020” shim between the tool release piston adjustment bolt and drawbar and press Cycle Start.
4. If DB CLS = 0 (tool unclamp), the process is complete. If not, adjust the upper switch out until the switch untrips (DB CLS = 0), and test the adjustment.
5. Press Reset.
6. Replace the 0.020” shim with a 0.040” shim and press Cycle Start.
7. Verify that DB CLS = 1. Readjust if necessary.

Setting TRP Height

This procedure must be done before adjusting the Clamp-Unclamp switches.

Place a tool in the spindle and place a machined aluminum block on the table under the toolholder (Vert), or set up a fixture to support an aluminum block for horizontal mills. Be sure to place a clean piece of paper under the block to protect the table, or fixture surface.

1. Jog the Z-axis until the toolholder is about 0.030” from the aluminum block. Switch to .001” increments. Jog one increment at a time until the toolholder just makes contact with the block firmly against the table, or fixture surface (should be able to move the block). This is the Zero Point. **Do not press** the Tool Release button; it will cause a Z-axis overload.



2. Press Handle Jog, then press .01 increments and jog the Z-axis in the positive (+) direction 0.100”.

40 Taper

3. Hold the Tool Release button down, grasp the aluminum block and try to move it. The block should be tight.

4. Jog the Z-axis in the positive (+) direction 0.110”.

5. Hold the Tool Release button down, grasp the aluminum block and try to move it. The block should be loose.

NOTE: If this is true, no adjustment is necessary. If it is not, proceed to the next step.

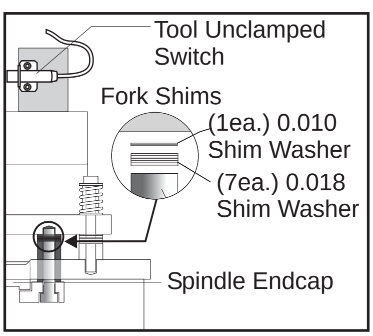
6. If the block moves at 0.100”, jog the Z-axis in the negative (-) direction one increment at a time. Check for movement of the block between increments until the block is tight. Each increment is equal to one piece of shim stock.

7. The increments jogged in the Z negative (-) direction are the amount of shim washers that must be added to the tool release bolt (or coolant tip for TSC) for the conventional spindle; or the amount of shims added to the tool release piston for the Inline spindle. Refer to Shim section.

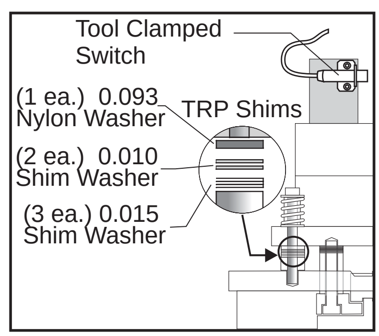
8. If the block is tight at 0.110”, move the Z-axis in the positive (+) direction one increment at a time. Press the Tool Release button and check for movement between increments until the aluminum block is loose.

9. The increments jogged in the Z positive (+) direction are the amount of shims that must be removed. Refer to Shim section.

50 Taper



Fork Shim Location



TRP Shim Location

10. The tool push out adjustment is 0.060” +/-0.010”. Add or remove shims from the tool release fork to make adjustments. The shims come in 0.010” and 0.018” thicknesses. Jog away from the plate (upward for Vert) 0.060. Press and hold the Tool Release button, and feel for movement in the aluminum block.

   • If the block is tight when the button is pressed, shims may have to be added to the TRP fork.

   • If the block is loose when the button is pressed, shims may have to be removed from the TRP fork.

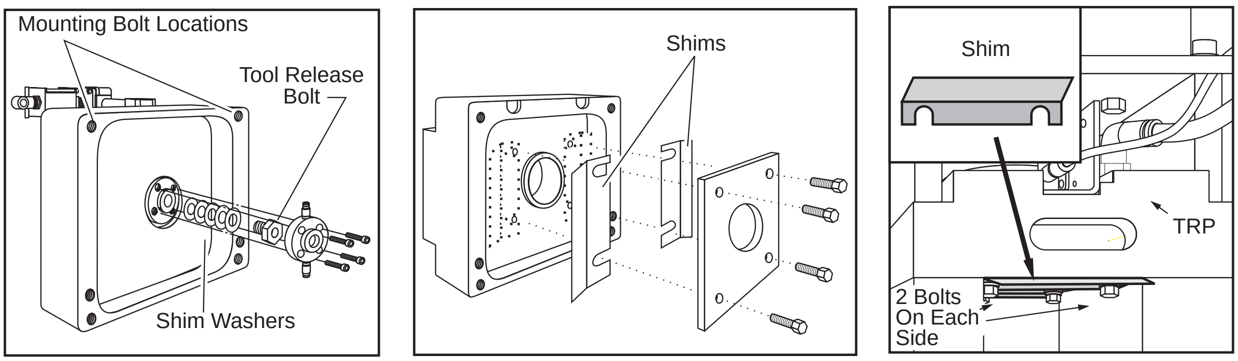
• If the aluminum block is tight at 0.060", release the button and jog the Z-Axis away from the block 0.001" and press the Tool Release button again. Feel for movement in the aluminum block. Repeat this until movement is felt. Note the last position where the block was tight. If the position is 0.070" or more, add shims to the TRP fork.

• If the aluminum block is loose at 0.060", jog the Z-Axis toward the block 0.001 at a time and check for movement in the aluminum block. If the position where the block becomes tight is 0.050" or less, remove shims from the TRP fork.

11. If shims were added to the TRP fork, add half that amount to the spacers supporting the TRP. This will keep the two clearance gaps between the TRP and the rotating spindle equal (approximately 0.095" each). If shims were removed from the TRP fork, remove half that number of shims from the spacers.

12. Apply red grease to the shoulder bolts used to mount the TRP when shim adjustments are complete. Use blue Loctite on the threads.

Shims



Conventional Spindle *Inline Spindle*

NOTE: Shims may need to be added or removed if the spindle cartridge, tool release piston assembly or drawbar have been replaced.

Conventional Spindle

1. To add or subtract shim washers, remove the tool release piston assembly from the head casting.

2. Check the condition of the tool release bolt and the drawbar. Repair or replace these items (if necessary) before setting the drawbar height.

3. Remove the tool release bolt. Note that it has a left-hand thread. If the machine is equipped with TSC, loosen the three set screws and remove the TSC coolant tip.

4. Add or subtract the required number of shim washers as previously described.

5. Before installing the tool release bolt, put a drop of serviceable (blue) Loctite on the bolt threads. If replacing the TSC coolant tip, put a drop of Loctite on the three set screws before installing them.

6. Install the tool release piston assembly and recheck the settings. If settings are not within specifications, repeat the procedure for setting the TRP height.

Inline Spindle

NOTE: Shims may need to be added or removed if the spindle cartridge, tool release piston assembly or drawbar have been replaced.

1. To add or subtract shims, loosen the four hex head bolts that attach the shims to the tool release piston.

2. Add or remove the necessary number of shims, as previously described, then reassemble

In-Line Drive Spindle Drawbar Height

The drawbar height is set as for the belt driven spindle; however, the shim washers are set up differently. The drawbar uses a one-piece shim which can be added or removed without having to remove the TRP assembly. Once the shims have been adjusted, the TRP is re-installed, and the final torque on the bolts is 35 ft-lb.

TRP Disassembly

1. Loosen and remove the shaft clamp. A punch and mallet may be required to break the clamp loose.
2. Remove the switch trip and compression spring.
3. Remove the 50T upper spacer.
4. Push the TRP shaft down.
5. Remove the 8 bolts holding the TRP assembly together, separate and remove upper half of the housing.
6. Remove the upper TRP piston and remove the lower half of the TRP housing.
7. Remove the TRP lower spacer, the lower TRP 50T piston and the TRP sub plate.

O-ring Replacement

1. Remove and replace the 4 o-rings (57-0027) on the TRP 50T shaft
2. Remove and replace the 2 o-rings (57-0092) on the TRP 50T piston, 1 o-ring per piston.
3. Remove and replace the 3 o-rings (57-0095); 2 in the center of the TRP 50T housing and 1 in the center of the TRP 50T sub plate.

TRP Assembly

1. Place the TRP sub plate over the TRP shaft, the lower TRP piston, grooved side up, and the TRP lower spacer over the TRP shaft.
2. Install the lower TRP housing, the upper TRP piston, grooved side up, and the upper TRP housing over the TRP shaft.
3. Replace the 8 bolts holding the TRP assembly together. Pattern torque to 50 ft-lb.
4. Place the TRP upper spacer over the TRP shaft.
5. Push the TRP shaft up from the bottom, using the mallet handle. The shaft will bottom out with approximately 1/4" of the shaft still showing.
6. Place the switch trip and compression spring over the TRP shaft.
7. Tighten the shaft clamp on the TRP shaft, then the shaft clamp locking bolt.

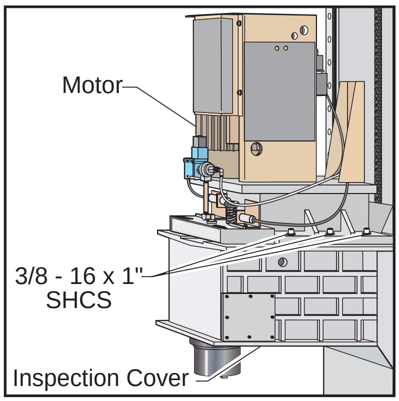
Please read this section in its entirety before attempting to replace the Vertical or EC-Series drive belt.

DRIVE BELT REPLACEMENT (VERT & EC-SERIES)

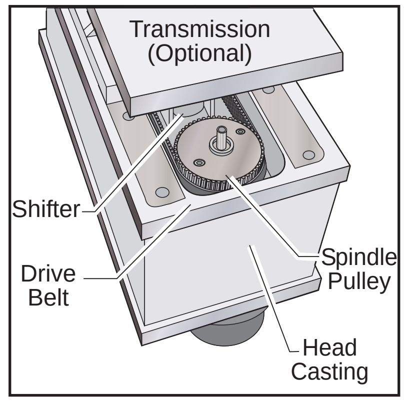
Removal

NOTE: For easier removal, place transmission in high gear before beginning.

1. Remove cover panels from headstock area in accordance with "Head Covers Removal/Installation".



Spindle Head Casting Disconnect Points



Head Casting Area Showing Belt Location

2. Remove tool release piston assembly in accordance with "Spindle TRP Removal".

3. a. **Vert:** Remove the six SHCS holding the transmission to the head casting and pull the transmission forward enough (½" to ¾" max.) to allow the drive belt to be pulled upward over the spindle pulley.

   b. **Horiz:** Remove the four large SHCS that attach the transmission mount plate to the spindle head and pull the transmission/motor assembly toward the front of the machine slightly to remove the tension on the drive belts, and remove the drive belts.

NOTE: On direct drive machines, remove the four SHCS holding the mounting plate to the spindle head casting. Slide the assembly forward enough to allow the drive belt to be pulled up over the spindle pulley.

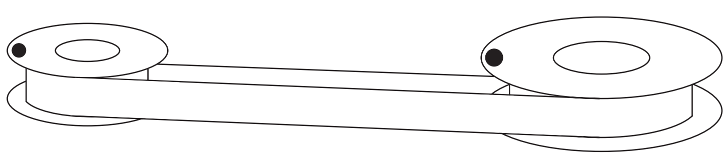
4. Remove the inspection cover from the bottom of the spindle head casting and carefully slide the drive belt between the sump tank and the web in the casting.

5. Pull the belt up over the spindle pulley, push the other end down to clear the shifter, and pull out.

NOTE: Do not bend or kink the belt in any way; damage to the fibers in the belt may result, and the belt will fail soon after installation.

Installation

NOTE: Belt clocking must be correct before placing replacement belt(s) onto the pulley(s). Rotate the pulleys until the alignment dots are in line, but not facing each other, as shown in the following illustration.



Belt Clocking

1. a. **Vert:** Slide the replacement belt(s) under the sump tank and onto the pulley.

NOTE: Do not wrap the belts over the pulley. The pulley can be rather sharp, and may cut the belts. Do not bend or kink the belt in any way; damage to the fibers in the belt may result, causing belt failure.

   b. **Horiz:** Slide on the drive belts.

2. a. **Vert:** Ensuring the belt is properly seated, push the transmission back, tightening the belt. Pull belt forward from rear of head casting. Pull belt over spindle pulley.

   b. **Horiz:** Replace the TRP solenoid assembly and TSC valve bracket. Orient the transmission/motor assembly and replace the transmission mount plate to the spindle head.

3. a. **Vert:** Tighten the drive belt in accordance with the following section.

   b. **Horiz:** Use a belt tensioning tool to tighten the drive belts. Do not over tighten.

4. Set the spindle orientation ("Spindle Orientation" section).

NOTE: The following step is necessary only if the spindle or transmission was exchanged prior to belt replacement.

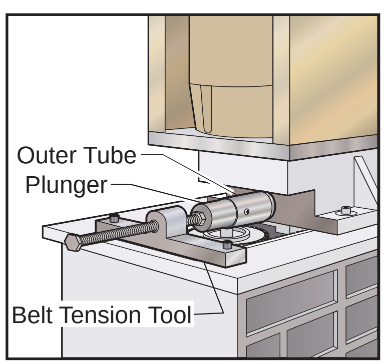
5. Double-check the spindle sweep to assure that nothing has moved during the previous steps. If sweep is within tolerance, continue; if not, sweep must be readjusted.

NOTE: Drive belt tension must be adjusted after every installation.

Drive Belt Tensioning (Vert & EC-Series)

NOTE: The drive belt tension should be adjusted after every service on the transmission or spindle of the machine. Information placed in parentheses applies to Direct Drive machines.

1. Turn the machine On. Jog the spindle head down to a level that will allow easy access to the drive belt.
2. Remove the cover panels from the head stock area as shown in "Head Covers Removal/Installation".
3. Remove the tool release piston assembly in accordance with "Spindle TRP Removal".
4. Loosen the six (four) SHCS holding the transmission (motor mounting plate) to the spindle head casting. Ensure the transmission (motor) is broken free by moving it slightly by hand.
5. Set the belt tension tool in place. Mount it to the head casting by inserting the two SHCS into the two front TRP mounting holes. Tighten the SHCS finger tight. Turn the handle until the tool is flat against the transmission casting (motor mounting plate). Ensure the transmission (motor) is straight, and not cocked, before tensioning belt.



Belt Tension Tool

6. Turn the handle until the edge of the tool's plunger and the outer tube are flush, and then 1/2 turn more. This will set the belt at the proper tension.

NOTE: A belt that is correctly tensioned will whine slightly, and requires approximately 12 hours of break-in time.

7. Check if the belt is too loose or too tight. If the belt is set too tight, the belt will whine excessively when the assembly is at speed; and if it is set too loose, it will vibrate during accelerations and decelerations.

8. With the tool still in place, tighten the six (four) SHCS holding the transmission (motor mounting plate) to the spindle head casting.

9. Loosen the two SHCS and remove the belt tension tool.

30K Spindle

There are two types of belts (3 rib and 4 rib) used on the 30K Spindle Drive. To ensure maximum performance, the spindle drive belt should be checked for proper tension every 6 months or 1000 hours of operation. The tension is measured using a Gates Sonic Tension Meter, model number 505C or 507C (used for all belt tension measurements).

The following table displays the proper lb_f (pounds force)/Hz tension readings.

Belt	New Belt		Used Belt	
Number of Ribs	Minimum	Maximum	Minimum	Maximum
3 Rib	53.7 lb_f 174 Hz	57.6 lb_f 180 Hz	46.2 lb_f 161 Hz	50.1 lb_f 167 Hz
4 Rib	60.8 lb_f 159 Hz	64.8 lb_f 165 Hz	52.0 lb_f 148 Hz	56.4 lb_f 154 Hz

NOTE: Specific settings must be entered into the tension meter to obtain a correct tension reading, and are listed below. The Gates Sonic Tension Meter is capable of retaining 10 to 20 separate combinations of settings depending upon model. Be sure that you are on the correct belt drive storage register before taking a reading.

Setting for 3 rib belt: Weight 13.1, Width 3, Span 225
Setting for 4 rib belt: Weight 13.1, Width 4, Span 225

SPINDLE BELT TENSIONING (OM-1A/OM-2A)

The spindle belt tension is measured using a Gates Sonic Tension Meter, model number 505C or 507C.

1. Place the Gates Sonic Tension Meter in Setting #1.

2. Place the meter's sensor within 3/8" of the belt, and pluck the belt like a guitar string, taking care that the sensor does not touch the belt.

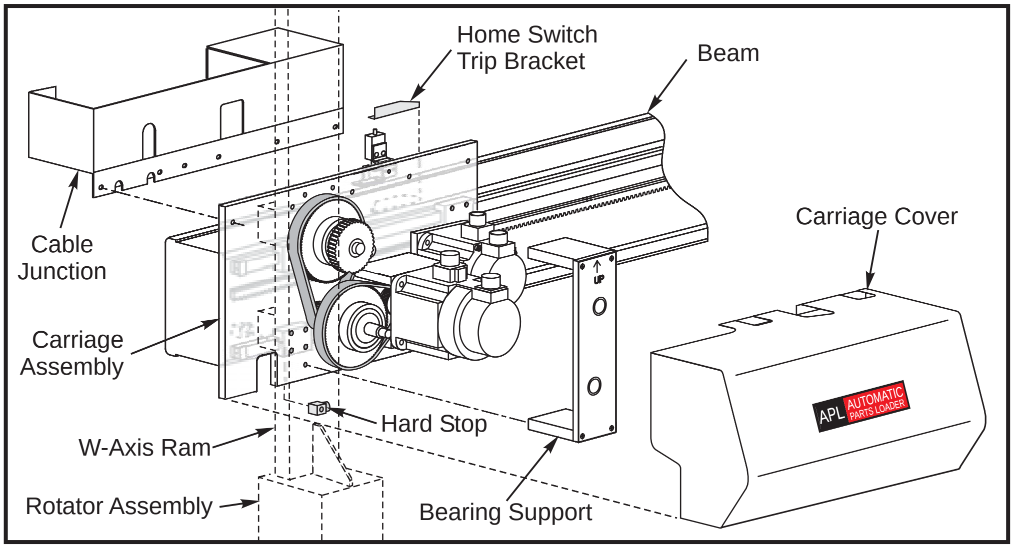
3. Set belt tension for the Office Mill 30,000 RPM spindle at 43# to 47#.

4. Torque spindle motor fasteners to 30 ft-lb.

APL MOTOR BELT REPLACEMENT

W-Axis Motor Belt Replacement

A lathe's W-axis motor belts control the raising and lowering of the APL arm. The following instructions are to service the belts in case a belt is in need of replacement. It is recommended to replace both belts at a time.

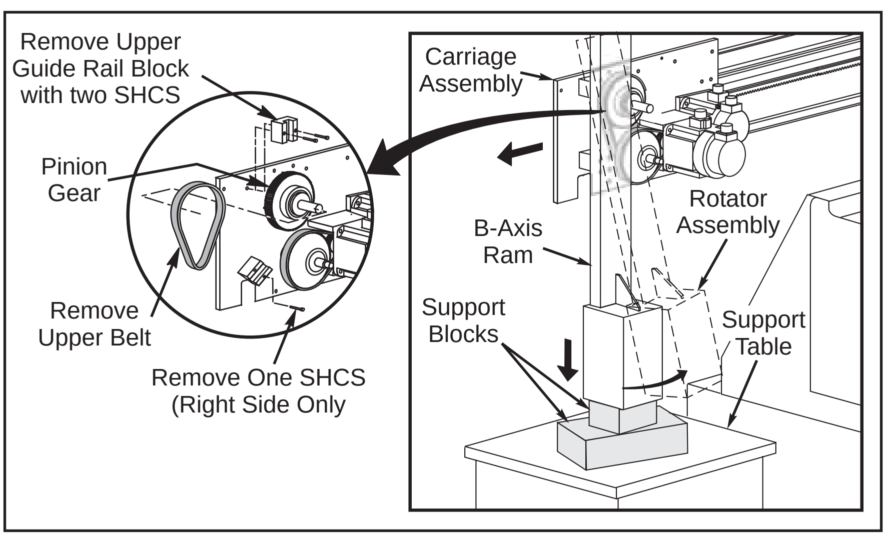


Replacing the Belt(s)

1. Jog the APL U-axis as far to the left of the machine as possible and disable the axis by selecting Parameter 354 and changing the bit value from 0 to 1.
2. Remove the hard stop and home switch trip bracket, remove the APL carriage cover, and press E-Stop.
3. Manually push the carriage away from the machine until the two metal linear rail guide pads (held by 2 bolts each) are exposed. The entire arm assembly has to clear the table.

NOTE: Only push as far as needed to be able to access the four bolts on the two guide rail blocks.

4. Using a sufficient block (which will have to be taller than the parts table) jog the APL down and support the bottom of the rotating head.



5. Remove the top linear rail guide block (2 bolts) which will drop down to the bottom block. **Only remove the inside bolt on the bottom linear guide block.** The remaining bolt (outside) on the bottom guide block should only be loose.
6. Remove the bearing support bracket and position the ram outwards so that there is sufficient clearance to remove the pinon gear which will yield access to the rear motor belt.

7. Loosen the W-axis motor support housing so that there is enough slack to position the belt. After the belts have been installed, replace the pinion gear and bearing support. Torque the W-axis motor bolts to 30 ft-lb, swing the arm back into place, and re-install the linear guide pads. Leave the bolts loose to jog the ram up, use a level to make sure the arm is straight, then torque the bolts.

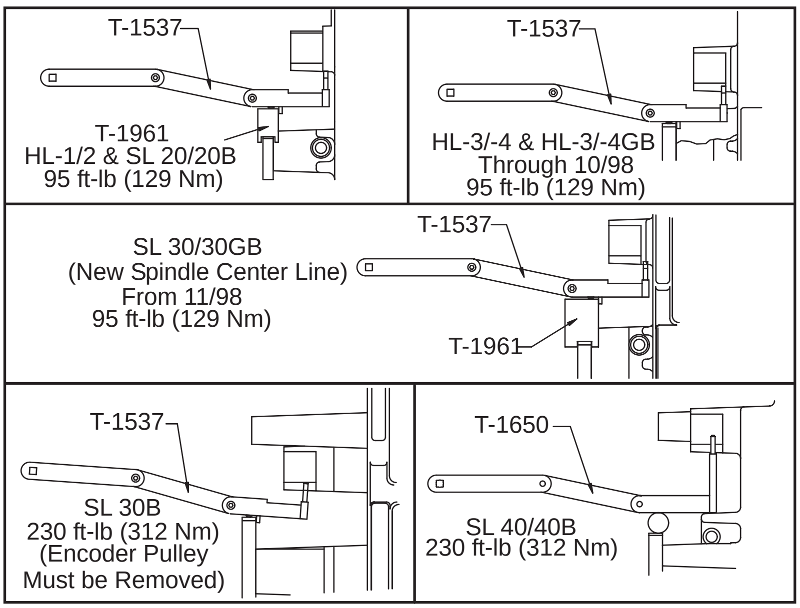
8 Manually push the APL back past the home switch plate to the center of the parts table, Zero Return the W-axis, re-fasten the rubber stop and home plate on the beam.

9. Re-enable the U-axis by changing the bit in Parameter 354 and Zero Return the axis.

10. Finally, re-check the offsets for the U- and W-axis.

Verifying Belt Tension (Lathe)

1. Apply proper tension to belts by wedging the T-shaped belt tensioner tool underneath the spindle head casting web, between the spindle head pulleys and motor/gearbox pulleys and the motor/gearbox mounting plate. Attach the 1/2" drive torque wrench to tensioner tool and apply required torque value. The path of the applied torque should be inline with the motor assembly. A belt tensioning chart follows.



2. While applying correct torque amount, tighten the four mounting motor/gearbox plate bolts.

CAUTION! This procedure should be performed with two service persons; one to apply torque, the other to tighten bolts.

3. Use a Gates Sonic Tension Meter to measure the belt tension.

4. Mount the encoder onto the spindle housing below the spindle shaft with four mounting bolts.

5. Place the 3/8" timing belt on the spindle pulley, with the other end on the encoder pulley.

6. Align and attach the hydraulic cylinder adapter onto the spindle shaft with the mounting bolts. Tolerance on the face of the adapter plate perpendicular to centerline should be within .001". Check tolerance of large I.D. bore circular to within .001".

7. Slide the hydraulic cylinder into spindle shaft. Insert and snug the mounting bolts.

8. Attach and clamp the oil drain hose and coolant drain hose onto hydraulic cylinder. Attach and screw in clamp and unclamp hoses.

9. Set magnetic base on top of the spindle housing with indicator touching the top of the hydraulic cylinder.
10. Replace all previously removed sheet metal.

Sub-spindle Motor Belt Replacement

1. Remove all sheet metal covering the sub-spindle motor.
2. Remove the chuck and unhook the hoses to the union.
3. Disconnect the electrical wiring to the encoder.
4. Loosen the set screw that holds the encoder to the motor shaft.
5. Remove the screw that holds the encoder bracket to the motor.
6. Loosen but do not remove the four sub-spindle motor mounting bolts.
7. Remove and replace the motor belt.
8. Reassemble in reverse steps to remove. Make sure the motor wiring is connected and secured properly.

Spindles

Operation

Spindle speed functions are controlled primarily by the **S** address code. The **S** address specifies RPM in integer values from 1 to maximum spindle speed (Parameter 131).

Mills: Speeds from S1 to the Parameter 142 value will automatically select low gear, and speeds above Parameter 142 will select high gear. Two **M** codes, M41 and M42 can be used to override the gear selection; M41 for low gear and M42 for high gear.

Lathes: The gear box position (low or High gear) must be commanded.

If there is no gear box, gear box commands are disabled by parameters and always in high gear.

15K & 50 Taper Spindles

Non-Serviceable, Anti-Rotation Drawbar

The drawbar and the spindle are not serviceable as separate items on the 15K spindle. The 15K spindle uses an extra high clamp drawbar and may be used in both TSC and non-TSC applications. If there is a need to replace the spindle or the drawbar, the entire spindle must be replaced.

NOTE: The spindle and drawbar are balanced at the factory as a matched assembly.

The anti-rotation drawbar does not allow the drawbar to turn in the spindle shaft. By not changing the position of the drawbar, changes in vibration output of the spindle are minimized. The balance is also retained when the drawbar does not turn.

Oil Flow

The specification for oil flow is 0.15 - 0.18cc per 0.5 hour when measured from the spindle restrictor with no airflow. This oil flow is measured on each machine. The flow rate is adjusted by changing the restrictor used and by changing the total output of the pump. The pump nominally puts out 3cc per 0.5 hour. The pump has a 0.5 hour cycle time. The pump runs only when the spindle is running or one of the axes is moving. Different sized restrictors are used to control flow. They are numbered according to their size, for example, a 3/0 restrictor has twice the flow of a 4/0, which has twice the flow of a 5/0 restrictor.

Stalling/Low Torque

Generally, complaints of stalling or low torque relate to incorrect tooling or machining practices. A spindle that is seizing will yield a poor finish machining, run very hot and very loud. Investigate machining problems before concluding the problem exists with the spindle or spindle drive.

Spindle Drive

Low line voltage may prevent the spindle from accelerating properly. If the spindle takes a long time to accelerate, slows down, or stays at a speed below the commanded speed with the load meter at full load, the spindle drive and motor are overloaded. High load, low voltage, or too fast accel/decel can cause this problem.

A resistor bank (regen resistors) located on the top of the control cabinet is used by the spindle drive to dissipate excess power caused by the regenerative effects of decelerating the spindle motor. If the spindle motor is repeatedly accelerated and decelerated in rapid succession, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat.

If the regen load resistors are not connected or open, it may result in an overvoltage alarm. A functional resistor will have a reading of 8 ohms.The overvoltage occurs because the regenerative energy being absorbed from the motor while decelerating is turned into voltage by the spindle drive. If this problem occurs, the possible fixes are to slow the decel rate or reduce the frequency of spindle speed changes.

Spindle Troubleshooting

Haas Automation does not honor warranty requests for gearbox or spindles without vibration analyzer signatures.

Not Turning

Spindle not turning

• Check machine parameters.

• If there are any alarms, refer to "Alarms" section.

• Check that the spindle turns freely when machine is off.

• If motor turns but spindle does not, see the "Belt Replacement and Tensioning" and "Spindle Motor and Transmission".

• Command spindle to turn at 1800 RPM (mills) and check spindle drive display. If display blinks “bb”, check spindle orientation switch.

• If spindle drive does not light the Run LED, check forward/reverse commands from I/O PCB.

• If spindle is still not turning, replace MOCON PCB.

• If spindle is still not turning, replace spindle drive.

• Check for gearbox or motor rotation (if applicable). If the motor or gearbox operates, check the drive belt.

• Disconnect the drive belt (mills). If the spindle will not turn, it is seized and must be replaced.

• Check wye/delta switch, if equipped, for proper operation.

NOTE: Before installing a replacement spindle, the cause of the previous failure must be determined.

Noise

Check the tooling (mills); balanced tooling will run smoother; possibly reducing the noise.

In-Line: Check for misalignment between the motor and the spindle. If misalignment is noted, loosen the motor mounting bolts, run the spindle at 1000 RPM, and then tighten the mounting bolts.

Remove the coolant union and run the spindle, if the spindle is quieter, the coolant union may need replacing.

Excessive noise coming from the spindle head area

Most noises attributed to the spindle actually lie in the motor/gearbox or drive belt of a machine. Isolate the sources of noise as follows:

Determine if the noise is related to the RPM of the motor or the RPM of the spindle. For example: if the noise appears at 2000 RPM in high gear (40T and 50T), listen for similar noise at 500 RPM (40T) or 620 RPM (50T) in low gear. If the same noise is heard, the problem lies with the gearbox. If the noise disappears, the problem could be either the gearbox or spindle, and further testing is necessary.

NOTE: 40 Taper gear ratio is 1:1.25 in high gear, and 3.2:1 in low gear.
50 Taper gear ratio is 1:1.02 in high gear, and 3.16:1 in low gear.

• Remove the vertical head covers or lathe left end covers and check the machine’s drive belt tension; adjust if necessary. If the belt is worn, replace the belt ("Belt Replacement and Tensioning" section).

• If the noise does not change, remove the belt and go on to the next step.

• Check the vertical machine pulleys for excessive runout (more than 0.003" axial or radial).

• Run the motor or the gearbox with the drive belt disconnected. If the noise persists, the problem lies with the gearbox/motor. If it disappears, go on to the next step.

• Check for the correct amount of lubrication to the spindle bearings in an air mist-lubricated spindle.

• If the spindle is not getting lubrication, correct the problem per the lube and air diagram at the back of this manual and replace the spindle ("Spindle Assembly" section).

• If the spindle is getting lubrication, replace the spindle ("Spindle Assembly" section).

Overheating (Mills)

When investigating complaints of overheating, a temperature probe must be used to accurately check the temperature at the top of the spindle taper. The temperature displayed on the Diagnostics page is not relevant. A machine that runs at high continuous RPM will have a much warmer spindle than a machine that runs at a lower RPM. New spindles tend to run much warmer than spindles that have already been run-in. In order to run a valid test on a new spindle, ensure that it is properly run-in. To run-in a new spindle, run program #O02020 (it will take approximately 6 hours).

NOTE: This program steps the spindle speed from 300 RPM up to 7500 RPM (or max RPM) at regular intervals of time, stop the spindle and allow it to cool to room temperature, then restart it so the temperature can be monitored.

Or use an alternate 2-hour spindle run-in program (#O02021) with the air pressure to the spindle at 30 PSI. If possible run the program overnight by changing M30 to M99 so it can repeat. Adjust spindle speed override depending on maximum spindle speed of machine: set at 50% for 5K RPM machines, 100% for 7.5K, 8K, and 10K, RPM machines; set at 120% for 12K RPM machines; set at 150% for 15K RPM machines.

If spindle temperature rises above 150°, check for correct amount of lubrication. Over lubrication is a common source of overheating. Check the oil flow carefully. In addition, ensure that the correct oil is being used, see the "Maintenance" section of the Operator manual.

Start the procedure over from the beginning. If the temperature rises above 150°F (65°C) a second time, call the Haas factory.

NOTE: Once the run-in program is complete, **reset** the air pressure (see the chart under "Checking Spindle Oil Flow" in the next section to check spindle temperature).

Tools Sticking In Spindle Taper (Mills)

This problem may occur after loading a cold tool into a hot spindle (result of thermal expansion of the toolholder inside the spindle taper). It may also occur due to heavy milling, milling with long tooling, or cuts with heavy vibration. This also is the result of thermal expansion.

If sticking only occurs during these situations, check the application to ensure proper machining techniques are used; check the feeds and speeds for the tools and material being used. If a tool is pulled out of the extractors due to a tool stuck in the taper, the unclamp switch is not adjusted correctly or is bad.

NOTE: In a proper working system the spindle will pop slightly during a tool change. This popping is normal provided it does not create flex in the double arm or the need to remove the tool with a flat-head screwdriver or mallet.

• Check the tool condition, verifying the tool taper is ground and not turned. Look for damage to the taper caused by chips in the taper or rough handling. If the tooling is suspected, try to duplicate the symptoms with new, or proven good tooling.

• Check the condition of the spindle taper. Look for damage such as deep gouges, caused by chips, damaged tooling, or tool crashing.

• Duplicate the cutting conditions under which the deflection occurs, then try to release the tool using the tool release button. If sticking is observed, the deflection is not caused by improper ATC adjustment, but is a problem in the spindle head on the machine.

• Ensure the spindle is not running too hot (150°F [65°C] or above).

• Check air supply. Max air pressure drop of 10 psi [69 kilopascals] during a tool change is allowed.

• Check drawbar height adjustment (mills).

• Does the tool tip to the spindle gauge line exceed 3.5”? If so, check machining practices.

• Are the correct pull studs being used? Are they pull studs overtorqued?

Toolholder/Spindle Fretting

Fretting is the result of movement of a toolholder in the spindle. Fretting can leave a wave pattern on the mating surfaces and will affect the fit and finish of both the toolholder and the spindle.

• If light fretting is present, check the application to ensure proper machining techniques are used; check the feeds and speeds for the tools and material being used.

• Check pullstuds for dimpling.

• Light fretting and rust may be cleaned from the toolholder with a fine scotchbrite hand pad and solvent. If scotchbrite is used, clean the toolholder and spindle taper thoroughly after use with an alcohol pad. Apply a thin coat of light oil to the taper of the toolholder. Grease the pull stud.

Spindle Lubrication System

Lubrication of the spindle bearings is supplied by and air-oil mist. Air is supplied to the machine at all times. An air valve to supply the lubrication is turned on and off automatically by the control. Oil is supplied from a lubrication oil tank at the back of the machine. This tank also supplied lubrication oil to the linear guides and ballscrews of the machine. The oil pump is turned on automatically by the control when the spindle is turning.

Absence of the air supply is detected by the control and if lost, the control automatically stops the spindle, axes motion, and shows an alarm condition. Absence of the oil supply or absence of oil pressure is also automatically detected by the control and stops the spindle, axes motion, and shows an alarm condition.

It is important to note that lubrication to the spindle is a mist of oil sent very slowly to the spindle. In addition, the mist is turned off when the spindle is not turning. Thus oil does not build up in the spindle bearings.

Checking Spindle Oil Flow

Disconnect the air/oil line to the spindle at the lube-air panel (30K 30 Taper and 15K GR-Series are disconnected at the check valve). Install a short piece of hose into the port on the regulator and place the other end into a graduated cylinder. Lower spindle air pressure regulator to 0 psi. Program a repetitive machine axis movement, **do not run the spindle** and note the amount of oil collected. The program should be allowed to run for four hours. Reset the spindle air pressure regulator to proper pressure, once completed.

NOTE: Use 5% or 25% rapid for axis movement. Moving axes faster will not change results.

The following gives the range for each type of spindle:

40 Taper (7.5K and 10K)	1.5 to 2.5cc every four hours Set spindle air pressure regulator to 17 PSI
15K 40 Taper / 12K	1.1 to 1.4cc every four hours* For GR-Series machines see below. Set spindle air pressure regulator to 20 PSI
50 Taper	1.7 to 2.1cc every 4 hours Set spindle air pressure regulator to 17 PSI

30K 30 Taper*	*Airmatic Pumps (These pumps are identified by the addition of a solenoid on top of the pump) The 30K 30 taper and the GR series 15K or higher spindle use this type of pump. Set spindle air pressure regulator to 25 PSI for 30K spindles and 20 PSI for 15K.
Lathes	1.0cc every two hours for the lathe.

*Airmatic Pumps

Disconnect the air/oil line at the check valve. Manually energize the solenoid 30 times, holding it for 2 seconds each time.

Each pulse from the pump will deliver .01cc for the 30K 30-taper, or .2cc for the GR 15K. After 30 pulses, .3cc 30K or 6cc 15K, should have been collected **per injector** (the 30K spindle has two injectors).

Spindle Assembly

Please read this section in its entirety before attempting to replace spindle.

WARNING!

The pulley is shrink-fitted to the spindle and is not field-serviceable. Any attempt to remove the pulley can damage the spindle or its components, the service warranty will be voided.

NOTE: Adjust drive belt tension after transmission or spindle service.

Spindle Replacement (Horiz & Vert)

NOTE: Vertical mills equipped with a 15K Spindle must remove the spindle and drawbar as a unit. Do not remove the drawbar separately.

Removal

1. Ensure the machine is OFF, and remove the spindle head cover/panels.

2. Put the tool into the spindle and remove any covers necessary to access the spindle.

3. Remove the tool release piston assembly in accordance with appropriate section and remove the spindle drive belt from the spindle pulley. It is not possible to completely remove the belt at this time.

4. Drawbars are held in the spindle shaft by a spiral ring (newer assemblies). **30K spindles:** The drawbar is not serviceable. Remove the spiral ring with a small screwdriver. Wedge the tip of the screwdriver to take out one end of the ring from the shaft groove. Force the ring end to stay open and simultaneously rotate the screwdriver all the way around so the entire ring comes out of the groove.

5. Put the tool release piston on and remove the tool. First disconnect the oil line from the fitting at the oil injection cover, then remove the brass fitting.

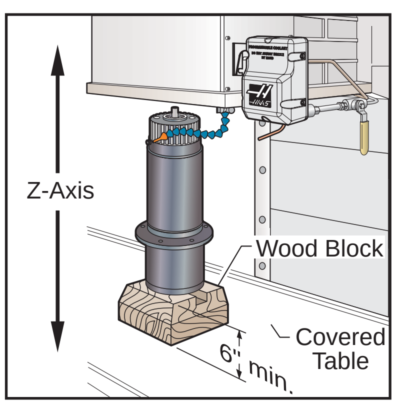
NOTE: When replacing a new design spindle in any vertical machine, it is important to note that the cavity between the housing and the spindle cartridge will be filled with either oil or grease. An oil filled spindle is identified by the oil fill hole to the left side of the spindle head near the spindle bore as viewed from above.

6. Ensure oil plug is inserted into oil injection port of spindle before removing spindle, or oil may spill into the spindle cartridge. The plug should fit flush with the spindle sides, if not, use tape to cover the hole.

7. **In-line drive and 30K spindles:** Remove the hose and oil fitting on the spindle and plug the oil-fitting hole(s) with the set screws from the new spindle.

8. Remove the spindle drive belt from the spindle pulley.

9. With 5/16" hex wrench, loosen the six SHCS that hold the spindle to the underside of the head casting approximately 2 turns.



Position Wood Block Under Spindle

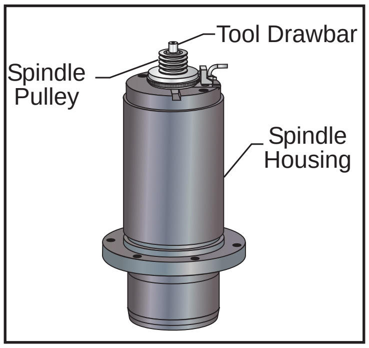
10. **Vert**: Put a wood block (minimum 6" thick) on the table directly under the spindle to help support the spindle. Slowly jog the spindle head down until the spindle rests on the block.

12. Remove the 6 bolts from the spindle.

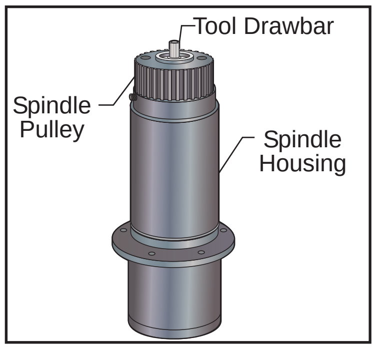
13. **Vert**: Jog the Z-axis up slowlyuntil it is completely free of the casting.
Horiz: Slide the spindle out of the casting.

    In-line drive: Remove spider coupling and transfer tube from the spindle or motor. Check these two components for any irregularities, and replace if needed.

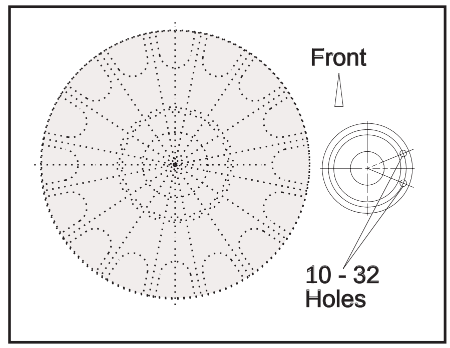
Installation



30K Spindle Cartridge



Vertical Spindle Cartridge

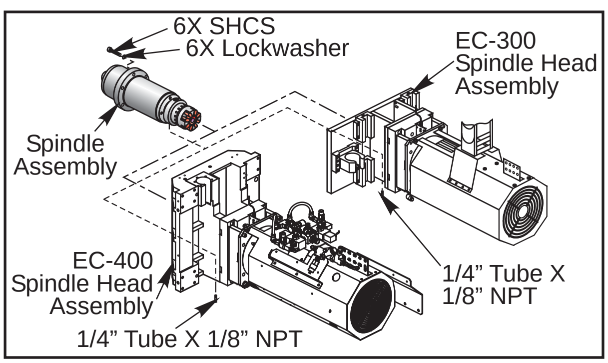


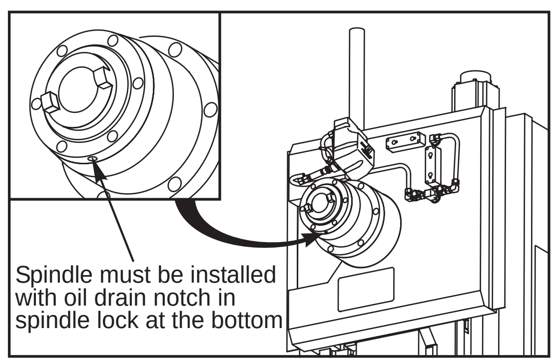
Underside View of Vertical Spindle Cartridge

In-line drive: Loosen the motor mounting plate bolts (4 bolts), and loosen the motor mounting bolts under the plate (4 bolts).

1. Thoroughly clean all mating surfaces of both the cartridge and the head casting, and lightly stone (if necessary) to remove burrs or high spots.

2. Mount the new spindle to the block. **HORIZ only:** Carefully install the new spindle into the bored sleeve of the head casting. Apply grease to the inside of the through bore in the spindle head. **The oil drain hole must point down**. Failure to do so causes the spindle to overheat, fail, and voids the warranty.





HORIZ only: Evenly tighten the six mounting SHCS on the front side of the spindle in a cross pattern until all bolts are completely tight.

HORIZ only: Reset spindle orientation and check the tool changer adjustment.

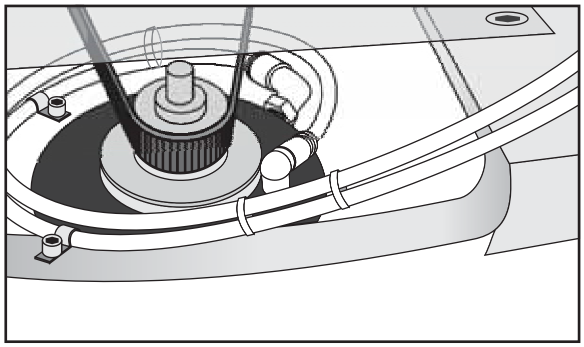
HORIZ only: Refer to "Spindle Troubleshooting - Overheating" and use the spindle run-in program. Verify that the spindle temperatures are acceptable.

3. Align the two 10-32 holes located on the spindle lock so they are approximately 90° from the front of the spindle on the right side. **In-line drive:** Install set screw plug into the oil fitting. This will prevent contamination to the bearings. Put grease on the O-ring of the transfer tube and install the transfer tube on the new spindle. Install the spider coupling on spindle. Orient the motor and spindle couplers.

4. Slowly jog the Z-axis down until the top portion of the spindle is inside the head casting. At this point, align spindle to the spindle bore. While performing this operation, you must make sure the spindle cartridge is straight to the spindle bore. If the spindle moves to one side, use a rubber mallet and/or the axes to align it. The spindle should slide into the casting easily. If not, check your alignment. Do not force it!

5. Install the spindle bolts and torque to 50 ft-lb.

6. **Vert:** Re-attach the brass fitting to the oil injection cover and connect the oil line to the fitting. Fill the cavity between the housing and the spindle cartridge with Mobil Vactra 2 oil. The oil fill hole is to the left side of the spindle head near the spindle bore, as viewed from the top.



30K Spindle Quick Disconnect Fittings to Oil Injection Cover

CAUTION! Do not overtighten the fittings on the oil injection cover. Overtightening may damage the spindle cartridge.

NOTE: If replacing copper tubing to spindle, clean out with filtered air.

7. **In-line drive:** Take the spindle sweep on the table and shim if needed. Loosen the spindle bolts again just for spindle and motor alignment. Remove set screw plug, install oil fitting, and connect the hose. Do not overtighten fittings.

8. **In-line drive:** Command the spindle to 300 RPM. Carefully tighten the motor bolts, and the motor mounting bolt under the motor plate (80 ft-lb). Tighten the spindle bolts evenly to 50 ft-lb. Stop spindle and check by hand for binding. If there is no binding, refill spindle orifice with Vactra Oil #2.

WARNING:

Never pour oil into the spindle housing. **If binding is felt, loosen the motor mount bolts and go back to step 7.**

9. **Vert:** Reinstall the drive belt and adjust the tension. Reinstall the tool release piston assembly.

10. **Vert:** Remove the tool release piston. Carefully install the spiral ring on the spindle shaft. Feed one end of the spiral ring into the shaft groove. Rotate the ring until the entire ring is in the groove. Check the spindle sweep and clamp/unclamp switch adjustment.

11. **In-line drive:** Verify the spindle air/oil regulator is set to 20 psi.

12. In MDI, write a program to move the machine axis at 5 inches per minute.

13. a. **In-line drive:** Disconnect the oil fitting from the air/oil mixer that feeds directly to the spindle. Use a graduated cylinder to verify the correct amount of oil is getting to the spindle (1.1cc to 1.4cc per 4 hours). If necessary, change restrictors to change oil flow. Do not adjust oil pump volume. If any changes are made, run the test again.

b. **Vert:** Check for correct amount of lubrication to the spindle bearings (0.5-1.0cc every two hours) in an air mist-lubricated spindle.

- If the spindle is not getting lubrication, correct the problem and replace the spindle.
- If the spindle is getting lubrication, replace the spindle.

NOTE: Refer to the appropriate sections and check the spindle orientation and ATC alignment.

14. **In-line drive:** Check drawbar and adjust the tool clamp/unclamp limit switches.

EC-630 Geared Head Replacement

1. Remove pallet from the load station. Workholding can remain on this pallet. Install the geared head service fixture and pallet to the load station.

2. Use a crane or forklift to lift the pallet and fixture assembly into the pallet load station and lower into position. Orient the slide assembly so that it is parallel to the pallet changer door (Perpendicular to the spindle centerline).

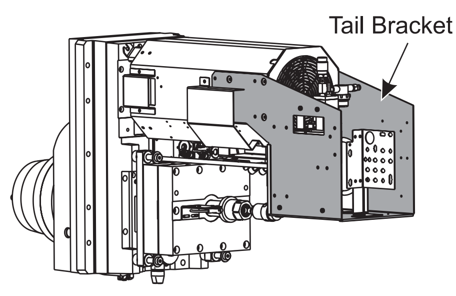
3. Command a pallet change to bring the service fixture into the machine.

4. Remove the screws holding the lower way cover to the spindle head. Disconnect the coolant lines and fittings. Remove the coolant ring from the spindle. Disconnect the P-Cool control and coolant lines, but leave the unit attached to the sheetmetal.

5. The upper way cover is held to the spindle head cover with clips behind the way cover. Remove these clips, lift the way cover and support with a 2" X 4" piece of wood to allow removal of the spindle cover screws. Remove the spindle cover.

6. Jog the Y-axis to the top of its travel and secure with a 4" X 4" wooden beam of suitable length. If necessary, lower the Y-axis enough to allow the spindle head to rest on the block. This is to prevent the spindle from falling if the brake fails while power is off.

7. Power off the machine and lock out the circuit breaker.



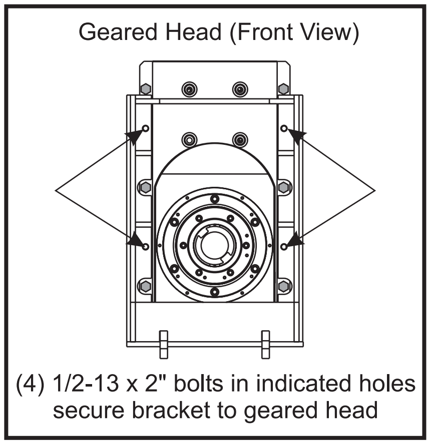
EC-630 Geared Head (Rear View)

8. At the rear of the spindle assembly, remove the tail bracket and disconnect all lines (electrical, air, lubricant, coolant) that run from the tail bracket to the spindle assembly. Label cables and lines if necessary for reconnection to the new spindle. Plug the 3/4" air line. Put an insulating cover on each motor head.

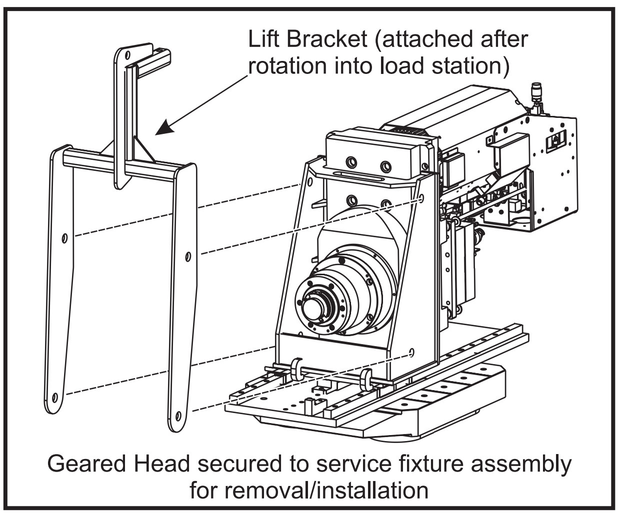
9. On the I/O board inside the control cabinet, remove the connector on P3 and replace with a tool changer jumper (33-8521). Remove the connector on P15 and replace with a spindle status jumper (33-8668A). install an encoder jumper, TRP unclamp jumper, motor overheat jumper, and disable GB in Parameter 209. This will allow axis motion while the spindle is disconnected.

10. Power the machine back on and clear any alarms. Remove the wood blocking the Y-axis and jog down until even with the spindle removal bracket.

11. Jog the Z-axis toward the spindle to give the slide fixture sufficient clearance to rotate and jog the A-axis to -90 degrees.



12. Jog the Z-axis to bring the slide fixture up to the geared head. Slide the spindle removal bracket against the geared head casting and lock in place with the T-pin. Jog the Z- and Y- axes to align the bolt holes on the geared head module and the bracket. Use the four 1/2-13 x 2" bolts supplied to secure the bracket to the spindle. Remove the six bolts through the notches in the bracket. Remove the T-pin and slide the spindle back. Remove any shims and note their locations. Note that wires have very little clearance. Move the geared head out slowly and push wires into a safe position.



13. Slide the geared head back to the extent of the slide fixture's travel and lock with the T-pin. Jog the Z-axis back far enough to zero the A-axis, then zero the Z-axis.

14. Command a pallet change to bring the geared head to the pallet load station. Remove the T-pin and slide the geared head to the left for easier access to install the lifting bracket. Attach the lifting bracket to the geared head bracket with the lift arm pointed toward the rear of the spindle. Secure the bracket with slide pins and cotter pins. Slide the geared head back and lock with the T-pin.

15. Remove the four bolts holding the geared head bracket to the fixture slide. Using a crane or forklift, carefully lift the geared head out of the pallet load station. Set the geared head down on the pallet that the service fixture was shipped in, and secure it to the pallet using four 1/2-13 x 1" bolts. Remove the lifting bracket.

16. While the new geared head is out of the machine, install the TSC union. Remove the screws holding the geared head connector bracket. This will simplify installation of the tail bracket when the geared head is installed. Leave the bracket at the rear of the assembly. Do not disconnect any cables at the bracket.

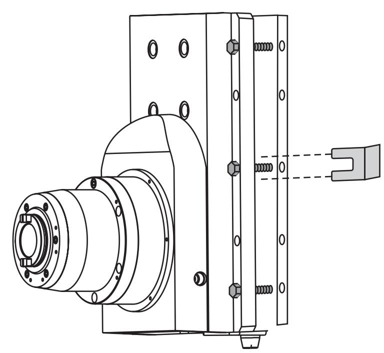
17. Attach the lifting bracket to the new geared head. Lift the assembly into the pallet load station, orienting the geared head to the right. Secure the bracket to the slide with four bolts and make sure the T-pin is locked. Remove the lifting bracket.

18. Command a pallet change. Jog the Z-axis forward for sufficient clearance and jog the A-axis to -90 degrees. Jog the Z-axis toward the machine column. Remove the T-pin and slide the geared head into the column, jogging the axes as necessary to align the geared head bolt holes and square the geared head to the column.

NOTE: Take care to ensure the spindle is square with the column, especially if the machine was involved in a crash. Do not attempt to use the bolts to square the spindle; this will lead to stripped bolts and holes. Use only the axes to square the spindle.

19. Once the geared head is square against the column, install bolts through the notches in the geared head bracket. Clean the shims and place where noted previously, then tighten the mounting bolts. Remove the bolts holding the bracket to the geared head.

20. Jog the Y-axis to the top of its travel, block the axis with the 4" X 4" beam and power off the machine. Reinstall the tail bracket. Reconnect geared head electrical cables, control cables and coolant lines. Remove the jumpers from the I/O control board and replace the appropriate cable connectors. Power on the machine.



Shim Placement Example

21. Perform a spindle sweep using a precision test bar and a .0005" indicator. Shim geared head if necessary.

22. Reinstall sheetmetal spindle cover, way covers, coolant fittings and coolant lines at the front of the spindle.

23. Command a pallet change and remove the pallet and service fixture slide assembly through the pallet load station door. Place the fixture on the pallet that the new geared head shipped in, and secure with four bolts.

Setting the Drawbar Height

Drawbar height must be set properly before adjusting switches. Add or subtract shim washers to the tool release piston until proper height is achieved (see “Setting TRP Height”).

Vertical Machines

1. Power on the mill and set the TRP air pressure regulator to 40 PSI.
2. **Vert**: Place a sheet of paper on the mill table under the spindle for protection, then place an aluminum block (approx. 4” x 4” x 4”) on the paper. **Horiz**: Set up a fixture with a loosey clamped block on the pallet.
3. Insert an empty toolholder into the spindle.
4. Jog the spindle so that the toolholder is approximately .03” from the block.
5. Set clearance from the block to the toolholder to zero. Do this by pressing Tool Release and jogging the Z-axis with the jog speed set to .001". Move the axis, then press Tool Release while feeling for movement on the toolholder. Feel between the toolholder and the spindle. Repeat this process until no movement is felt.

6. Change the jog speed to .01 and jog the Z-axis to .060" from the block.
7. Press and hold the Tool Release button. Try to move the block. The block should be tight at .050" and loose at .060". If it can be moved at .050", jog the Z-axis towards the block one increment at a time until it is tight. If it is tight at .060", jog the Z-axis away one increment at a time until it is loose.
8. The number of increments jogged are the number of shims to add or remove. If the block was tight at .060", remove shim washers. If the block was loose at .050", add shim washers. See the "TRP Switch Adjustment" section.

TRP Unclamp Switch

Use the same set-up as the previous instructions.

1. Using an empty toolholder in the spindle, and the jog speed set to .001", jog the Z-axis until it has pinched the aluminum block against the table or fixture, then jog away up .030".
2. Bolts holding the lower switch must be loose so the switch can move for proper adjustment.
3. Go to the Discrete Inputs page on the control and find the input, "Drawbar Open".
4. Press and hold the Tool Release button. Slide the switch toward the piston until the switch trips. The input "Drawbar Open" should read "1". Tighten the screws that secure the switch.
5. Release the Tool Release button and verify that the switch trips (Drawbar Open = 1) at .030" from the block and not tripped (Drawbar Open = 0) at .020" from the block.

TRP Clamp Switch

Loosen the mounting screws and push the switch in slowly until it trips (Drawbar Closed = 1). Tighten the bolts to secure the switch.

Set TRP air pressure regulator to 50 PSI after the TRP drawbar height and switches have been set. Perform a spindle run-in before machining.

Run-in Programs

Perform the Spindle Run-in Program: Run program O02023. As the spindle is running, check for proper oil flow. Periodically check the temperature of the spindle. Stop the program if the spindle begins to overheat.

CAUTION! **30K only**: Never run the spindle without a toolholder in the spindle. Running the spindle without a toolholder will damage the spindle.

Belt Driven Spindles: The belt may whip during acceleration and deceleration but should not when a constant speed has been reached. Check the behavior of the belt at different speeds, throughout the RPM range. If the belt whips while at a constant RPM, adjust the belt tension.

Office Mill Spindle Run-in

NSK Spindle: The spindle run-in program must be run prior to machine use and especially at the time of installation. Failure to run this program can result in spindle over heating and spindle failure. The run-in will distribute grease which may have settled in the bearings during shipping. The program is #O02027 (SPINDLE RUN-IN) and will take approximately fifty (50) minutes to run. During this time, verify spindle rotation. The spindle should be checked periodically for spindle temperature rise. If the temperature rises above 140°F, restart the program from the beginning. If the temperature again rises above 140°F, contact your dealer.

NOTE: **Do not** tighten the collet without mounting a tool or "dummy bar" as this will damage the collet, spindle, and collet nut.

40K, ISO20 Spindle: The spindle run-in program must be run prior to any machining use (especially upon installation or after any transportation). Failure to run this program can result in spindle over heating and spindle failure. The run-in will distribute grease which may have settled in the bearings during shipping. The program is #O02025 (SPINDLE RUN-IN) and will take approximately six (6) hours to run. During this time, verify spindle rotation.

IMPORTANT: A balanced ISO20 toolholder must be in the spindle during run-in and/or warm-up.

Drawbar Replacement

Removal

In-Line spindles: Should a spindle fail, both the spindle and drawbar are to be replaced as a unit. If the drawbar fails, it is not necessary to replace the spindle. However, the drawbar is replaceable on the 8K spindle, not on the 12K spindle.

NOTE: 15K Spindles: The spindle and drawbar must be removed as a unit. Do not remove the drawbar separately.

1. Place an empty toolholder in the spindle.

   In-line: Remove motor.

2. Remove the necessary covers to access the spindle.
3. Remove the TRP. **In-line:** Remove the key from the drawbar and remove from spindle.
4. Remove the snap ring from the top of the spindle shaft.

   50 taper: Remove the TSC extension tube if the machine is equipped with the TSC option. Refer to the “Spindle TRP Removal” section.

5. Reinstall the TRP. Remove the toolholder from the spindle, then remove the TRP again.

   50 taper: Remove six bolts holding the spindle cap to the machine and remove the drawbar.

   40 taper: Remove bolts from the transmission and use 2” x 4” blocks of wood, placed underneath the front of the transmission housing, to keep it from falling forward. Angle the transmission back and remove the drawbar from the spindle.

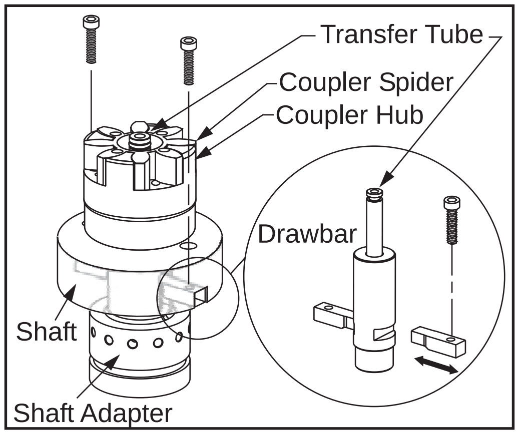
NOTE: Direct drive machines do not require movement of the drive assembly to access/remove the drawbar.

Installation

6. Thoroughly coat the replacement drawbar with grease, including the end of the shaft where the four holding balls are located.

CAUTION! Excess grease may cause the drawbar to hydraulic lock, preventing the full stroke of the drawbar.

7. Install the two keys, flat side up. Use a “C” clamp to press the keys together to seat them against the drawbar. Torque the 5/16-18 retaining bolts to 30 ft-lb.



Horizontal Drawbar

8. If machine is equipped with Through the Spindle Coolant option, grease the O-rings.
9. Insert four new balls (six new balls for 50 taper) in the replacement drawbar and insert into the spindle shaft. Be sure that as the shaft is installed, the balls do not fall out of the bores in the drawbar.

CAUTION! Insert drawbar so the O-rings are not damaged. Do not force it.

NOTE: Carefully inspect the spindle shaft for galling or burrs inside the spindle shaft where the end of the drawbar rides. If it is damaged, replace the spindle.

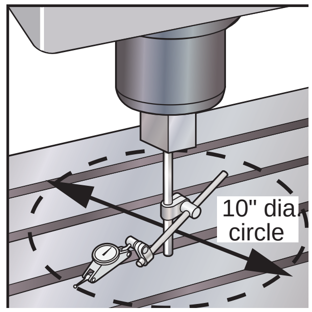
10. **40 Taper:** The tool release piston will have to be reinstalled at this time; therefore, install a toolholder with no cutter into the spindle taper. Remove the tool release piston and install the spiral ring on the spindle shaft. Reinstall the tool release piston.
11. Set the drawbar height, and clamp/unclamp switches as described in the following section. Install the drawbar and re-install the tool release piston.
12. Reinstall the sheetmetal.
13. Test-run the machine and perform necessary tool changer adjustments. Verify the operation of the spindle by running it. Run through the spindle speed range, pausing at each 1000 RPM increment. If there is excessive vibration, loosen the bolts to the spindle cartridge and spindle head. Run the spindle at 1000 RPM and snug the bolts. Stop spindle and tighten bolts.

Mill Spindle Sweep Adjustment

Vertical Mills

NOTE: The machine must be properly leveled for the spindle sweep adjustment to be accurate; no more than .0002” twist on the Y-axis (vert mill).

1. To check spindle sweep, place a .0005” indicator on a suitable holder, place on spindle nose and jog the Z-axis in the negative (-) direction enough so that you can adjust the indicator to sweep a 5" radius from the center of X- and Y-axis travel. Slowly jog Z-axis in the negative (-) direction to zero out indicator.
2. Establish a reference point (indicator zero), sweep the three remaining points and record the reading.



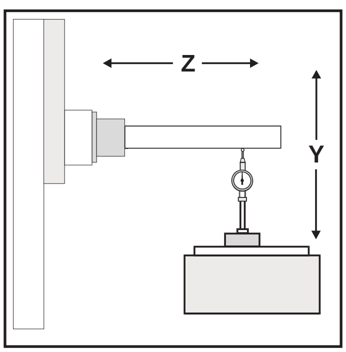
Spindle Sweep Area

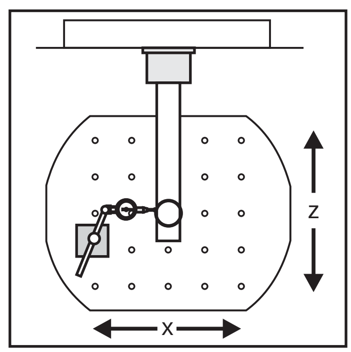
3. Shim the spindle, if necessary, to correct the spindle sweep to specifications.
4. Recheck sweep. It must be within .0005” in both X/Z and Y/Z planes, as stated in the inspection report supplied with the mill.

Horizontal Mills

NOTE: The machine must be properly leveled for the spindle sweep adjustment to be accurate.

1. Place an indicator on the table and insert a 6" precision test bar into the spindle.
2. Jog the Z-axis while indicating the bottom, then the side, of the test bar. The readings must be within 0.0005”/10" in both the Y/Z and X/Z planes, as stated in the inspection report supplied with the machine.
3. Shim the spindle, if necessary, to correct the spindle sweep to specifications. Recheck spindle sweep.





Spindle Orientation

Please read this section in its entirety before attempting to orient the spindle.
Orientation of the spindle is automatically performed for tool changes and can be programmed with M19.

1. Place the machine in low gear.
2. Adjust Parameter 257, "Spindl Orient Ofset", until the spindle dogs are parallel to the X-axis. Ensure that the dogs are within 0.030" using a dial indicator.

   For 50 taper mills with an offset tool changer: Add a 5° offset (111 encoder steps) to Parameter 257 to match the tool changer arm offset.

A, B Axis Re-Alignment (Vert)

Gimbaled head mills only - If tramming the A or B axis is necessary, sweep a 10” diameter circle on the table with a dial indicator mounted to the spindle. To select A or B axis when in the jog mode, use the shift key on the keyboard, then select A or B axis. The display will indicate which axis is enabled. It is recommended that when jogging the A and B axes, the operator use only the .0001, .0010, or .0100 increments.

The rule of thumb is that for every .001” out of position, add or subtract 100 from the appropriate parameter. This will re-calibrate the distance from the A/B axes home switch. Parameters 212 and 213 are the tool change offset parameters for the A and B-axis. These parameters also control the tram of the A and B-axis. Record the factory set values before changing parameters 212 and 213 in the event that an invalid number is entered.

When adjusting the tram, it is recommended that the same feedrate be used to home the A or B axis between checking the sweeps, this will allow the machine to repeat accurately. The A and B-axis should be trammed individually to reduce the possibility of error.

LATHE SPINDLE REMOVAL

NOTE: **Power off** the machine before performing the following procedure.

Mini Lathe (ML): Remove the door, the coolant collector from the spindle, and the left front and left side enclosure panels. Disconnect the air/oil lube lines that supply the spindle and the air closer.

NOTE: Ensure the turret and tailstock, if equipped, are in the home position.

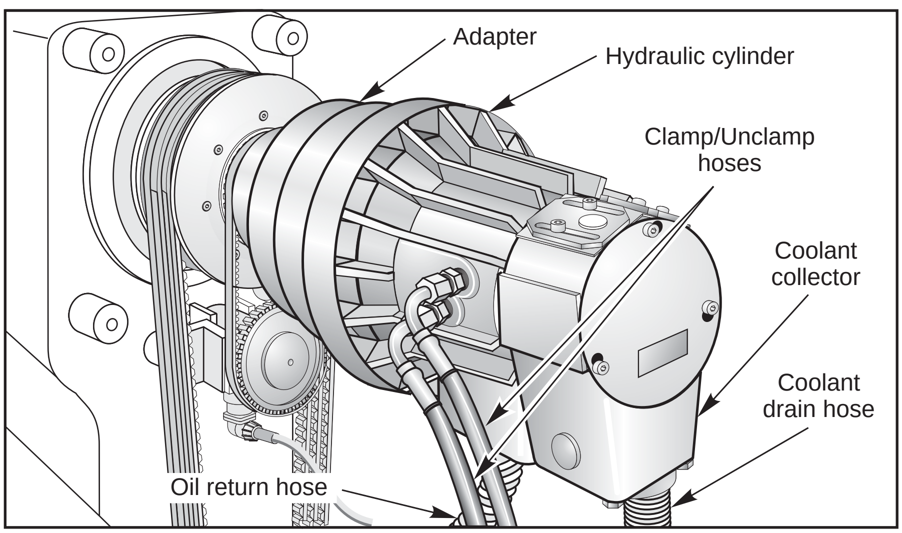
1. Remove the chuck or collet nose from the lathe and the necessary covers to gain access to the spindle assembly. **ML:** Remove the workholding device, air closer, adapter, and draw tube (by screwing it out).

   Toolroom Lathe (TL): Remove sheetmetal panel from the left side of the machine casting. This will gain access to the spindle motor and belt.

   TL: Remove the belt from the spindle pulley. To do this loosen the three bolts on the motor mounting plate (see the spindle motor removal section). Use a bottle jack to lift the motor mounting plate. This will gain slack in the belt so it can be removed from the pulley.

   ML: Remove the belt from the drive pulley. Attach a hydraulic puller to the drive sprocket.

   TL and ML: Remove the SHCS that secure the spindle front cap to the spindle housing and remove the spindle cartridge from the motor end of the spindle housing.
2. Disconnect oil return hose and coolant drain hose from the hydraulic cylinder.
3. Loosen the clamp and unclamp hoses, then remove.
4. Loosen the SHCS from the adapter, and detach the hydraulic cylinder.
5. Loosen the SHCS on the inside of adapter, and detach from spindle shaft.



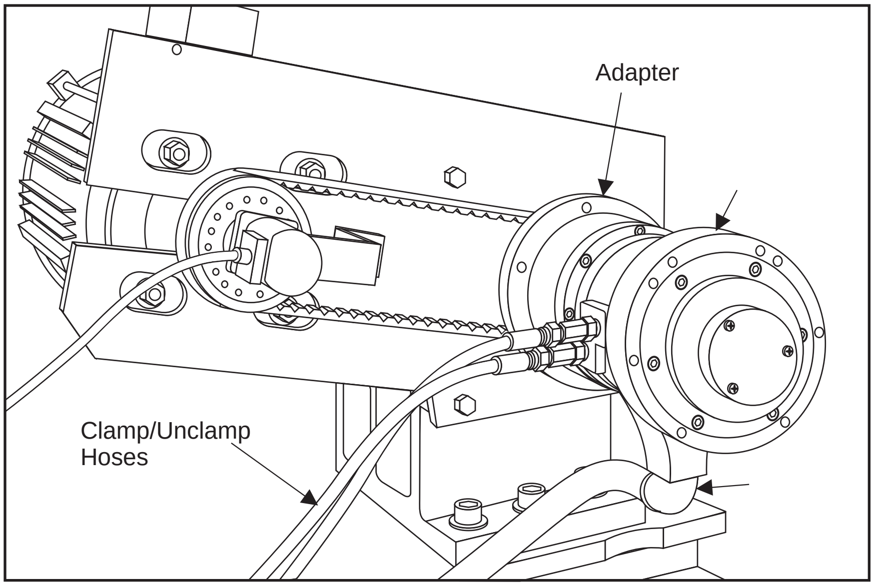
Hydraulic Cylinder

6. Loosen the four SHCS holding the spindle motor. Slide the motor up by squeezing the belts. Tighten the SHCS and remove the drive belts from the spindle assembly.
7. Unplug the encoder. Unscrew the encoder bracket, remove the encoder, then remove the belt.
8. Loosen the six SHCS and remove the spindle drive pulley.

9. Disconnect the two lubrication hoses and unscrew the fittings from the spindle housing. Note the direction of the flat sides of the fittings for lubricating the spindle bearings.

10. Unscrew SHCS holding the spindle retaining ring (located at spindle nose) and remove. Also remove o-ring.

11. Remove the spindle carefully through the machine front.

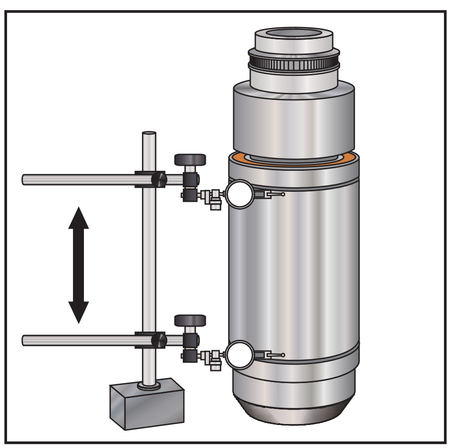


SL-10 Hydraulic Cylinder (Coolant Collector not Shown)

Spindle Installation

Tools Required: Blue Loctite, 1/2" Torque Wrench (Up to 250 ft-lb), Haas Belt Tensioning Tool P/N 93-8143 (SL 20), P/N T1537 (SL 30 and 40)

1. Inspect the new spindle once it is removed from the packaging. Check the alignment of the spacer between the two bearings. Use a dial indicator on the spacer and bearings to check the runout. Also verify the axial runout on the face of the bearing, which should not exceed .0004".

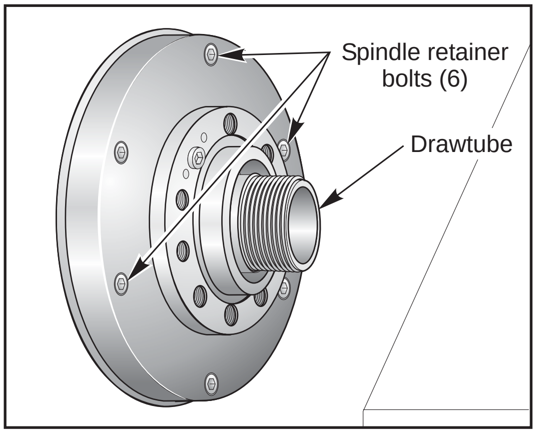


2. Install spindle into housing. Check location of oil holes for proper alignment.

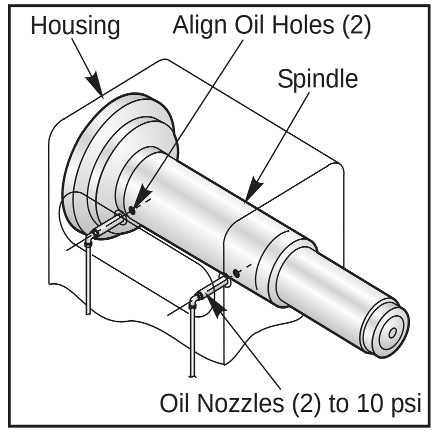
3. Place the retainer ring on the spindle with the o-ring toward the spindle. Ensure that the drain holes are at the bottom of the retainer ring and that the o-ring remains in place.

4. Apply blue Loctite to the six retainer ring mounting bolts and install them.

NOTE: The bolts should be torqued in a star pattern and in increments of 10, 20, 30,40 and finally 50 ft-lb. Check alignment of the spindle and retaining ring with a .001" shim at each torque value.



Spindle Retaining Bolts



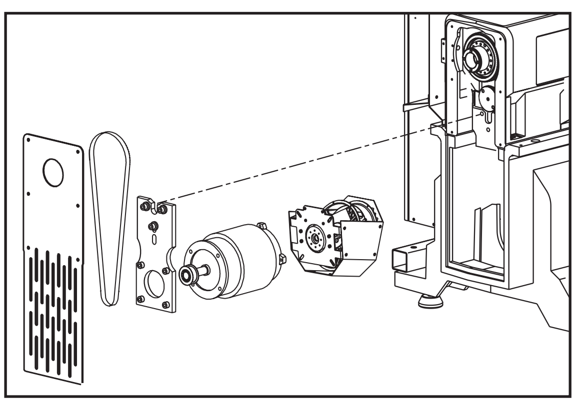
Alignment of Oil Mist Holes

5. Ensure that the spindle can spin freely and the spindle and housing oil mist holes are aligned. If not, remove the retainer ring and spindle and reinstall.
6. Screw the oil mist nozzles in by hand until they stop. Then un-screw the nozzles 1.5 - 2 turns, ensuring that the holes on the nozzles and spindle housing are aligned correctly and pointed toward the bearings. Make sure the nozzles do not come into contact with the spindle shaft.
7. Tighten the hex nut on the nozzles, ensuring the nozzles do not spin. After tightening the nuts, verify the nozzle oil mist holes are still positioned correctly, and set the oil pressure to 10 PSI.
8. Attach the two 1/4" nylon tubes onto the swivel fittings.
9. Install the spindle drive pulley and drive belts onto the spindle and motor pulleys.

See “Verifying Belt Tension (lathe)” to complete this procedure.

Toolroom Lathe Spindle Motor

Removal



NOTE: It will take two people to lower the motor mount plate, motor, and fan from the machine.

1. Remove the sheet metal panel from the left side of the machine casting.
2. Before removing the spindle motor make sure to stabilize the motor and fan assemblies.

3. Disconnect all electrical connections from the under side of the motor.
4. Remove the three SHCS from the mounting plate and remove the pulley belt.
5. Leave the mounting plate connected to the spindle motor and carefully remove the spindle motor and fan.
6. Remove the four SHCS that are connecting the mounting plate to the motor, then remove the four SHCS that are connecting the fan to the spindle motor.

Installation

NOTE: It will take two people to lift and attach the motor mount plate, motor and fan to the machine.

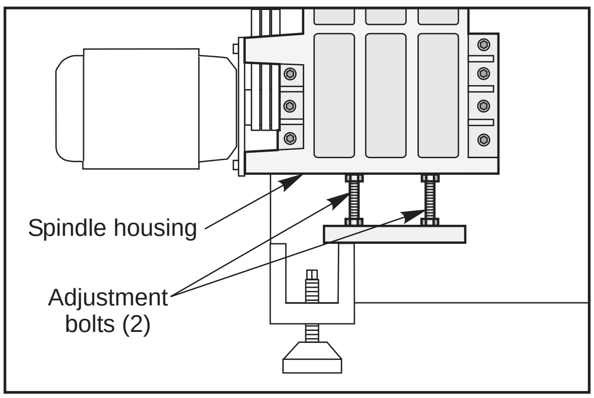
1. Attach the motor mount plate to the motor using the four SHCS, and torque the SHCS to 70 ft-lb. Attach the fan to the motor using the four SHCS.
2. Lift the mounting plate, motor and fan into place and fasten the plate to the casting using the three SHCS. Do not tighten the bolts, they should be snug enough to hold the motor in place. Install the drive belt, and check for correct tension. Tighten the three SHCS on the motor mount plate.
3. Reconnect the electrical connections on the motor, and install the sheet metal motor cover.

SPINDLE HEAD ALIGNMENT

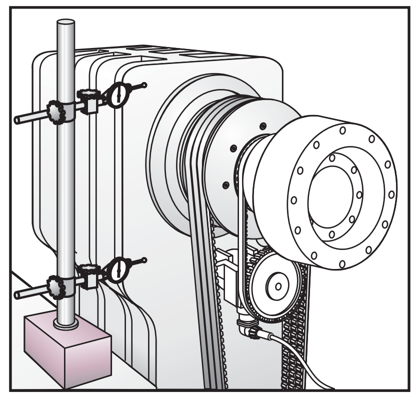
TOOLS REQUIRED: Dual Indicator Stand

Depending on lathe model, the following sheet metal pieces may need to be removed: Front left panel, front bottom panel, drain rail, front door

1. Loosen all spindle head mounting bolts. Loosen the locknuts on the two jack screws (adjustment bolts) underneath the spindle head casting, then screw them in to lower the spindle casting.
2. Bolt spindle alignment bar tool to spindle and attach a 0.0001" indicator onto the face of the turret. Jog indicator such that the indicator runs tangent to alignment bar along the Z-axis.
3. Level the spindle head assembly by adjusting the jack screws up or down and jogging the indicator along the alignment bar in the Z-axis. The tolerance reading should be .0001" within 10".



Adjustment Bolts



Indicator Setup

4. Once the spindle head assembly is level, setup dual indicators on the large magnetic base and place on the base casting to the rear. Indicate them at the machined face to maintain the spindle head level (see figure). This setup is to ensure the spindle remains parallel in the Z-axis plane while raising the spindle head. It is recommended to only turn the jackscrews a quarter turn each time so that the spindle head does not become positioned too high above the turret pocket.

NOTE: If the face of the spindle head casting is not machined, an alternate method to set up the indicators is to retract the B-axis waycover from the left side and mount the mag base to the base casting. Two indicators are then positioned on the machined surface beneath the spindle head casting.

5. Place the tenths indicator at the end of the spindle alignment bar and jog the tool turret in the Z- axis towards the spindle until the indicator rest on the inside of the tool pocket.
6. Align the tool pocket holder along the X-axis with the spindle alignment bar by rotating the spindle and sweeping the indicator 180° along the axis (Refer to the “Turrets - Turret Alignment Verification” section). Note that the toolholder alignment pins create a bump in the pocket that should be ignored.
7. Jog the turret along the X-axis until a measurement reading within .001" is indicated.

NOTE: Use the jog handle in tenths mode to zero pocket

8. Next, zero the spindle alignment at the top and bottom of the turret pocket by sweeping the indicator at those positions and adjusting the jack screws equally.
9. Rotate the spindle 180° and adjust the jackscrews until the indicator reads within a .001" at the top and bottom of pocket. Repeat Steps 6 and 7, to ensure the X-axis is zeroed for each adjustment in the vertical direction.

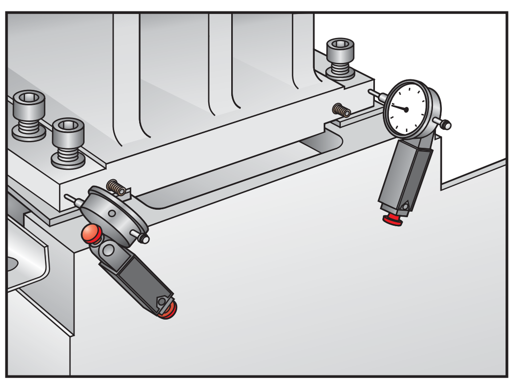
10. Torque the spindle head mounting bolts to 500 ft-lb so as not to change the spindle's position.
11. Once the pocket is zero, X-axis value on the screen becomes the new machine spindle centerline. Tighten the jam nuts on the jack screws under the spindle head.

NOTE: The X-axis value in the Positions page is the new machine centerline. This value should be stored in Parameter 254.

12. Repeat Step 2 to ensure that the shaft has remained horizontal. If the shaft has moved, return to Step 9 and recheck the pocket position.
13. Test the other pockets in the same way as pocket #1 (Step 9) without moving the X-axis position. The tolerances for the other pockets are 0.003 inch from the centerline.
14. Reinstall the sheet metal pieces that were removed for this process.

SL-10 and GT-Series Spindle Head Alignment

1. Attach the spindle alignment bar to the spindle. Adjust the position of the alignment bar until the measured runout at both the base and end of the bar is less than 0.0001". To adjust the position of the alignment bar, slightly loosen the mounting bolts and tap on the mounting end of the alignment bar.
2. Loosen the eight SHCS mounting bolts for the spindle head. Back out the two set screws on the front side, lower edge of the spindle head.
3. Attach a 0.0001" dial indicator to the turret. Jog the X- and Z-axes to position the dial indicator on the side of the alignment bar.
4. Sweep down the length of the alignment bar to measure the spindle head parallelism with the Z-axis.
5. Push the spindle head toward the back of the machine. Run in the set screws on the front, lower edge of the spindle head until they contact the locating dowels underneath the spindle head. Adjust the spindle head parallelism with the Z-axis using these two set screws. The spindle head should be parallel with the Z-axis with in 0.0004"/10".
6. Mount two travel dial indicators onto the side of the base. Place the tips at the extreme ends of the spindle head casting. Zero the indicators.



7. Attach a 0.0001" dial indicator into the end of the alignment bar.
8. Install a boring bar toolholder into tool position #1. Ensure the bore of the toolholder is clean and free of any burrs, chips, or other contaminants. The toolholder must be seated completely against the turret.
9. Jog the X-axis down to the original spindle centerline.
10. Jog the Z-axis until the tip of the dial indicator can be placed on the inside of the bore in the toolholder. Sweep the bore to measure the concentricity of the spindle head to the tool position. The toolholder bore must be concentric with the spindle within 0.001" TIR.

11. Adjust the position of the spindle head by carefully screwing in the set screws if the tool pocket is low. Loosen the set screws and push the head stock towards the back of the machine if the pocket is high. Ensure that the spindle head parallelism to the Z-axis remains constant by moving the spindle equal amounts as indicated on the two travel dial indicators.
12. Once the runout is less than 0.002” TIR, verify that the spindle head parallelism to the Z-axis is within 0.0004”/10”. Evenly torque the spindle head bolts to 300 ft-lb and ensure that all SSS in the spindle head casting are bottomed out on the dowel pins.

Transmission Oil Lubrication System

All of the Haas mills with a transmission use a pumped oil system to lubricate the gears of the transmission. There is a sump below the transmission and a motor and pump above the transmission.

Power to the motor is turned on and off automatically by the control when spindle rotation is commanded.

There is a pressure sense switch in the oil lines that detects the pressure of the pump. If pressure is not detected, the control will automatically turn off the spindle, stop axes motion, and show an alarm condition.

Spindle Motor Cooling System

There is a fan supplying forced-air cooling of the spindle motor. It is mounted directly above the motor and ducting directs the airflow over the cooling fins of the motor.

Power to the spindle motor fan is turned on automatically when the spindle is turning. There is an over-temperature detecting switch mounted in the motor. The control monitors the over-temperature switch and will respond to an over-temperature condition by stopping the spindle, stopping axes motion, and showing an alarm.

Gearbox (Mill)

There is a double solenoid valve controlling air to the gearbox. This solenoid sends air to select either the high gear or the low gear. When power is removed from the solenoids, the valve remains in its last state. Air is always required to ensure the gears are held in either high or low gear. Circuit breaker CB4 will interrupt power to these solenoids. Power is left on the solenoid which is commanded last.

Two gearbox switches are used to sense the position of the gears. One switch indicates High by opening and the other indicates Low by opening. Between gears, both switches are closed, indicating a between-gear condition. The diagnostic display shows the switch status and the Curnt Comds display shows which gear is selected. If the switches indicate the gearbox is between gears, the display will indicate “No Gear”.

NOTE: The transmission high/low gear position switches are located at the bottom of the gearbox assembly, facing the spindle and are difficult to reach. Removal of this assembly is necessary to replace these switches.

The current gear status is monitored by discrete outputs SP Hig (Spindle High) and SP Low (Spindle Low). A "0" (zero) in either of these outputs indicates it is the current gear. If the outputs are the same, neither gear is selected. If the gearbox remains in this condition (between gears) for a certain amount of time, Alarm 126, "Gear Fault", is generated. The only way to reset this alarm is to press the Power Up/Restart key. The current gear can also be monitored by pressing the Curnt Comds key. This display will show whether the machine is currently in "High Gear", "Low Gear", or "No Gear".

There are a number of parameters related to the gearbox. Their values should not be changed by the operator.

The gearbox cannot be serviced in the field and must be replaced as a unit.

Transmission (Lathe)

The Lathe spindle motor is directly coupled to the transmission, which is between the motor and the spindle casting, The transmission is V belt-coupled to the spindle pulley. An air solenoid drives the gearbox shifter into high or low gear. The transmission cannot be serviced in the field and must be replaced as a unit. Never remove the motor from the transmission, as this will damage the transmission and void the warranty.

High gear and low gear are selected by programming an M41 (Low Gear) or M42 (High Gear). **The transmission will not change automatically**. The spindle will come to a complete stop when changing gears.

TROUBLESHOOTING

Noise

Gearboxes can be damaged by gearshift cylinders, or bearings, resulting in noisy operation. While gearbox vibration can cause a poor finish on a workpiece, noisy gearbox operation may not.

Excessive or unusual noise coming from the gearbox, transmission, and/or spindle motor.
Operate the machine in both high and low gears. Monitor for noise in both gear positions, and if the pitch of the noise varies with the motor or the output shaft speed.

• If the noise only occurs in one gear throughout the entire RPM range of that gear position, the problem lies with the gearbox or transmission, and it must be replaced.

• If the noise occurs in both gear positions, disconnect the drive belt(s) and repeat the previous step. If the noise persists, the gearbox or transmission is damaged and must be replaced.

• With the drive belt(s) disconnected, run the machine in high gear. Command a change of direction and listen for a banging noise in the gearbox or transmission as the machine slows to zero RPM and speeds back up in reverse. If noise occurs, the motor has failed and the gearbox or transmission must be replaced.

Gears Will Not Change
Machine will not execute a gear change.

NOTE: An alarm will display when a gear change problem occurs, and an alarm will also occur. Refer to ALARMS section of te Electrical Components manual to diagnose each problem before working on the machine.

When a gear change is performed, the following sequence of events occurs:

If the spindle is turning, it is commanded to stop, pauses until spindle is stopped, gear change spindle speed is commanded forward, pauses until spindle is at speed, commanded high or low gear solenoid active, pauses until in new gear or reversal time, alarms and stops if max. gear change time elapsed, if not in new gear, reverses spindle direction, and turns off high and low gear solenoids

• If pressure is too low, the gears will not change - Check air supply pressure. In addition, disconnect the air lines from the solenoid and blow compressed air through the air lines to ensure the lines are not clogged.

• Check the air solenoid assembly on the solenoid bracket (rear of gearbox). If the solenoid and limit switches operate properly, the problem lies with the gear change piston; replace the gearbox.

• Check contactor CB4.

• **Lathe/50T Vert:** Check the voltage to the gear shifter motor. The voltage between pins 2 and 3 should be approximately +28V when high gear is commanded and -28V when low gear is commanded. If these voltages are correct, the gear shifter motor has failed and the transmission must be replaced. If these voltages are incorrect, the cabling or transmission power supply is at fault.

Low Pressure Alarm (Mill)
Alarm 179 (Low Pressure Transmission Oil) has been triggered.
• Check for low oil supply in reservoir. The gearbox is lubricated and cooled with oil. It uses an oil sump and is cooled by gear oil.

• Check to see that pump motor is running.

• Check for an air leak in the suction side of the pump.

• Check for a bad pressure sensor.

• Check for a broken or damaged cable.

• Check for a worn pump head.

Incorrect Gear Selected or Sensed (Lathe)

Spindle speed is not consistent with selected gear

Monitor discrete inputs and outputs SP Hig and SP Low on the diagnostics display while commanding high and low gear. The output SP Hig should be 1 when high gear is selected, and SP Low should be 1 when low gear is selected. The inputs SP Hig and SP Low should be 0 when that gear is engaged, and should both be 1 when the transmission is between gears. These inputs should never read 0 at the same time. If any of these inputs/outputs are incorrect, either the gear change limit switches or the wiring to the I/O PCB is at fault. The limit switches are located inside the transmission, and cannot be replaced.

Spindle Motor & Transmission (Mills)

Please read this section in its entirety before attempting to remove/replace a transmission.

NOTE: The drive belt tension should be adjusted after every service on the transmission or spindle.

Motor Removal

1. **Vert:** Ensure the mill is on. You will need to move the head stock to remove the transmission. Raise the Z-axis to the full up position.

2. a. **Vert:** Remove the cover panels from head stock area ("Head Covers Removal and Installation" section).

   b. **Horiz:** Remove the rear enclosure panel.

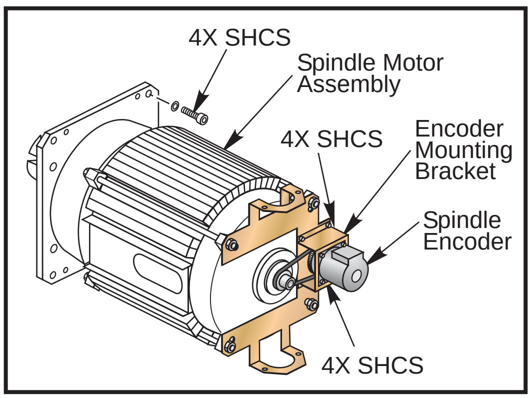
3. a. **Vert:** Remove the tool release piston assembly ("Tool Release Piston Assembly" section).

   b. **Horiz:** Disconnect the electrical cable to the fan.

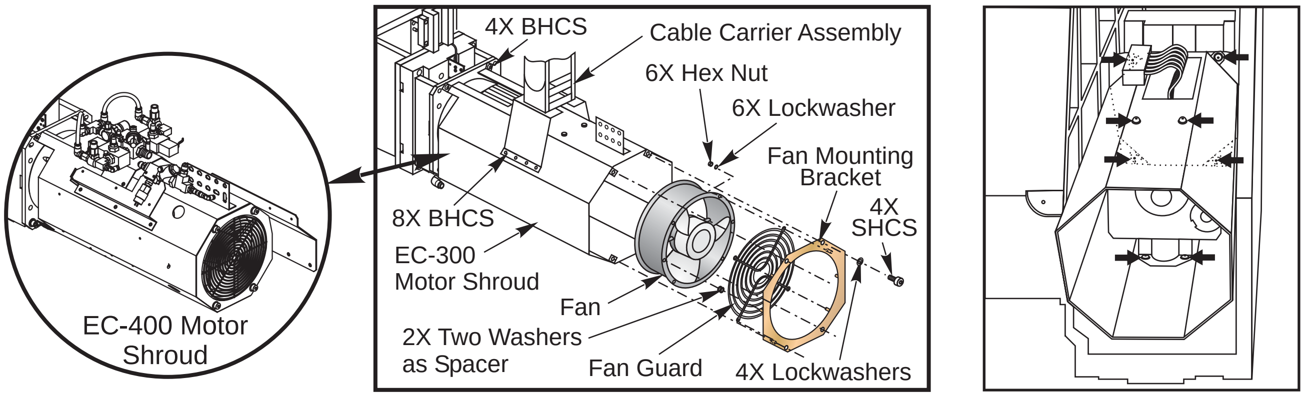
4. Press the Power Off button on the control panel and turn the main breaker off. If there is an external breaker box, turn it off and lock it out.

5. a. **Vert:** Disconnect the air supply and remove the electrical and pneumatic lines from the solenoid bracket on top of the spindle motor assembly. Mark any connections that have not been previously labeled for reassembly.

   b. **Horiz:** At the rear of the spindle and motor shroud, remove the four (4) SHCS that hold the fan mounting bracket in place. Disconnect the air supply and remove the electrical and pneumatic connections from the solenoid valve assembly.



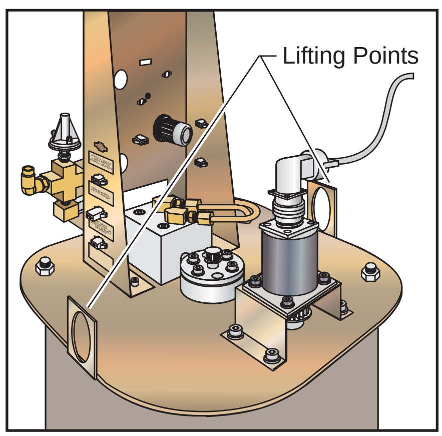
EC-400: Remove the motor shroud, which is held on with four (4) BHCS. Disconnect the encoder cable, spindle air blast, and TSC coolant union, if equipped.



EC-300: Remove the Y-axis cable carrier and bracket. Loosen the X-axis cable carrier and position it away from the back of the spindle casting.

6. **Vert:** Remove the two SHCS holding the cable carrier to the solenoid bracket and position the cable carrier so as to not interfere with removal of the motor. It may be necessary to tie the cable carrier back to the Z-axis motor to keep it in place.

7. **Vert:** If machine is equipped with Through the Spindle Coolant option, remove the pressure regulator and bracket from the old transmission and install them on the new transmission.



Direct Drive with Lifting Eyeholes

8. a. **Vert:** Remove the four SHCS and carefully lift the spindle motor assembly off the spindle head. Take care to not damage the drive pulley during removal.

NOTE: For this operation, the Haas Transmission Hoist is recommended.

b. **Horiz:** Remove the four (4) bolts that mount the spindle motor assembly to the column and remove the spindle motor assembly.

Direct Drive Installation

1. Carefully lower the motor assembly down to just above the spindle head casting, taking care not to damage the drive pulley or pinch the drive belt.

2. Place the drive belt on the motor's drive pulley and lower the motor down onto the spindle head casting.

3. Insert and tighten down the four SHCS attaching the motor to the spindle head casting. Adjust the drive belt as noted in "Belt Replacement and Tensioning" before tightening down completely.

4. Refer to the appropriate section and set the spindle orientation. Check for proper orientation of the machine and be aware of any unusual noises or vibration that may occur because of incorrect belt tension.

5. Reattach the cable carrier to the solenoid bracket and reconnect all electrical and fluid lines. Replace any leaking or damaged lines at this time, if necessary.

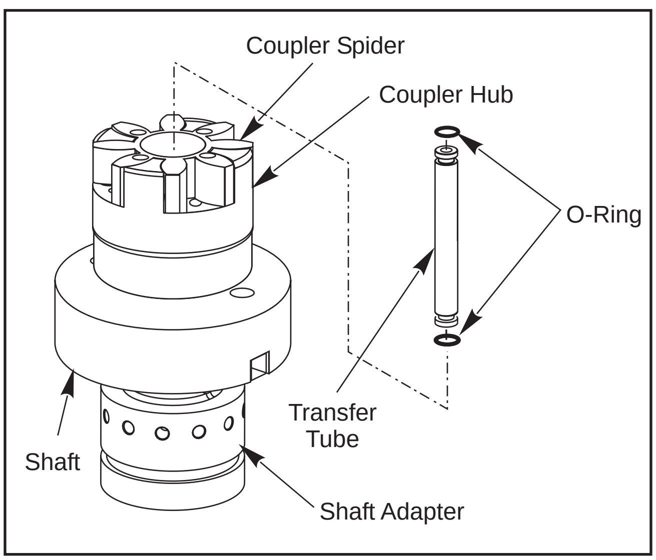
NOTE: Ensure the orient ring has an adequate layer of grease around the circumference before starting operation.

In-Line Drive Installation (Horiz & Vert)

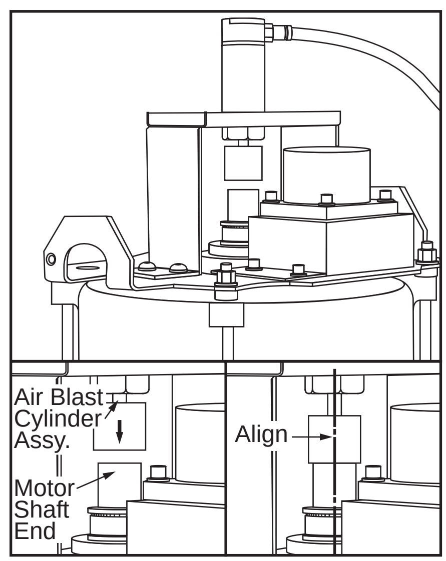
1. Sweep the spindle before the motor installation is started.
2. Check the condition of the coupler hub on top of the spindle, and the condition of the coupler spider. Lift the motor up and position it just above the TRP using a forklift or hoist. Check the condition of the coupler hub on the motor, and align it with the coupler on the spindle. Inspect the transfer tube for damage and the o-rings for deterioration. Replace, if necessary.

NOTE: Ensure that the transfer tube has been installed prior to motor installation.

3. Lower/bring the motor toward the TRP. The couplers should engage with very little interference. It may be necessary to rotate/move the spindle back and forth slightly to line up the coupler hubs or rock the motor housing to square the assemblies. Do this by hand on the spindle dogs, at the spindle nose.
4. Once the coupler hubs are mated, put the bolts in that hold the motor to the spacer blocks; leave them loose. Join all the motor cables to the harness of the machine. Command a spindle speed of 1000 RPM, leaving the motor mounting bolts loose. Let the spindle run for about 5 minutes, to allow the spindle assembly to seat and help the final alignment. Snug bolts while spindle is rotating, then stop the spindle and torque the bolts.
5. Install the airblast (purge) bracket (or TSC, if applicable) and solenoid on top of the motor. Ensure the cylinder is centered over the motor shaft, and adjust as necessary. Connect the air line to the solenoid.



Transfer Tube and Motor Shaft



Motor and Air Blast Purge Bracket

EC1600-3000 Transmission and Motor Replacement

NOTE: The motor and transmission are removed as a unit.

Removal

1. Power Off the machine. Remove all air and power service from the machine.
2. Remove the rear enclosure panel and the upper Y-axis way cover (refer to "Y-axis Way Cover Removal").
3. Remove the TRP Blast air line.

4. Remove the TRP assembly. Refer to “Tool Release Piston Replacement”.

NOTE: An Extension Tube is threaded through the center of the TRP and into the spindle. You must pull the Extension Tube out before you can remove the TRP on machines that have Through the Spindle Coolant (TSC) (see Coolant Union procedure).

CAUTION! The TRP assembly is very heavy. When moving, ensure you have a place to set the assembly when removed.

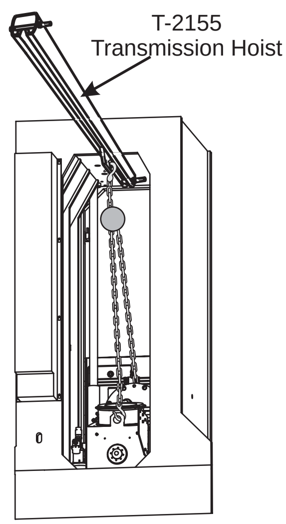
NOTE: Make sure you collect all washers and spacers from beneath the TRP assembly. Keep these separated in sets.

5. If your machine is equipped with TSC, remove the TSC Assembly.
6. Remove the Low Air/Low Oil, Fan, Spindle Head Solenoid, Spindle Status, and P-Cool cables from the manifold attached to the transmission.

NOTE: It will probably be necessary to position the head before removing cables, or alarms may occur.

7. Remove the three cables from the Encoder Assembly.
8. Remove the Encoder Assembly (take the belt off first by loosening the encoder screws).

CAUTION! Before proceeding, make sure you have appropriate lifting equipment to safely lift 250 lbs., room to maneuver it, and a stable place to set the transmission/motor assembly once it is removed. A transmission hoist, T-2155, is available.



9. Lift the transmission by using Handle Jog to lift the spindle. The spindle and transmission assembly will slide up the Y-axis linear guides. Place a block of wood under the front of the spindle (inside the enclosure) and use Handle Jog to lower the spindle/transmission onto the block.
10. The power terminal block is under the rear of the transmission. Remove it (2 screws). Note wiring configuration, then remove the six power cables (1-6).
11. Attach a heavy chain or strap to the lifting eyes of the top motor plate using hooks or C-clips of appropriate weight rating (approximately 250 lbs.).

NOTE: A lifting eye must be screwed into a receptacle in the front end of the transmission assembly. A rear lifting eye is there as part of the assembly, but the fan must be removed and set it on top of the transmission to access it.

12. Remove the four large SHCS that attach the transmission mount plate to the spindle head and lift the transmission/motor assembly slightly. This will remove the tension on the drive belt. Remove the drive belt.
13. Lift the transmission/motor assembly and slide it out of the enclosure.

Installation

CAUTION! Before proceeding, make sure you have appropriate lifting equipment to safely lift 250 lbs. A transmission hoist, T-2155, is available.

1. Hang the transmission belt on the rear of the spindle.
2. Attach a heavy chain or strap to the lifting eyes on the top motor plate of the transmission using hooks or C-clips of appropriate weight rating (approximately 250 lbs.).

NOTE: A lifting eye must be screwed into a receptacle in the front end of the transmission assembly. A rear lifting eye is there as part of the assembly, but the fan must be removed and set it on top of the transmission to access it.

3. Check all the wiring on the transmission before lifting it into the enclosure, to ensure that nothing has come loose during removal.
4. Lift the transmission/motor assembly into place, lining the face up with the bolt holes on the casting.
5. Slide the transmission belt onto the transmission pulley.
6. Insert the four bolts required to attach the transmission to the casting.
7. Rotate the spindle to seat the belt into the notches on the transmission gear, and ensure the spindle rotates freely.
8. Place a block of wood under the transmission and lift and lower it until the proper belt tension is achieved.
9. Tighten the top two bolts to 80 ft/lbs.
10. Loosen and remove the straps from the transmission, and remove the lifting eye.
11. Tighten the lower two bolts to 80 ft/lbs.
12. Lift the transmission by using Handle Jog to lift the spindle. The spindle and transmission assembly will slide up the Y-axis linear guides. Place a block of wood under the front of the spindle (inside the enclosure) and use Handle Jog to lower the spindle/transmission onto the block.
13. The power terminal block is under the rear of the transmission. Remove it (2 screws). A plate covering the terminal block contains the numbers 1 thru 6 to indicate where wires should be attached. Check that the wires not previously removed are still properly connected.
14. The two large power cables contain wires numbered from 1 to 6. Make sure they are attached in the proper place per the terminal block plate. They should be attached opposite wires 1 thru 6 on the other side of the terminal block (wires are labeled). Reattach the terminal block to the bottom of the transmission.
15. Attach the encoder assembly to the face of the transmission, and pull the encoder belt onto the pulley on the end of the transmission.
16. Attach the three cables to the encoder assembly and the Low Air/Low Oil, Fan, Spindle Head Solenoid, Spindle Status, and P-Cool cables to the manifold attached to the transmission.
17. If your machine is equipped with TSC, replace the TSC assembly.

18. Replace the TRP assembly (“Tool Release Piston Replacement” section) and the TRP Blast air line.

19. Replace sheet metal and reconnect air and power services.

20. Set spindle orientation (“Spindle Orientation” section), and check tool changer function.

Vertical Machine Transmission Replacement

NOTE: This procedure is not for direct drive machines.

Removal

1. Ensure the mill is on. You will need to raise and lower the head stock to remove the transmission. At this time, raise the Z-axis to the full up position. **50 taper:** Lower the Z-axis to its full negative value (full down). Position the mill table so that it is centered on the X-axis and as close to the doors as possible (full Y-axis). This will allow the best working surface.

2. Clean the mill table of any grease, coolant, or chips. You will be standing on the mill table during this procedure and need firm footing.

3. Press the Power Off button on the control panel and turn the main breaker off. If there is an external breaker box, turn it off and lock it up. Remove the cover panels from head stock area ("Head Covers Removal and Installation" section).

   50 taper: Remove the TRP assembly. Refer to the “Tool Release Piston Assembly” section.

CAUTION! The TRP assembly is very heavy. When moving, ensure you have a place to set the assembly when removed.

NOTE: Make sure you collect all washers and spacers from beneath the TRP assembly. Keep these separated in sets.

4. Remove the TSC extension tube if the machine is equipped with Through the Spindle Coolant option. Refer to the “Through The Spindle Coolant System” section.

NOTE: The TSC union and extension shaft are **reverse** thread.

5. If your machine is equipped with TSC, remove the 3/16” SHCS that attach the TSC valve bracket to the right side of the motor. Let the TSC valve bracket hang off the right side of the spindle head, ensuring that the hoses do not get kinked.

6. If machine is equipped with the Through the Spindle Coolant option, remove the pressure regulator, check valve assembly, and bracket from the old transmission, so they can be installed later on new transmission.

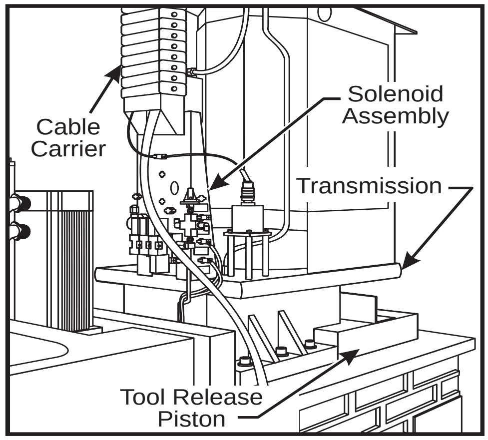
7. Remove the tool release piston assembly ("Tool Release Piston Assembly" section).

50 Taper mills: skip to step 12.

8. **Vert**: Loosen the six SHCS holding the transmission to the head casting. Slide the transmission forward enough to release the drive belt from the transmission and spindle pulleys. **Horiz:** The transmission is removed by lowering it onto blocks of wood (4”x4”) inside the column casting. The transmission is then pulled toward the rear of the machine to separate from the spindle head. Completely remove transmission mounting bolts and pull transmission toward the rear of the machine until it is clear of the column casting.

9. Remove the SHCS that attach the TRP solenoid assembly to the top of the motor lift plate. Cable tie the assembly to rear sheetmetal or column to prevent damage while removing transmission/motor assembly.

10. Disconnect all electrical lines and air lines from the transmission solenoid bracket. Disconnect the electrical and oil lines from the oil pump. Plug the oil lines to prevent contamination. Most of the lines should be marked and identified. If not marked, do so as it is removed.



Solenoid Bracket with All Lines Connected.

11. Remove the two SHCS holding the cable carrier to the solenoid bracket and position the cable carrier so as to not interfere with the transmission removal. It may be necessary to tie the cable carrier back to the Z-axis motor to keep it in place.
12. **50 taper:** Remove the plug for the gear change solenoid and remove the Encoder-to-Transmission Shaft belt. This can most easily be accomplished by removing the four SHCS that attach the Encoder bracket to the spindle head (located inside the spindle head cavity between the drive belts). Use a universal swivel joint and hex-head socket for these SHCS.
13. Break loose the four large SHCS that attach the transmission mount plate to the spindle head. Remove the SHCS and set aside. Pull the transmission/motor assembly toward the front of the machine slightly. This will remove the tension on the drive belts.
14. Remove the encoder belt and the drive belts.

CAUTION! Measure distance between the bottom of the Z-axis motor and the ballscrew anchor mount. Cut a wood block to the proper length and put in place. This is necessary to counteract the hydraulic counterbalance mechanism when the transmission/motor assembly is lifted off the machine.

15. Mark and remove the power cables from the motor. Attach a heavy chain to the lifting eyeholes on the top motor plate using hooks or C-clips of appropriate weight rating (approximately 250 lbs.).

CAUTION! Before proceeding, make sure you have appropriate lifting equipment to safely lift 250 lbs., room to maneuver it, and a stable place to set the transmission/motor assembly once it is removed.

16. Lift off the transmission/motor assembly.

Installation

1. **50 taper:** Lower the Z-axis travel to its full negative value (full down). Position the mill table so that it is centered on the X-axis and as close to the doors as possible (full Y) to allow the best working surface.

   40 taper: If machine is equipped with Through the Spindle Coolant option, reinstall the pressure regulator, check valve assembly and bracket. Install two cable ties on the replacement transmission as follows:

   • Place one cable tie around the limit switch cable.
   • Place the second cable tie through the first one, forming a loop.
   • Tighten the first cable tie.

NOTE: The loop of the second cable tie must allow the drain line to slip through.

2. **40 taper:** Place cradle under new transmission and lift just enough to put tension on the cables.

3. **40 taper:** Ensure new transmission is seated securely and lift. Only lift high enough to clear the enclosure and to swing into place.

4. **40 taper:** Slowly swing boom around to center the cradle and transmission over the spindle head.

NOTE: Inspect the gearbox isolators to ensure the spacer is flush with the bushing on the underside of the housing.

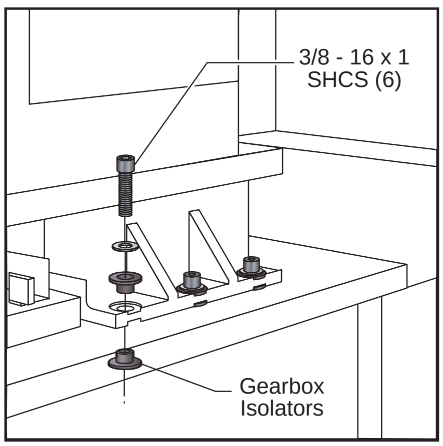
50 taper: Connect the power wires and attach the electrical plug panel to the rear of the motor. Reattach any Molex plugs to the panel, if removed during the previous procedure.

5. **50 taper:** Slide on the drive belts and place and secure the TRP solenoid assembly to the top of the motor lift plate using the removed SHCS.

6. **50 taper:** Place and secure the TSC valve bracket to the right side of the motor lift plate using the removed SHCS (if so equipped).

7. Lower the transmission carefully to just above the spindle head. Place the drive belt onto the transmission pulley and lower. Do not crush or bind the time belt.

8. Insert and tighten down the SHCS attaching the transmission to the spindle head. If these screws include gearbox isolators, ensure the 3/8" fender washer is **not** touching the gearbox housing.



Gearbox Isolators

9. Adjust drive belt tension as noted in "Belt Replacement and Tensioning" section before tightening screws down completely.

50 taper: Slip on the Encoder belt. Reattach the Encoder bracket.

10. Replace the TRP assembly. See the description in the "Tool Release Piston (TRP) Assembly" section.

11. Replace the TSC union and extension shaft. Refer to the “Through The Spindle Coolant System” section.

12. Reattach cable carrier to solenoid bracket and reconnect and secure all electrical, fluid and air lines. Replace any leaking lines, if necessary. **50 taper:** If equipped with TSC, check drawbar for runout (see appropriate section).

13. Fill the transmission with Mobil DTE 25 oil.

NOTE: The hoist must be disassembled before removing from the mill table. Break down the hoist by removing the boom assembly, then the mast.

Transmission (Lathe)

Removal

Tools Required: Hoist and lifting straps or floor jack and (4) wood blocks

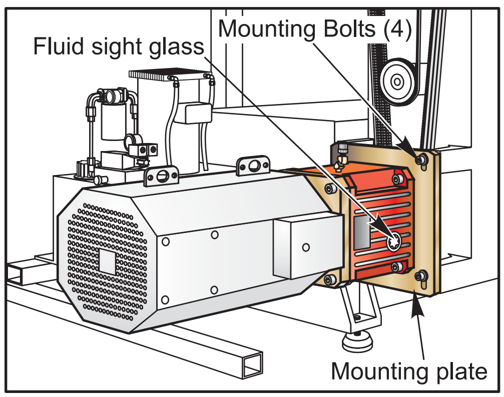
1. Power off the machine.
2. Remove the left side panel to access the spindle motor and transmission assembly.

> **NOTE:** If you are using a floor jack, the bottom left front panel needs to be removed.

3. Disconnect all electrical lines from the motor and transmission assembly.
4. Position the hoist directly to the motor's rear and place lifting straps around motor and transmission. Make sure there is enough tension so when mounting bolts are loosened, the motor assembly does not shift.

> **NOTE:** If you are using a floor jack, slide the jack under the transmission assembly from the front side of the machine. Being careful not to damage any components, place the wood block supports under the transmission and motor .

5. Remove the four transmission mounting plate bolts. Raise the transmission enough to remove the drive belts, then slide the entire assembly out.



Lathe Transmission Mounting Plate

Installation

All Haas gearbox replacements for lathes are supported using 16DP-50M gearsets. They have oil pumps, with oil pressure switches, and use motor encoders with an M23 connector. The 16DP Haas gearbox is identified with a “16DP” engraved on the top surface of the gearbox housing.

If the gearbox that is being replaced already has an oil pump and pressure switch, the necessary software, Parameter 57 bit 26 set to 1, power cable, and signal cables are already in place.

The 16DP gearbox may require changes for Parameter 150 when changing the gearbox, and must be verified.

The gearbox motor encoder connector has an attached adapter cable that converts to the previous style molex connector in case it is needed. If the adapter cable is not needed, remove it and attach the existing M23 connector to the motor encoder.

In order for the transmission to function correctly the following items need to be verified and/or installed:

- The control must have software version 5.08 or later.
- Parameter 150 set correctly (see following list).
- Parameter 57 bit 26 “trans lo oil” set to 1.
- The encoder cable for the motor encoder is correct.
- Replace CBL890 (Hi Gear, Lo Gear, Trans Lo Oil) and install CBL300A (oil pump power), if necessary.

Parameter 150 values for Haas 16DP gearboxes:

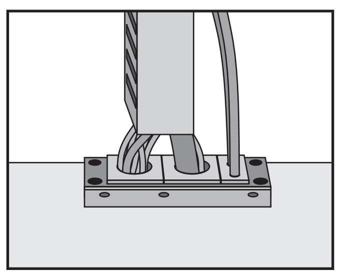
SL-30/TL-25 with gearbox option	1054
SL-30B/TL-25B	744
SL-30 with OPC12 and gearbox option	943
SL-40/40L (incl XP option)	744
SL-40B/40LB (incl XP option)	434

1. Place lifting straps under new transmission assembly and lift just enough to put tension on the cables.

NOTE: If you are using a floor jack, slide the jack under the front side of the machine. Being careful not to damage any components, place the wood block supports on the jack and slide the transmission and motor onto the jack.

2. Ensure the new transmission is seated securely on the straps and lift up slowly. Lift only high enough to install the drive belts, then gently swing the assembly into place.
3. Insert the four bolts that secure the transmission mounting plate to the spindle head.
4. Adjust the drive belt tension, then tighten down screws completely. Refer to the "Spindle Installation" section for proper belt tension procedures and tension chart.
5. Remove the existing CBL890 and replace it with the CBL890 included in the service kit (33-1894). CBL890 connects to I/O PCB P15 inside the control cabinet, exits the control cabinet through the top or bottom opening, and connects to the gearbox Hi Gear, Lo Gear, and Trans Lo oil connectors.

   If the control cabinet cables exit through the cabinet bottom, thread the end of CBL890 up through the gray rubber grommets in the opening in the bottom of the control cabinet as shown. If the control cabinet cables exit through the junction box at the top of the control, thread CBL890 through the top junction box.



Bottom-Exit Control Cabinet

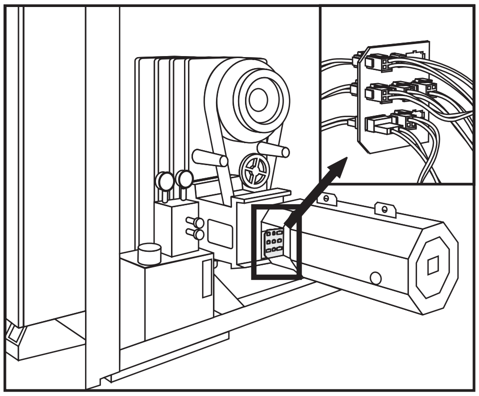
   Remove cable guide covers necessary to route CBL890 to I/O PCB P15 and place CBL890 in cable guide.

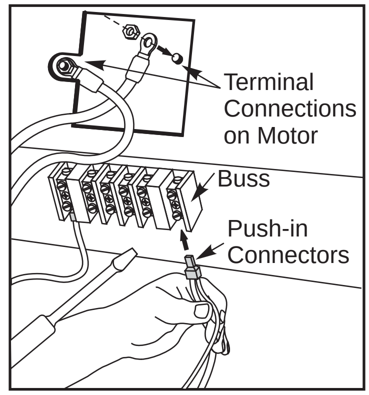
   Route the other end of cable 890 in the most direct, safe path to the bracket on the side of the gearbox. Plug the connectors into their appropriate slots in the bracket, and plug the matching Hi Gear, Lo Gear, and Trans Lo Oil (from the pressure switch) connectors together. If there are no available slots in the bracket, or no bracket, tie the connectors out of the way.

6. Install CBL300A (33-8169). CBL300A connects to I/O PCB P41 inside the control cabinet, exits the control cabinet through the top or bottom opening, and connects to the gearbox oil pump power leads connector.

   Thread CBL300A through same opening into control cabinet as CBL890, and connect it to I/O PCB P41.

   Outside the control cabinet, route CBL300A in the most direct, safe path to the bracket mounted on the side of the gearbox. Plug the connector into the appropriate slot on the bracket and plug the matching connector from the gearbox oil pump motor into the opposite side of the bracket as shown. If there is no bracket, tie the connectors out of the way.





7. Inside the control cabinet, replace the cable guide covers. Close the control cabinet door and turn the main power on.

   Check that the oil pump works properly - Power the machine on. Verify that Parameter 150 is correct and that Parameter 57 bit 26 Trans Lo Oil is set to 1. Push power up restart and check that the transmission oil pump is running. The oil can been seen moving through the clear line. The oil pump will run whenever the spindle is turning.

   Check that the low transmission oil pressure alarm works by commanding a spindle speed and then disconnecting the pressure switch. There is a 60-second pause and then Alarm 179 is generated. Reconnect the switch after the test.

8. Replace the left side panel.

NOTE: If you are using a floor jack, replace the bottom left front panel.

55 HP Lathe Transmission and Motor Replacement

Removal

1. Remove the sheet metal on the left side of the lathe in order to gain access to the motor and transmission
2. Remove the motor cables from the buss, under the motor.
3. Disconnect all the motor feedback cables at the subplate on the motor/transmission.

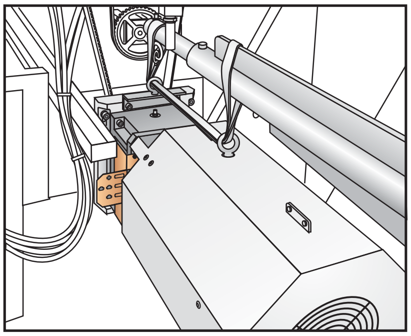
NOTE: Additional lifting means are needed, such as a forklift, to pick up the assembly.

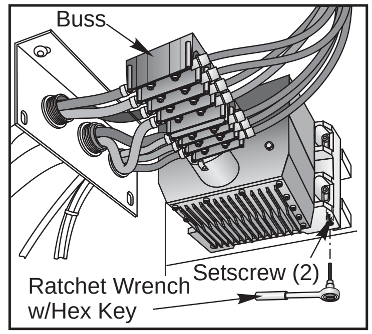
4. Use lifting eyes to support the motor/transmission assembly. There is a provision for a lifting eye close to the center of the motor cover and another at the pulley end. Use a lifting strap between the two lifting eyes and secure the strap to the lifting equipment.
5. Support the motor/transmission assembly.
6. Remove the bolts that secure the transmission to the spindle casting.
7. Lift the motor/assembly up to clear the belts and then pull the assembly away from the spindle casting.

Installation

1. Install new belts on the spindle pulley. These need to be a matched set.

NOTE: The next step requires the use of additional lifting means, for example use a forklift to pick up the assembly. Use lifting eyes to lift and position the motor/transmission assembly. There is a provision for a lifting eye close to the center of the motor cover and another at the pulley end. Use a lifting strap between the two lifting eyes and secure the strap to the lifting equipment.





2. Lift assembly and position it over the belts. Lower it into position and loosely install the 4 mounting bolts.

3. Tension the belts using the tension adjusting screws. These 2 screws are located under the transmission. A long 1/4" Allen wrench and a torque wrench are needed to adjust these screws. Adjust them to 44 in/lb. Once both are adjusted, recheck the first one, then the second. It may be necessary to recheck the screws a few times in order to attain the proper torque.

4. Torque the mounting bolts to 80 ft/lb.

5. Replace the wires on the motor. Match cable numbers from the machine, to the numbers on the buss.

6. Replace the motor feedback cables. These are located on the sub-panel on the left of the motor assembly.

7. Ensure all cables are away from moving parts.

8. Reinstall any other spindle related pieces that were removed (e.g. Coolant collector and hose)

9. Command the spindle forward at low RPM (do not exceed 500 rpm); look for leaks. Start the run-in program. This program will run for about 2 hours.

10. Verify that the transmission oil is at the proper level. The machine is full (2 1/4 liters) when oil is visible 3/4 of the way up on the sight glass. Add Mobil DTE-25 (amber) or Mobil SHC-625 (green) as needed. Use only the type of oil already used in the transmission; do not mix oil types.

Spindle Encoder Replacement

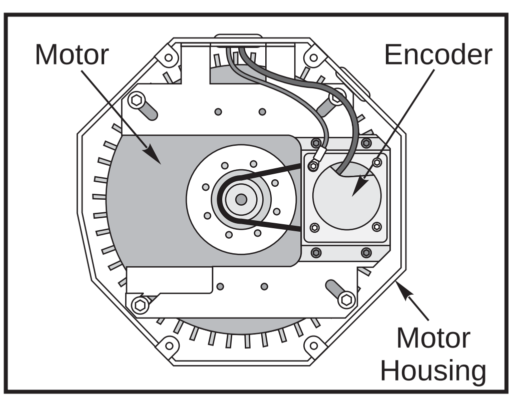
Please read this section in its entirety before attempting to remove or replace encoder.

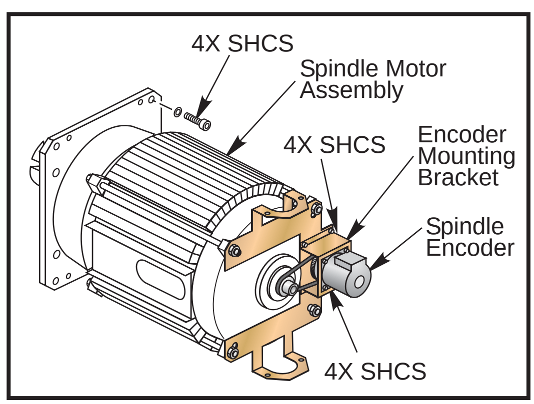
Removal

1. Turn machine power on. Move the spindle head to a position that will allow you to easily work on the back of the spindle motor. Turn the machine off.

2. a. Remove the necessary sheetmetal to gain access to the spindle encoder.

   b. **Horiz:** Remove the fan and fan shroud, then the tool release piston to access the encoder.

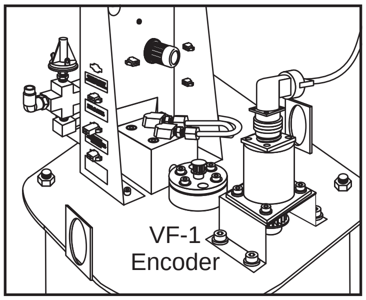




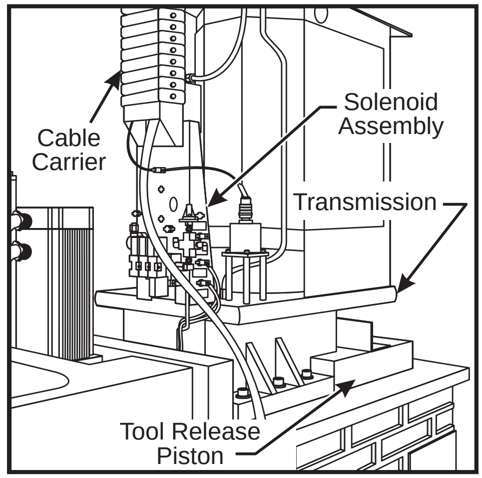
EC-300 Spindle Encoder Installation (Fan and Fan Shroud Removed)

3. a. Remove the four screws holding the encoder to the bracket.

   b. **Vert:** Remove screws holding the encoder to the four standoffs (VF-1 thru VF-4) or mounting bracket (Direct Drive). Remove the encoder, leaving the belt on the pulley at the orient ring.



Spindle Encoder Installation (VF-1/VF-2)



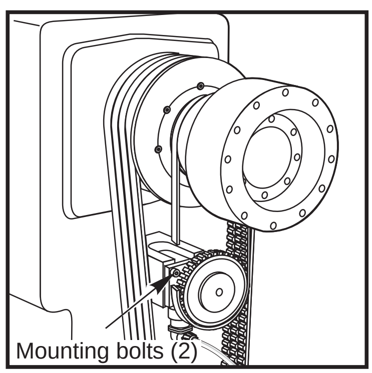
Encoder Installation for Direct Drive Machines

4. Inspect the belt and replace if necessary.

Installation

NOTE: Handle the new encoder with care; it is very susceptible to damage.

1. **Lathe:** Install the pulley onto the new encoder, aligning the set screw hole with the flat on the encoder shaft. Use only one set screw and a small drop of removable grade loctite, to hold the pulley on the shaft. Note that some pulleys may have two set screw holes and screws; remove the unused set screw.



Lathe Encoder Belt Locations

2. Mount the new encoder and tighten the bolts

3. Apply tension to the belts. Belt tension is very critical, do not create an excessive amount of tension. The maximum radial load (side load) for the encoder shaft is 13 1/2 lbs (60 N). Exceeding this amount may damage the encoder. Some machines have an automatic belt-tensioning bracket. Allow the bracket springs to properly tension the belt and then tighten the screws.

4. a. **Horiz:** Replace the fan and fan shroud, then the tool release piston.

   b. Replace the sheet metal previously removed.

Tool Coolant Overview

All Haas mills have a system that can be used at the customers discretion to provide a liquid coolant to the tool and workpiece. There is a tank at the back or side of the machine that contains the liquid coolant and a pump that moves the coolant up to the spindle head area.

The makeup of the coolant has a wide variety of possibilities. The customer can choose to use anything from water to oil. Typical coolant is water with some additives to improve lubrication and reduce rust and bacteria.

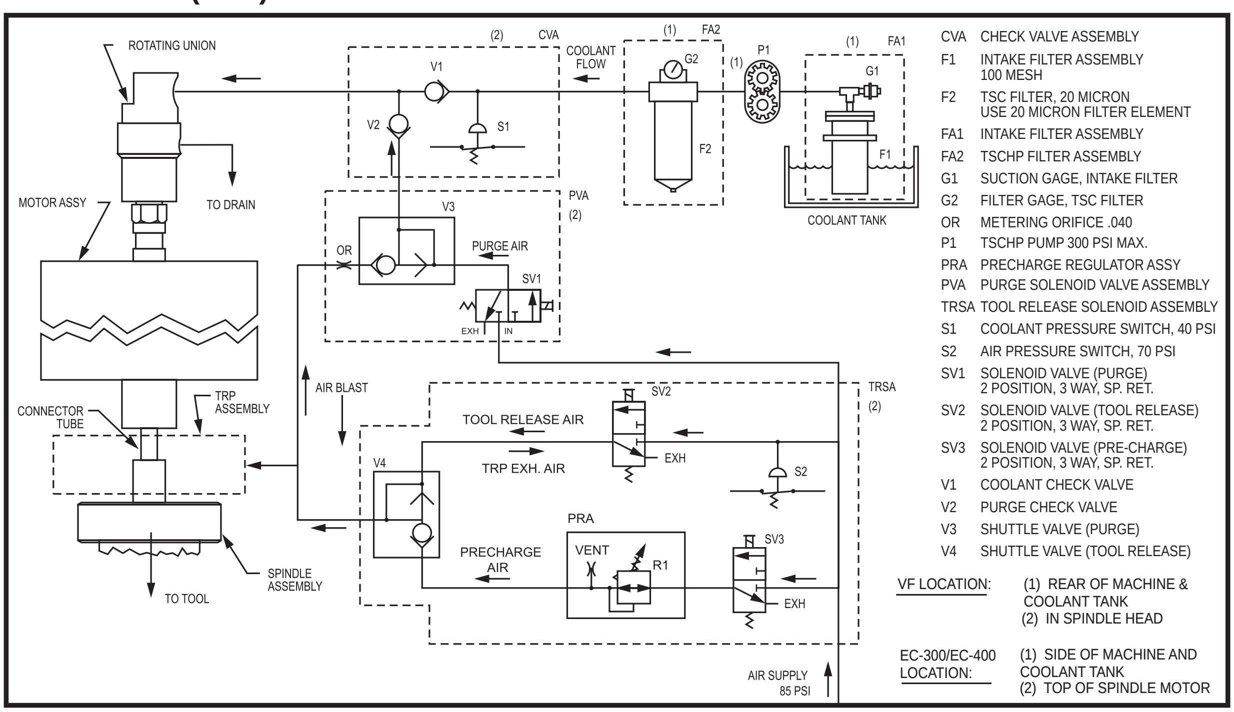
At the spindle area, the coolant is first circulated through a jacket around the spindle. This is done to help maintain the spindle head at a constant temperature to improve machine accuracy. The machine is more accurate if the spindle head temperature can be maintained within +/-5 F degrees. This cooling of the iron casting of the spindle is a very minor effect on machine temperature and accuracy and the machine can always be used in every type of cutting without turning on the coolant pump.

The coolant pump is electric and can be turned on and off both by the operator at the front panel and under program control. There are codes that the CNC programmer puts into the CNC program to turn on and to turn off the coolant. The machine can be operated normally without this coolant.

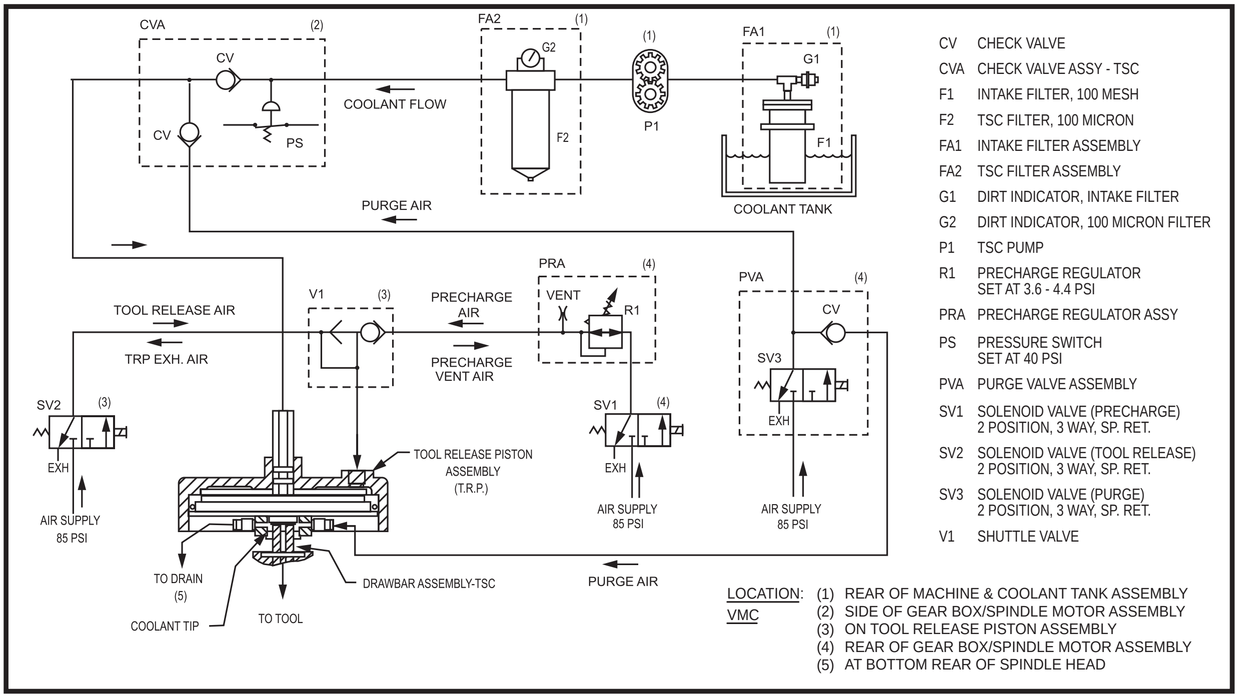
After the spindle jacket, the coolant comes out to one or more exit ports that can be aimed manually or automatically by the machine. Typically these ports are aimed directly at the tip of the working tool.

There is an optional “thru-the-spindle-coolant” system that can be installed on most machines. It consists of a second pump that can also be turned on from the CNC program and supply lines that bring the coolant down the center of the spindle of thru the tool. It provides no cooling functions to the spindle.

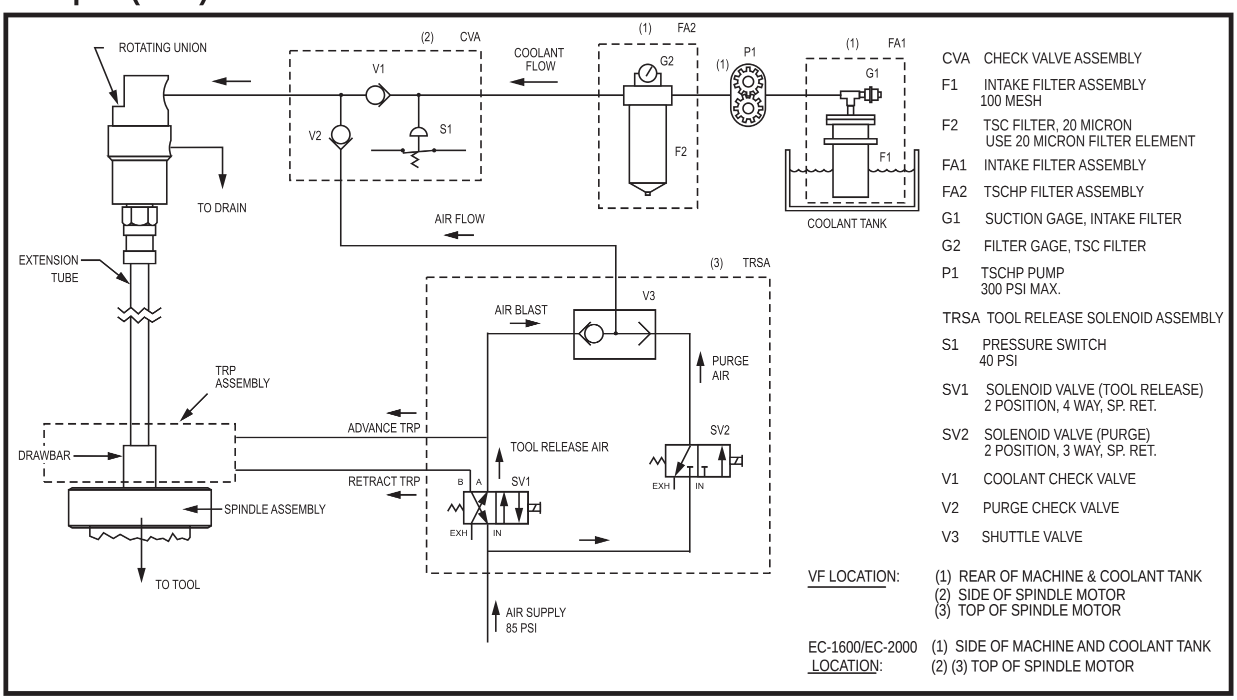
In-Line Drive (TSC)



40 Taper (TSC)



50 Taper (TSC)



TSC Troubleshooting

NOTE: Abrasive swarf from grinding or ceramic machining operations will cause heavy wear of the TSC coolant pump, mill coolant tip and mill drawbar. This is not covered by warranty on new machines. Notify Haas Service Department if machine is being used for this application.

Coolant Overflow

Check the alarm history to determine the cause of the problem before any action is taken.

• Check the customer's tooling for through holes in the toolholder, tool, and pull stud (mill).

• Check the TSC coolant union. If failure is found, replace the coolant union.

• Check that the coolant drain and purge lines connected to the seal housing are intact. Replace the tubing if necessary.

• Check for coolant flowing from a failed fitting or check valve.

• Check precharge pressure in accordance with "Pressure Regulator Adjustment' section and reset if necessary. **Mills:** Low precharge pressure can cause coolant to dump into the spindle head.

• Ensure coolant pump relief valve has not been tampered with (paint band is intact). Check the coolant pump pressure (should be 300 PSI, or 1000 PSI for TSC 1000 option), with a standard (no coolant through hole) toolholder in spindle. If pump pressure is above 300 PSI (or 1000 PSI for TSC 1000 option), reset the pump relief valve in accordance with the "Setting TSC Pump Relief Valve" section.

Excessive coolant flow out of drain line or pulsating flow through tool and drain line.

• Check precharge pressure in accordance with "Precharge Regulator Adjustment" section. Reset precharge pressure if necessary. Low precharge pressure will cause heavy or pulsating flow from the drain line. Check main air pressure regulator for 85 PSI. A higher supply pressure will reduce precharge pressure. Lower supply pressure will increase precharge pressure.

• Ensure the coolant pump relief valve has not been tampered with (paint band is intact). Check the coolant pump pressure (should be 300 PSI), using a standard tool holder. If pump pressure is above 310 PSI, reset the pump relief valve.

Low Coolant, Alarm 151

• Check coolant tank level. Check for slow coolant drainage from the machine enclosure.

• Check the filter and intake strainer for any clogging. Read filter gauges with TSC/HPC running without a tool. Check coolant lines for any clogging or kinking. Clean or replace as needed.

• Check for overheating TSC/HPC pump motor. These three-phase motors have a thermal circuit that will interrupt power to the relay coil.

• If received at start-up, check that the breaker has not tripped and that the pump is turning. Check the electrical continuity of cables.

• Check for pressure switch failure, and replace if necessary. Check the electrical continuity of the switch cable and the control function by monitoring the "LO CLNT" bit on the Diagnostics page (0 = pressure on, 1= pressure off). Shorting the leads should cause the bit to switch from 1 to 0. Check this before replacing the pressure switch. Leaking switches can give intermittent alarms.

• Check pump pressure with TSC/HPC running and without a tool; normal pressure for standard TSC is 75-95 PSI. If the pressure is less than 60 PSI, replace the pump.

• May be generated if another machine alarm occurs during TSC/HPC operation.

Pre-Charge Failure, Mill Alarm 198

NOTE: This alarm only applies to the TSC system. This alarm does not apply to 50 taper spindle machines. If this alarm is received on a 50 taper TSC machine, check that Parameter 235 is set to zero. A non-zero value will cause the control to act as a 40 taper TSC.

• Check for broken or disconnected precharge air line, and replace if necessary.

• Check if the "Tool Clamped" limit switch is sticking or out of adjustment; readjust or replace if necessary.

• Check for low precharge pressure and check precharge solenoid for proper operation.

• May be generated if another machine alarm occurs during TSC operation.

Mill Pre-Charge Regulator Adjustment

CAUTION! Extreme care must be taken in making this delicate adjustment.

Tools Required: Toolholder with small TSC drill or restrictor (with small orifice #T-1461). TSC Gauge Kit (P/N 93-9011), including 0-15 PSI Precharge pressure gauge, 0-160 PSI Purge pressure gauge, 0-600 Coolant pressure gauge, and ball valve.

1. Insert a short piece of 1/4" plastic tubing into the 0-15 PSI pressure gauge. Insert the short tube into the precharge pressure regulator (located on top of the transmission) and connect the plastic precharge tube (leading to the TRP) to the pressure gauge.
2. Manually turn on the precharge air by pushing the plunger on the precharge solenoid valve.
3. Hold down the precharge solenoid valve for at least 20 seconds to allow the pressure reading to stabilize, then set the precharge pressure to 4.0 PSI (±0.4 PSI). Release the solenoid and hold it down again for 20 seconds and re-check the precharge pressure. Repeat this a few times to ensure the pressure setting remains stable. Be sure the regulator adjustment knob is securely locked in place.
4. Remove the pressure gauge and short 1/4" hose. Reattach the precharge tube to the regulator.

Checking Pump Pressure

NOTE: If the coolant pressure with no tool in the spindle is 60 PSI or less, replace the pump assembly (30-3281A). Old TSC system uses pump head (93-3280B).

1. Insert the 0-600 PSI coolant pressure gauge into the coolant line between the machine enclosure and the TSC pump hose. Use wrenches to tighten the fittings snug. Do not overtighten!
2. Use a standard toolholder (no coolant through hole) and turn on TSC.
3. Check for leaks while the system is running.
4. Turn off TSC, remove pressure gauge, and reconnect the pump to the machine.

If the pump relief valve has been changed, adjust the relief valve in the following manner:

1. Remove the sealing cap from the pump relief valve. Loosen the lock nut.
2. Start with the pressure below 300 PSI. Adjust the pressure relief valve until the pressure on the gauge rises to 300 PSI. Tighten the lock nut, and replace the sealing cap. Setting range is 280-300 PSI.
3. Mark across the pump and sealing cap with a paint marker. This will indicate any future tampering.

Testing the Coolant Pressure Switch

1. Insert the ball valve and pressure gauge into the coolant line between the machine enclosure and the TSC pump hose. The ball valve must be *between* the pump and pressure gauge. Connect the other end to the machine. Tighten the fittings snugly with wrenches. Do not overtighten!
2. Run the system for one minute to purge air.
3. Install a through-hole toolholder (with a small drill or restrictor) and set Parameter 236 to 100.

CAUTION! Changing tools after running TSC can cause coolant to spray out. Wear safety glasses.

4. Turn on the coolant system. Test low coolant pressure switch by slowly shutting off the ball valve in the coolant line (pump should shut off at 40 PSI ± 5 PSI). If the switch is outside this range, replace it.

NOTE: Test electrical continuity of switch cable and control function by monitoring the "Lo Clnt" bit on the Diagnostics page. Shorting the leads should cause the bit to switch from 1 to 0. Check this before replacing the pressure switch.

5. Reset Parameter 236 to the default value (1000).

TSC-1000 Troubleshooting

TSC 1000 pump and motor do not turn on when programmed to (M88/89 or AUX CLNT Button).

1. Check that the TSC 1000 pump has been connected to an external power supply. Power required by default is 208-230 Volt 3-phase 50/60 Hz with a 20-Amp circuit breaker. Alternate power (240-230V 50/60 Hz @ 20 or 480V 50/60 Hz @ 10) can be connected but requires that the pump motor be rewired and the plug replaced. See rewiring directions on the side of the pump motor housing.

2. Check inside the control that a jumper pin is in place over Pin #50 set on the I/O board. The jumper should span pins 1 and 2 (the bottom two pins).

3. Check cable connections. The power supply cable should connect pin set 44 on the I/O board to pin sets 20 and 16 on the power card. The signal cable should connect the TSC out port on the side panel to pin set 45 on the I/O board.

4. Check for blown TSC fuses on the power card.

TSC 1000 pump motor turns on but does not pump (no coolant reaches the spindle).

1. Verify that the auxiliary filter (AF) tank on the TSC 1000 pump stand is full of coolant and sealed tightly. Clean the upper tank ring seal each time the lid is removed.

2. Verify that the spindle is free of debris and that the tool and toolholder being used are TSC-compatible. Some tools have a plug in place that must be removed to use TSC. Before the initial startup of the TSC 1000 system, it is recommended that tools be removed from the spindle.

3. Turn on the TSC 1000 system via a control command (M88 or AUX CLNT button), follow the pressure regulator output hose to the high-pressure fitting, and slightly loosen the fitting.

NOTE: This will cause coolant leakage under pressure. Wrap a rag around the fitting before loosening.

As soon as coolant flow to the spindle is achieved, retighten the fitting to stop the leakage, then turn off the system. Clean any leaked coolant from the hoses and fittings and turn the system back on to verify that there are no more leaks.

TSC 1000 pump turns on and pumps for a time but soon fails or stops pumping.

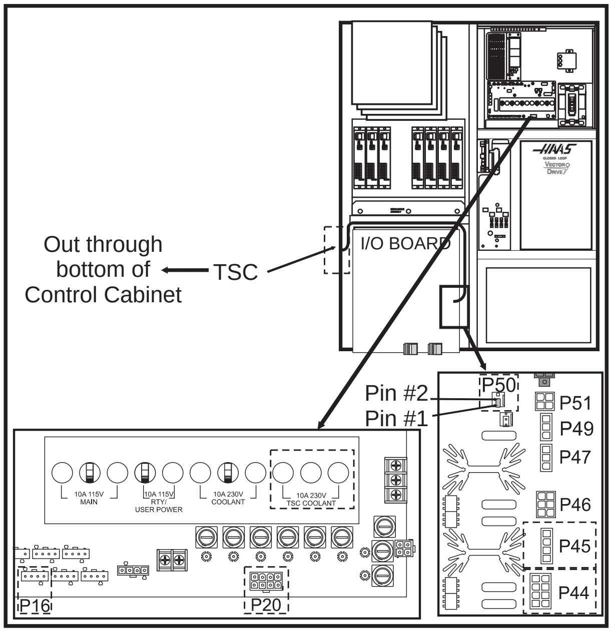
1. Check the AF tank filter bag for clogging or excess debris.

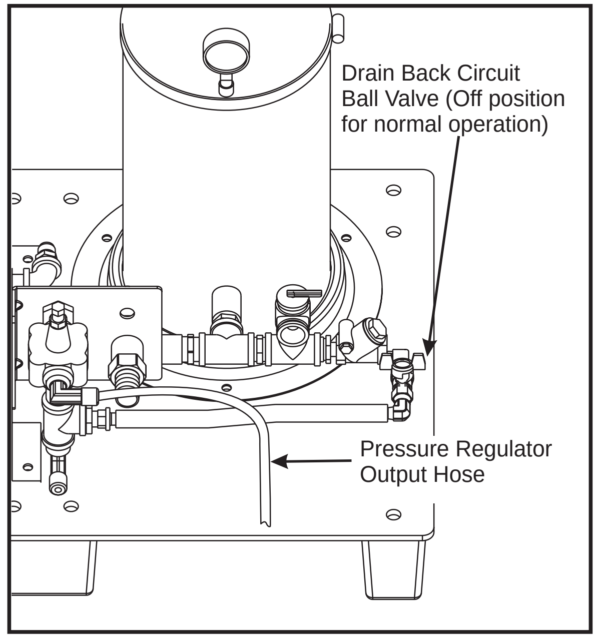
2. Verify that the upper ring seal on the AF tank is undamaged and free of debris.

3. Verify that all fittings are tight on the inlet side of the system and that the standard coolant tank is full.

4. Verify that the drain back circuit valve T-handle is in the off position. See the following illustration.

5. Verify that the standard coolant pump has not been branched off before the check valve.

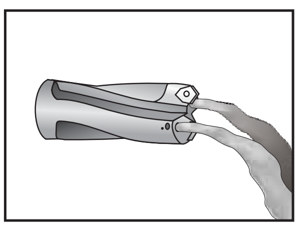


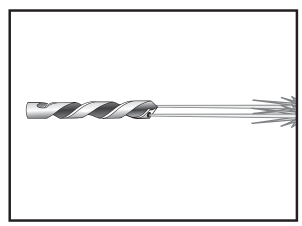


TSC 1000 Control / Electrical Connections

TSC Pressure Effects

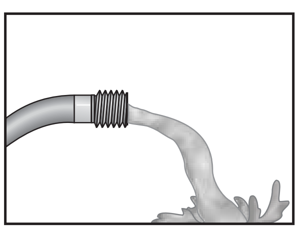
On machines using TSC during cutting operations, tooling size will have to be taken into consideration. As shown below, proper TSC system operation will deliver different pressures at the orifice of the tool; this depends on the diameter and number of coolant passages in the tool.

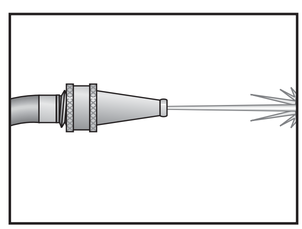


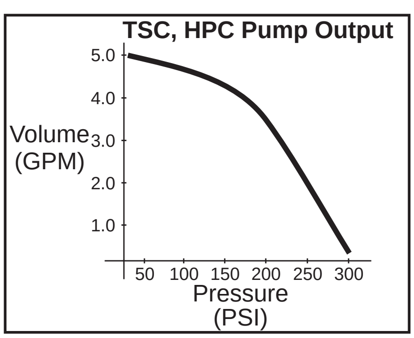


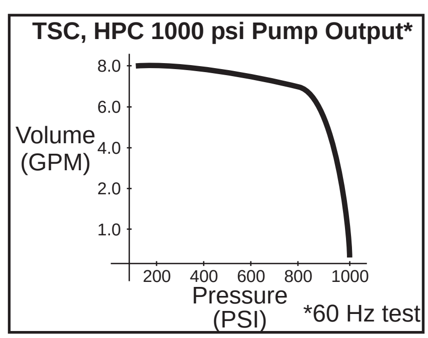
Larger tooling has larger diameter coolant passages. Coolant flow is higher at lower pressures

Smaller tooling has smaller diameter coolant passages. This produces higher pressures at lower flow.

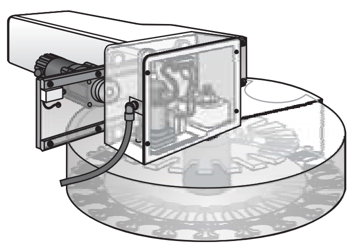


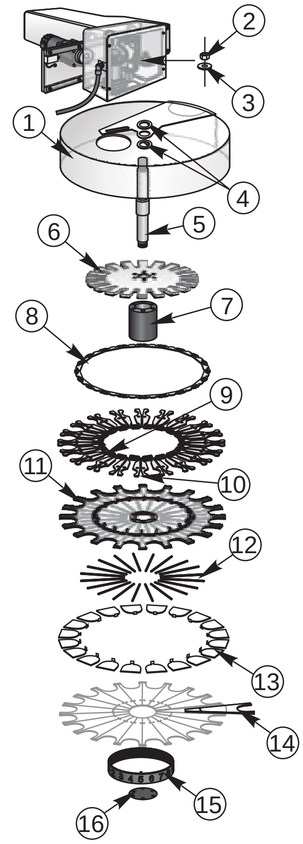






1. Tool Changer Trap Door
2. Loc Nut Elastic
3. Washer
4. Nylon Washer
5. Vertical Axle
6. 2 Pin Geneva Star
7. Bearing Housing
8. Extractor Key
9. Extractor Spring
10. Extractor Finger
11. 20 Pocket Carousel
12. Tool Changer Door Spring
13. Sliding Panel
14. Sliding Panel Cover
15. Number Ring
16. Cap, Tool Changer





Tools are always loaded through the spindle and should never be installed directly in the carousel in order to avoid crashes. The pocket open to the spindle must always be empty in the retracted position. All wiring to the tool changer goes through connector P8 on the side of the control cabinet.

Low air pressure or insufficient volume reduces the pressure applied to the tool unclamp piston and slows down tool change time or will not release the tool. The air pressure is checked prior to moving the carousel on a mill with a side mount tool changer and Alarm 120, Low Air Pressure, is generated if such a problem exists.

If the shuttle should become jammed, the control will automatically come to an alarm state. To correct this, push the Emergency Stop button and remove the cause of the jam. Push the Reset key to clear any alarms. Press "Tool Changer Restore" button, to automatically reset the tool changer after a crash.

There is a fuse for tool changer motors. It might be blown by an overload or jam of the tool changer. Operation of the tool changer can also be interrupted by problems with the tool clamp/unclamp and the spindle orientation mechanism. Problems with them can be caused by low air pressure or a blown solenoid circuit breaker (CB2).

TROUBLESHOOTING

Refer to the alarm description when problems arise with the ATC, and see the Spindle section for additional trouble shooting information.

Deflection

Deflection is usually caused by ATC misalignment, and sometimes caused by damaged or poor quality tooling, a damaged spindle taper, or a damaged drawbar or poor air supply. Before beginning any troubleshooting, observe the direction of the ATC deflection.

During a tool change, the umbrella tool changer appears to be pushed down.

• Check to see if pull studs on the toolholder are correct and tight.

• Check the adjustment of the “Z” offset (Parameter 64).

NOTE: If the offset is incorrect, a tool changer crash can occur and a thorough inspection of the ATC will be necessary.

• Check the adjustment of the “Z” offset. Check Parameters 71, 72, and 143 against the values that are in the documentation sent with the machine.

• Ensure the toolholders are held firmly in place by the extractor forks.

• Ensure the balls on the drawbar move freely in the holes in the drawbar when the Tool Release button is pressed. If they do not move freely, the ATC will be pushed down about 1/4" before the toolholder is seated in the taper, resulting in damage to the roller bolts on the ATC shuttle. Replace the drawbar.

• Check drawbar height adjustment.

• If TSC, check for excessive coolant tip wear.

Toolholder sticking in spindle taper causes umbrella tool changer to pull up, accompanied by popping noise, as spindle head is travelling distance specified in Parameter 71.

NOTE: Loading a cold tool into a hot spindle (a result of thermal expansion of the toolholder inside the spindle taper) may cause this. It may also occur in cuts with heavy vibration (also the result of thermal expansion). If sticking only occurs during these situations, check your application to ensure use of proper machining techniques. If tool is pulled out of extractors due to a tool being stuck in the taper, the unclamp switch is not adjusted correctly or is bad.

• Check the condition of the customer’s tooling, verifying the taper on the toolholder is ground and not turned. Look for damage to the taper caused by chips in the taper or rough handling. If the tooling is suspected, try to duplicate the symptoms with different tooling.

• Check the condition of the spindle taper. Look for damage caused by chips or damaged tooling. Also, look for damage such as deep gouges in the spindle taper caused by tool crashing.

• Duplicate the cutting conditions under which the deflection occurs, but do not execute an automatic tool change. Try instead to release the tool using the Tool Release button on the front of the spindle head. If sticking is observed, the deflection is not caused by improper ATC adjustment, but is a problem in the spindle or tool release piston. See the "Spindle Assembly" section for spindle cartridge replacement.

• Check for air supply pressure of 85 PSI (min). An air pressure drop of 10 PSI during tool release is acceptable. A drop greater than 10 PSI is caused by a supply line restriction or an undersize supply line. Use of quick couplers ($^1/_4$") can cause restriction. Directly connecting the air hose to a barb fitting can help.

During tool change, the umbrella tool changer appears to be pulled up; no popping noises.

• Check the adjustment of the “Z” offset ("Setting Parameter 64" section).

NOTE: If the offset is incorrect, a tool changer crash can occurred, and a thorough inspection of the ATC will be necessary.

• Ensure the roller bolts on the shuttle of the ATC are tight against the V-guides on the ATC holding arm. If the lower right roller bolt is loose against the V-guide, the upper right bolt is probably bent. Bent roller bolts are a symptom of another problem with the ATC. Repair the bent roller bolt and isolate the ATC problem.

• Check Parameter 71 against the values that are in the documentation sent with the machine.

• Ensure the balls on the drawbar move freely in the holes in the drawbar when the Tool Release button is pressed. If they do not move freely, the ATC will be pushed down about ¼” before the toolholder is seated in the taper, resulting in damage to the roller bolts on the ATC shuttle. Replace drawbar.

Toolholders twist against extractor fork during a tool change.
• Check the alignment of the ATC in the X and Y axes ("Automatic Tool Changer Alignment" section).

Toolholders spin at all pockets of the ATC when the ATC shuttle retracts.
• ATC is misaligned in the “Y” axis; realign ATC. Observe the direction the toolholder rotates, as this will be the direction in which the “Y” axis of the ATC needs to be moved.

Toolholders spin only at certain pockets of the ATC when the ATC shuttle retracts.
• Check all the extractor forks to ensure they are centered in the pocket of the ATC. If the ATC shows this problem, each extractor fork must be checked and centered to eliminate the possibility of the ATC being aligned against an incorrectly-centered fork.

Noisy Operation
To isolate noise(s) in the ATC, carefully observe the ATC in operation and look for the following:

ATC makes noise as the shuttle moves.
• Check the adjustment of the roller bolts on the ATC. Loose roller bolts can cause the ATC to make a clunking noise when the shuttle is commanded to move. Tight roller bolts can cause the shuttle motor to stall, possibly damaging the motor or the I/O board. In this case, the shuttle may also move too slowly.

• Check for damage to the trap door on the ATC cover. See appropriate section for trap door replacement.

• Check for missing plastic riders on ATC shutter. See appropriate section for shutter replacement.

• Ensure guide pin mounted to holding plate is not bent and does not scrape ATC cover during movement.

• Listen for damage to the gear train in the shuttle motor. If the motor is the source of the noise, replace the motor. Do not try to repair the motor or to further isolate motor noise.

• Ensure the Geneva driver on the turret motor is tight and properly adjusted. If the Geneva driver is found to be loose, check for damage to the Geneva star. Any roughness in the slots will require that it be replaced.

• Check the adjustment of the Geneva driver in relation to the Geneva star. If the adjustment is too loose, the carousel will vibrate heavily and make a loud clanking noise during carousel rotation. If the adjustment is too tight, the turret motor will labor excessively and the carousel may appear to move erratically.

NOTE: If turret motor adjustment is tight for extended periods, the turret motor, Geneva star, and I/O board may be damaged. If Geneva star adjustment appears tight at some pockets and loose at others, the problem lies with the Geneva star. Check concentricity of the star relative to the bearing housing on the carousel. If it is within specification and the problem remains, replace the Geneva star.

• Ensure screws holding the turret motor to the mounting plate are tight.

• Ensure the screws attaching the motor mounting plate to the shuttle casting are tight.

• Check for excessive noise in the turret motor gear train. See appropriate section for replacement.

NOTE: If the motor is found to be the source of noise, replace the motor assembly (motor, mounting plate, and Geneva driver). **Do not** attempt to repair the motor or to further isolate the problem in the motor.

Orientation
When commanded to orient the spindle, the spindle will rotate to the position determined by Parameter 257 (spindle orient offset).

ATC out of orientation with the spindle. Incorrect spindle orientation will cause the ATC to crash as the shuttle moves. Alarm 113 will be generated.
• Check the orientation of the spindle.

ATC will not run.

• In all cases where the tool changer will not run, an alarm is generated to indicate either a shuttle in/out or turret rotation problem. The alarms occur either on an attempt to change tools (ATC Fwd) or to Zero Return the machine (Auto All Axes). Use appropriate alarm to select one of the following problems:

ATC shuttle will not move; shuttle is getting power (Command a tool change and check for power being applied to the shuttle motor).

• Disconnect the slip clutch arm from the ATC shuttle and ensure the shuttle can move freely. If not, see appropriate section for shuttle adjustment.

• Command a tool change with the shuttle disconnected.

  • If shuttle cycles, check slip clutch on the ATC. See appropriate section for slip clutch replacement.

NOTE: The slip clutch should move the shuttle with a fair amount of force, but not so much that the shuttle cannot be made to slip when holding it back by hand. If the slip clutch is frozen, replace it. It cannot be rebuilt in the field.

  • If ATC shuttle does not cycle, motor has failed and must be replaced. Turn motor by hand and feel for binding in the gear train, which uses a large amount of gear reduction and is hard to turn by hand.

ATC shuttle will not move; shuttle is not getting power.

• Command a tool change check for power being applied to the shuttle motor.

• Check that the TC In/TC Out LED on the I/O PCB is illuminated when a tool change takes place.

  • If LED lights, check fuse FU5 on the Power PCB or FU1 on the I/O PCB. Otherwise, check I/O PCB.

  • If the LED does not light, check cables I/O-P65-510 and I/O-P64-520.

• Check ATC shuttle relay

ATC turret will not rotate; turret motor is getting power.

• Command a tool change check for power being applied to the turret motor.

• If power is applied, but output shaft on motor does not turn, check for binding between turret motor assembly and Geneva star. Check for damage to Geneva star or Geneva driver. Check for a broken turret motor.

NOTE: Do not attempt to repair the motor or to further isolate the problem in the motor.

ATC turret will not rotate; turret motor is not getting power.

• Command a tool change check for power being applied to the turret motor.

• Check that the TC CW/TC CCW LED on the I/O PCB is illuminated when a tool change takes place.

  • If LED lights, check fuse FU5 on the Power PCB or FU1 on the I/O PCB. Otherwise, replace I/O PCB.

  • If LED does not light, check cables I/O-P65-510 and I/O-P64-520.

  • Check ATC turret relay.

Tool Changer Position Switches

Two switches are used to sense the position of the tool changer carousel. One switch is activated when the carousel is moved full travel inward and one is activated when it is full travel outward. These switches are normally closed so that both will be closed between in and out. The diagnostic display will show this status of this input switch. A “1” indicates the associated switch is activated or open.

Breakage

Breakage of the ATC is caused by either very hard and repeated crashes or excessive TSC coolant tip wear.

ATC shuttle is broken off of the holding plate.

• Carefully inspect bosses on the shuttle casting (where roller bolts mount) for damage to the threads or cracks. If any bosses are cracked, replace the casting. Realign the tool changer after repairing machine.

ATC extractor forks are damaged after breakage.
• Check the condition of the mounting holes in the carousel. If the threads are damaged, they must be repaired or the carousel replaced. See appropriate section for extractor fork replacement.

Crashing

If any of these crashes occur, thoroughly inspect the ATC for damage. Pay close attention to extractor forks, sliding covers on ATC carousel, and roller bolts on the ATC shuttle. See appropriate section for extractor fork replacement.

Crashing of the ATC is usually a result of operator error. The most common ATC crashes occur as the part or fixture on the mill table crashes into long tooling or into the ATC double arm during a tool change

• Inspect the pocket involved in the crash for damage and replace parts as necessary.

• The machine will normally home the Z-axis as part of the tool change sequence. Check Parameter 209 bit "TC Z No Home", and ensure it is set to zero.

The most common ATC crashes are outlined as follows:

Shuttle crashes into spindle when a tool change is commanded (toolholder is in the pocket facing the spindle head).
This crash is fairly common and is due to operator error. If the ATC is stopped in the middle of a tool change cycle, the operator must command the ATC to an empty pocket before the machine will operate correctly. Repeated crashes of this type can damage the I/O board, slip clutch, and shuttle motor in the ATC.

• Rotate the carousel to an empty pocket.

During a tool change spindle crashes into top of the toolholder after a turret rotation.
When the spindle head moves down over the top of the toolholder during a tool change, the pull stud will bind inside the drawbar bore of the spindle, forcing the ATC down, breaking the carousel. Bending the upper right roller bolt on the ATC shuttle or completely breaking it off is also possible. Toolholder is not held correctly in the extractor fork, possibly held only in one side of the extractor and at an odd angle.

• Check all of the extractor forks on the ATC.

During a tool change spindle crashes into top of the toolholder after a turret rotation.
The balls in the drawbar do not move freely, causing the ATC to be forced down far enough to break the carousel. Bending the upper right roller bolt on the ATC shuttle or completely breaking it off is also possible.

• Ensure balls on the drawbar move freely in the drawbar holes when the Tool Release button is pressed. If this failure occurs, check all of the extractor forks on the ATC for damage and repair the spindle drawbar.

• Check drawbar height and set according to the appropriate section, if necessary.

ATC puts toolholder in spindle, but tools are dropped onto machine table when shuttle retracts.
• Inspect the balls and the Belleville springs in the drawbar. Replace drawbar.

The part or fixture on the mill table crashes into long tooling or into the ATC itself when machining.
• Reposition the tools to remove interference, or program carousel to rotate long tooling out of the way.

Carriage Casting Replacement

Tools Required: Two-jaw puller Hydraulic jack 1-2-3 Block Cardboard

If the carriage casting is damaged in a crash, it must be replaced. Look specifically for broken bosses where the roller bolts mount to the casting. If the carriage casting is broken off of the holding plate but not damaged, only the roller bolts need be replaced.

1. Turn the machine power off. Remove the left side enclosure panel of the machine.
2. Disconnect all cables from the carriage casting and remove any bolts holding the ATC to the holding plate.

NOTE: If the carriage casting has been damaged, replacement is necessary; move the ATC to a bench and remove all components from the damaged carriage casting and place in the new casting. Skip to Step 6 for replacement.

3. Place a piece of cardboard over the machine's table, and carefully lower the carriage casting (with carousel) onto the machine table.
4. If the carriage casting has crashed and/or has been broken off of the holding plate, it should be inspected for damage before going any further.
5. Remove any damaged roller bolts from the carriage casting. Replace with new bolts.
6. With a lifting device, carefully lift the ATC assembly up and onto the holding plate.

NOTE: Ensure cam follower on the slip clutch engages slot on the carriage casting.

7. With the ATC assembly securely supported, install the lower roller bolts and adjust in accordance with "Roller Bolt Replacement".
8. Repair or replace any cables damaged and adjust the ATC. Align the ATC assembly in accordance with the following sections, and set Parameter 64 in accordance with "Spindle Motor and Transmission" section.

Roller Bolt Replacement

1. Remove the shuttle motor cover from the back of the machine (VF-1, VF-2).
2. Place a support under the center of the carousel.
3. Loosen the eccentric locks on the bottom roller bolts.

CAUTION! Ensure the ATC is securely supported, otherwise it may fall when an upper roller bolt is removed.

4. Carefully remove the damaged roller bolt from the ATC shuttle and replace with a new bolt.

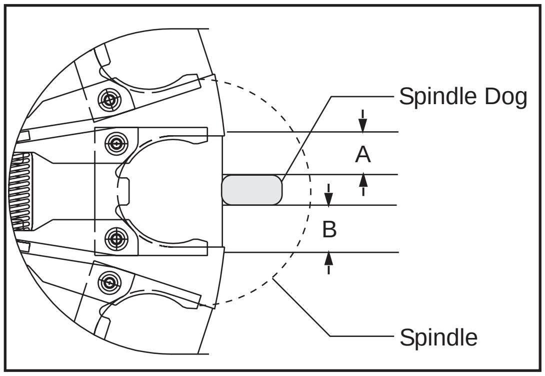
NOTE: Replace only one roller bolt at a time. Carefully inspect the V-groove rollers for roughness or damage, and replace if necessary.

5. Tighten the eccentric locks on the bottom rollers until there is no play between the rollers and the V-guide on the ATC holding plate.
6. Set the tool change offset (Parameter 64) in accordance with "Setting Parameter 64" section.
7. Verify the ATC alignment in accordance with the following section.
8. Reinstall the shuttle motor cover (VF-1, VF-2).

ATC Alignment

1. Verify that the spindle orientation is correct (refer to appropriate section).
2. Command an automatic tool change, and press Emergency Stop when the shuttle is fully in.
3. Verify that the spindle dog lines up to the alignment key in the ATC, in the Y plane.

NOTE: If the spindle dog and alignment key do not line up, loosen the four HHB that hold the ATC holding arm to the column.



Underside Showing Centering Measurements

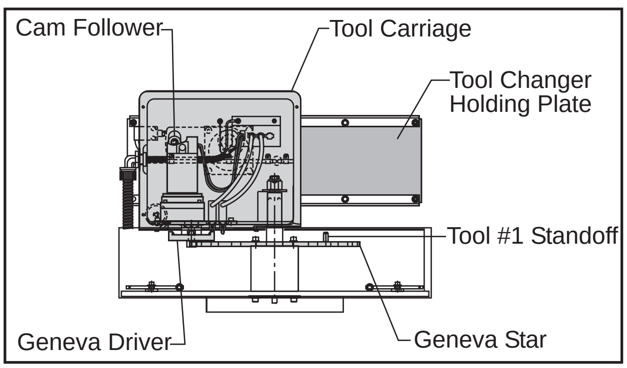
4. Move entire tool changer until the tool alignment key lines up with the spindle dog. Tighten the four HHB.

NOTE: Parameter 64 must be checked and adjusted when the ATC is aligned.

5. Make at least 50 tool changes after alignment is complete. Verify tools are being picked up squarely.

Shuttle Stroke Adjustment

1. Move the ATC away from the spindle and loosen the four HHBs in the ATC holding arm in the X-axis plane.
2. Push the cam follower to its full upward stroke, then push the entire ATC assembly in by pushing on the tool changer holding plate until ATC is fully engaged on the toolholder.
3. Ensure the extractor is making full contact on the tool flange.



Automatic Tool Changer - Mechanical Assembly (Side View)

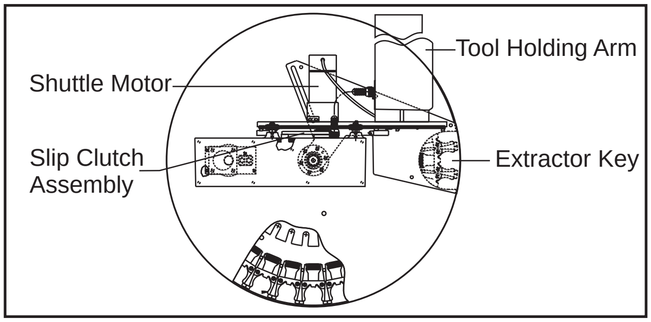
Extractor Fork Replacement

NOTE: Extractor forks that do not hold the toolholders firmly, or forks that are bent, must be replaced. Damage to the ATC will result if not replaced.

1. With no toolholders in the spindle or in the ATC, command "ATC Fwd" until the extractor fork needing replacement is facing the spindle.
2. Command "ATC Fwd", but press Emergency Stop after the spindle head lifts up off the carousel.

NOTE: At this point, the shuttle should be in and the spindle should be about 4½" above the carousel.

3. Loosen the SHCS that attach the damaged extractor fork to the ATC carousel.



Automatic Tool Changer - Mechanical Assembly (Top View)

4. With the extractor fork removed, inspect the alignment key mounted under the extractor. If it is damaged due to improper spindle orientation, replace it and correct the orientation (refer to appropriate section) after the extractor fork has been replaced.

5. Put a drop of blue Loctite on each of the SHCS and attach the new extractor fork to the ATC with the SHCS. **Do not over-torque!** Ensure the distance from the edge of the extractor fork to the edge of the pocket in the carousel is the same on both sides in accordance with the following section.

6. Test run the ATC to ensure proper operation.

Sliding Cover Replacement

NOTE: If any of the sliding covers on the ATC do not slide freely or are bent in a crash, they must be replaced.

1. Loosen the four screws that attach the sliding panel cover to the carousel. Be careful to not lose the spring that holds the sliding cover closed or the number plate on the ATC carousel.

2. Inspect the cover for any galling or damage. Inspect the spring for damage.

3. Loosely install the two innermost screws that attach the number plate and the cover to the carousel and slide the spring into position in the slot in the ATC carousel.

4. Put the replacement sliding panel in place, making certain that the tongue on the panel pushes on the end of the spring.

5. Tighten the two rear screws completely and install the two front screws.

6. Ensure the sliding panel moves freely.

NOTE: If the sliding door is bent, determine why before resuming normal operation.

Shuttle In/Out Motor

A motor moves the tool changer assembly (shuttle) towards and away from the spindle. The motor is geared to a low RPM and then connected to an arm that rotates through 180° and pushes the shuttle in and out.

Removal

1. Turn the mill off, and remove the cover from the tool carriage casting.

2. Remove the hex bolt that attaches the cam follower to the slip clutch.

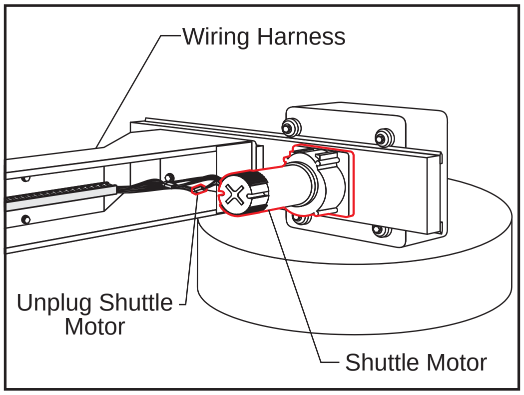
3. Push the tool changer in as far as it will go.

4. Loosen the set screw that secures the slip clutch assembly to the shuttle motor .

5. Using a small two-jaw puller, pull the slip clutch assembly off the shuttle motor shaft.

6. Remove the SHCS attaching the cover to the holding arm casting on the tool changer.

7. Remove cover from wire channel inside holding arm casting and unplug shuttle motor from wiring harness.



Wiring Harness for Shuttle Motor

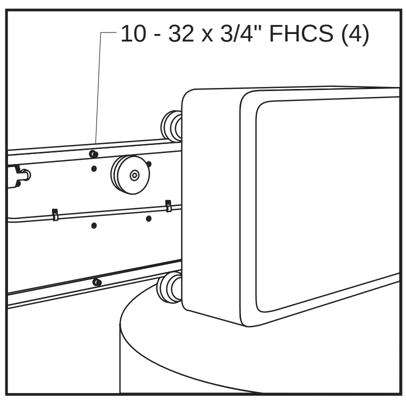
8. Remove the four FHCS attaching the shuttle motor to the holding plate on the tool changer. The FHCS are visible from the front of the VMC. Do not remove the HHBs holding the shuttle motor gearbox together.

Installation

1. Install the new motor on the tool changer holding plate using the four 10-32 x ¾" FHCS. Before inserting the FHCS, place a drop of blue Loctite® on each screw.

2. Reattach the shuttle motor connection to the wiring harness in the holding arm casting.

3. Replace the cover on the holding arm casting.



Front View of Holding Plate Showing FHCS Location

4. Reattach the slip clutch assembly to the shuttle motor shaft. Before placing on the shaft, put two or three drops of red Loctite® on the slip clutch hub.

5. Insert and tighten down the set screw holding the slip clutch assembly to the shuttle motor shaft. Before inserting the set screw, put a drop of blue Loctite® on the set screw.

6. Ensure the actuating arm on the slip clutch assembly is within 0.12" of the shuttle In and Out proximity limit switches, or makes contact with mechanical limit switches.

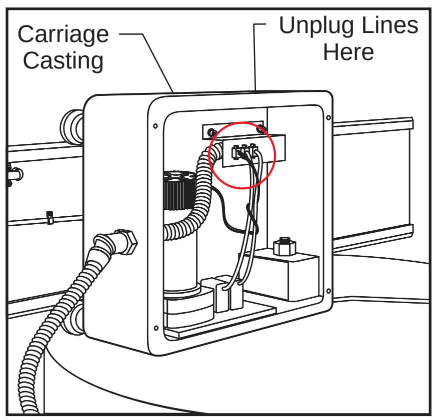
7. Ensure the hub of the slip clutch assembly does not interfere with the face plate on the shuttle motor.

8. Start the VMC and perform at least 30 tool changes, assuring correct operation.

A motor is used to rotate the tool turret between tool changes. This motor is geared to a low RPM and connected to a Geneva mechanism. Each 1/2 revolution of the Geneva mechanism moves the tool turret one tool position forward or backward.

Removal

1. Power on the mill and put it in MDI mode.
2. Zero Return all axes (Zero Ret - Auto All Axes).
3. Press ATC Fwd, then Emergency Stop after the spindle head has moved during the tool change cycle. The tool changer should be at the full In position and the spindle head should be above the tool changer.
4. Turn the mill power off.
5. Remove the 10-32 SHCS from the carriage casting cover and remove the cover.
6. Tag both limit switch connections for reassembly, then unplug the limit switches and the power connections at the carriage casting.
7. Remove the four SHCS attaching the turret motor and mounting plate to the tool carriage casting.

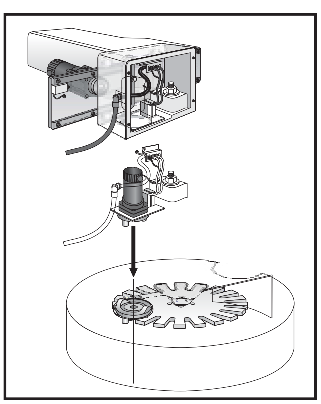


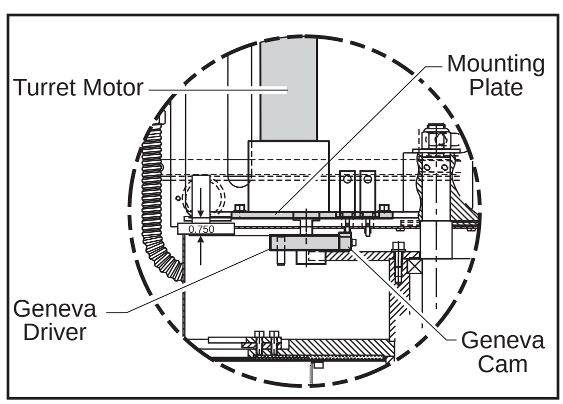
Carriage Casting with Cover Removed

8. Carefully lift the turret motor assembly off of the tool carriage casting.

NOTE: The gear motor should never be disassembled and is not field-serviceable. All gear motors should be returned to Haas for evaluation.

Installation





Required Spacing for Geneva Driver

1. Grease the locking element and drive pin on the Geneva driver. Also, grease the teeth on the Geneva star.
2. Rotate the Geneva driver until the cam depresses the limit switch on the turret motor assembly.
3. Place a narrow strip of paper around the locking element of the Geneva driver and install the turret motor assembly onto the casting. Be certain that the locking element of the Geneva driver is seated against the star with the paper strip acting as a shim.
4. Attach the turret motor assembly to the carriage casting with the four SHCS.
5. Reconnect the power and limit switch lines to the turret motor.
6. Power on the mill and Zero Return all axes (Zero Ret - Auto All Axes).
7. Go to MDI mode and press "T - 1 - ATC Fwd".

NOTE: The machine may alarm at this time (Alarm 115 or 127). If this occurs, Zero Return the Z-axis (Zero Ret - Singl Axis) and repeat step 7. This step may need to be repeated two times to clear all possible alarms.

8. Press "T - 9 - ATC Fwd". The tool changer should go to tool nine. If the tool changer travels to tool seven, the turret motor is wired backward. Reverse motor leads and repeat steps 7-10. The turret should run quietly with no strain in the motor, banging, or vibration.
9. Reinstall the tool carriage casting cover.
10. Test the tool changer for proper operation.

Geneva Star Replacement

NOTE: If ATC Geneva star is damaged or worn in its driven slots, it must be replaced.

1. Turn the machine power off.
2. Remove the cover from the front of the ATC shuttle.
3. Remove the turret motor assembly (refer to previous section).
4. Place a support for the ATC under the center of the carousel.
5. Loosen the nut inside the carriage casting that attaches the ATC carousel assembly to the casting. There is a socket head in the top of the shaft to hold it stationary while loosening the nut.
6. Place the cardboard over the mill table and carefully lower the carousel until it rests on the table.
7. Remove the six SHCS that attach the Geneva star to the bearing housing on the ATC carousel.
8. Install the Tool #1 standoff on the replacement Geneva star.
9. Install the replacement Geneva star. Check the concentricity of the star to the shaft on the carousel assembly; it must be within 0.005". If the star is not within tolerance, loosen the SHCS and adjust the alignment until it is acceptable.
10. Installation is reverse of removal. Grease the perimeter of the star before installation and readjust the ATC in accordance with "ATC Alignment" and "Shuttle Stroke Adjustment", if necessary.

ATC Trap Door Replacement

NOTE: If the ATC trap door is damaged in a crash, it must be replaced.

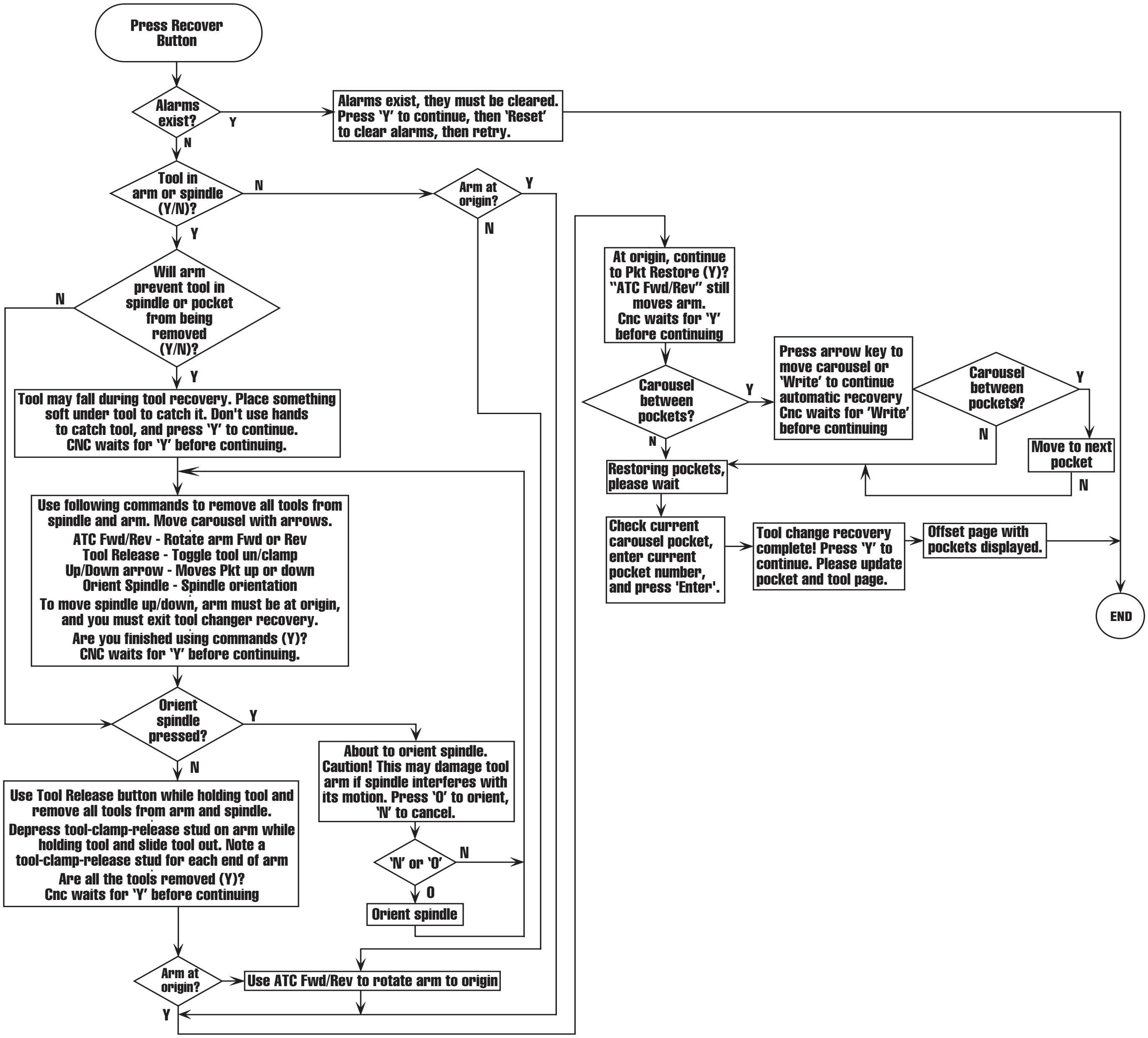
1. Turn the machine power off.
2. Remove the turret motor assembly in accordance with the previous section.

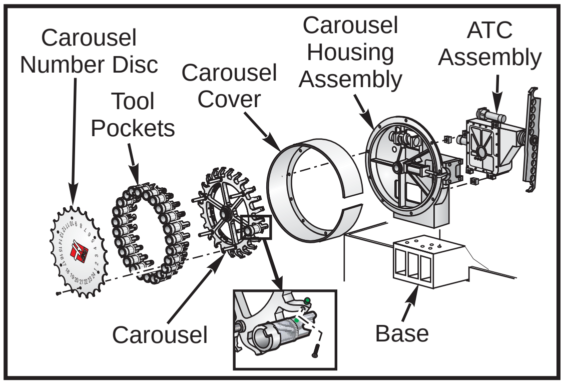
3. Place a support for the ATC under the center of the carousel.
4. Loosen the nut inside the carriage casting that attaches the ATC carousel assembly to the casting. There is a socket head in the top of the shaft to hold it stationary while loosening the nut.
5. Place the cardboard over the mill table and carefully lower the carousel until it rests on the table.
6. Remove the two SHCS that attach the guide pin for the ATC trap door to the ATC holding plate and remove the guide pin.
7. Slide the trap door from between the carousel cover and the shuttle casting. Be careful to not lose the two nylon washers that sandwich the trap door between the carousel cover and the shuttle casting.
8. Installation is reverse of removal. When installing the guide pin, ensure the mounting slot is approximately central to the mounting screws and that the pin does not interfere with the top of the ATC carousel cover. Grease the carousel cover where the plastic standoffs ride, the slot in the ATC shutter, the guide pin, and the nylon washers where the shutter pivots. ATC positioning may need to be readjusted after installation.

The tool changer is driven by a single axis control mounted inside the cabinet.

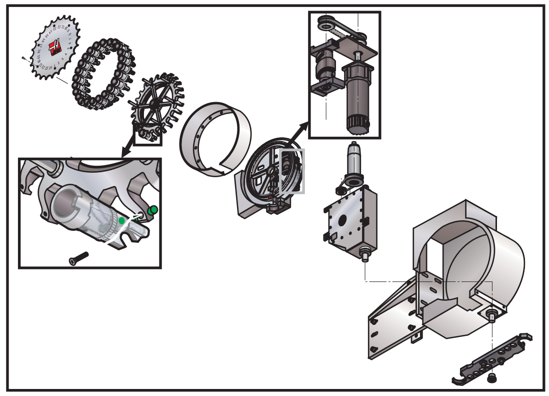
TROUBLE SHOOTING

Side Mount Tool Changer Recovery Flow Chart





SMTC (Horiz)



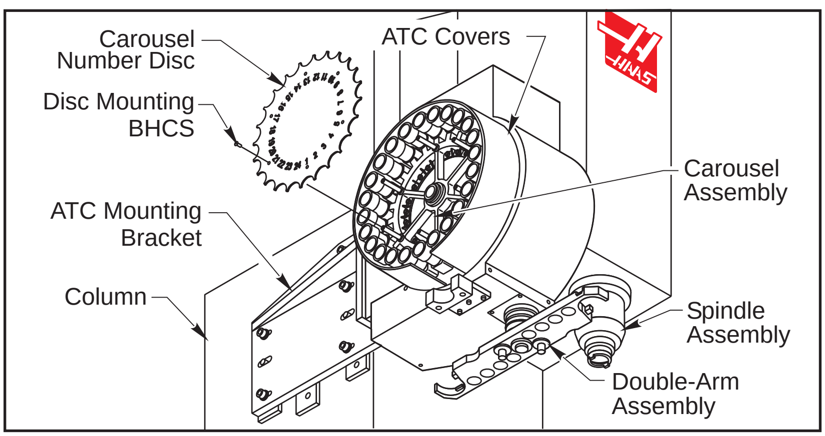
SMTC (Vert)

Special Tools Required: Lifting Device (1000lb capacity for 40-pocket ATC removal, 3000lb capacity for 60- and 70-pocket ATC removal), Spanner Wrench, Split Tools

Removal

1. Power Off machine.

2. Unscrew the BHCS from the carousel number disc and remove.



3. Using a spanner wrench, remove nut on the center shaft of the carousel.

4. Carefully pull the carousel assembly from the ATC center shaft. Lift carousel away from the machine and carefully avoid hitting the sheet metal covers. Place assembly in service area.

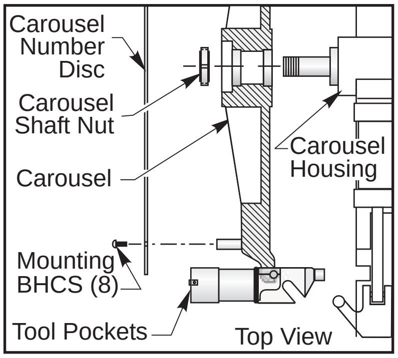
CAUTION! Be careful not to bend the tool pocket orientation tabs when storing the carousel assembly.

5. Unscrew the FHCS for each tool pocket. Remove the tool pocket holders from carousel as shown below.

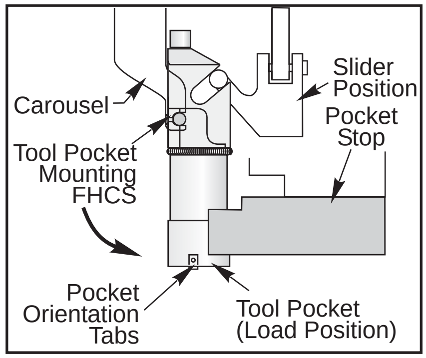
Installation

1. Carefully lift and place carousel onto the center shaft.

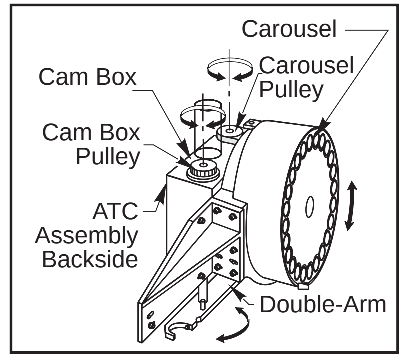
2. Install new carousel retaining nut onto the ATC center shaft and torque to 85 ft-lbs (place the locking portion of the nut toward the end of the shaft). Remove the pocket stop and slider.



Carousel Assembly



Carousel and Tool Pocket Installation



Pulley Locations and ATC Movement

3. Install each toolholder through the spindle. Attach the tool pocket to the carousel. Apply blue loctite to the Torx and torque to 15 ft-lbs (1/4-20) / 23 ft-lbs (5/16-18). Manually rotate the carousel for each tool pocket installation. Re-install the pocket stop and slider as shown above. The carousel can be rotated by manually rotating the carousel pulley by hand as shown above.

50 Taper Carousel Removal and Installation

Special Tools Required: Lifting Device (3000 lbs. capacity for Tool Changer Removal), Haas tool P/N 1357

CAUTION! Do not attempt to remove the carousel with the pockets installed.

1. Remove sheetmetal disc covering the carousel. Press Tool Changer Restore. Press **Y** three times to enter Tool Changer Recover Mode.
2. Remove all tool changer pockets. See "SMTC Pocket Removal and Installation" in this section.

NOTE: The carousel can be manually rotated by turning the carousel drive motor by hand while in E-Stop.

3. Remove the center bearing nut using Haas tool P/N 1357.
4. Remove the carousel using a suitable lifting device.

CAUTION! The carousel is extremely heavy. Ensure you have an appropriate lifting device and straps capable of lifting the carousel weight.

Installation

1. Using a suitable lifting device, place the carousel onto the tool changer body.
2. Use a new bearing nut and thread onto the carousel shaft. Torque to 80 ft. lbs.
3. Install pockets into the carousel following the "SMTC Pocket Removal and Installation" section.
4. Rotate the carousel by hand to the next pocket. Line up the pocket mounting finger with the actuator shaft (or micro switch) on the flat spot on the carousel cam.

ATC Assembly Removal/Installation

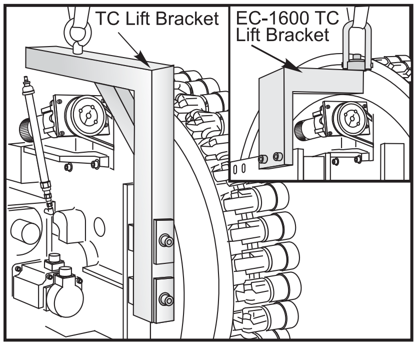
Special Tools Required: Lifting Device (3000lb Capacity), Lifting Bracket/Bar

Removal

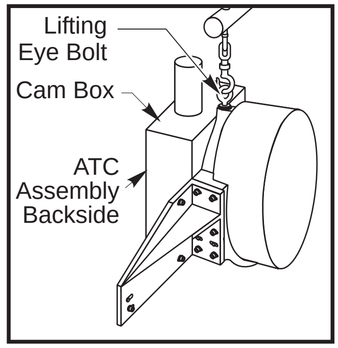
1. Power off machine.
2. Remove all ATC assembly sheet metal covers and fasteners.

3. Remove the tool changer amphenol connection at the control box and tool pocket air line at the top of the carousel. Wrap and tie the amphenol connector to the top of the carousel cam box.

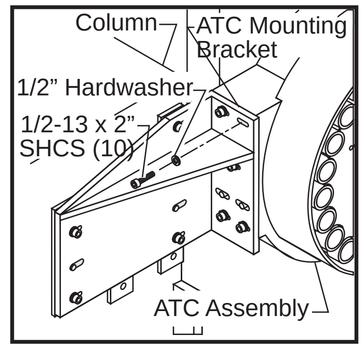
4. Insert an eyebolt into the threaded 1/2-13 hole at the top of the carousel housing. Note that 60-, 70-pocket and 50-taper/50-tool tool changers require that a lifting bar be attached to the back of the carousel housing assembly (see illustration). Attach the lifting device to the eyebolt and support the ATC assembly as shown. Remove the five carousel mounting SHCS from the Vertical ATC mounting bracket and move ATC assembly away from the column as shown.



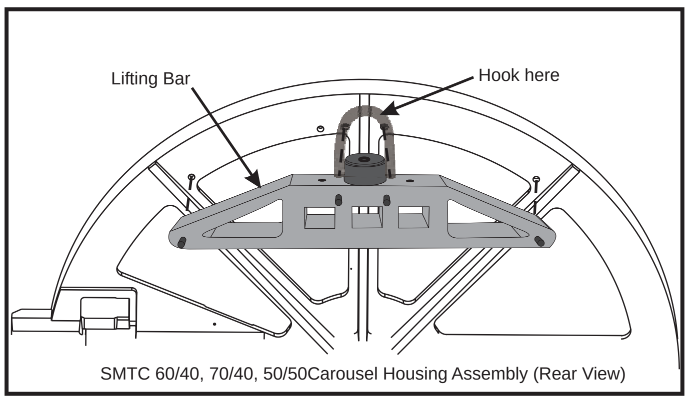
Horizontal ATC Assembly Lifting Position



Vertical ATC Assembly Lifting Position



Vertical ATC Mounting Bracket



Lifting Bar Mount Location

5. Carefully raise the ATC assembly until it is out of the machine. Avoid catching the double-arm on other machine parts.

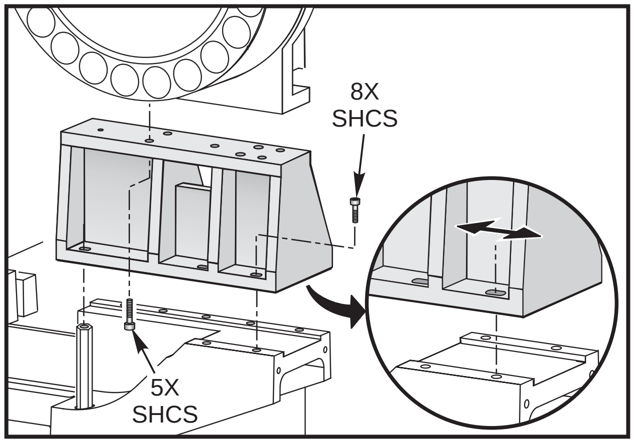
6. Lower the ATC assembly with the back side of the cam box towards the ground.

Installation

1. Power Off machine.

2. Clean mounting surfaces of the ATC mounting bracket and the ATC.

3. Align the ATC with the mounting bracket and attach with SHCS. Only snug the SHCS.



Horizontal Tool Changer Installation

4. Reconnect the tool changer amphenol connector to the control and reattach the air line to the carousel assembly.
5. Align the ATC assembly according to section on ATC alignment.
6. Torque the SHCS to 100 ft-lbs.
7. Replace all carousel sheet metal covers and fasteners. Apply blue loctite to all fasteners and tighten.

ATC Alignment (Horiz)

This procedure is to assist in the alignment of the automatic tool changer and the double arm for the EC-300, EC-400, EC-500, and EC-1600-3000 Horizontal Mills.

Use Split Tool P/N	T-2086 for 40 taper, CT type	T-2088 for 50 taper, BT type
	T-2087 for 40 taper, BT type	T-2089 for 50 taper, CT type

Horizontal machines require three directions of alignment, as well as spindle orientation. Note that:

EC-300: The X-, Y- and Z-axis, and the spindle orientation are set by parameters

EC-400 and EC-500: The X- and Y-axis, and the spindle orientation, are set by parameters. The Z-axis is adjusted by physically moving the SMTC.

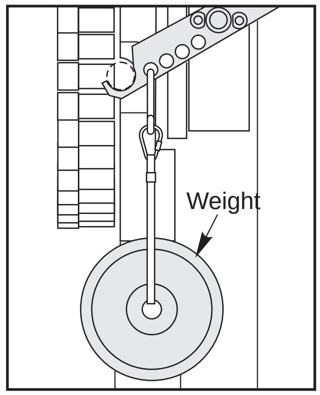
EC-1600 - EC-3000: The Y- and Z-axis, and the spindle orientation, are set by parameters. The X-axis is adjusted by physically moving the SMTC.

Horizontal Machine Double Arm to Tool Pocket Alignment

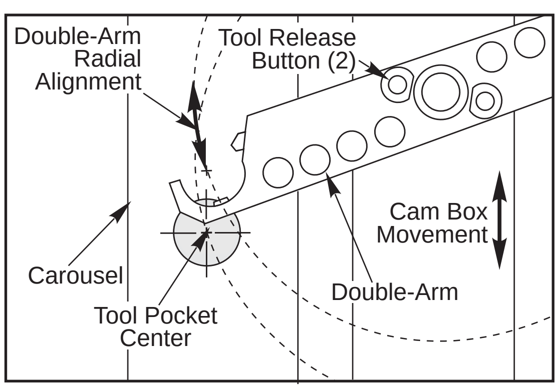
1. **EC-300, and EC-1600-EC-3000:** Go to Parameter 64, write down its value, and set it to zero. This will allow maximum clearance to spindle. **EC-400:** As the alignment is checked or adjusted, ensure the tool changer arm does not hit the spindle. Note that spindle cannot be moved in Z-axis by parameters, as other mills.
2. Without a tool in the spindle, command a tool change. Press E-Stop before the double arm reaches the pocket. This causes the mill to move the axes to the ATC position. Do not run the double arm into the spindle
3. Clear the E-Stop alarm.
4. Using T/C Recovery, rotate the double arm in the forward direction. Continue rotating the double arm until it reaches the pocket, then extends approximately 4" (100mm) for the 40-taper spindle, or 6" (150 mm) for a 50-taper spindle in front of the pocket.
5. Using the dowel pin as a handle, install the tapered half of the split tool into the pocket. Be careful to not place your hands in the pinch point between the tool and the pocket.

6. Install second half of the split tool into end of the double arm in front of pocket. It is necessary to manually press the tool lock plunger (near center of shaft as shown in following section) for spilt tool to be inserted.
7. Using T/C Recovery in the reverse direction, move the double arm back until the halves of the split tool are approximately 1" (25 mm) apart.
8. **EC-300/EC-400/EC-500:** Slightly push the double arm in the counterclockwise direction to remove backlash in the drive assembly.

   EC-1600: Hang a 40 lb (18.2 kg) weight from the pocket side of the arm. Hang the weight from the hole closest to the pocket. This will preload the arm.

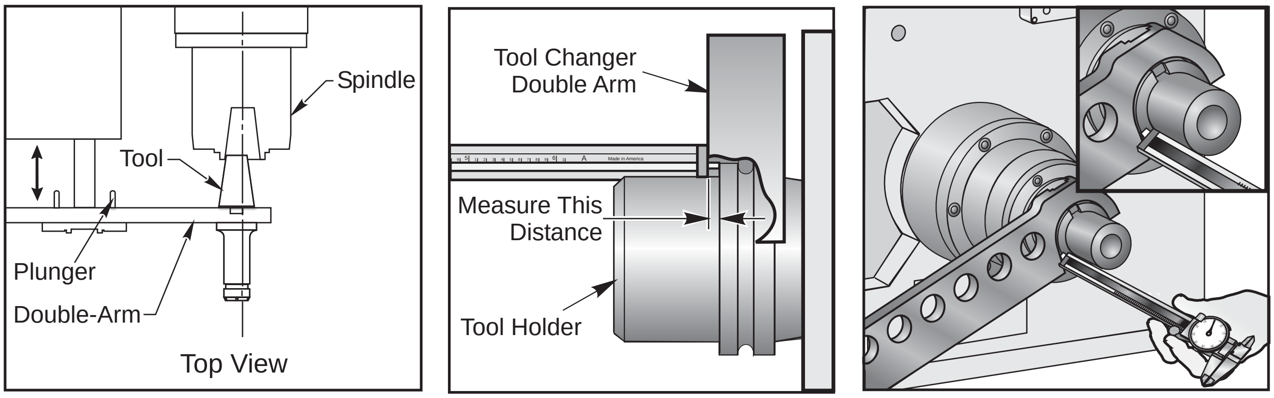


9. Continue to move the arm toward the pocket. Watch the double arm as it approaches the pocket. Continue moving closer until there is a maximum of 1/8" (3 mm) gap between the split tool halves, ensuring that the halves do not touch each other.
10. Check the X and Y alignment of the double arm to the pocket by inserting the alignment dowel through both halves of the split tool. The dowel should slide freely. If the pin does not slide freely, the direction of the misalignment may be determined by feeling the “step” between the split tool halves, by using a steel rule, straight edge, or similar tool.
11. If the dowel pin does not slide in freely, adjust radial alignment of the split tool to the double arm, loosen the lock ring SHCS and adjust the double arm, as described in “Double Arm Removal and Installation” .
12. If the double arm is not aligned in the Y-axis with the centerline of the split tool, loosen the four cam box SHCS and insert a pry-bar between the slots. Adjust the cam box until the centerline of the split tool is aligned with the centerline of the tool pocket.
13. Torque the cam box SHCS to 80 ft-lbs.
14. Recheck alignment.



Cam Box/Double Arm Alignment, Front View

15. **EC-300 and EC-1600-3000:** Fully retract the Z-axis (Z+ direction).
16. Using Tool Change Recovery, press the down arrow to rotate the tool pocket to the tool change position.
17. Move the double arm in the forward direction until the arm rotates to the tool pocket, then move away from the pocket in the Z direction. Do not crash the arm into the spindle. This distance is approximately 4" (100 mm) for a 40 taper spindle or 6" (150 mm) for a 50 taper spindle.
18. Install a toolholder into the double arm. It will be necessary to manually depress the plunger to do this.



Tool to Spindle Alignment Shown. Tool to Pocket Alignment is Done the Same Way

19. Measure the distance from the front of the double arm to the front face of the toolholder and record it.
20. Press the plunger to unlock the tool and remove the tool from the double arm.
21. Using Tool Change Recovery, return the double arm to the origin (Home) position.
22. Install the same toolholder, as used in the previous step, into the tool pocket.
23. Using Tool Change Recovery, rotate the double arm in the forward direction until the arm is very close to the toolholder, but not touching it. (The spring-loaded slide will be touching the toolholder.)
24. Using a caliper, measure the same two surface positions described in Step 5. The measurement should be the same, +/- .01" (.254 mm), as step 5.
25. If adjustment is required, move the double arm on the output shaft as described in “Double Arm Removal and Installation”.
26. Recheck both radial and axial positions until correct alignment is achieved.
27. Using T/C Recovery, move double arm forward, away from pocket and remove both halves of the split tool.
28. Verify the spindle is clear of the double arm. Reverse the double arm away from the spindle if necessary.
29. Return the double arm to the “Home” position and exit Tool Change Recovery.
30. Reset Parameter 64 to its original value if changed.

Double-Arm to Spindle Alignment

1. Double arm to carousel pocket alignment must be correct before setting double arm to spindle alignment.
2. With no tools in the machine, command a tool change. Press E-Stop before the double arm reaches the spindle. This causes the machine to move the axes into tool change position. Reset the E-Stop alarm.
3. Orient the spindle; use the command in Tool Changer Recovery.
4. Advance the double arm to the spindle, watching carefully for any interference. Be sure to check orientation of the spindle drive dogs to the double arm key.

5. If orientation is incorrect, press Reset to allow the spindle to be manually rotated to the correct position. Correct Parameter 257 (Spindle Orientation) as described in the “Setting Spindle Orientation”.

6. Continue moving the double arm in the forward direction until the arm extends approximately 4" (100mm) for the 40-taper spindle, or 6" (150mm) for the 50-taper spindle, in front of the spindle.

7. Using the dowel pin as a handle, install the tapered half of the split tool into the spindle. Be careful to not place your hands in the pinch point between the tool and the spindle. The Tool Release button operates in a Toggle On/Off mode during Tool Recovery. Press once to activate the Tool Release; press again to clamp.

8. Install the second half of the split tool into the end of the double arm in front of the spindle. It will be necessary to manually press the tool lock plunger (near the center of the shaft, see the previous figure) to allow the split tool to be inserted.

9. Using T/C Recovery in the reverse direction, move the double arm back toward the spindle until the halves of the split tool are approximately 1" (25.4 mm) apart.

10. **EC-300, EC 400 and EC-500:** Push the double arm in a counterclockwise direction to remove backlash.

    EC-1600-3000: Hang a 40 lb (18.2 kg) weight on the pocket side of the double arm as shown in “Cam Box to Tool Pocket Alignment”.

11. Continue to move the arm toward the spindle. Watch the double arm as it approaches the spindle. The spindle dogs and the slots in the double arm should line up. Continue moving closer until there is a maximum 1/8" (3.2 mm) gap between the split tool halves, ensuring that the halves do not touch each other.

12. Check the X and Y alignment of the double arm to the spindle by inserting the alignment dowel through both halves of the split tool. The dowel should slide freely. If the pin does not slide freely, the direction of the misalignment may be determined by feeling the “step” between the split tool halves. Do this by using a steel rule, straight edge, or similar tool.

13. If misalignment is present, the method of alignment varies, depending upon the machine.

    a. **EC-300/EC-400/EC-500**

    1) Adjust Parameters 210 (X) and 211 (Y) to correctly center the spindle to the double arm.

    2) Using T/C Recovery, move the double arm forward to clear the spindle dogs.

    3) Put the mill in Debug mode.

    4) Handle jog the X- and Y-axis to center the two halves of the split tool.

    5) Record the actual values for the X- and Y-axis on the “Pos-Raw Dat” screen. Omit the decimals, but include the “-” sign.

    6) Enter the X value into Parameter 210, and the Y value into Parameter 211.

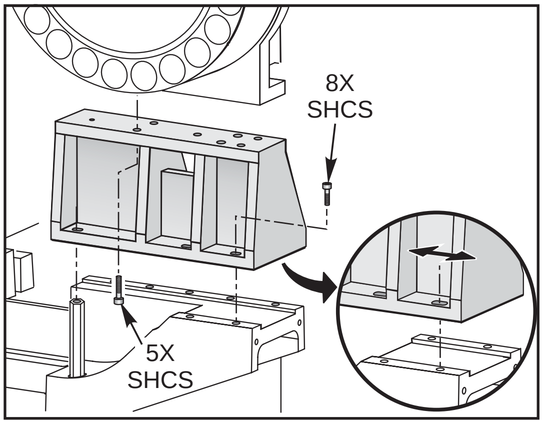
    7) Remove the split tool.

    8) Using T/C Recovery, return the double arm to the origin (Home) position.

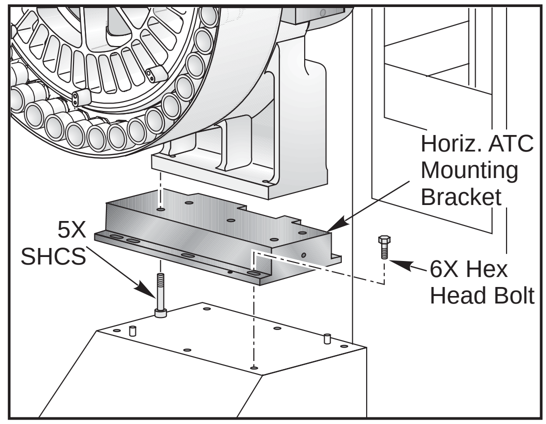
    9) Return the tool pocket to the tool stored position (arrow up).

    10) Cycle power to the machine and recheck alignment.

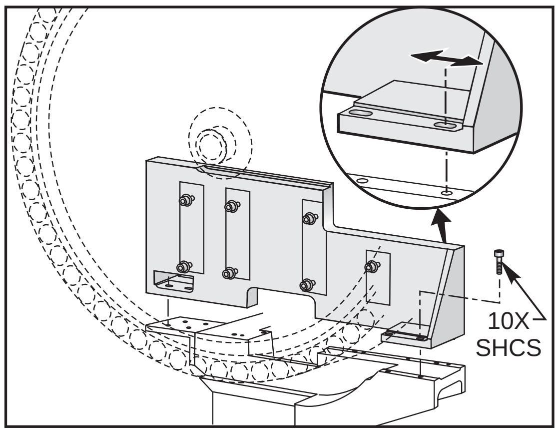
    11) **EC-300:** Parameter 64 is used to adjust the Z direction (see Setting Parameter 64). **EC-400 and EC-500:** If Z-axis adjustment is necessary, loosen the ATC mounting SHCS, slide the ATC as required, retorque the SHCS to 80 ft-lbs, and recheck alignment. The screws to loosen hold the tool changer spacer to the main base casting.



EC-400 24-Pocket Mount



EC-400 40-Pocket Mount



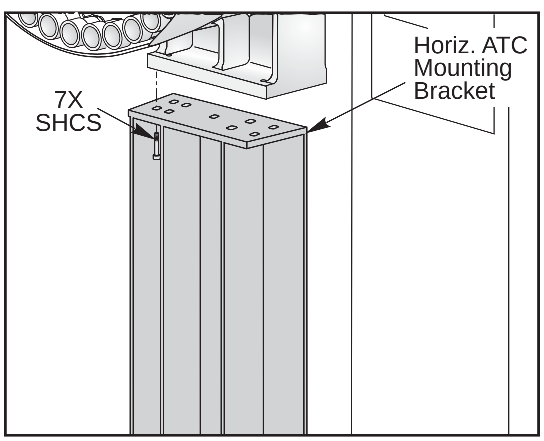
EC-400 60 and 70-Pocket Mount

b. **EC-1600-3000**

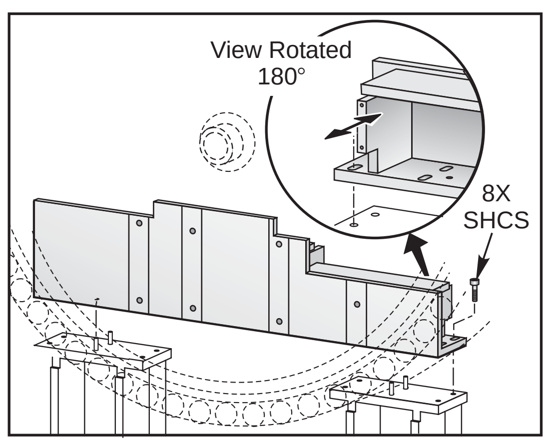
1) Adjust the Y direction and spindle orientation in the same manner as for the EC-400.

2) Adjust Parameter 64 to move the spindle in the Z-axis direction.

3) If X-axis adjustment is necessary, loosen the SHCS, slide the SMTC as required, retorque the SHCS to 80 ft-lb, and recheck alignment.



EC-1600 Standard Mount

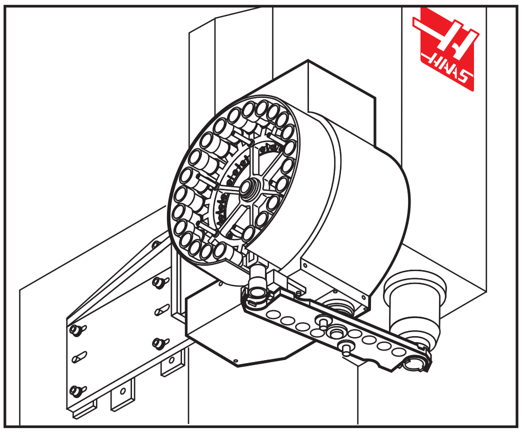


EC-1600 50-Pocket Mount

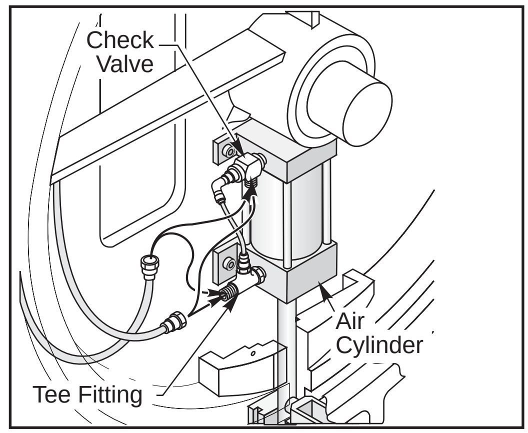
For Vertical machines, the servo tool changer, like those used on super speed machines, must have the grid offset and tool change offset set before starting the alignment procedure.

Cam Box to Tool Pocket Alignment

1. Remove all cam box sheet metal fasteners and covers. Place protective covers on the machine table.
2. Power up machine. Raise Z-axis to top of travel. Set machine control to Tool Change Recovery (TCR).
3. Push the down arrow button to activate the tool pocket down (ensure proper tool pocket operation).

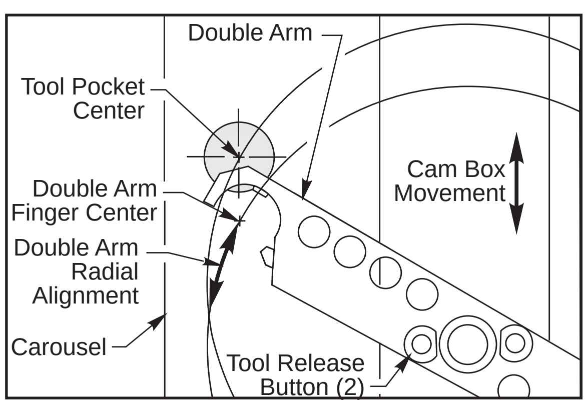


Double Arm Alignment



Airline Connection Location

4. Power off machine. Disconnect air supply at rear of machine. Tool pocket raises once air is disconnected.
5. At the top of the ATC assembly, reverse the two air lines going from the solenoid valve to the air cylinder as shown above. Reconnect the air supply line at the rear of the machine. (The tool pocket holder in the tool change position should move down.)
6. At the top of the ATC assembly, manually rotate the cam box pulley clockwise until the output shaft is lowered and just before it begins to rotate 180^0.
7. Align the double arm underneath the tool pocket and spindle with unlocking finger buttons facing upward. Place the double arm onto the shaft and snug the lock ring on the double arm bottom with the SHCS.
8. Place the split tool (P/N's previously shown) into the double arm end beneath the tool pocket. Depress the Tool Release button on top of the double arm and insert the split tool. Slightly push the double arm in the clockwise direction to remove backlash in the drive assembly, as shown in the following figure.



Cam Box to Tool Pocket Alignment (Top View)

Radial Alignment of Double Arm to Carousel

9. Rotate the cam box pulley counter-clockwise to raise the double arm into the split tool. Visually check the centerline alignment of the split tool to the centerline of the tool pocket.
10. In order to adjust the radial alignment of the split tool to the double arm, loosen the lock ring SHCS and adjust the double arm as shown above.
11. If the double arm is not aligned in the Y-axis with the centerline of the split tool, loosen the four cam box SHCS and insert a pry-bar between the slots. Adjust the cam box until the centerline of the split tool is aligned with the centerline of the tool pocket.
12. Torque the cam box SHCS to 100 ft-lbs.

Checking Parallelism of Double Arm to Table

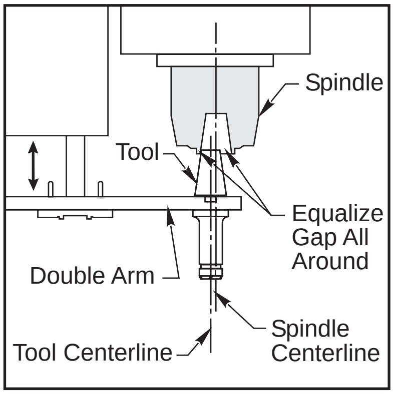
13. Rotate the cam box pulley clockwise to lower the double arm. Remove the split tool from the double arm.
14. Rotate the cam box pulley counter-clockwise to raise the double arm back to its home position.
15. Remove the air supply line from the rear of the machine. **Switch the inlet and outlet airlines back to their original positions at the top of the ATC assembly.** Re-attach the air supply line (the tool pocket holder should retract to its home position).
16. Power On the machine and enter TCR mode. For more information on TCR mode refer to the TCR flow chart located in the Technical Reference section.
17. Press the ATC Forward button until the arm lowers and is parallel to the X-axis. Insert a split tool into the double arm by pressing the Tool Release button located near the shaft as shown above.
18. Place a magnetic base and indicator on to the machine table. Measure the bottom of the split tool to the nearest .001".
19. Move the split tool and indicator setup to the other end of the double arm. Measure the bottom of the split tool to the nearest .001". The maximum allowable height tolerance between the two ends is .030". Adjust the alignment as necessary. Repeat this test with the arm rotated 180^0.
20. Remove the split tool from the double arm. Return the double arm to the home position.

Setting the Double Arm Height

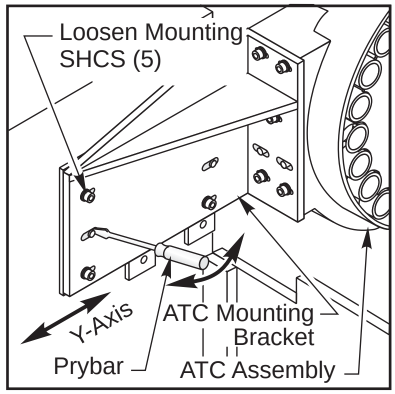
21. Press the Down Arrow to command the tool pocket down. Place the split tool **with** the pull stud into the tool pocket. In TCR mode, rotate the double arm near the tool pocket.
22. Visually check the height alignment of the double arm to the V-groove on the split tool. If necessary, loosen the lock ring SHCS and adjust the height of the double arm. Torque the lock ring SHCS to 15-17 ft-lbs.
23. Repeat steps 9 & 10 to re-check radial alignment.
24. Return the double arm to the home position.

Double Arm to Spindle Alignment

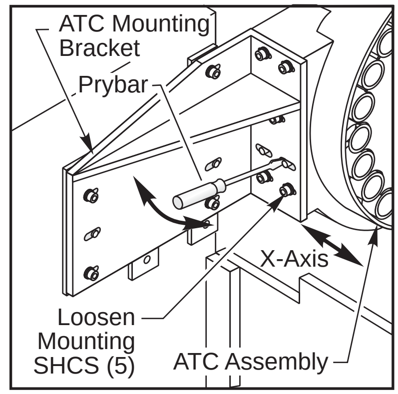
1. Zero Return the Z-axis.
2. In TCR mode, lower the double arm and re-insert the split tool into the double arm. Orient the spindle dogs for a tool change. (If the orientation has changed reset Parameter 257. Refer to section on setting spindle orientation). If spindle dogs are not aligned with the toolholder slot, manually rotate the spindle dogs.
3. Raise and lower the double arm to move the tool in and out of the spindle and check for alignment.
4. Check the X-axis alignment of the split tool to the spindle center.
5. If necessary, loosen the five ATC mounting SHCS.



Double Arm to Spindle Center Alignment, Along the Y-Axis



ATC Assembly X-Axis Alignment



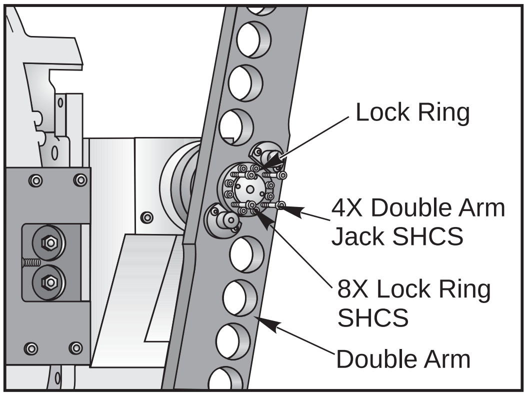
ATC Assembly Y-Axis Alignment

6. Insert a pry-bar between the locating pins and the ATC mounting bracket. Adjust the bracket to align the split tool in the double arm to the center of the spindle in the X-axis.
7. Torque the SHCS to 80 ft-lbs.
8. Check the Y-axis alignment of the split tool to the spindle.
9. If necessary, loosen the five ATC SHCS (shown above). Insert a small pry bar between the locating pins and the mounting bracket. Adjust the ATC along the mounting slots and align the tool and spindle's center.
10. Check the spindle tool change height. If the spindle tool change height has changed, reset Parameter 64.
11. Return to normal operation. Insert toolholders through the spindle and perform several tool changes. Observe the tool changer during operation and make any adjustments if necessary.
12. Torque the ATC mounting SHCS to 100 ft-lbs. Replace all cam box sheet metal covers and fasteners. Apply blue loctite to the fasteners and tighten.

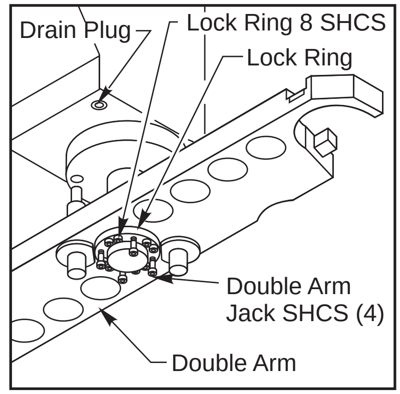
Double Arm Replacement

Removal

1. In TCR mode, lower the double arm. Power Off machine.
2. Underneath the double arm, loosen the six SHCS from the lock ring. Insert four new jackscrews into the lock ring (coat the jack screw threads and tips with moly grease).
3. Slowly tighten the jackscrews in order to push the double arm away from the lock ring. If necessary, tap the center of the double arm from underneath with a soft mallet until the double arm breaks free. Note that there is a second set of jackscrews available. These use 5/16 bolts. Place a piece of steel between the collar and the double arm and then tighten the 5/16 screws to remove the double arm.
4. Once the double arm is loose, pull the double arm assembly off the shaft.



Double-Arm Removal (Horiz)



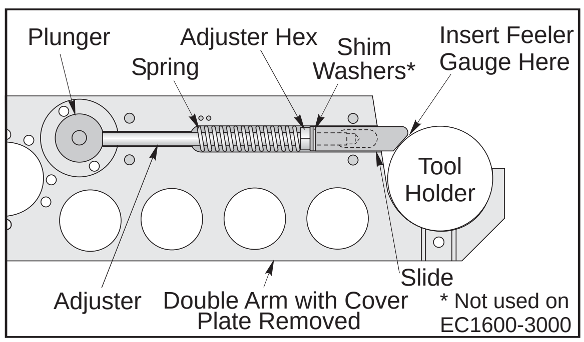
Double-Arm Removal (Vert)

Installation

1. Place the double arm onto output shaft. Align the double arm, as described in the previous sections.

2. Reattach the lock ring to the double arm with eight (8) SHCS. Tighten in a star pattern to 15 ft-lbs; repeat 3 times to seat the arm lock bushing. Verify the slides are correctly adjusted on the double arm

   a. With the double arm lowered, and the split tool inserted into the double arm, a feeler gauge, between .015" and .020" should fit between the slide and the tool flange O.D. The plunger should be able to rise fully to the locked position with the gauge between the split tool and the plunger.



   b. The plunger will not return reliably to the fully raised locked position when the tool is inserted if there is insufficient clearance. The split tool will be excessively loose in the double arm if there is too much clearance. Either condition can cause dropped tools.

   c. To adjust the clearance, remove the slide and the cover by removing the cover plate and lifting the slide out at an angle. Be careful not to lose the spring. Loosen the adjuster and correct the clearance by adding or removing shim washer. Apply blue Locctite and retighten. Grease the spring and the slide assembly and reinstall them both. Reattach the cover plate and recheck the clearance. Both ends of the double arm are separately adjusted.

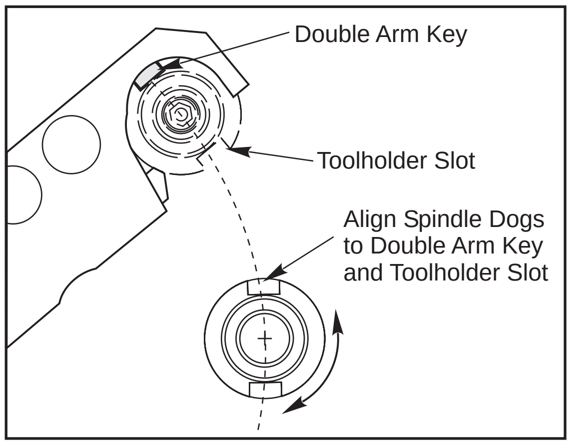
3. Re-align the double arm to the spindle and tool pocket. Refer to double arm alignment instructions in the previous “ATC alignment” section.

Setting Spindle Orientation

1. Power up machine. Go to Parameters. Jog the spindle head to the tool change position. Unlock Parameters and change the Parameter 257 value to “0.”

2. Place a tool into the spindle. Enter TCR mode. Align the spindle dogs to the double arm key (see the following figure). Press the ATC Forward button until the double arm engages the tool (manually rotate the spindle dogs if necessary).

3. Enter Debug mode. Record the encoder value under “spindle orientation position”.
4. Return to Parameter 257. Enter the spindle orientation value from Debug and lock parameters.
5. In TCR mode, press the ATC Reverse button until the double arm is in the home position. Return to normal operation mode.
6. Manually insert tools into spindle and perform several tool changes. Observe for any misalignment.
7. Adjust the Parameter 257 setting value if necessary.

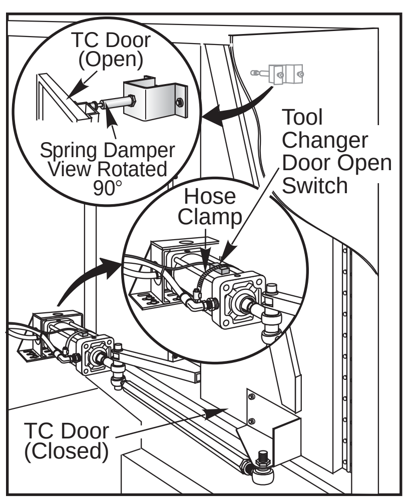


Spindle Orientation Setting

EC-300 Tool Changer Door Open Switch Adjustment

The tool changer door must be completely open before the sensor switch on the air cylinder changes its state.

1. With the machine on E-stop, disconnect the main air supply.
2. Clamped to the air cylinder with a hose clamp, is the tool changer door open switch. Move the sensor switch toward the rod end of the air cylinder until it reaches the end cap of the air cylinder.
3. Open the tool changer door all the way. Watch the diagnostic screen. Slowly slide the sensor switch back along the air cylinder until the tool changer door bit changes from 0 to 1.



4. Mark the spot where the bit changes to 1 and secure the switch with a hose clamp.
5. Reconnect the main air supply, and take the machine off of E-stop.

6. Run the tool changer door and check for speed.
7. Adjust the speed at the solenoid valve on the lube panel.
8. Check the action of the spring damper that stops the tool changer door when it opens. The tension can be adjusted by turning the adjustment screw on the back of the spring.

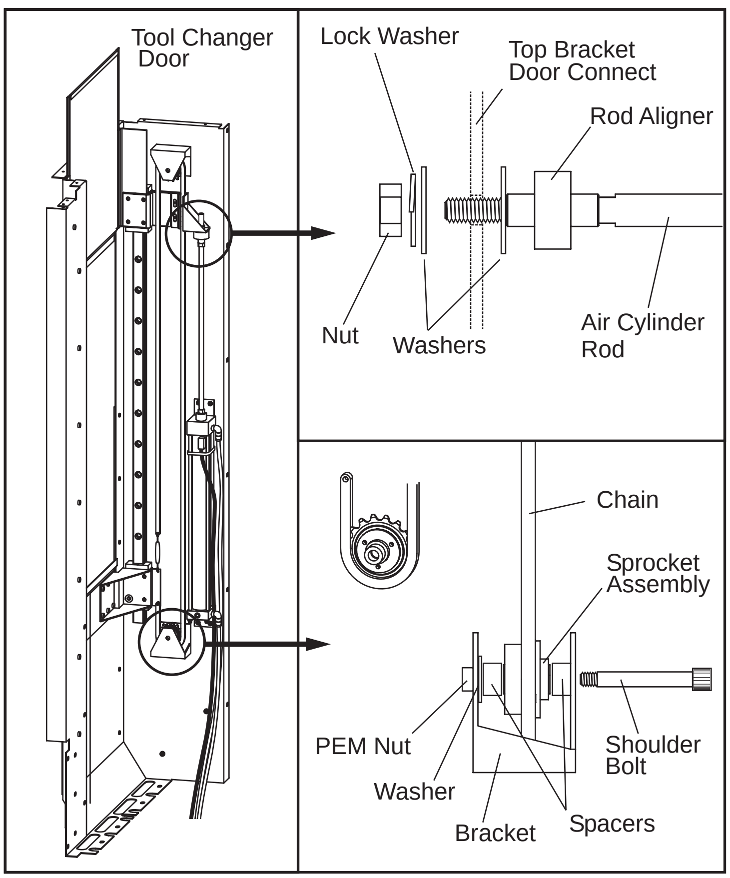
EC-400 Tool Changer Door Replacement

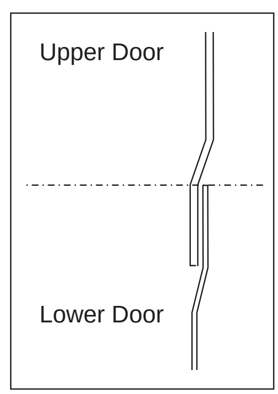
This procedure describes the installation of the complete door assembly. It may not be necessary to start the procedure from the beginning. Remove the damaged or inoperative parts and then rebuild the door assembly.

Installation and Alignment

Linear Guides and Air Cylinder

1. Push the top of the linear guide toward main panel wall and tighten top bolt. Push the bottom of the linear guide toward panel wall and lightly tighten bottom bolt. Securely tighten the remaining bolts, then tighten the top and bottom bolts. Install linear guide trucks and grease using fittings.
2. Grease shoulder bolt and slide through panel bracket, spacer, idler assembly, second spacer, and washer. Thread the bolt into the pemnut and tighten.





3. Push air cylinder towards linear guide rail while tightening bolts.
4. Thread and tighten onto cylinder rod end.

Tool Changer Doors

5. Grease main panel face where the door guide will be mounted. Mount door guide to main panel, with the guide spacer between them using 10-32 flat-head screws.

6. Grease the edges of the door that will be sliding against main panel and door guide. Slide top door into door guide and place flange onto linear guide pad (top/right). Put the top door bracket over the door flange and position the door between the bracket and the upper linear guide truck. Push door flush against main panel and tighten the four bolts that hold the bracket to the linear guide. Check sliding motion of top door, bracket and truck, this should be smooth and uniform.

7. Retract air cylinder rod. Place a 7/16 washer over rod aligner thread. Move top door bracket down to air cylinder rod aligner. The hole in bracket should line up with rod aligner without forcing it over rod end. If not, loosen air cylinder mounting bolts, reposition and then retighten the bolts. Place flat washer and split washer over rod end and tighten with a 7/16-20 nut. By hand, move the cylinder rod, door bracket and door, in and out, looking for any binding. If there is any misalignment, loosen the air cylinder mounting bolts and let it self-align, then retighten the bolts.

8. Grease main panel faces where door guides will be mounted. Mount door guides to main panel, with guide spacers sandwiched between them, via 10-32, zinc, flat head screws.

9. Attach the lower door bracket to bottom/left linear guide pad and leave bolts loose. Grease the edges of the door that will be sliding against main panel and door guide. Slide door into door guides and attach to the lower door bracket. Align door so it is square to panel prior to tightening the door bracket screws. Loosen 4 linear guide pad bolts and push door flush against main panel face and re-tighten.

Drive Chain

10. Place chain around idler assemblies and attach one end to bottom door bracket at the hole closest to the lower idler assembly using a master link. Install jam nut onto threaded, right-handed side of the turnbuckle. Attach the opposite end of the turnbuckle to the other hole in the bottom door bracket using a second master link. Make sure chain is properly located on both idler assemblies. Tighten the chain using the turnbuckle and lock with jam nut.

11. Retract air cylinder and top door to the closed position. Move the bottom door so the top edge is even with the first bend line in the top door. Attach chain retainer to top connect bracket and lock it into the chain.

Door Adjustment

12. Check the motion of both doors by connecting an air supply to the cylinder, verifying that air pressure is at 85-95 PSI. Move the top connect bracket back and forth with the cylinder stroke. The rod aligner should prevent any binding.

    Verify door motion by toggling air on and off, adjusting the chain turnbuckle as required so that the door does not bang shut and bend. If adjustment is not possible, replace the cylinder.

SMTC Pocket Removal and Installation

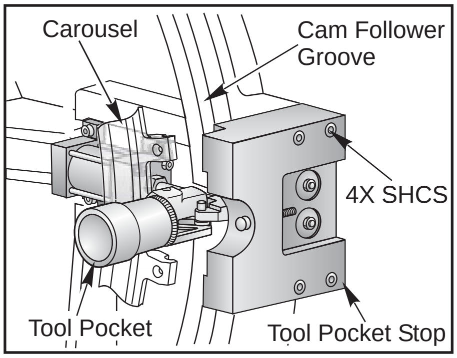
Removal

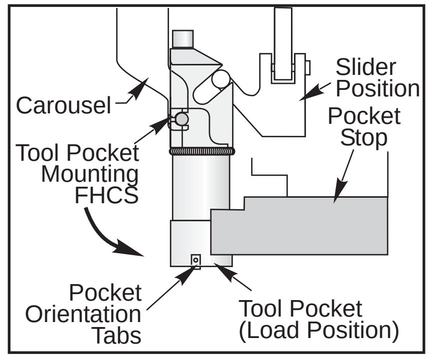
1. Turn the machine on and rotate the carousel to the pocket you want to change. Remove the sheetmetal in order to gain access to pocket limit switches. Remove the sheetmetal disc covering the carousel.

2. Press Tool Changer Restore. Press **Y** three times.

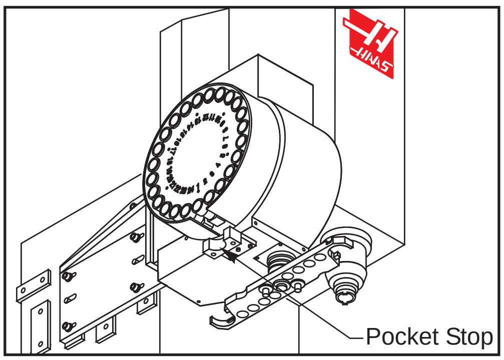
3. Remove the four SHCS that hold the pocket stop. Remove shoulder bolt from the back of the pocket slide.

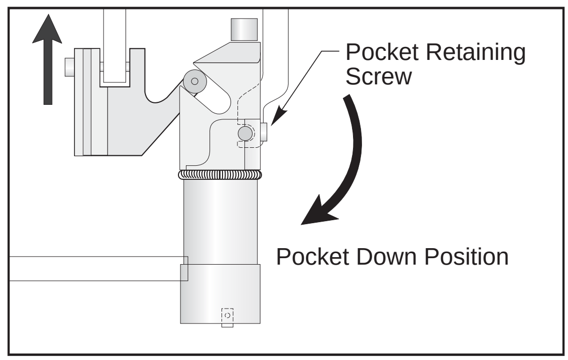
NOTE: Don't remove set screws. It changes pocket slide and groove alignment.





Horizontal Machines





Vertical Machines

NOTE: The machine must be in Tool Changer Recovery Mode to perform the next step.

4. Press **v** (down arrow) to retract the air cylinder shaft. Manually lower the pocket and remove the pocket retaining screw. See the previous figure.

5. Remove the tool changer pocket by carefully maneuvering the pocket out of the carousel, taking care not to drop the pocket slide.

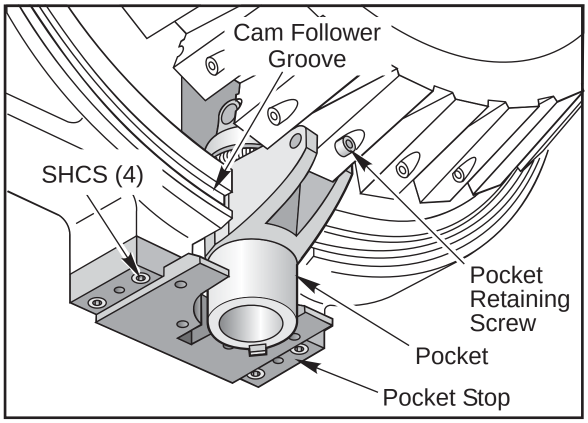
NOTE: If the carousel is to be replaced, skip to the Carousel Removal and Installation.

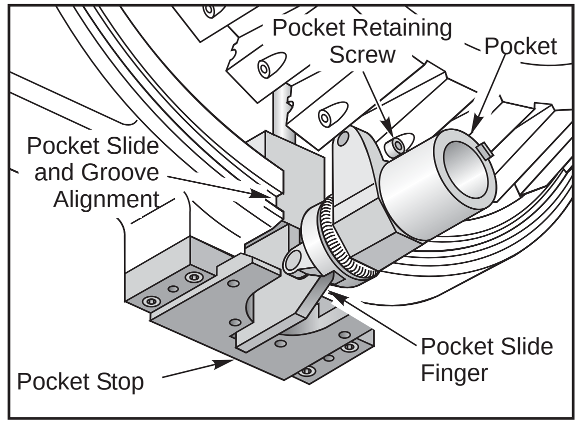
Installation

1. Replace the damaged pocket with a new one. Apply grease to the shaft. Install the pocket slide and pocket into the carousel. Apply a drop of Blue Loctite to the pocket retaining screw and install. Torque to 14 ft.-lbs (23 ft.-lbs for 50-taper).

2. Clear all alarms. Return to Tool Changer Recovery Mode and press **^** (up arrow). This will extend the air cylinder shaft. Install the pocket slide shoulder bolt, taking care not to pinch the microswitch roller. Ensure that the microswitch roller rests on the shoulder bolt head.

3. Install the pocket stop, and torque the four SHCS to 40 ft.-lbs (45 ft.-lbs for 50-taper). Activate the pocket up and down several times to verify the pocket slide groove matches the casting groove.



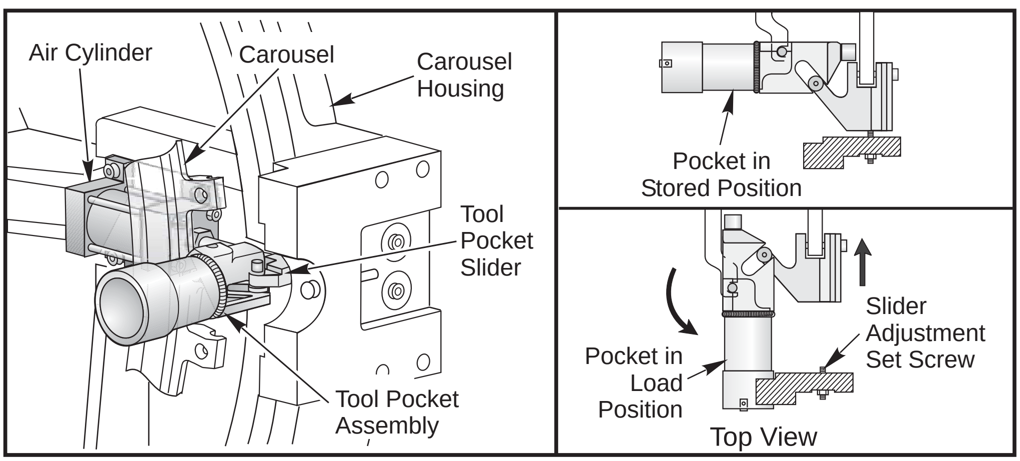


4. Restore the machine to automatic mode and perform a tool change by pressing **MDI** and then **ATC Fwd**. Check for any binding or interference of installed parts.

Tool Pocket Slider Adjustment

The slider set screw is used to adjust the tool pocket's end-of-stroke with the circular path on the carousel housing.

1. Rotate carousel by turning the carousel cam pulley by hand.
2. Visually check for misalignment (tool pockets should move smoothly).
3. If necessary, loosen the set screw nut. Adjust the set screw in or out until the tool pocket is aligned with the circular path on the carousel housing. Advance the tool pocket and observe for proper alignment.
4. Tighten set screw lock nut.

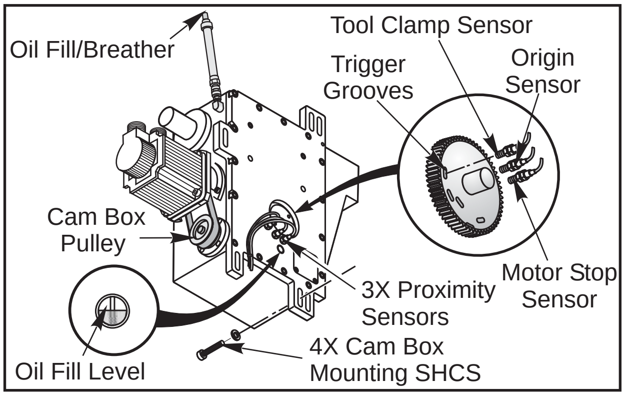


Tool Pocket Orientation/Set Screw Adjustment

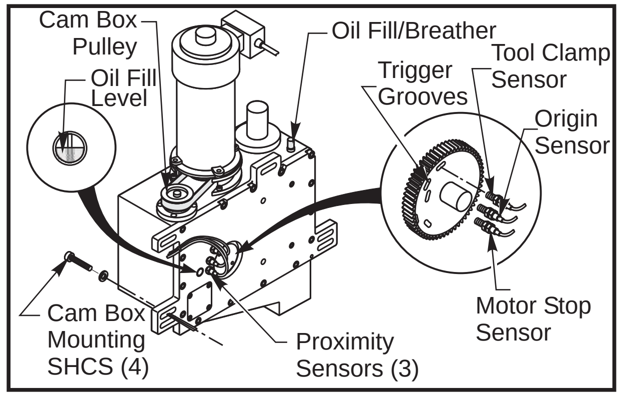
Proximity Switch Removal/Installation

Removal

1. Power Off machine. Remove the carousel number disc and the top cover plate.
2. Remove the 1/4” NPT plug near the cam box output shaft and drain the cam box oil.
3. Disconnect the proximity switch connector from the bracket on the top of the assembly.
4. Loosen the double nuts retaining the proximity switch. Carefully remove the proximity switch from the cam box assembly. Refer to following figures.



Horizontal Machine Proximity Sensor Switch Location

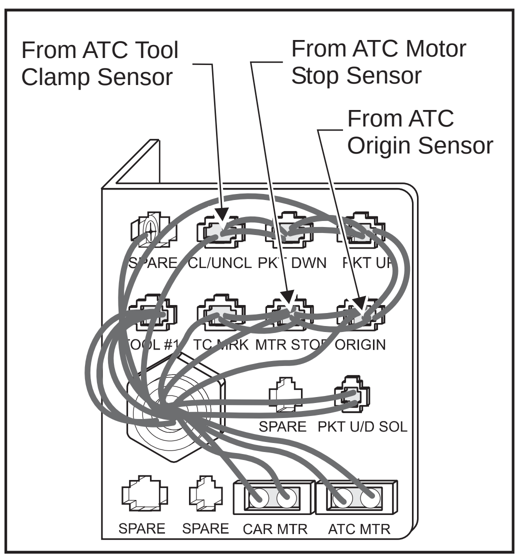


Vertical Machine Proximity Sensor Switch Location

Installation

The proximity trigger disk inside the cam box determines the sensor operation. The sensor must be approximately .030" away from a flat surface on the disk to function properly. An LED light will come on at the back of the sensor when it is triggered.

1. Look through the sensor hole and rotate the cam box pulley by hand until the groove is not visible.
2. Screw two nuts to the threaded section of the proximity switch. Snug the two nuts together and apply thread sealant to the threads. Carefully screw the switch into the cam box. Connect the proximity switch connector to the plug on the switch bracket as shown in the following illustration.



Proximity Switch Connection Bracket.

3. Power On machine. Press E-Stop.
4. Screw the proximity sensor into the cam box an additional 1/8 turn after the LED light comes on. Loosen both nuts then re-tighten the inner nut against the cam box housing. Tighten outer nut against inner nut.
5. Repeat this procedure for each proximity sensor switch.
6. Refill the cam box with oil to the fill level line.
7. Check for correct operation of the tool changer and alignment. Adjust as necessary.
8. Replace the carousel disc and top cover plate. Apply blue loctite to the fasteners and tighten.

Setting Parameter 64

CAUTION! The EC-400 Z-axis can crash into the pallet changer actuator if Parameter 64 is not set correctly.

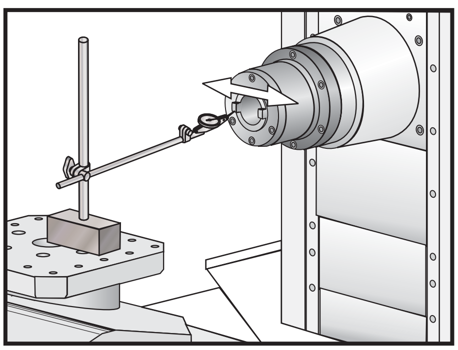
For Z-axis, this is the displacement from home switch to tool change position and machine zero.

(Distance from Home in Inches) X (Line Encoder Constant) = Z-axis tool change position setting

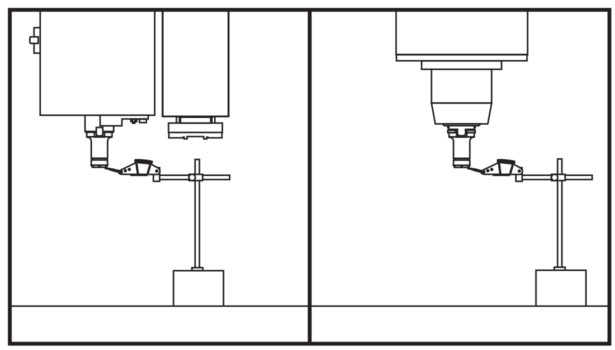
Example:
.625 x 138718 = 861699

To reset Parameter 64 (Z-axis tool change position) if an ATC assembly has been replaced or realigned.

1. Enter Parameters page and record original Parameter 64 setting value.
2. (Make sure there are no tools in the spindle head or tool pocket positions.) Command the spindle head to its tool change position. Enter Debug and record Z-axis spindle position value.
3. Enter TCR mode, press the Down Arrow, command a tool pocket down, and manually insert a tool into the tool pocket.



Setting Parameter 64 for Horizontal Machines



Setting Parameter 64 for Vertical Machines

4. Place a 0.0005” indicator with an extended arm base onto the machine table. Indicate the bottom of the tool with the indicator to the nearest 0.001.” Record the measurement.
5. Remove indicator from the table and the toolholder from the tool pocket. Insert the tool into the spindle head position. Place the measurement indicator under the spindle head.
6. Enter Debug. Jog handle the Z-axis up or down until the end of the tool is at the same height as the measured value found when the tool was placed in the tool pocket. Record the Z-axis spindle height value.
7. Take the difference in the spindle height values found in Debug mode and add the encoder count value to the original value for Parameter 64 setting.

Example:

(Difference in Z-axis encoder counts) + (Old Z-axis Tool Change Setting) = New Z-axis Tool Setting
20681 + 861699 = 882380

8. Enter Parameters page. Unlock settings and write new setting value for Parameter 64. Lock parameter settings.
9. Perform a tool change and observe for misalignment. Adjust the Parameter 64 setting if necessary.

Invisible Axis Explanation

The SMTC uses an invisible axis to control the double arm. If the axis is made visible to service or adjust it, the safety interlocks are disabled, and the automatic operation of the tool changer is prohibited. Be sure the spindle head is out of the way before rotating the double arm.

Offsets

Both the Tool Change Offset and the Grid Offset must be set before using the tool changer. The Grid Offset must be set first.

Setting the Grid Offset

The control calculates grid offset parameters with a 'Grid' command. A grid offset is an offset that is applied to the home position of an axis so that the zero location for that axis is re-defined to be half an encoder revolution away from the home switch. It is recommended that the Grid command be used on each axis separately.

1. Zero Return all axes.
2. Turn the machine off and back on. This will un-zero all the axes.
3. Select the Alarms screen and enter Debug mode.
4. Perform a Zero Single Axis on the Tt axis. Ignore the Zero Ret Margin Too Small alarm if it occurs. If a tool arm fault is generated, the tool arm is out of position and must be repositioned using tool change recovery.
5. Select the Positions screen, enter "Grid TT" and press Enter. The message Grid Ofset Done should appear and the Grid Offset parameters for the homed axes will have been updated. If the message "No Zero" appears, this indicates that none of the axes had been zeroed.

Setting the Tool Change Offset

1. Set the tool changer axis to "Visible". This is done by setting bit 18 of Parameter 462 to zero.
2. Make sure the spindle head is up out of the way
3. Go to the Discrete Inputs page and look at the cambox origin display.
4. Handle Jog (rate .01) the TT (B) axis until "Origin" and Motor Stop" are "1".
5. Handle Jog in the positive direction, until both the "Motor Stop" and "Origin" are "0". Switch displays to the Position page and continue jogging the axis 3-5 degrees, in the same direction, past this position.
6. Handle Jog the axis in the negative direction (.01 degrees per pulse) until both "Motor Stop" and "Origin" are "1". Note that you cannot back up if the mark is missed. If the mark has been missed go back to step 5.
7. Go to the Pos Raw Data page. Under the "Command" header the display shows the "B" axis encoder counts. Write down the current number.
8. Go back to the Discrete Inputs page. Watch "Motor Stop" and "Origin". Handle Jog in negative direction, until one of them changes to "0" (the first one to change).
9. Go back to the Position page and write down the current number from the same column as step 7. Add both numbers and divide by 2, this is the amount of tool change offset, but with the wrong sign.
10. Return to the Discrete Inputs page and Handle Jog the axis back until the "Motor Stop" and "Origin" are "1".
11. Enter the calculated number, as a negative number in the TT axis, Parameter 487 (not the B-axis).
12. Return the axis to "Invisible", set Parameter 462 to 1, and cycle power.
13. Zero return the TT axis. The double arm should be in the middle of the home position.

TURRET CRASH RECOVERY PROCEDURE

1. Change Setting 7, "Parameter Lock", to Off. Move to Parameter 43 on the Parameters display. This is the tool turret motor parameters. Change Invis Axis from “1” to “0” (zero).
2. Move to the Alarm display, type “Debug”, and press the Write key. Verify that the debug line is displayed.

NOTE: Ensure there is adequate clearance between the turret and chuck before performing the next step.

3. Press Prgrm/Cnvrs, then the MDI key. Type “M43” into MDI and press Write/Enter, then press Cycle Start. This will unlock the turret by pushing it in the Z-direction.
4. Press the Handle Jog key. The A-axis should be displayed below the X and Z axes.
5. Press the letter "A", then "Handle Jog", and then a jog speed other than ".1". A message should indicate that the A-axis is being jogged.
6. Position Pocket #1 in the cutting position, using the coolant nozzle to align the pocket. If an overcurrent alarm is received, press Reset and turn the Jog Handle in the opposite direction.
7. Press MDI, type M44, and press Alter. Press Cycle Start. The turret should clamp in the Pocket #1 position.
8. Press Param Dgnos twice to get to diagnostics. Verify that TT LOK = 1.
9. Move to Parameter 43 on the Parameter display and change Invis Axis to “1”. Change Setting 7 back to on.
10. Turn the control power off and then back on. The turret can now be positioned by pressing either Power Up/ Restart or Auto All Axes.

NOTE: If alarms 111 or 164 occur it may be necessary to adjust the turret motor coupling.

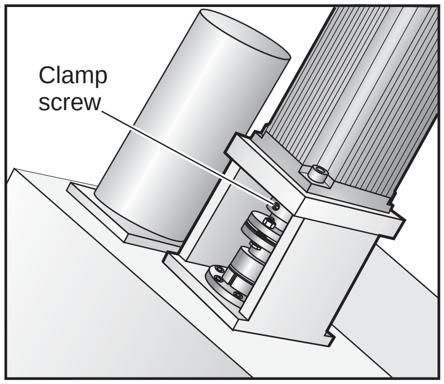
NOTE: The turret is now at Tool #1 and clamped.

11. Remove the sliding tool changer cover. Go to Setting 7 and turn off the Parameter Lock. Go to Parameter 43, change “Z CH Only” to “1”.
12. Loosen the turret motor coupling clamp screw on either side of the motor (refer to the following figure).
13. Press the Zero Ret key, the A key, and the Zero Singl Axis key. This will cause the motor to go to the first encoder Z pulse.
14. With the servos on, move the turret motor coupling back and forth to find the center of its backlash, and torque the clamp screw as close to the center of the backlash as possible.

NOTE: If it is tight (no backlash) it will be necessary to force it in one direction or the other until it pops into its backlash area. If it gets tighter when it is turned, stop; this is the wrong direction.

15. Change Parameter 43, “Z CH Only” back to “0” (zero), and Invis Axis to 1. Go to Setting 7 and turn on the Parameter Lock.
16. Press the Zero Ret key, A key, and Zero Singl Axis key. This will home the turret at tool #1, or the pocket set in Setting 81.
17. Press the Emergency Stop button and turn the turret motor coupling back and forth to verify that the backlash is centered.

18. Replace the sliding tool changer cover.



Turret Motor Adjustment

IMPORTANT!! After a crash the following procedures should be performed in order to verify proper turret alignment.

1. Turret alignment verification (X-Axis).
2. Spindle alignment verification.
3. Turret alignment verification (Spindle).

Turret Clamp/Unclamp

Alarm 113 and 114 (Turret Unlock/Lock Fault)

1. Check the tool changer solenoid.

    a. Does the solenoid appear to be activating?

    1) No: Check power to the solenoid during a tool change. If there is voltage replace the solenoid.

    2) Yes: Proceed to the next step.

    b. Are the exhaust mufflers dirty?

    1) Yes: Remove the muffler and do a tool change. If the alarm goes away then replace the muffler

    2) No: Proceed to the next step.

    c. Is there water in the airlines?

    1) Yes: Ensure that the air is now dry and replace the solenoid.

    2) No: Proceed to the next step.

2. Check air pressure.

    a. Set the main regulator to a minimum 85 PSI.

    b. Does the air pressure drop more than 10 PSI during a tool change?

    1) No: Go to the next check.

    2) Yes: The lathe has insufficient air volume. 100 PSI at 4 sfm is required at the regulator. A small diameter air supply hose, hose length, and fitting size may restrict air volume to the machine.

3. Remove the top turret cover. Confirm that the air cylinder is fully clamping (114 alarm) or fully unclamping (113 alarm).

    a. Yes: Go to the next check.

    b. No: Try to push the air cylinder into position.

1) If the air cylinder will not fully clamp or unclamp disconnect the air cylinder from the cam lever and retry. If the air cylinder still does not fully clamp or unclamp, replace the air cylinder.

2) If the air cylinder fully clamps and unclamps then:

a) Cam balls fell out of time with each other. This would be more common on the original style cams, which does not have a cage. Fully clamping the air cylinder by hand should position the 3 balls correctly.

b) If this problem persists, the cams might be damaged. Replace with part number 93-8138 “Cam Upgrade Kit”. This is a cam assembly with the cage, compatible with all lathes.

4. Clamp switch or unclamp switch is failing or is out of adjustment.

a. Switch identification and adjustment.

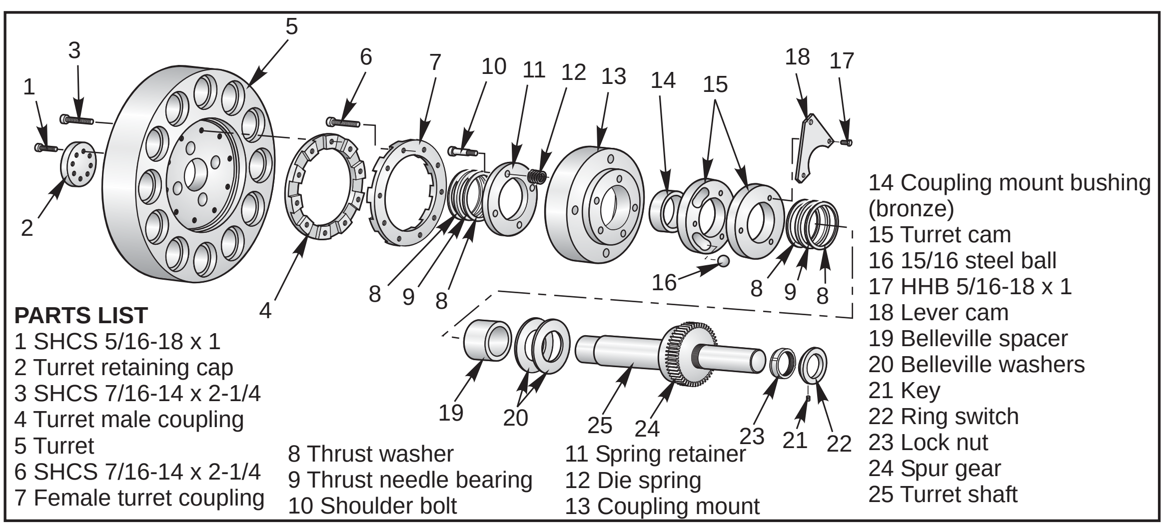
1) Reed style switches- these types of clamp/unclamp switches are mounted on the air cylinder to detect the clamp and unclamp position of the turret. The air cylinder has a magnetic piston, which activates the switch when the magnetic piston is under it. This style detects the movement of the piston, not the turret shaft.

a) Adjust the switch by first confirming that the air cylinder is fully clamped. While observing the diagnostic data for the control, slide the switch in one direction until the bit changes from a “1” to a “0”. Mark the position with a pen then do the same while sliding the switch in the other direction. Position the switch between the two markings and tighten the clamp.

b) If the alarm still persists then the switch might be failing. Change the clamp switch with the unclamp switch at the air cylinder and at the lube panel. If the problem goes away or changes to an unclamp alarm, replace the switch.

2) The Clamp/unclamp switches at the rear of the turret shaft detect the position of the turret shaft during a tool change, these switches are installed on the same bracket as the turret home switch, also called the A-axis home switch. The amount of shaft movement or turret pop out is very important. The switches are an indication of the position of the shaft. If the turret in/out travel is not adjusted correctly or the switch bracket is holding the switches too far apart, alarms during a tool change will occur.

Turret Removal and Replacement



Pneumatic Turret Removal

1. Position the turret for easy removal from the lathe. Index the turret to the pocket #1 position.

2. Remove the sliding tool changer and turret assembly covers.

3. Change Parameter 76 from 500 to 50000 (so you will not trip on a low air pressure alarm).
4. Remove the air line.
5. Put a 3/4" wrench on the bolt at the end of the air cylinder. Pull down (-X) until the turret is fully unclamped.
6. Place a block between the back of the turret shaft and the casting to keep the turret shaft from shifting.

CAUTION! If the shaft moves back when the turret is disconnected, the ball bearings in the turret cam may fall and have to be replaced before the turret can be reassembled.

7. Remove the four bolts from the turret retainer and remove the retainer.

NOTE: If a shaft extension is available, install it at this time. Using the extension gives you greater movement of the turret and allows you to remove and easily install the key, washers, and needle bearings.

CAUTION! The turret is heavy and could be slippery.

8. Remove the turret from the shaft.
9. The two washers, needle bearing, and key should be removed from the shaft and put aside at this time.

Installation

1. Put a small amount of grease on one side of the washers.
2. Place the washer on the surface of the turret and center it using your fingers. Be sure to keep grease off the surface facing the needle bearing.
3. Put a small amount of grease on both sides of the second washer.
4. Place the washer on the spring retainer on the lip of the turret shaft. Clean any grease on the shaft.
5. Place the needle bearing on the lip and stick it to the washer. Be sure the other surface of the bearing is clean and free of grease.
6. Put a small amount of grease on the turret key to hold it in place.
7. Place the turret on the shaft (align the turret key).

NOTE: Check that the turret key did not fall off, that the washer is centered on the turret, and that the washer and needle bearing are still on the shaft lip.

8. Slide the turret fully on the shaft.
9. Replace the turret retainer and snug the four bolts.

NOTE: Check the turret "O" ring. If you can see either the washer or the needle bearing they have slid off the shaft. Remove the turret and return to step 1.

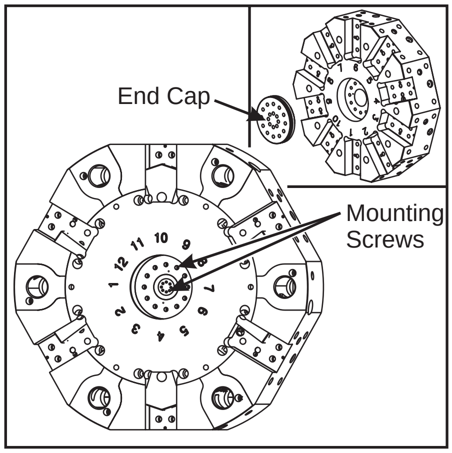
10. Tighten the four turret retainer bolts.
11. Remove the brace from between the turret shaft and the casing.
12. Connect the air. The turret should clamp.
13. Change Parameter 76 back to 500.
14. Exercise the tool changer to verify proper operation.
15. Replace the turret assembly and sliding tool change covers.

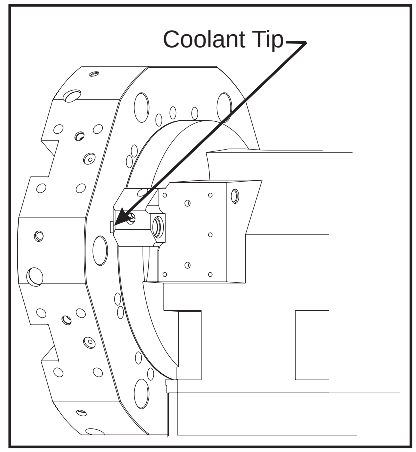
Hydraulic Turret

Removal

1. Clamp the turret in the pocket 1 position.

2. Remove the eight (8) bolts from the inner part of the end cap, and then remove the twelve (12) bolts from the outer part of the end cap.





3. Remove the end cap.

4. Remove the turret.

CAUTION! The turret is heavy, additional lifting equipment will be necessary to safely remove the turret.

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5. Remove the coupling from the tool changer housing and replace it with the one that came with the replacement turret. Center the coupler in the bolt holes then torque to 75 ft lbs. **Do not loosen the front coupler that comes attached to the turret.**

Installation

1. Install the turret, lining up the coolant tip in the pocket 1 position.

2. Check and Adjust if necessary, using the Rear Coupling only, the centerline of pocket one before tightening the bolts. It may be necessary to install a pocket on some turrets. Pocket one must be .002" TIR maximum & .001" centerline.

3. Install the end cap and snug the twelve (12) outer bolts.

4. Install the eight (8) inner bolts and snug.

5. Torque the twelve (12) outer bolts. to 30 ft-lbs.

6. Torque the eight (8) inner bolts. to 30 ft-lbs.

7. Repeat the torque process for 30 ft-lbs of torque.

8. Set Parameter 212 as described in the following section. This will correct alignment for clamping and unclamping the turret.

Turret Clamp Adjustment (Hydraulic Turret)

1. Enter Debug mode (type "DEBUG" in the alarms page and press enter).

2. Change parameter 43, Invis Axis to a 0 (zero).

3. Run a M43 (Turret Unlock) in MDI mode, and set Parameter 212 to 0 (zero).

4. Zero-return the A-axis.

5. Reset the turret clamp failure and command a M43 in MDI mode.

6. Use the Handle Jog and move the A-axis (jog speed 0.0001). Line up the coolant tube to the hole on the back of pocket 1.

7.Command a M44 and make sure the turret clamps properly. You may need to Handle Jog the A-axis into a better position until it clamps properly.

8. Write down the A-axis Actual value from the Pos-Raw Dat 1 page. Enter this value in Parameter 212 as a negative value, do not include the decimal point.

9. Zero-return the A-axis. Doing this will activate the new Parameter 212.

10. Return to the Pos-Raw Dat 1 screen.

11. With the turret clamped, jog the A-axis slowly (jog speed 0.0001) clockwise. Note the fuse level of the A-axis as the turret is jogged. When the fuse level starts to climb, write down the actual position for the A-axis.

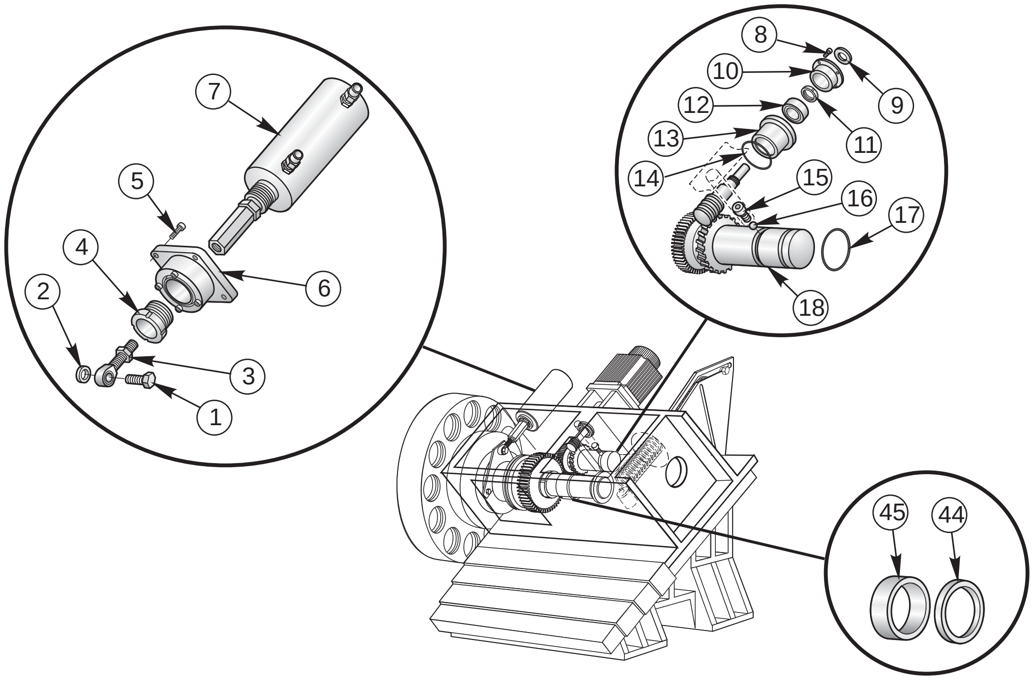
12. Jog the A-axis in the counter-clockwise direction, repeat the procedure and write down the actual position for the A-axis.

13. Add the absolute values of each number together (ignore the minus sign), for example:
(a) -.1813 + .0113= .1926 (ignore the negative sign)
(b) Divide this value by 2= .0963
(c) Combine this number with the value in Parameter 212. As the negative value is larger (see line (a)) than the other value, subtract the calculated value (.0963) from the value in Parameter 212; this will make a larger negative number.

For example; -410569 - .0963 = -411532 (ignore decimal point)

If the line (a) positive value is larger, add this number to the value in Parameter 212 to make a smaller negative number.

For example; -152117 + .0963 = -151154 (ignore the decimal point)



Turret Shaft Removal

1. Remove turret as previously described. Mark retaining ring and turret casting for alignment purposes.
2. Remove coolant tube bracket and move out of the way.
3. Remove inspection plate which will allow the gearbox oil to drain. Catch oil in a bucket.
4. Remove the bolt that holds the rod end to the lever cam. **Do not** adjust the rod end. Remove the lever cam and the switch bracket.
5. Remove the two set screws on the home switch cam at the back of the shaft, then remove the key. Turn the motor shaft to gain access to key or set screws. (servos off, E-stop).
6. Remove back half of curvic coupling (10-12 bolts), inspect o-ring.
7. Remove assembly (coupling holder and shaft) being careful to keep tension on the assembly to hold the cam and bearings in place.

Turret Shaft Replacement

Tools required: Installation tool for coupling mount

1. Apply grease to the ball bearing areas of the cam. Install coupling mount (cams and bearing) using the installation tool, and line up key way with the bolt that is equidistant between the springs (or previous marked alignment).
2. Install turret shaft assembly (align mark on retaining ring with the mark on the casting).
3. Align keyway facing up.
4. Install back half of curvic coupling on to gearbox snug two bolts and center the play between the bolt holes. Install the remainder of the bolts and torque to specifications.
5. Install lever cam, and the key for limit switch cam. Install limit switch cam and the limit switch bracket.
6. Attach actuator to lever cam and install the inspection plate and coolant tube bracket.

7. Add oil to the gearbox; 10 cups (2400 ml).
8. Install turret as described in previous section.

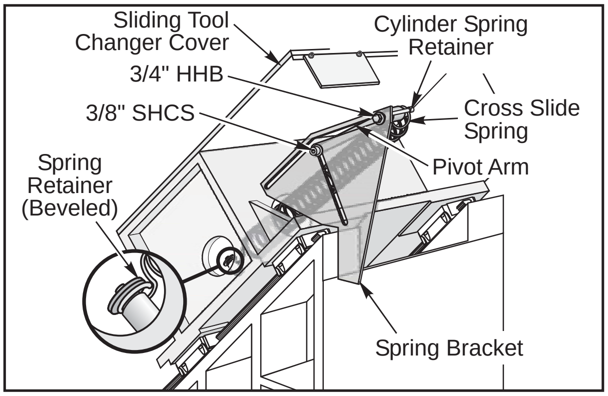
Turret motor coupling adjustment procedure must be completed for proper alignment.

Turret Cross-Slide Spring Replacement

WARNING!

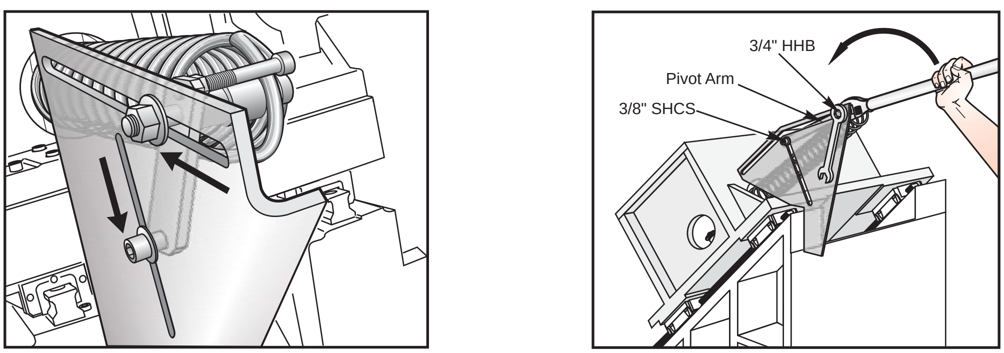
Power on machine, but do not press Emergency Stop, or turret will fall during spring removal.

1. Remove sliding tool changer cover, located in the back of the machine, to gain access to spring.



Cross-Slide Spring Components

2. Unbolt X-axis way cover from tool changer box. Jog the turret to top of X-axis travel.
3. Insert a wood block between ballscrew support and ballscrew nut to safely block the assembly.
4. Loosen 3/8" SHCS that holds lower pivot arm to spring bracket, then loosen 3/4" nut of upper pivot arm of spring bracket.



Spring Tension Relief

5. Place a wrench on the pivot arm and push the spring forward slowly to relieve the spring tension.

WARNING!

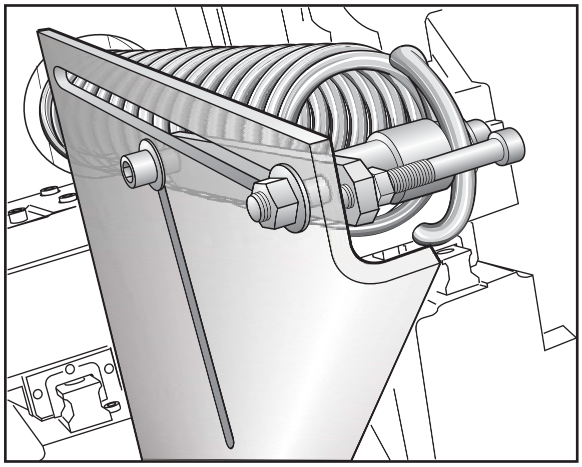
Be careful not to release tension too fast.

NOTE: Recommend using a wrench with a cheater bar for leverage when relieving spring tension.

6. Remove cross slide spring and remove spring retainer located inside turret housing. Use access hole located on the opposite side of turret to remove spring retainer. Replace used spring retainer with new beveled spring retainer.

NOTE: Old style bracket is not equipped with a cylinder spring retainer. Remove the two mounting bolts and old style bracket then replace with new bracket equipped with pivot arm and remount with two mounting bolts. Skip to Step 9.

7. Remove cylinder spring retainer attached to pivot arm and replace with new cylinder spring retainer.
8. Install new cross slide spring. Attach spring to spring retainer in turret housing and cylinder spring retainer of pivot arm.
9. Place a wrench on pivot arm then pull toward rear of bracket until pivot arm locks to restore spring tension.



10. Tighten 3/8" SHCS of lower pivot arm and nut of upper pivot arm on spring bracket.
11. Remove the wood safety block.
12. Re-attach the X-axis way cover.
13. Install sliding tool changer cover.

Adjusting Turret Backlash

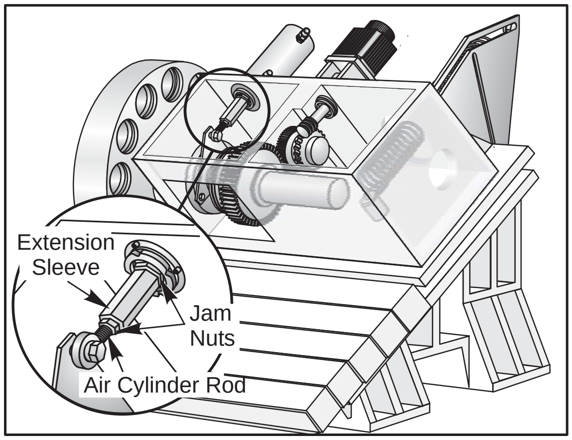
1. Affix the magnetic base and indicator on a clean surface and check rigidity.
2. Set the indicator pointer on the worm gear. Pointer should be in line with the lead angle on the center thread of the worm gear.
3. Rotate the worm gear to the end of rotational travel in the counterclockwise direction. Zero your indicator.
4. Rotate the worm gear to the end of rotational travel in the clockwise direction. Record your reading.
5. Rotate the worm gear to exactly half the value of your recorded reading; this is the position to now clamp your coupler. Coupler torque value is 16 ft-lb.

Example: Rotate the coupler and observe the indicated reading. The force used to rotate the coupler should be great enough so that when the force is removed you will see the indicated reading lessen; i.e. with little force T.I.R. is noted at .006 with more force T.I.R. is .012 (see note).

NOTE: While holding coupler at maximum rotational movement release pressure and note the backlash reading falls to lesser value. By experimenting,you will find a “spongy” area. This area is the end play in the worm and cluster gear.

NOTE: Excessive backlash can come from the coupler or bearing retainer.

Turret motor coupling adjustment procedure must be completed for proper alignment.



Turret Travel Adjustment Components

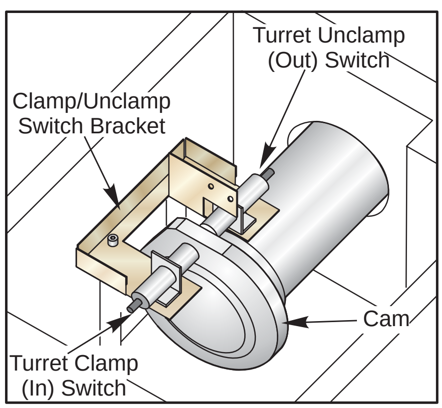
NOTE: Alarms 113 and 114, "Turret Unlock Fault" and "Turret Lock Fault", indicate a turret in/out adjustment is necessary. Alarms occur when turret clamp and unclamp switches sense a turret positioning error.

1. If turret travel is not .150", ensure no mechanical problem or obstruction affects travel. If not, air cylinder rod travel needs adjusted. To do so, loosen the two jam nuts, and screw extension sleeve **away** from air cylinder to increase turret travel, or **toward** air cylinder to decrease turret travel. When adjustment is complete, tighten the jam nuts to the extension sleeve.

2. Once the turret travel is set, the Clamp/Unclamp switches must be adjusted. Enter the diagnostic data page in order to monitor the TT UNL (Turret Unlocked) and TT LOK (Turret Locked) discrete inputs.

For the following procedures follow:
Section I - Production units making turret in/out adjustments with trip switches.
Section II - Production units making turret in/out adjustments using air cylinder mounted reed switches.

Section I



Turret Clamp/Unclamp Switches

a. In MDI, enter an M43 (Unlock Turret). The turret unclamp switch should be tripped at this point, and discrete input TT UNL should read "1".

b. Place a 0.160" gage block between the turret clamp switch and side of the cam, ensuring it is flat against the cam. The switch should trip and discrete input TT LOK should read "1". Remove the gage block.

If either switch does not trip when the gage block is in place, the switches need to be adjusted. Adjust the switches by loosening the two SHCS and moving the entire switch bracket; Do not move the individual switches unless absolutely necessary.

c. Enter an M44 (Lock Turret). The turret clamp switch should be tripped at this point, and discrete input TT LOK should be "1".

d. Place a 0.160" gage block between the turret unclamp switch and the side of the cam, ensuring it is flat against the cam. The turret unclamp switch should trip and discrete input TT UNL should read "1". Remove the gage block.

e. If either switch does not trip when the gage block is in place, the switches need to be adjusted. Adjust the switches by loosening the two SHCS and moving the entire switch bracket; Do not move the individual switches unless absolutely necessary.

Section II

a. In MDI, enter an M43 (Unlock Turret). The turret unclamp switch should be tripped at this point, and discrete input TT UNL should read "1".

If this does not occur, the lower air cylinder mounted reed switch needs to be adjusted by loosening the worm drive clamp retaining the sensor and moving it until the input reads “1”. Mark the location. Move the sensor slowly in both directions until the input reads “0” and mark the location. Place the sensor in between the marks and tighten the worm-drive clamp. Retighten sensor. When the turret is in any other position than Unlock Turret, the discrete input should read "0."

b. In MDI, enter an M44 (Lock Turret). The turret clamp switch should be tripped at this point, and discrete input TT LOK should read "1".

If this does not occur, the upper air cylinder mounted reed switch needs to be adjusted by loosening the worm drive clamp retaining the sensor and moving it until the input reads “1”. Mark the location. Move the sensor slowly in both directions until the input reads “0” and mark the location. Place the sensor in between the marks and tighten the worm-drive clamp. Retighten sensor. When the turret is in any other position than Lock Turret, the discrete input should read "0."

Centering Inner Turret Coupling (Without Brass Plug)

Only perform this procedure if there is not enough adjustment to perform an outer coupling alignment.

If the turret has a 1/4" brass plug, proceed to the next section.

1. Before starting, make sure tool pocket #1 is in position.
2. Pull the turret air cylinder all the way forward (unclamp) and place something snugly between the back of the turret shaft and the casting to keep the turret shaft from shifting.
3. Remove the four bolts from the center turret shaft cover.
4. To gain access to the rear coupling, either remove the turret or install a turret shaft extension and slide the turret onto it.
5. Loosen the 10 bolts on the inner coupling and center the coupling to the bolt holes. Retighten them to the required specifications (refer to the torque chart at beginning of the section).
6. Install the thrust bearing and both thrust bearing washers to the shoulder of the turret shaft.
7. Reinstall the turret and turret shaft cover. Make sure that the turret makes it over the o-ring before the bolts are tightened completely. If the bolts tighten up and the o-ring is still visible, one of the thrust washers is not on the shoulder of the turret shaft.
8. Return to Step 1 of the "Turret Alignment Verification" section and verify your readings.

All alignments could change spindle centerline. Enter new spindle centerline position in Parameter 254.

Centering Inner Turret Coupling (With 1/4" Brass Plug)

Only perform this procedure if there is not enough adjustment to perform an outer coupling alignment.

This procedure is only performed if the turret is equipped with a 1/4" brass plug.

1. Remove the 1/4" brass plug to gain access to the rear coupling.
2. Loosen, then lightly snug all the inner coupling bolts by doing a tool change to each station.
3. Using toolholder in turret, move turret in necessary direction with a rubber or plastic mallet to align spindle.
4. Tighten all 10 inner coupling bolts (jogging the A-axis for access) and torque them to the required specifications. Refer to torque chart at beginning of section.

NOTE: All alignments done could change spindle centerline. Verify and enter new spindle centerline position in Parameter 254.

Turret Alignment (X-Axis)

Read the following sections in their entirety before starting the alignment procedures.

1. Remove the rear cover and the sliding toolchanger cover.

NOTE: Be sure to remove the 4 SHCS located behind the turret. The X-axis wiper may also need to be replaced if damaged.

2. Remove top plate cover to the turret housing. Be sure to check the gasket and see if it needs replacement.
3. Remove the SHCS that mount the coolant adapter block to the turret housing. The turret must be in the unclamped position (M43) in order to lift the coolant line over the black access plate.
4. Remove the black access plate. The plate may need to be pried off with a screwdriver.

CAUTION: Have a bucket ready to catch oil draining from the housing.

5. Loosen all turret housing mounting bolts except for the front left bolt nearest the turret.
6. Clamp the turret (M44) and jog to the center of the X-travel.
7. Tap on the turret casting in order to bring the face of the turret into alignment.

NOTE: In order to help keep the turret housing from slipping down during the alignment procedure, keep the turret housing bolts as snug as possible.

Verify the turret alignment before continuing.

8. Apply Loctite and torque all turret housing mounting bolts to 50 ft-lbs.
9. Recheck the turret face to ensure the measurement did not change. Install the access cover and gasket.
10. Pour 10 cups of oil (DTE 25) into gear side of turret housing. Install the coolant adapter block.

NOTE: The turret must be in the unclamped position

11. Install the turret housing top plate and sliding tool changer cover, then zero return the machine.

After the turret face has been realigned it is important to verify that the spindle is still in alignment.

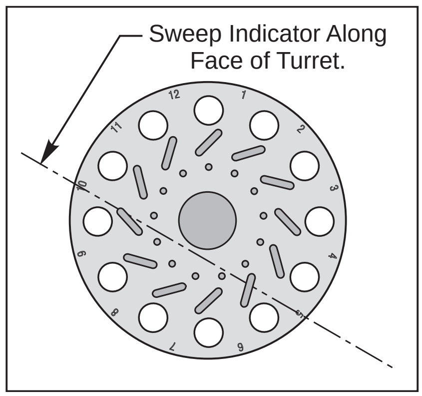
Proceed to “Turret Alignment Verification (Spindle)”.

NOTE: All alignments done could change spindle centerline. Verify and enter new spindle centerline position in Parameter 254.

TURRET ALIGNMENT VERIFICATION (X-AXIS)

Tools Required: Magnetic Base with a dial indicator (0.0005" or less resolution).

1. Remove all toolholders and fittings from the turret and Jog the X-axis to the center of its travel.
2. Place the magnetic indicator base on the spindle retainer ring. Position the indicator tip on the turret face so there is at least 3.5" of travel in each direction from the center of the X-axis and 1/4" below the center cap. Refer to the following figure.
3. Jog the X-axis so the indicator is at one end of its travel, then zero the indicator.
4. Jog the X-axis to the other end of its travel and check your reading (tolerance 0.0003" TIR).
5. If the reading is **greater** than the tolerance specified, the turret needs to be realigned.

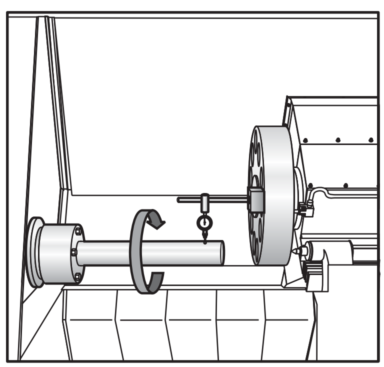


Turret Alignment Verification (X-Axis)

SPINDLE ALIGNMENT VERIFICATION

This procedure should be performed after the turret face has been realigned.
Tools Required: Spindle Alignment Test Bar (T-1312)

1. Mount a 0.0001" indicator (*short setup*) to face of turret.



Checking Runout

2. Install Spindle Alignment Test Bar. Take up any slack between bolts with washers.
3. Place the indicator tip onto the test bar near the spindle. Rotate the spindle to determine the runout. The tolerance is .0001". If the tolerance is greater than .0001, loosen the test bar mounting bolts, rotate the spindle and tap on the mounted end of the fixture until the runout is within tolerance.
4. Tighten the bolts to the test bar, being careful not to alter the alignment.

5. Move indicator tip to end of the test bar and check for runout. Tolerance should not exceed 0.0001".

NOTE: If reading is greater than 0.0001" remove test bar, and clean both surfaces.

6. Next rotate the test bar until the reading is 1/2 of the total runout. Using the Z-axis, jog the indicator tip over 10" of the test bar to determine if spindle is high or low. Tolerance should not exceed 0.0004/10".

NOTE: If the measurement is greater than allowable tolerance, the spindle head casting must be realigned. Before realignment, perform a Turret Alignment Verification - Parallelism of X-axis (Turrets section). If the measurement is within the allowable tolerance, go to step 7.

7. Position the indicator tip on the backside of the test bar. Jog the indicator tip over 10 inches of the test bar to determine spindle parallelism. The maximum allowable tolerance is 0.0004/10".

NOTE: If this tolerance is out, call Haas Automation Service Department. If the spindle is in alignment, proceed to "Turret Alignment Verification".

Turret Alignment Verification (Spindle)

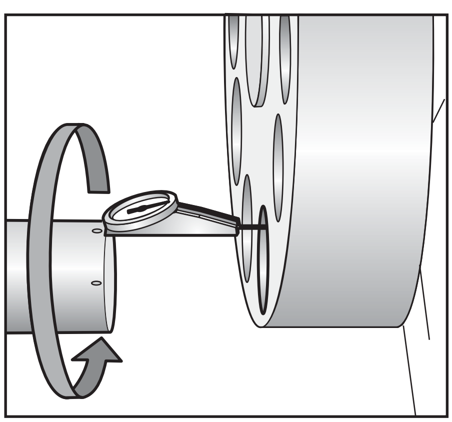
This procedure should be performed after spindle alignment has been checked.
Tools Required: Spindle Alignment Tool, Dial Indicator (0.0005" or less resoultion)

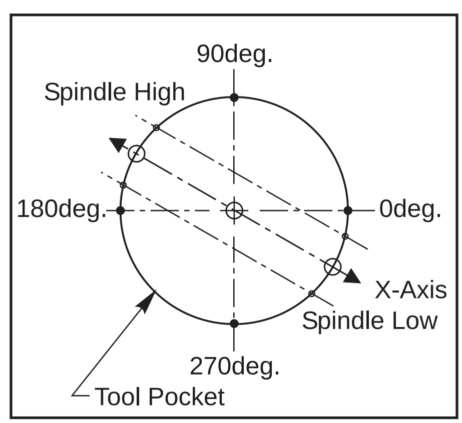
1. Remove all toolholders and fittings from the turret.
2. Clean the turret pockets and toolholders.
3. Mount spindle alignment tool onto spindle retainer ring with dial indicator mounted to the end of the tool.
4. Jog the X-axis to the spindle center line. This is the value stored in Parameter 254, found on the "Position Raw Data" page (this page is entered through Debug mode).
5. Position the indicator tip just inside pocket #1 so that it is almost parallel to the X-axis. Zero the indicator, then rotate the spindle 180°. The indicator should read Zero.

NOTE: Use the Jog Handle in tenths mode to zero the pocket.

6. Next, rotate the spindle and take readings at both the top and bottom of the pocket.
7. If the reading exceeds .0010" from the centerline or .0020" TIR, the inner coupling may need adjustment.
8. Perform turret motor coupling adjustment.

NOTE: If the reading is within specifications, but the X-axis position is different from Parameter 254, enter the new number in Parameter 254.





Turret Pocket Alignment

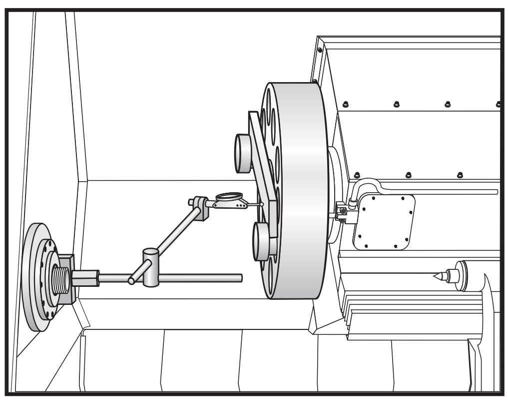
Converting Spindle Centerline to Encoder Step

1. Jog the X-axis to the spindle center.
2. Press Alarms, enter "Debug", press Write/Enter.
3. Press Posit, and Page Up until you see the debug screen Pos-Raw Dat 1.
4. Observe X-axis Command position. This is encoder steps. Ignore the negative sign and the decimal point.
5. Copy this number to Parameter 254 as a positive number with no decimal point.
6. Press Alarms, enter "Debug" and press Write/Enter, or turn the power off and back on to deactivate debug.

Turret Alignment Verification (Parallelism of X-Axis)

Tools Required: Magnetic Indicator Base**,** Dial Indicator (0.0005" or less resolution)**,** a bar approximately 12"x 4"x 1" (ground to within 0.0001" on the 1" width side)

1. Remove all toolholders and fittings from the turret.
2. Clean the turret pockets and toolholders, then command tool #1 to the cutting position.
3. Place a clean and undamaged toolholder loosely (do not thread nuts) in the nearest pocket to the spindle and the other in the opposite toolholder.
4. Place the 12" x 4" x 1" bar across the small diameter of the two toolholders (ground side down).



Turret Bar Sweep

5. Jog the X-axis to the center of its travel.
6. Mount the indicator to the spindle retainer ring. Position the indicator tip at the bottom edge of the bar.
7. Jog the X-axis so the indicator is at one end of the bar, and zero the indicator.
8. Jog the X-axis to the other end of the bar, and check your reading (tolerance is 0.0003" TIR).
9. If the reading is not within tolerance, loosen all (10) turret bolts with the turret in the clamped position.

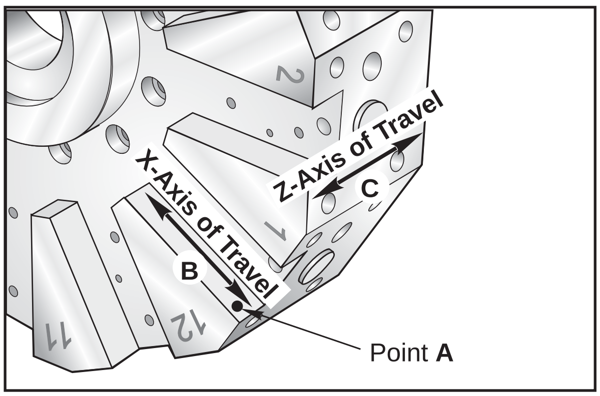
NOTE: For turret replacement, loosen and adjust the inner coupling.

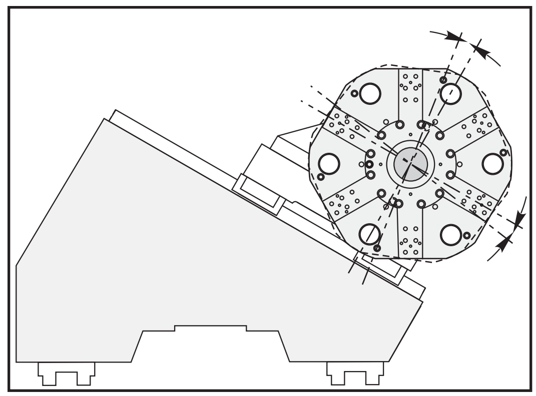
10. Rotate the turret 180° and check for .0003" TIR or less with the indicator.
11. Tap on the turret until the readings are within tolerance.
12. Retighten all (ten) turret bolts.

If the reading is within tolerance, proceed to “Turret Alignment Verification (Spindle)”. If the reading is **greater** than the tolerance specified, proceed to the appropriate coupling adjustment procedure.

Bolt On Turret Alignment

1. Clean the turret thoroughly before beginning alignment.
2. Index tool position #1 into the cutting position.
3. If the machine has a tailstock, move the turret and tailstock head next to each other and use the tailstock head as a secure mounting point for the indicator. If there is no tailstock, move the turret as close the fixed spindle bulkhead as possible. Assemble a short and rigid indicator mount as possible on the spindle retaining cap. A rigid setup is critical for proper turret indication.
4. Select four (4) equally spaced SHCS that secure the turret to the coupler and mark them with a felt pen. Loosen all the remaining bolts.
5. Place the indicator tip at the outside edge of the turret, point A in the following figure. Sweep the indicator along this edge by jogging the X-axis, direction B. This edge should be parallel to the X-axis within 0.0002” along its entire length and should as close to zero as possible.

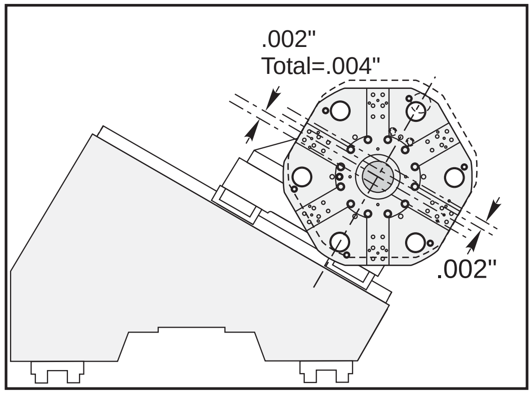




Hybrid Turret Shown

The previous illustrations shows a turret that is twisted about the coupler along direction “B” as described in step five. The turret flats should be parallel to the X-axis with in 0.0002”.

6. If the reading is not within specification, install a boring bar tool onto the top of the turret. Slightly loosen the four (4) marked SHCS and tap on the side of toolholder to twist the turret about the coupler. The clearance between the SHCS that secure the turret to the coupler allows for this adjustment. This step is to remove the twist between the turret tool positions and the center of rotation of the coupler. See the previous figure.
7. Place the indicator tip back at point A and set the indicator dial at zero (0). Jog the turret away from the indicator along the Z-axis (Direction C). Index the turret 180° so that tool position #7, on SL-10 and SL-30, or tool position #6 on SL-20 and SL-40, is in the cutting position.
8. Jog the turret back into position along the Z-axis relative to the indicator tip. This reading not to exceed 0.001”. If the reading is out of specification, then the turret is not yet on the same center of rotation as the coupler. If the indicator is showing the turret is lower at this position, index the turret 180 degrees to bring tool position #1 back into the cutting position. Ensure that the turret is above the coupler center of rotation so that when the turret is moved onto center, gravity does not work against you.
9. Loosen the four (4) marked SHCS and tap on the turret perpendicular to the X-axis. Move the turret half of the distance indicated. This will place this half of the turret on the center of rotation of the coupler. See the following figure.



The previous example illustrates a turret that is off center from the coupler center of rotation. The reading taken at point “A” in step seven, indicates how far off center the turret is. It must be moved half of this value to place it on to the coupler center of rotation. This must also be performed 90° from the first position.

10. Recheck that the turret did not become twisted by repeating step #5.
11. Index the turret so that tool position #4, (SL-10/SL-30) or #3 (SL-20/SL-40), is in the cutting position.
12. Place the indicator at point A on the flat for this tool position. Repeat steps #7 through #10. This will move the turret on to the center of rotation of the coupler for the other half of the turret. See the previous figure.
13. If the turret is moved relative to the coupler again, twist and on-center, in both directions, must be measured again to ensure they are within specifications.
14. The tool positions of the turret are now centered to the coupler. Torque all the SHCS and recheck readings.
15. Index tool position #1 into the cutting position.
16. Install the appropriate alignment bar onto the spindle and remove all runout from the alignment bar. Install a test indicator in the end of the spindle alignment bar.
17. On SL-10s there is not enough travel in the X-axis to reach the indication hole on the turret, so a good toolholder must be used. Install the toolholder in tool position #1. Ensure that the tool is seated completely against the turret and the front edge is pushed back against the turret face. Check with shim stock that the tool is completely seated against the turret.
18. Jog the X-axis to the centerline position listed in Parameter 254. If the 3/16” pin hole is used for centerline verification, the turret must be moved 3.0000” (SL-20/SL-30; 3.5200 for SL-40) further away from the home position to place the pin hole in line with the spindle.
19. Place the indicator tip into the 3/16” indication hole in the turret or the toolholder. Sweep the hole 360°. TIR not to exceed 0.002” for tool position #1.
20. Sweep all other tool positions in the same manner. All other positions TIR not to exceed 0.006”
21. After the turret is indicated into position, sweep the flats of the turret that are parallel to the Z-axis. They are to be parallel to the Z-axis within 0.001” along their length. Direction C. If they are out of specification, the turret gearbox may have to be re-squared on the X-axis.

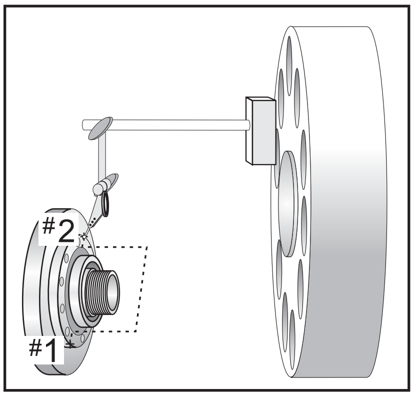
WEDGE ALIGNMENT

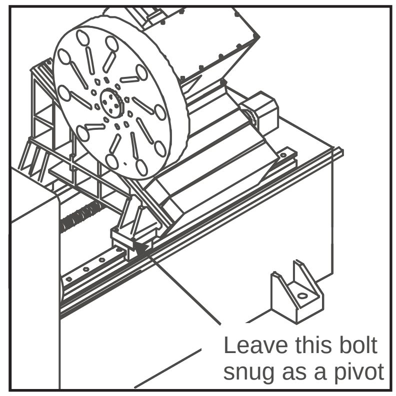
Using the data from the "Service Lathe Alignment" report as this procedure is followed. It is important that the form is filled out in its entirety before any adjustments of the wedge are attempted.

Run the spindle at its highest RPM to check for noise and vibration. If vibration or noise is detected, repair this first before making any wedge adjustments.

Verify the spindle alignment and if necessary correct before beginning the wedge alignment (see the "Turret Alignment Verification (Spindle)" section).

1. Mount magnetic base on turret face and check two positions on spindle face (as shown in following figure).





2. A difference in readings between the two positions proves the wedge is out of alignment. To correct the alignment, loosen all linear guide truck bolts for the wedge, leaving the outside corner bolt, closest to the spindle, snug. This will create a pivot when the wedge is moved for alignment (see the previous figure).

NOTE: X- and Z-axis way covers will need to be disconnected from the wedge in order to access the linear guide trucks.

3. Loosen the bolts on the ballscrew nut face on the Z-axis. Pivot the wedge to bring the spindle face reading to zero.

4. Snug the wedge bolts to keep the wedge from moving during the next procedure.

5. Verify the turret alignment by completing the steps in the "Turret Alignment Verification" sections. When moving the wedge, do not change its squareness to the Z-axis.

6. When both alignments are correct, gently snug all the Z-axis linear guide truck bolts, then torque to the required values.

7. Jog the Z-axis towards the spindle stopping 1" from the end of travel. Torque nut face bolts to required values (tighten in star pattern).

8. Check for binding at the start, middle and end of travel.

TOOLROOM LATHE X AND Z-AXIS ALIGNMENT

1. Place a granite tri-stone on the cross-slide tooling plate. Place a magnetic base on the base casting and put the tip of the indicator onto the edge parallel to the X-axis and align the stone parallel to the X-axis within .0001" over full travel.

2. Disconnect the Z-axis ballscrew nut from the nut housing.

3. Place the indicator tip on the granite parallel to the Z-axis. Loosen all but one of the SHCS which secure the saddle to the Z-axis. The one screw left tight will work as a pivot to align the axis. Align the X-axis to the Z-axis within .0005"/10". Tighten the saddle SHCS to 30 ft-lb.

4. Retighten the ballscrew SHCS to 30 ft-lb.

Axis Motors

Axis Motor Encoders

Haas machines are equipped with brushless motors, which provide for better performance and no maintenance. In addition to performance differences, the following list highlights additional benefits:

• Brushless motors have 8192 line encoders built in, with a resolution of 32768 steps per revolution.

• "In Position" Parameters 101, 102, 103, 104, and 165 affect brushless motors.

• The motor controller board has a dedicated processor which does all the servo control algorithms.

• Care should be taken, since there are high voltages present on the amplifiers, even when power is shut off The high voltage comes from the vector drive, which does have a charge light; only service the machine when this light is out.

• Brushless servo amplifiers are used to control the motors.

• The servo drive assembly has a low voltage power supply module to supply required amplifier voltage.

Axis Motor Amplifiers

The brushless servo amplifier is a Pulse Width Modulation (PWM) based current source. The PWM outputs control the current to a three phase brushless motor. The PWM frequency is either 12.5 KHz or 16 KHz. The amplifiers are current limited to 30 amps peak (45A peak for a medium amplifier). However, there are fuse limits both in hardware and software to protect the amplifiers and motors from over current. The nominal voltage for these amplifiers is 320 volts; therefore, the peak power is about 9600 watts or 13 HP. The amplifiers also have short circuit, over temperature and over voltage protection.

There is a 32 amp (small amplifier), 45 amp (medium amplifier), and 60 amp (large amplifier) supply fuse for failure protection. This fuse is relatively slow, therefore it can handle the 30amp peak of a small amplifier. Continuous current limit to the motor is controlled by software.

Replace these fuses with the same type and rating. A fuse kit (93-1089) may be purchased. Make sure that the machine is turned off and that the “High voltage present” LED light in the control cabinet is completely off.

Commands to the amplifier are +/-5 volts current in two legs of the motor and a digital enable signal. A signal from the amplifier indicates drive fault or sustained high current in a stalled motor.

The connectors on the amplifiers are:

+H.V.	+320 volts DC
-H.V.	320 volts return
A	Motor lead phase A
B	Motor lead phase B
C	Motor lead phase C
J1	Three pin Molex connector used for +/-12 and GND.
J2	Eight pin Molex connector used for input signals.

Axis Motor Removal/Installation

Please read this section in its entirety before attempting to remove or replace the axis motors.

Tool required for vertical mill Z-axis equipped with a counterbalance system: Cylinder shaft stop (P/N 99-7562 - VF-1 through 4, P/N 93-9962 - VF-6 through 11).

Precautions

Mills are currently equipped with either a hydraulic counterbalance system or an electric brake motor. Care must be taken, in either case, to avoid damaging the machine or severely injuring yourself. Heed all warnings and cautions and read all the steps of the procedure before starting any disassembly.

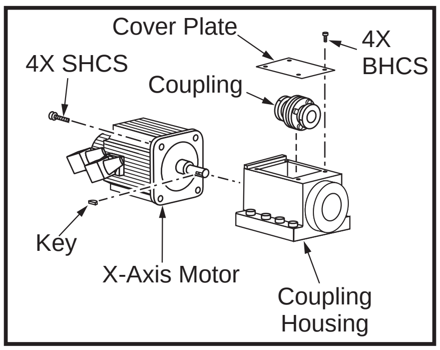
If removing a vertical axis, brace the spindle head. The spindle head will fall if this is not done. Use a cylinder Short Stop, block of wood, or shipping bolts (Horiz.) to secure the head.

WARNING! MILLS WITHOUT A COUNTERBALANCE

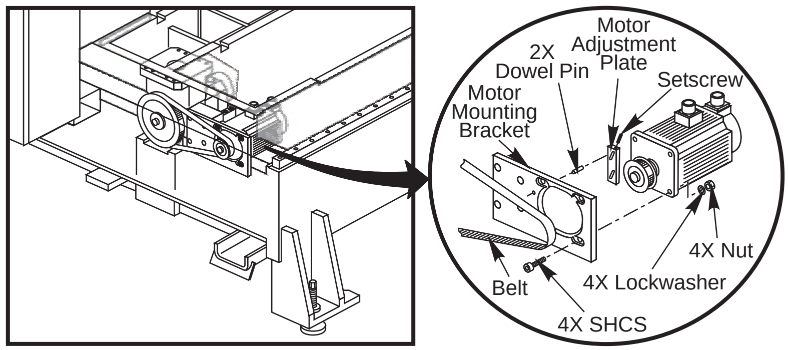
If debug is on and a vertical axis is disabled, the spindle head will fall. This is extremely dangerous and must be avoided.

NOTE: When replacing the X-axis on GR-series mills, a belt must be removed from the motor; all work is done beneath the mill.

Axis Motor Replacement



Typical Motor Assembly



GR-Series X-Axis Motor Location

Removal

1. Power On the machine. Zero return all axes and put machine in Handle Jog mode.
2. Remove sheet metal necessary to access the axis motor (jog axes if necessary).
3. Power Off the machine.
4. **Vert:** Remove the Lube/Air Panel (VF-1 through VF-5).
5. Remove the motor from the motor coupling.
6. **GR-series X-axis:** Remove the four SHCS that secure the motor to the mounting bracket, and loosen the set screw on top of the motor adjustment plate. (The adjustment plate is not fastened to the motor or the bracket, therefore it may fall off the dowel pins once the motor is removed.) Disconnect the belt from the pulley and remove the motor.
7. Disconnect all wiring and remove the motor.

Installation

1. Reconnect all wiring to the motor.
2. Attach the motor to the coupling.
3. a. **GR-series X-axis:** Position the motor in the motor mounting bracket, attach the belt, reinstall the motor adjustment plate and set proper belt tension. Tighten motor bolts and recheck belt tension.

   b. **VERT:** Replace the Lube/Air Panel (VF-1 through VF-5).
4. Replace all removed sheet metal.

5. Power On the machine.
6. Check for backlash in the ballscrew ("Accuracy/Backlash" section) or noisy operation.
7. Zero Return the axis and set the grid offset.
8. **Z-axis:** Reset the value for Parameter 64.

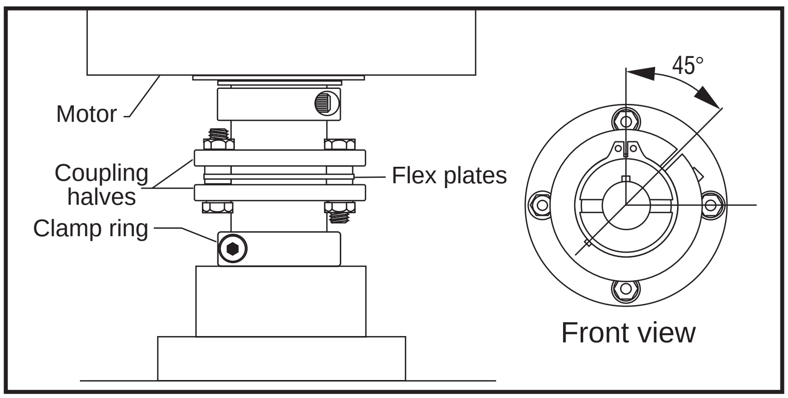
CAUTION! Work offsets will change.

Coupling Replacement

WARNING!
MILLS WITHOUT A COUNTERBALANCE
If debug is on and the Z-axis is disabled, the spindle head will fall.

Removal

1. Remove the axis motor in accordance with "Axis Motor Removal/Installation" section.
2. Completely loosen the two SHCS on the two coupling clamp rings and remove the coupling.



Motor Coupling Components

Installation

1. Visually inspect the flex plates to ensure they are parallel to the coupling halves. Slide the new coupling onto the motor shaft until the coupling half is flush to the end of the shaft.
2. The slot in the locking collar must be positioned 45^0 between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the ballscrew or motor shaft.
3. Add one drop of blue Loctite to each screw on the coupling's clamp ring and tighten.
4. Reinstall the axis motor.

Axis Brake Motor (Mills Only)

The servo brake motor compensates for the weight of the spindle head. The brake is released when the servo motors are activated; however, the disk brake engagement spline may produce a small noise when the head is in motion, **this is normal**.

A parameter governs the ability of the brake motor; therefore, Parameter 25, Y-Axis Torque Preload, must be set correctly, and Vertical machines **without** counterbalances must have Parameter 39, Z-Axis Torque Preload, set correctly.

BEARING SLEEVE REMOVAL/INSTALLATION

Please read this section in its entirety before attempting to remove or replace the bearing sleeve.

Vertical Tool Required: Spanner wrench, Pre-load fixture, Wood block (16" long)

Z-Axis machines with counterbalance: Cylinder shaft stop (P/N 99-7562 - VF-1 through 4, P/N 93-9962 - VF-6 through 10)

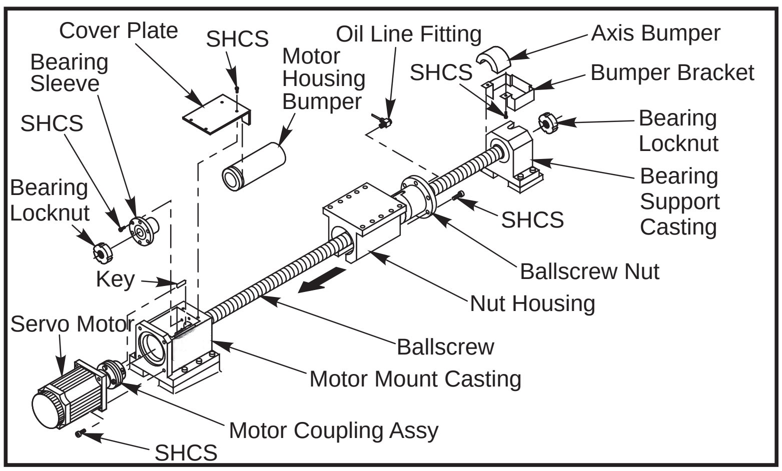
NOTE: For machines equipped with 40 or 50 mm ballscrews, the ballscrew must be removed in order to remove the bearing sleeve. Refer to the "Ballscrew Removal/Installation" section for instructions.

NOTE: When replacing the ballscrew in an older machine, always replace the bearing sleeve with the current angular contact design bearing sleeve.

BEARING SLEEVE REPLACEMENT

Removal

1. Power on the machine. Zero return all axes and put the machine in Handle Jog mode.



Typical Ballscrew Assembly

2. Remove all necessary sheet metal and jog the axis away from the bearing support. **Vertical Axes**: Place a wood block beneath the spindle head and lower the spindle head until it is resting on the block to prevent it from crashing down during servicing.

3. Power off the machine.

4. Remove the hardstop bracket from bearing support end, and remove the locknut. If necessary, manually screw the axis away from the motor housing in order to access the motor (not possible with vertical axes).

CAUTION! Do not screw the axis too far away, since the hardstops are removed!

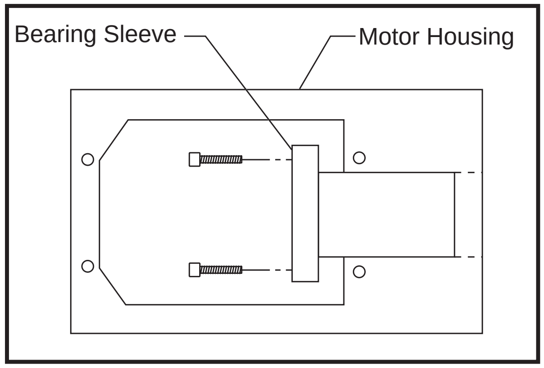
5. Remove the axis motor ("Axis Motor Removal/Installation" section).

6. Remove the motor coupling.

7. Loosen the SHCS on the locknut at the motor end of the ballscrew, and remove the locknut.

8. Loosen the SHCS and remove the bearing sleeve from the coupling housing. Push on the opposite end of the ballscrew to loosen.

CAUTION! Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, motor housing or ballscrew will result.



Bearing Sleeve Mounting Location

Installation

1. Ensure all mating surfaces on the bearing sleeve and motor housing are free of dirt, burrs, grease, or other contaminants. Failure to do so may cause misalignment.
2. Move the axis, by hand, to the support end of the ballscrew.
3. Place the bearing sleeve in the motor mount. It may be necessary to align the bearings in the sleeve to facilitate mounting on the ballscrew.
4. Install the SHCS on the bearing sleeve, attaching it to the motor housing, and torque to 15 ft-lb. (Place a drop of blue Loctite on each of the SHCS before inserting.)

CAUTION! Do not use more than one drop of Loctite. An excessive amount will cause a film between the sleeve and housing, which could result in backlash.

CAUTION! Do not screw the axis too far away, since the hardstops are removed!

5. Screw the locknut on the motor end of the ballscrew two or three turns, but do not tighten.
6. Move the axis by hand, to the motor end of the ballscrew.
7. Loosen the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing and retighten to 15 ft-lb. This step ensures that the ballscrew is installed and runs parallel and flat to the linear guides and saddle.
8. Tighten the ballscrew against the locknuts. An angular contact design bearing requires no pre-load. Tighten the locknut on the motor housing end of the ballscrew to 15 ft-lb. Tighten the SHCS on the locknut. Place a spanner nut over the locknut on the support bearing end of the ballscrew and slowly tighten to 4 in-lb. Remove the spanner nut. Tighten the SHCS on the locknut with Loctite, and mark it with paint.
9. Reinstall and tighten the hard stop on the bearing support and reinstall the axis motor.
10. **Vertical Axis:** Jog off the wood block beneath the spindle head and remove the wood block.
11. Check for backlash or noisy operation in the ballscrew (see the "Accuracy/Backlash" section), zero the axis, and set the grid offset.

BALLSCREW TROUBLE SHOOTING

NOT OPERATING

All problems that are caused by servo motor failures should also register an alarm. Check the alarm history to determine the cause of the problem before any action is taken.

Servo motor is not functioning

• Check the power cable from rear electrical cabinet to ensure connection is tight.

• Encoder is faulty or contaminated (Alarms 139-142, 153-156, 165-168, 182-185). Replace motor assembly.

• Open circuit in motor (Alarms 103-106, 139-142, 153-156, 182-185). Replace motor assembly ("Axis Motor Removal/Installation").

• Motor has overheated, resulting in damage to the interior components (Alarms 135-138, 176). Replace motor assembly ("Axis Motor Removal/Installation").

• Wiring is broken, shorted, or missing shield (Alarms 153-156, 175, 182-185).

• Motor has overheated with no damage to the interior components and an Overheat alarm has been triggered. After a thorough check of the motor **(do not disassemble!)**, take necessary steps to eliminate the problem and clear the alarm to resume operation. If motor is still inoperable, replace the motor assembly.

• Check for broken or loose coupling between the servo motor and the ballscrew.

• Check for a damaged ballscrew, and replace if necessary.

NOTE: If a ballscrew fails, it is most often due to a failed bearing sleeve. When replacing the ballscrew, always replace the bearing sleeve.

NOISE

Ballscrew noise is usually caused by a lack of lubrication and is usually accompanied by heating. Other causes are misalignment, bearing sleeve damage, or ball nut damage. Check the alarm history of the machine and look for axis overcurrent and following error alarms.

NOTE: Do not replace ballscrews or bearing sleeves without considering other factors; they are extremely durable and reliable. Verify that customer complaints are not due to tooling, programming, or fixturing problems.

Servo motor noise

• Disconnect the servo motor from the ballscrew and rotate the motor by hand. If the noise persists, replace the motor assembly.

• Noise is caused by bearings. Grinding sound is heard coming from the motor. If bearings are making a loud sound, replace the motor.

Ballscrew noise

NOTE: Customer complaints of ballscrew noise may not indicate a bad screw. Screws from different manufacturers produce varying levels of noise. Often machines are built with two or more different brands of screws. If complaints are generated about one axis screw in comparison to another, it is possible that the screws are simply sourced from different manufacturers.

• Ensure oil is getting to the ballscrew through the lubrication system. Look for a plugged metering valve.

• Check for damage to the bearing sleeve.

NOTE: The current angular contact design sleeve has a fixed pre-load; it cannot be adjusted.

• Run the axis back and forth. The motor will get very hot if the bearing sleeve is damaged. If so, turn the axis by hand and feel for roughness in the ballscrew. Loosen the clamp nuts at both ends of the ballscrew. If the symptom disappears, replace the bearing sleeve. Be certain to check for damage to the ballscrew shaft where the bearing sleeve is mounted. If the noise persists, the ballscrew is damaged and must be replaced.

• Misalignment in the ballscrew itself will tend to cause the ballscrew to tighten up and make excessive noise at both ends of the travel. The ball nut may get hot. Misalignment radially at the yoke where the ball nut mounts is indicated by the heating of the ball nut on the ballscrew, and noise and tightness throughout the travel of the ballscrew. Misalignment at the yoke where the ball nut mounts is indicated by noise and tightness at both ends of the travel of the ballscrew.

Accuracy/Backlash

Accuracy complaints are usually related to tooling, programming, or fixturing problems. Verify that all these are correct before working on the machine.

Poor positioning accuracy

• Check parameters for that axis. Check the parameter values with the paperwork shipped with the machine.

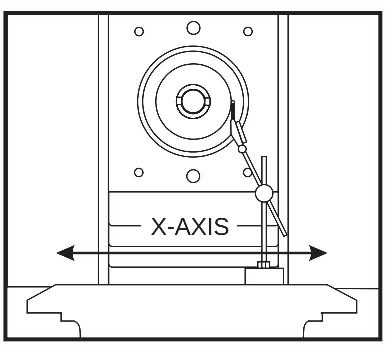
• Check for backlash in the ballscrew as described in the following section.

Initial Preparation

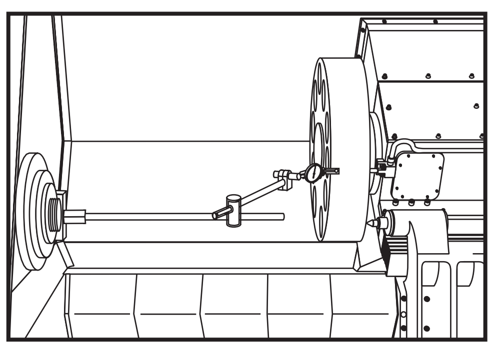
1. Turn the machine On and zero return the machine.
2. Center all the axes. (For Horizontal mills move the Z-axis so the spindle and the table are the closest to the end of travel toward the table.)

Checking X-axis

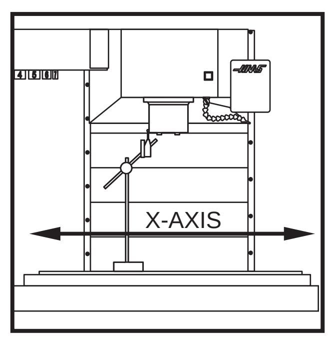
1. Set up a dial indicator and base as shown in the following figures.



Horizontal Mill



Lathe



Vertical Mill

2. Set dial indicator and the "Distance to go" display in the Handle Jog mode to zero as follows:

   • Zero the dial indicator.

   • Press the MDI button on the control panel.

   • Press the Handle Jog key on the control panel.

   The "Distance to go" display in the lower right hand corner of the screen should read: X = 0 Y = 0 Z = 0.

3. Set the rate of travel to .001 on the control panel and jog the machine .010 in the positive (+) X direction. Jog back to zero (0) on the display. The dial indicator should read zero (0) ± .0001.
4. Repeat Step 3 in the negative (-) direction.

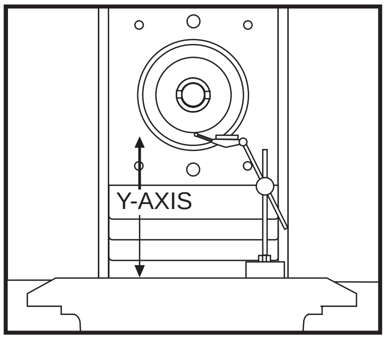
Total deviation between the dial indicator and the control panel display should not exceed .0002.

An alternate method for checking X-axis backlash is to place the dial indicator as previously shown and manually push the X-axis in both directions. The dial indicator should return to zero after releasing the axis. The axis motors must be on to check backlash by this method. Do not press E-Stop.

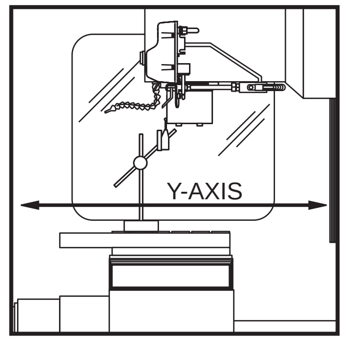
5. If backlash is found, refer to "Backlash - Possible Causes" in this section.

Checking Y-axis

1. Set up a dial indicator and base on the mill table as shown in the following figures.



Horizontal Y-axis



Vertical Y-axis

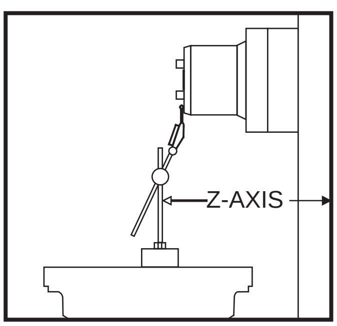
2. Follow the same procedure used for checking the X-axis.

An alternate method for checking Y-axis backlash is to place the dial indicator as previously shown and manually push the Y-axis in both directions. The dial indicator should return to zero after releasing the axis. The Axis motors must be on to check backlash by this method. Do not press E-Stop.

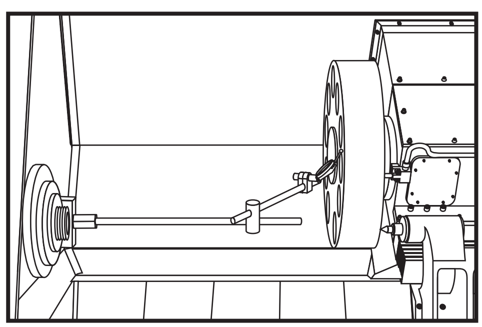
3. If backlash is found, refer to "Backlash - Possible Causes" in this section.

Checking Z-axis

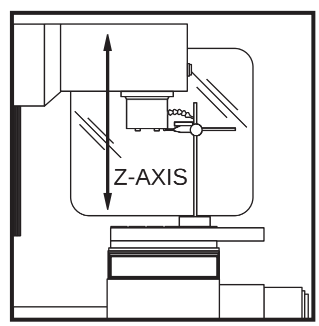
1. Set up a dial indicator and base as shown in the following figures.



Horizontal Z-axis



Lathe Z-axis



Vertical Z-axis

NOTE: For the Lathe, position the tip of the indicator on the face of the turret.

2. Follow the same procedure used for checking the X-axis.

An alternate method for checking Z-axis backlash is to place the dial indicator as previously shown and manually push the Z-axis in both directions. The dial indicator should return to zero after releasing the axis. The axis motors must be on to check backlash by this method. Do not press E-Stop.

NOTE: Do not mistake deflection for backlash in the system.

3. If backlash is found, refer to "Backlash - Possible Causes" in this section.

Backlash - Possible Causes

If backlash is found in the system, check for the following possible causes:

• Loosen the SHCS attaching the ball nut to the nut housing. Tighten the SHCS as described.

• Loosen the SHCS attaching the nut housing to the axis. Tighten the SHCS as described.

• Loosen the clamp nut on the bearing sleeve. Tighten the SHCS on the clamp nut.

• Loosen the motor coupling. Tighten as described.

• Broken or loose flex plates on the motor coupling.

• Loosen the SHCS attaching the bearing sleeve to the motor housing or top of the column. Tighten as described in "Ballscrew Removal and Installation".

• Defective thrust bearings in the bearing sleeve. Replace the bearing sleeve as outlined in "Bearing Sleeve Removal/Installation".

• Loose SHCS attaching the axis motor to the motor housing. If the SHCS are found to be loose, inspect the motor for damage and if none is found, tighten the SHCS. If damage is found, replace the motor.

• Incorrect backlash compensation number in the machine parameter. Check Parameters 13, 27 (mills only), and 41.

• Worn ballscrew.

Ballscrews - Visual Inspection

The three main causes of ballscrew failure are loss of lubrication, contamination, and machine crash. Wear of the nut balls and the screw threads is generally a non-issue under proper operating conditions. Each type of suspect cause will leave telltale signs on the Ballscrew itself.

Loss of Lubrication:

The lubrication system of the machine provides a layer of oil for the ballscrew components to operate on, eliminating metal-to-metal contact. Problems with the lubrication system will accelerate all wear issues.

1. Dry metal-to-metal contact following lube breakdown will create intense heat at the contact points. The nut balls will weld to the nut races due to heat and pressure of the preload. When movement of the ballscrew continues, the welds will be broken, ripping off particles of both the balls and the races. This loss of diameter will reduce the preload, reducing machine accuracy.
2. Another cause of wear of ballscrews is material fatigue. Material fatigue typically occurs at the end of the ballscrew service life and includes black, contaminated coolant, pitting of the screw surface, loss of preload, and metal flakes on the ballscrew. Ballscrews damaged by material fatigue are not repairable.

Contamination:

Contamination of the lubrication and/or coolant systems of the machine will produce problems with the ballscrews.

Check the condition of the lube on the ballscrew threads.

1. If the lube is wet and clean, it indicates a properly functioning lube system.
2. If the lube is thick and dark, but free of metal chips, the lube itself is old and must be changed out. The entire system should be cleaned of the old lube.
3. If lube is wet and black, lube system is contaminated by metal particles. Inspect the ballscrews for wear.

Contamination of lube and/or coolant systems can be caused by a wearing ballscrew, or metal chips entering the systems through open or loose way covers. Check all way covers and seals for excessive clearances.

Machine Crash

A hard machine crash can cause a ballscrew to lock up. The static overload created during a machine crash can break apart the ball nut balls, denting the thread surfaces. Turning the nut by hand will result in an obvious grinding feeling and/or sound.

1. Check the screw for straightness.
2. Look for ball dents at the ends of the screw length. These indents indicate a hard machine crash. The table inertia is transferred directly to the balls inside the ball nut, creating impressions on the screw surface.

Ballscrew Cleaning

In most cases, thorough cleaning of a suspect ballscrew will resolve many issues, including noise complaints.

1. Manually jog the ball nut to one end of the screw, and visually inspect the screw threads. Look for metal flakes, dark or thick lube, or contaminated coolant: See the previous "Contamination" section.
2. Use alcohol, or other approved cleaning agents, to wash the screw.

CAUTION! Do not use detergents, degreasers, or solvents to clean Ballscrews or their components. Do not use water-based cleaners, they may cause rust.

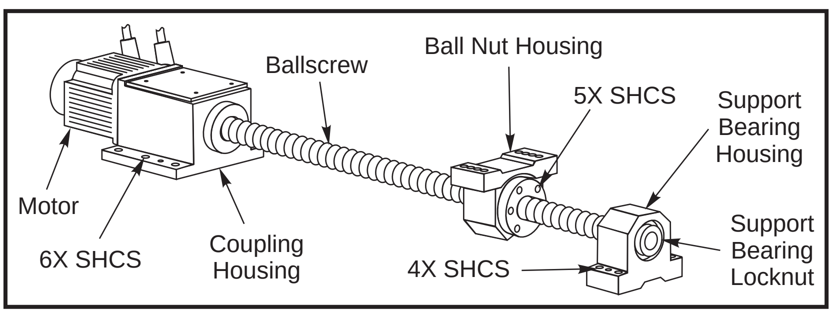
3. Jog ball nut to other end of travel. If metal flakes are present on screw threads, you may have wear issues.
4. Re-lubricate screw threads before returning the machine to service.

Horizontal Axis Ballscrew Replacement

Please read this section in its entirety before attempting to remove or replace the ballscrews.

Tools Required: Horiz: Torque wrench, Spanner nut. **Lathe:** Spanner Wrench (32mm or 40/50mm), Shaft Lock (32mm or 40/50mm). **Vert:** Spanner wrench (32 mm or 40/50 mm), 2" x 4" wood block (21"-23$^1/_2$" long), Shaft lock (32 mm or 40/50 mm), Torque tester, Z-axis if it has a counterbalance system: Cylinder shaft stop (P/N 99-7562 - VF-1 through 4, P/N 93-9962 - VF-6 through 10)

NOTE: Certain following steps apply only to 40 and 50 mm ballscrews.



Removal

1. Turn the machine on. Zero return all axes and put the machine in Handle Jog mode.
2. Remove the sheet metal necessary to access the ballscrew and its components.
3. Jog the vertical axis to the bottom of its travel, and the horizontal axis to the center of travel.
4. Power off the machine.
5. If applicable, remove the hard stop from the bearing housing on the ballscrew.
6. Disconnect the oil line from the ball nut.

7. Loosen the 10-32 x ½" SHCS and remove the locknut on the ballscrew support bearing end.

8. Remove the axis motor in accordance with "Axis Motor Removal/Installation".

9. Loosen the SHCS and remove the bearing sleeve from the motor mount in accordance with "Bearing Sleeve Removal/Installation". Push on the opposite end of the ballscrew to loosen.

CAUTION! Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or ballscrew will result.

10. **Vert:** Loosen the 10-32 x ½" SHCS and remove the clamp nut on the ballscrew in the motor housing.

11. Loosen and remove the five SHCS attaching the ball nut to the nut housing.

12. a. **Vert:** Push the mill table towards the motor end until the ballscrew clears the bearing support. Remove the ballscrew by pulling from the bearing support end.

    b. **Horiz:** Pull the ballscrew toward the control box side and out of the bearing in the bearing support. Lift the ballscrew up, forward, and to the side of the machine until the motor end of the ballscrew is free. Carefully remove the ballscrew.

    c. **For 40 and 50 mm ballscrews:** Loosen the SHCS mounting the bearing support to the saddle and remove. Remove the pull pins from the bearing support. Loosen the five SHCS in the ball nut and remove the ballscrew by pulling from the bearing support end.

    d. **For MDC-500 ballscrews:**

    • **X-axis:** Jog the column to the middle of travel and turn the machine Off. Remove the eight (8) bolts securing the nut housing to the casting. The entire casting is now free to move by hand.

    • **Y-axis:** This procedure is most efficiently completed if the column is jogged back until the nut housing is directly above the hole in the casting. Jog the column back until the bearing support housing is over the hole in the saddle and Power Off the machine. From the right hand side of the machine, remove the nut housing (8 bolts) that attach the ballscrew to the saddle. The casting is now free to move by hand.

    • **Y-axis with no hole in casting:** Jog the column all the way forward and remove the bearing support housing (4 bolts, 2 alignment pins). Remove the nut housing by using an allen wrench to remove the 8 bolts. Note that at this point, the casting is free to move by hand. Take extreme caution when moving by hand as there are no safety stops to prohibit the column from sliding off of the linear guides. Finally, remove the motor support housing and remove the ballscrew through the back of the machine.

    • **X & Y Axes Removal:** Now remove the six (6) bolts and two (2) alignment pins on the motor support housing and the four (4) bolts and two (2) alignment pins on the bearing support housing. Remove the oil line fitting (**X-Axis**) from the side of the ballscrew nut. Angle the ballscrew and pull it out the back of the machine (**X-Axis**) or slide the ballscrew out between the bottom of the column and the base casting to the back of the machine (**Y-Axis**).

If MDC-500 has to be turned On with ballscrew disconnected, the corresponding Parameter bit has to be changed to disable that axis. In Parameter 1, change bit from 0 to 1 to disable X-axis only. In Parameter 15, change bit from 0 to 1 to disable Y-axis only. When ballscrew is in place, change bit back to enable axis.

Installation

NOTE: For vertical machines, this procedure assumes that the nut and motor housing have not been removed.

1. Center the mill table on the saddle.

2. Ensure all mating on the bearing sleeve, coupling housing, nut housing, and ball nut are free of dirt, burrs, grease, or other contaminants.

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

3. **Vert:** Insert the ballscrew through the nut housing and motor housing, taking care not to make contact with the screw threads, which will cause possible damage.

   If 40 or 50 mm ballscrew:

   • Mount the bearing support to the saddle with six SHCS, but do not tighten completely. Replace the pull pins in the bearing support.

   • Install the spacer ring on the motor end of the ballscrew.

   • Insert the 5/16-18 x 3/4" (or M10 x 25 mm) SHCS, attaching the ball nut to the nut housing, but do not tighten completely. (Place a drop of blue Loctite on each of the SHCS before inserting.)

   • Skip to Step 8.

4. **Horiz:** Hold the ballscrew vertically with the motor end down and the nut near the support end (top) at the front left side of the machine and lower into place, rotating the ballscrew into position, being careful not to bump or scratch it. Gently push the bearing support end of the ballscrew into the bearing in the bearing support housing.

   EC-300: Slide the motor end of the ballscrew from the front of the machine over the bearing housing, taking care not to damage the screw threads.

   EC-400: Slide bearing support end of the ballscrew past the rotary table toward the front of the machine.

   EC-1600: Slide bearing support end of ballscrew under the column, taking care not to damage the screw threads. Position ballscrew to the right side of the nut housing and slide toward the front of the machine.

5. Replace the bearing sleeve in accordance with "Bearing Sleeve Removal/Installation". It may be necessary to align the bearings in the sleeve to facilitate mounting on the ballscrew.
6. Rotate the ballscrew nut so it goes into the nut housing and start the SHCS that secure the ballscrew nut to the nut housing. Do not tighten.
7. Reattach the oil line to the ballscrew nut.
8. Replace the axis motor in accordance with "Axis Motor Removal/Installation".
9. Torque the SHCS from the nut to the nut housing to 15 ft-lb **(30 ft-lb for EC-1600)**.
10. If applicable, replace the bearing support end hard stop.
11. The following sequence is important to ensure proper installation of the ballscrew:

    • Tighten the locknut, hand tight, on the motor end.

    • Install and tighten locknut on bearing support. Ensure nut **does not** touch the bearing support.

    • Install the shaft lock onto the bearing support end of the ballscrew. This will keep the ballscrew from turning while torquing the lock.

    • Place a spanner wrench on the locknut at the motor end of the assembly.

    • **Vert & EC-300:** Torque the locknut against the bearing sleeve to 15 ft-lb.

    • **40/50 mm, EC-400, and EC-1600:** Torque the ballscrew locknut against the bearing sleeve to 50 ft-lb.

    • **Horiz & EC-400:** Torque the locknut against the bearing sleeve to 10 ft-lb.

    • With a T-handle wrench hand tighten the locknut screw and mark with paint.

• **(EC-300)** Loosen the locknut screw and bearing locknut and tighten to 4 in-lb against the bearing. Retighten the locknut screw.

• **(EC-400/EC-1600):** Loosen the locknut screw and the bearing locknut and tighten to 10 ft-lb against the bearing. Retighten the locknut screw.

• **Vert:** Torque support mounting bolts to proper specifications. Loosen locknut screw and locknut at the bearing support end and tighten to 4 in-lb against the bearing. Retighten the locknut screw.

• Remove the shaft lock for vertical machines with a counterbalance system.

For 40 and 50 mm ball screws only:

• Tighten down completely the SHCS that mount the bearing support to the saddle.

• Loosen the locknut on the bearing support end. Adjust the nut until it seats on the bearing. Retighten the locknut hand-tight, then 1/8 turn more (4 in-lb if using a torque screwdriver).

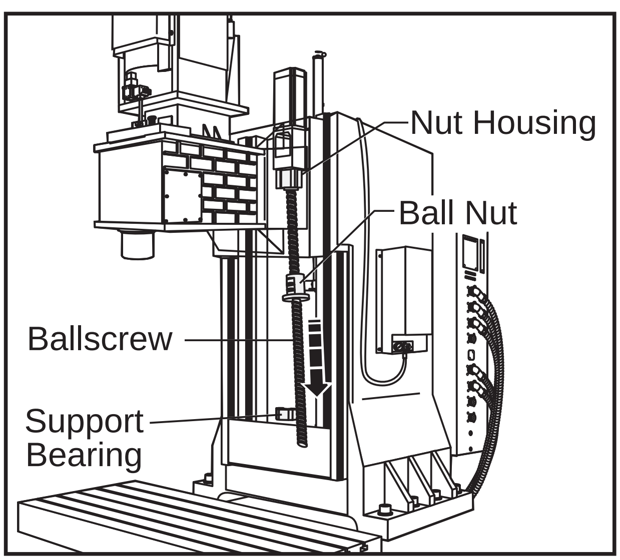
12. Power on the machine.
13. a. **Horiz:** Rotate the ballscrew by hand to assure free movement.

    b. **Vert:** Check ballscrew torque at bearing support end with torque tester. Jog the table all the way to the right. Check the ballscrew torque again. It should be the same as the previous reading.
14. Jog the axis to check for free movement.
15. Check for backlash or noisy operation in the ballscrew ("Accuracy/Backlash" section).
16. Replace appropriate sheet metal.
17. Zero return the axis and set grid offset.

Vertical Axis Ballscrew Replacement

Removal

Machines are currently equipped with either a hydraulic counterbalance system or an electric brake motor. Care must be taken, in either case, to avoid damaging the machine or severely injuring yourself. Heed all warnings and cautions, and read all the steps of the procedure before starting any disassembly.



VF-Series Ballscrew Replacement

WARNING!

If the machine is equipped with a hydraulic counterbalance, a shaft stop block must be used to secure the spindle head. Do not move the spindle during ballscrew service.

WARNING! MILLS WITHOUT A COUNTERBALANCE

If debug is on and the Z-axis is disabled the spindle head will fall. This is extremely dangerous and must be avoided.

1. Turn the machine on. Zero Return all axes and put the machine in Handle Jog mode.
2. Remove the sheet metal necessary to access the ballscrew and its components.
3. a. **Machines with counterbalances:** Lower the spindle head to its lowest position. Install cylinder shaft stop. Handle jog axis up until the shaft stop blocks the axis.

   b. **Machines with Brake motors:** Brace the spindle head up with a 4” x 4” x 14” block of wood.
4. Power off the machine.
5. If applicable, remove the hard stop from the bearing housing on the ballscrew.
6. Disconnect the oil line at the ball nut.
7. Loosen the 10-32 x ½" SHCS and remove the locknut on the ballscrew support bearing end.
8. Remove the axis motor in accordance with "Axis Motor Removal/Installation".
9. Loosen the 10-32 x ½" SHCS and remove the locknut on the ballscrew in the motor housing.
10. **For 32 mm ballscrews:**

    • Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the opposite end of the ballscrew to loosen.

    CAUTION! Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or ballscrew will result.

    • Hand-turn the ballscrew to move the screw up until the bottom end clears the support bearing by approximately six inches (6").

    • Remove the SHCS from the ball nut remove. Lower the ballscrew down and to the right of the support bearing to remove. For the VF-6 and Horizontal machines, remove the ballscrew from top of column, being careful to not damage the threads on the ballscrew.

    For 40 and 50 mm ballscrews:

    • Loosen the SHCS that mount the bearing support to the column, and remove. Remove the pull pins from the bearing support.

    • Loosen five SHCS in the ball nut and remove the ballscrew by pulling from the bearing support end.

    For MDC-500 ballscrew:

    • Remove the column enclosure components covering the ballscrew, bottom way cover, spindle head cover and the column frame cross brace.

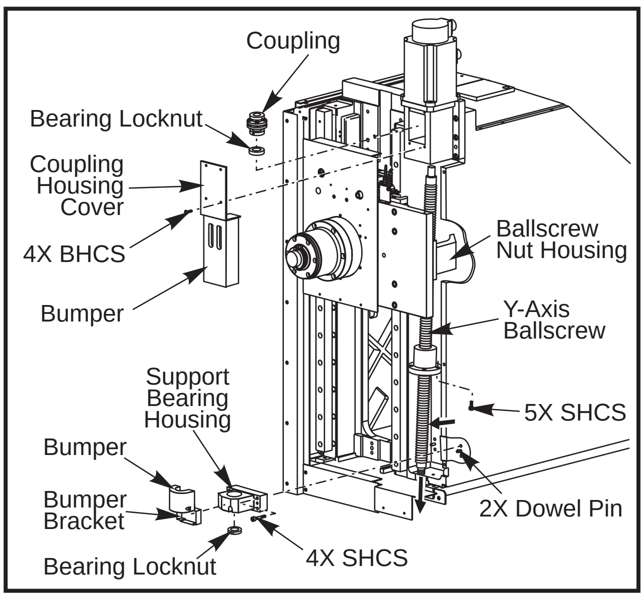
    • Turn the machine On, Zero Return all axes and select Handle Jog mode. Block the spindle (using a 4" x 4" x 14" piece of wood) on the bottom of the column or the spindle face itself (lower is better) by lowering the spindle head on the wood, and turn the machine Off.

• Loosen all screws on the bearing support housing, nut housing, and motor support housing. First remove the four (4) bolts and two (2) alignment pins on the bearing support housing (the 10/32 pins are threaded, insert a screw into the opening and pull out). Then remove the eight (8) bolts securing the nut housing to the casting (these are accessed from the back of the machine through the column). Note that at this point the spindle column will be **resting entirely on the block**; make sure that the spindle is securely supported. Finally, remove the six (6) bolts and two (2) alignment pins that secure the motor support housing to the casting and remove the ballscrew assembly from the machine.

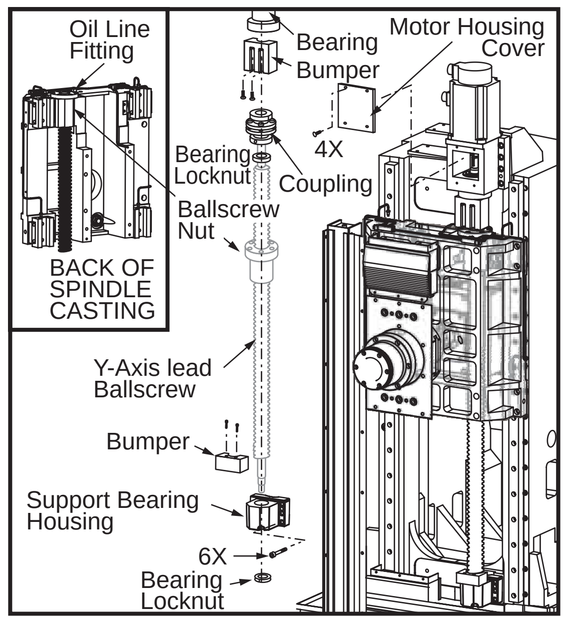
NOTE: Only when the machine is powered Off, can the motor cables be removed so that the entire ballscrew assembly can be disconnected from the machine.

If the MDC-500 has to be turned on with the ballscrew disconnected, the corresponding Parameter bit has to be changed to disable that axis. In Parameter 29, change the bit from 0 to 1 to disable the Z-axis only if needed. When the ballscrew is in place, change the bit back to enable the axis.

Installation



EC-300 Ballscrew Assembly



EC-400 Ballscrew Assembly

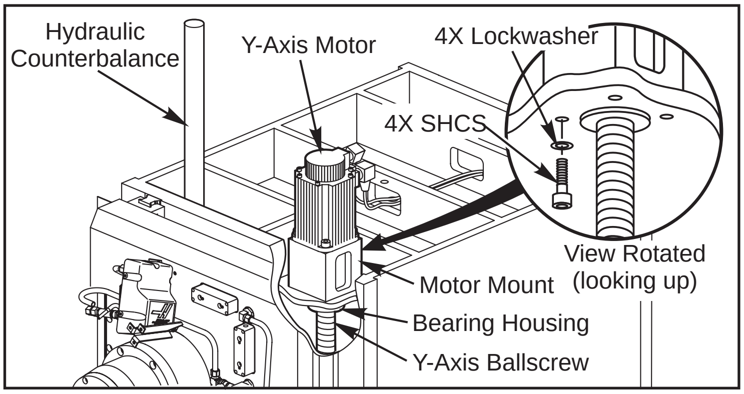
1. Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing, and ball nut are free of dirt, burrs, grease, or other contaminants.

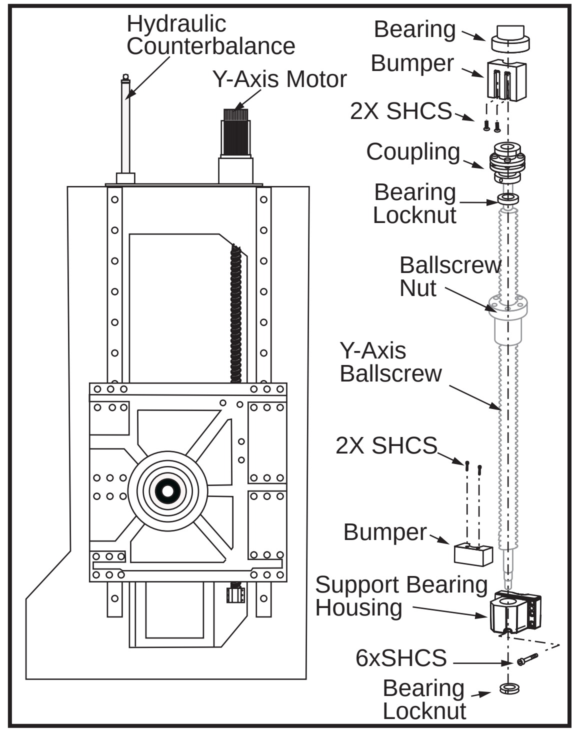
CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

2. Slide the ballscrew up into the nut housing and gently lower it until it is resting in the support bearing.

NOTE: Correct alignment is critical to sliding the ballscrew into the bearing. Binding will not occur if it is guided carefully and correctly into the bearing.

3. Insert the ballscrew into the bearing support. Screw the clamp nut on a few turns.
4. Insert the ballscrew, with the bearing support attached, into place. Ensure the ballscrew goes through the ball nut housing and the bearing sleeve.
5. Mount bearing support with SHCS, but do not tighten completely. Replace dowel pins in bearing support.
6. Install the spacer ring on the motor end of the ballscrew.





EC-1600 Ball Screw and Motor Components

7. Place the bearing sleeve in the motor housing. (It may be necessary to align the bearings in the sleeve to facilitate mounting on the ballscrew.)
8. Insert the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing (Place a drop of blue Loctite on each of the SHCS before inserting).

CAUTION! Do not use more than one drop of Loctite. An excessive amount will cause a film between the sleeve and housing, which could result in backlash.

9. Hand-turn ball nut until it contacts nut housing mounting surface. If necessary, turn ballscrew to correctly position lube fitting of ball nut. Insert, but do not tighten, the five ¼-20 x 1" (or ¼-20 x ¾") SHCS attaching the ball nut to the nut housing. (Place a drop of blue Loctite on each of the SHCS before inserting.)
10. Loosely install the locknut on the motor end of the ballscrew.
11. Hand-turn the ballscrew to move the spindle motor up and down, assuring free movement of the ballscrew.
12. Torque the SHCS that hold the ball nut to the nut housing.
13. The following sequence is important to ensure proper installation of the ballscrew:

• Tighten the locknut, hand tight, on the motor end.

• Install and tighten locknut on bearing support. Ensure the nut **does not** touch the support bearing. It will be used to hold the ballscrew while the other end is tightened.

• Install shaft lock onto ballscrew bearing support end to keep it from turning while torquing locknut.

• Place a spanner wrench on the locknut at the motor end of the assembly.

• Torque the locknut to 15 ft-lb for Vertical machines (30 ft-lb for Horizontal machines). The 40/50 mm and EC-400 and EC-1600 ballscrew locknut should be torqued to 50 ft-lb.

• Tighten the locknut screw and mark with yellow paint.

• Remove the shaft lock.

• Torque support mounting bolts to proper specifications.

• Loosen the locknut screw and locknut at the bearing support end and tighten to 4 in-lb (32 mm ballscrews) against the bearing (10 in-lb for EC-400 and EC-1600). Retighten the locknut.

14. Tighten down completely the five SHCS attaching the ball nut to the nut housing.

15. Reinstall the motor according to "Axis Motor Removal and Installation". Reinstall the hard stop at the support bearing end of the ballscrew.

16. Reconnect the oil line to the ball nut.

17. Reconnect electrical power.

18. a. **Machines with counterbalances:** Jog the spindle down and remove the cylinder shaft stop.

    b. **Machines with brake motors:** Jog the spindle up slightly, just above the block of wood and push Emergency stop. Watch to see if the spindle head drops. If it does, check motor installation and electrical connections, and make proper repair.

    c. **For 40 and 50 mm ballscrews only:**

    • Jog the spindle head toward the bearing support end.

    • Tighten down completely the SHCS that mount the bearing support to the column.

    • Loosen the locknut on the bearing support end. Adjust the nut until it seats on the bearing. Re-tighten the locknut hand-tight, then torque the locknut to 10 ft-lb).

19. Check ballscrew torque at bearing support end with torque tester. Jog the spindle head to its highest position. Check the ballscrew torque again. It should be the same as the previous reading.

20. Check for backlash or noisy operation in the ballscrew ("Accuracy/Backlash" section).

21. Zero Return axis and set grid offset and Parameter 64.

22. Replace appropriate sheet metal.

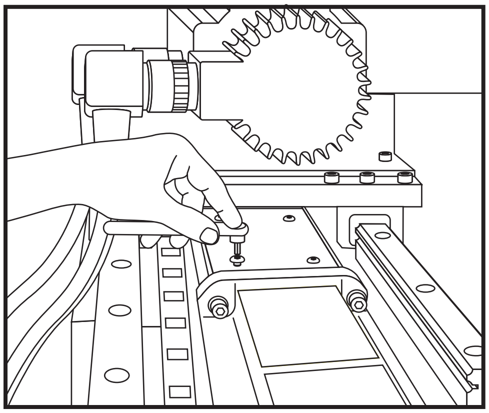
Lathe Ballscrew Replacement - X-Axis

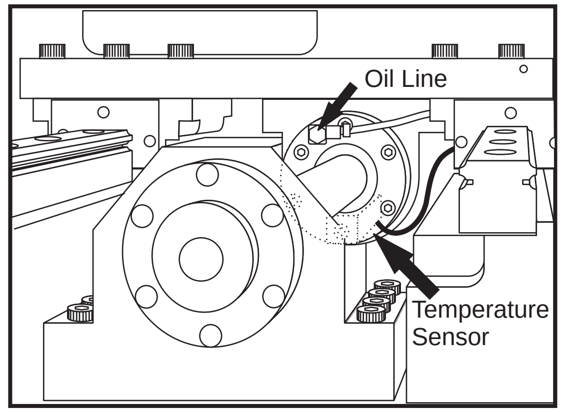
Removal

1. Turn the machine on. Zero Return all axes and put the machine in Handle Jog mode.

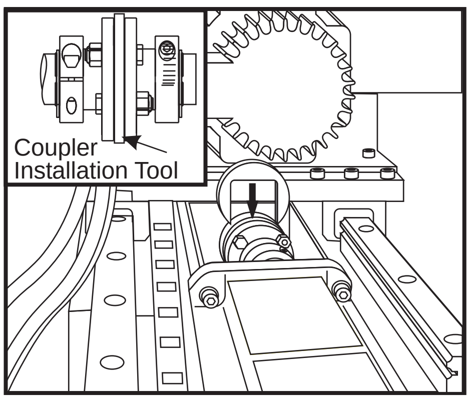
2. Remove all sheet metal necessary to gain access to the X-axis ballscrew, servo motor, and coupler. Remove the way cover.

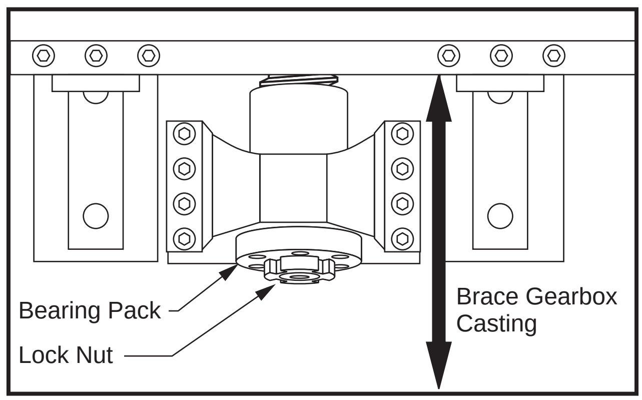
3. Handle jog the turret down the X-axis until there is access to the motor housing cover.





4. Remove the motor housing cover.
5. Loosen the clamp collar that ties the X-axis motor coupler to the ballscrew.
6. Jog the X-axis to the home position. Remove the temperature sensor and oil line. Remove all but one of the SHCS that secure the ball nut to the nut mount. Loosen the remaining SHCS to hand tight.





7. Carefully handle jog the X-axis until there is enough room to install the coupler installation tool (T-1451). Install the coupler installation tool into the coupler to prevent damage when the motor is removed.
8. Brace the gearbox casting to prevent it from movement when disconnected from the nut. Use a block of wood or other such material that will not cause damage.
9. Disconnect motor cables. Remove the four (4) SHCS that secure the axis motor to the motor housing. Pull the motor away from the casting, sliding the coupler off of the ballscrew, leaving it attached to the motor output shaft.
10. Remove the bearing locknut and the bearing housing from the bearing support end of the ballscrew.
11. Remove the ballscrew retaining ring from the motor end of the ballscrew.
12. Ballscrew removal for the (SL-10):

    a. Remove the last SHCS from the ball nut.

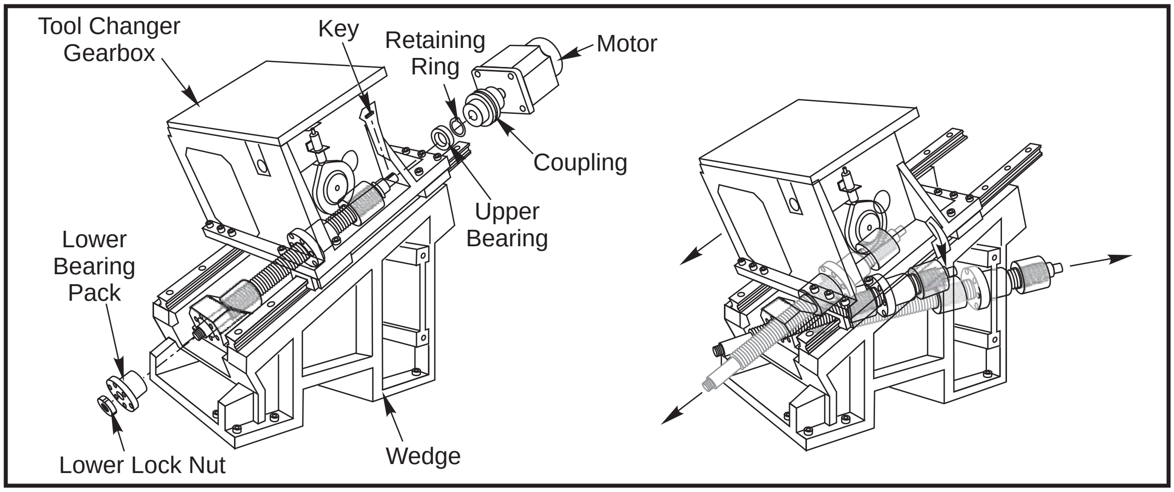
    b. Slide the ballscrew down through the bearing support casting.

    c. Thread the ball nut up the ballscrew toward the motor end, as you feed the ballscrew down through the bearing support casting.

    d. Thread the nut up the ballscrew until the ballscrew can be swung down through the opening in the wedge casting.

e. Remove the ballscrew through the back side of the wedge casting.

f. Take extreme care not to damage the ballscrew while pulling it through the castings.



13. Ballscrew removal for (SL-20, SL-30, and SL-40):

    a. Loosen the counterbalance spring nut at the motor end of the ballscrew. Using a crescent wrench, hold swing arm and loosen upper hex bolt to slowly release the spring tension.

    b. Remove the last SHCS from the ball nut.

    c. Guide the ballscrew out of the front of the machine

Installation

1. Reinstall the bumpers onto the ballscrew.
2. Replace the ballscrew into the wedge casting in the reverse order by which it was removed:

    a. Thread the ball nut up the ballscrew toward the motor end until there is clearance to install the ballscrew through the wedge casting.

    b. Slide the bearing support end of the ballscrew through the bearing support casting.

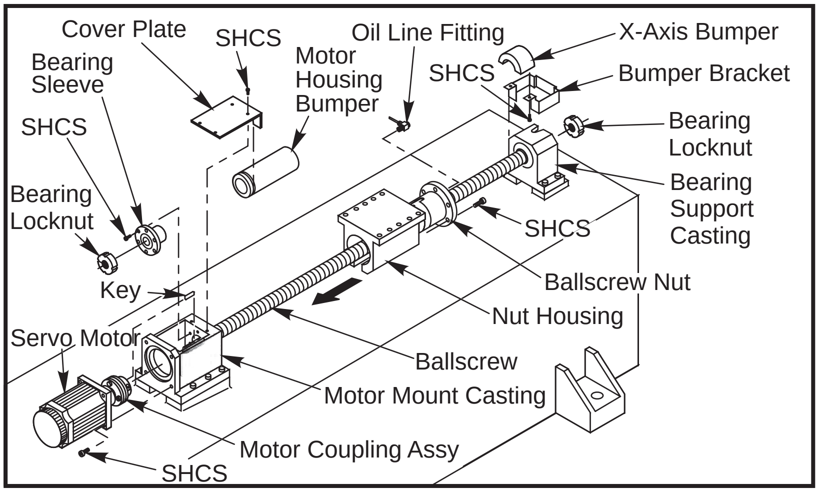
    c. Swing the ballscrew up through the hole in the wedge casting.

    d. Thread the ball nut down the ballscrew, toward the bearing support end, until the ballscrew can be reinserted into the motor end bearing.

3. Ensure that the upper bearing is properly seated and then install the retaining ring.
4. Reinstall the bearing support cartridge into the bearing support casting and over the ballscrew. Secure with the SHCS and torque in a crisscross pattern to 15 ft-lb.
5. **SL-20, 30, 40:** Retighten the counterbalance spring (see Turret Cross-slide Spring Replacement section).
6. Reinstall the lock nut onto the bearing support end of the ballscrew. Torque the lock nut to 50 ft-lb and then torque the SHCS in the lock nut to 15 in-lb.
7. Thread the ball nut up the ballscrew until the nut is back in alignment with the nut housing. Torque the SHCS to 15 ft-lb.
8. Reinstall the oil line and the temperature sensor.
9. Check for binding in the beginning, middle and end of travel. Check for backlash or noisy operation.

Removal

1. Turn the machine on. Zero Return all axes and put the machine in Handle Jog mode.
2. Remove rear and right side covers. Remove hard stops from bearing support and motor end of ballscrew.
3. Remove the cover from the motor housing. Disconnect the oil line from the ballscrew nut.



4. At the bearing support side, loosen the lock nut screw. Unscrew the locknut an 1/8" and retighten locknut screw. Attach shaft lock tool.
5. At the motor end, loosen the motor coupling on the ballscrew side of the coupling. Remove the four motor mount SHCS and the motor. Remove the Woodruff key from the key way on the ballscrew.
6. In the motor housing, loosen the locknut screw, attach the spanner wrench to the locknut and remove the nut from the ballscrew.

   32mm: Remove six ¼-20 x 1” SHCS from the bearing sleeve and remove bearing sleeve from the motor housing. On bearing support side, remove bearing support locknut. Push wedge all the way toward motor end. Underneath wedge, remove SHCS that attach ballscrew nut to nut housing. Pull ballscrew forward to clear nut from housing and angle ballscrew toward right of the bearing support. Carefully remove ballscrew.

   40mm: Underneath the wedge, remove the SHCS from the ballscrew nut and push the wedge toward the motor housing. On the bearing support side, remove the shaft lock tool and locknut. Remove the alignment pins and the SHCS from the bearing support casting. Make note of any shims. Hold the ballscrew in place and remove the bearing support. Pull forward on the ballscrew and carefully remove.

CAUTION! Be careful during ballscrew removal/installation, to protect surfaces.

Installation

Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing and the ballscrew nut are free of dirt, burrs, grease or other contaminants.

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

1. a. **32mm:** Reinsert the ballscrew, with the motor housing bumper on it, from the right hand side of the bearing support into the motor housing. Align the ballscrew with the bearing support end and insert the ballscrew. Prevent contact with the screw threads, to avoid any possible damage.

b. **40mm:** Reinsert the ballscrew with bumpers into the bearing sleeve in the motor housing. (Make sure the ballscrew nut will be able to slide in to the wedge nut housing.) Support the ballscrew on the bearing support end and re-attach the bearing support housing and bearing.

2. a. **32mm:** Hold ballscrew level on the motor side. Slide the bearing sleeve onto the ballscrew and insert bearing sleeve into motor housing. Attach bearing sleeve to the housing with six ¼-20 x 1" SHCS. Place a drop of blue Loctite on each of the SHCS before inserting. Torque the bearing sleeve SHCS to 15 ft-lb.

   b. **40mm:** Reinsert alignment pins through the housing into the base casting, replace shims if needed. Fasten to the base casting using the six bearing support housing SHCS, lock washers, and Loctite.

CAUTION! Do not use more than one drop of Loctite. An excessive amount causes a film between the sleeve and housing which could result in backlash.

3. The following sequence is important to ensure proper installation of the ballscrew:

   a. On the bearing support end, install the locknut 1/8" away from the bearing. Tighten the locknut screw. Install the shaft lock onto the bearing support end of the ballscrew.

CAUTION! Do not attach bearing locknut against bearing support until the motor side locknut is torqued to its proper specification. Damage will occur to the bearing and ballscrew on the support side.

   b. At the motor side of the ballscrew, attach locknut. Place a spanner wrench on the locknut in the motor housing and torque it against the bearing to 15 ft-lb (50 ft-lb for 40mm).

   c. Tighten the locknut screw and mark with paint.

   d. At the bearing support end, remove the shaft lock.

   e. **32mm:** Loosen the clamp nut screw. Tighten the lock nut against the bearing to 4 in-lb. Retighten the clamp nut screw and mark with paint.

   f. Align the ballscrew nut to the nut housing on the wedge, and check the oil line fitting is in the correct position. Apply a drop of blue Loctite to the five SHCS and fasten the nut to the housing. Torque the ballscrew nut SHCS to 15 ft-lb (30 ft-lb for 40mm).

   g. Place the Woodruff key back into the key way slot on the ballscrew.

   h. Install the motor with the coupling attached check condition of the coupler and tighten the four motor mounting SHCS. Torque the motor mounting SHCS to 30 ft-lb.

4. Tighten the collar on the motor coupling to the ballscrew and torque to 15 ft-lb. Attach bumper, and replace motor housing cover.

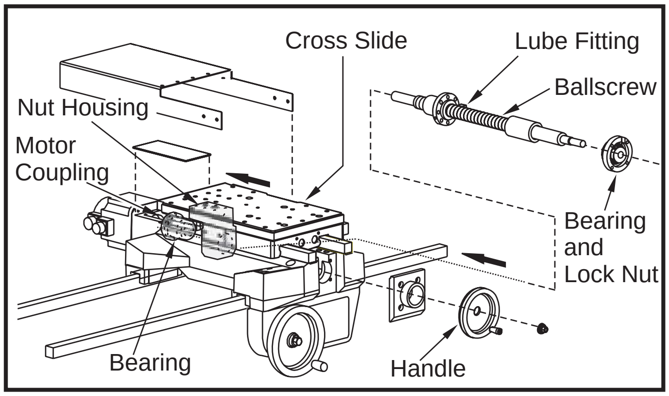
   40mm: Move turret to support housing end, taking care to stop before hitting the support housing. Torque the bearing support housing SHCS to 30 ft-lb. Prevent contact with the ballscrew threads, to avoid any possible damage. Loosen the locknut screw. Tighten the locknut against the bearing to 4 in-lb. Retighten the locknut screw and mark with paint.

5. Check for binding in the beginning, middle, and end of travel. You should be able to rotate the ballscrew by hand when the servos are off. Check for backlash or noisy operation.

6. Replace the ballscrew hardstops and reconnect oil line to the ballscrew nut.

7. Zero Return the axis and set grid offset.

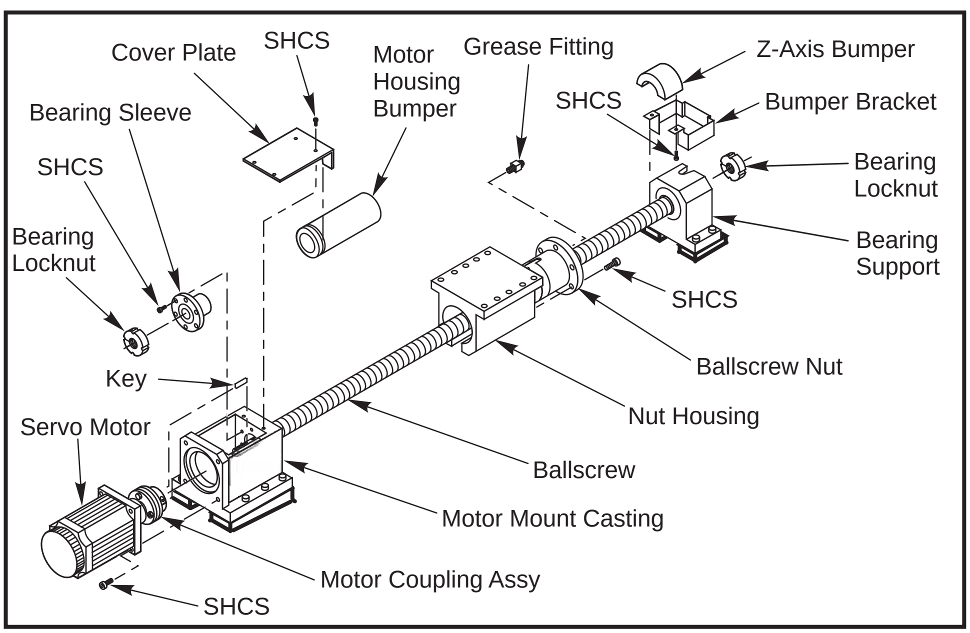
Removal



1. Remove the hand wheel.
2. Remove all necessary sheet metal to gain access to the ballscrew, servo motor, and coupler. Remove the motor housing cover and loosen the coupling. Remove the lubrication line from the X-axis ball nut.
3. Remove the SHCS that secure the ball nut to the nut mount.
4. Remove the bearing locknut and the bearing support (pull the dowel pins out of the Z-axis casting).
5. a. **X-axis:** Remove the ballscrew retaining ring from the motor end of the ballscrew.

   b. **Z-axis:** Unscrew the bearing locknut inside the motor housing.
6. a. **X-axis:** Slide the ballscrew away from the motor. Once the ballscrew nut is clear of the nut housing, lift the ballscrew up, then toward the front of the machine, and lift it out of the casting assembly. It may be necessary to slide the saddle toward the motor.

   b. **Z-axis:** Unscrew the ballscrew from the machine.



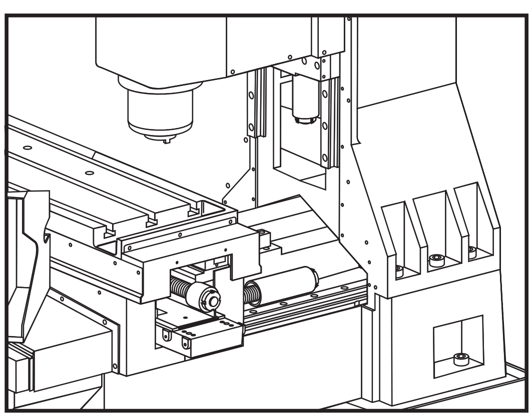
Installation

1. Install the ballscrew in the nut housing. Note the orientation of the lubrication fitting for the X-axis and the machined flat on the ballscrew. The fitting should be at the 7 o'clock position with the flat face down.
2. Snug bolts securing the ball nut to the nut housing and move the X-axis saddle toward the machine's rear.
3. Torque the clamp nut on the motor support end to 15 ft-lb.
4. Torque the SHCS in the X-axis nut to 12 in-lb.
5. Lock the ballscrew (lock tool T-1601) and torque the SHCS that secure the bearing cartridge to 15 ft-lb. Remove the lock tool.
6. Move the X-axis saddle to the front bearing support.
7. Install the bearing support over the end of the ballscrew.
8. Install the Z-axis dowel pins and torque the bolts to 30 ft-lb.
9. Torque the locknut on the bearing support side to 4 in-lb and the SHCS in the nut to 15 in-lb.
10. Install the X-axis lubrication line from the ball nut to the saddle assembly.
11. Install the hand wheel.
12. Check for binding in the beginning, middle and end of travel. Check for backlash or noisy operation.
13. Reinstall the X-axis saddle covers.

Mini Mill Ballscrew Replacement

Replacement of the mini-mill ballscrews follows the same procedures as for the other mills. The ballscrews are only supported at the motor end, thereby simplifing the alignment procedure.

1. Use a standard ballscrew support bearing assembly to prevent the ballscrew for sagging, and to allow the use of the shaft lock for tightening the clamp nut at the motor end. Use only one screw to fasten the support bearing assembly (no dowel pins are necessary) to prevent it from rotating while the shaft lock is in place, and tighten the clamp nut at the motor end.
2. Remove the fastener from the support bearing assembly to allow it to float on its support surface. Position the ballscrew nut toward the motor end to allow it to self-align to the motor housing bearing assembly.
3. Tightening the five screws to the nut housing.
4. Install the ballscrew bumpers.
5. Install the shaft lock on the clamp nut at the motor end, allow it to wedge itself in the coupler cavity and torque the clamp nut to 15 ft-lb.

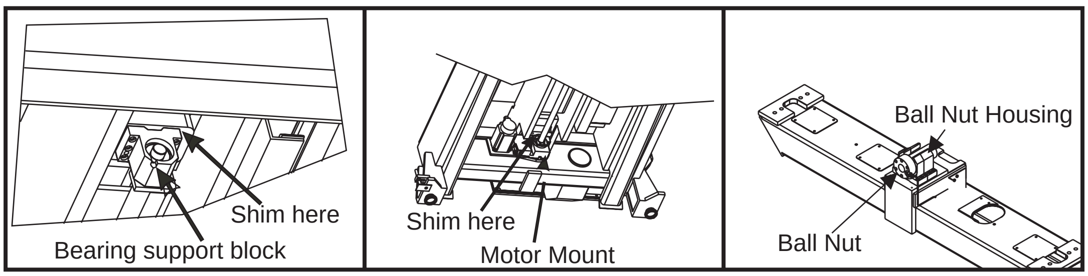


GR-Series X-Axis Ballscrew Alignment

Be sure that machine is level before starting this procedure.

1. Remove the back sheet metal cover from the top of the base and move all axes to machine zero locations.
2. Remove any binding in the nut by slightly loosening the ball nut and ball nut housing and retightening them.
3. Jog the saddle (X-axis) all the way to the other end (max. travel). Remove the six SHCS from the bearing support block.
4. Remove the dowel pins from the bearing support block.
5. a. If the bearing support block is loose in this state, shim both sides of the support block evenly (see figure) and re-tighten the six SHCS. Do not replace the dowel pins.

   b. If the bearing support block is not loose in this state: replace the six SHCS (do not replace the dowel pins), jog the X-axis to machine zero, loosen the six SHCS on the motor mount but do not remove the dowel pins, and shim the motor mount .005” and retighten the screws. Make sure both sides are shimmed the same.



6. Repeat steps 2, 3, and 5b until the bearing support block becomes loose. Once the bearing support block is loose, tighten the six SHCS and jog the X-axis to machine zero, remove the last set of shims that were added, tighten the motor mount, and with the X-axis at machine zero, loosen and retighten the screws on the ball nut and the ball nut housing.
7. Check the servo motor loads by jogging the X-axis from machine zero to the maximum travel, then check the servo motor loads on the X-axis servo motor. View the current command page. The load should not deviate more than 5%. If necessary, repeat this process.
8. Replace the ballscrew hardstops and reconnect oil line to the ballscrew nut.
9. Zero return the Z-axis and set the grid offset.

Ballscrew Compensation

1. Unlock the machine parameters (Setting 7).
2. Starting at zero, move the machine across its full travel.
3. Measure the error registered on the calibration device. A laser, step gauge, or similar measuring tool is necessary to complete this task
4. Divide the error by the travel of the machine. For example, a machine has 30 inches of travel and has an error of +0.003" at full travel. The machine has an error of 0.003"/30" or 0.0001"/inch.
5. Multiply the error per inch calculated in the step above by 1,000,000,000. In this case above, the calculated value would be 100,000.
6. Go to Parameter 229, 230, or 231 (depending on the axis being compensated), type the value computed from the previous step into the display, and press Write/Enter. This will compensate for any scaling error in the machine. Note that no values will appear in the lead screw compensation tables.

Tailstock Alignment

Tailstock alignment procedures should only be done after the X- and Z-axes have been checked for proper alignment.

There are two different tailstocks: a one-piece design, and a two-piece design. If the tailstock needs to be aligned, follow the procedure for that type of tailstock.

One-Piece Tailstock Alignment Verification

Tools Required: Spindle Alignment Test Bar (P/N T-1312), Tailstock Taper Bar (P/N T-1416), .0001" Indicator and Magnetic Base

1. Mount the spindle alignment test bar to the spindle.

NOTE: Make sure all contact surfaces, including the test bar, are clean.

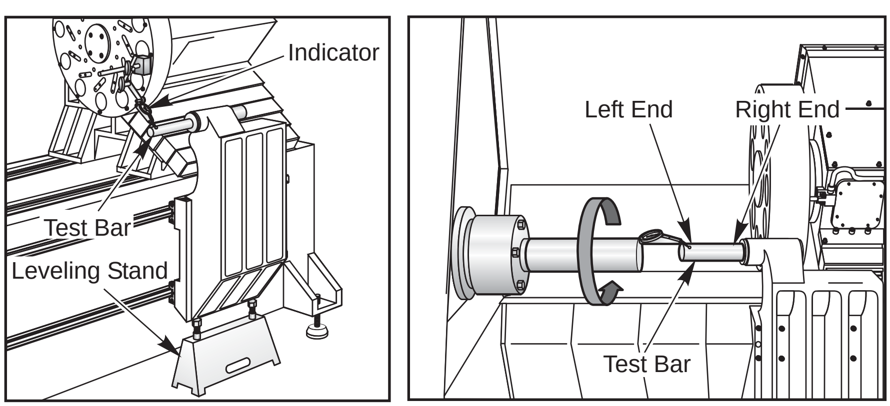
2. Mount a .0001 indicator to the end of the alignment bar, and insert the tailstock taper alignment test bar.
3. Place the indicator tip at the base of the tailstock test bar (closest to the tailstock). Check the total runout at base of the test bar by rotating the indicator 360^0. Max. tolerance is .001" from centerline.
4. Jog the tailstock back and measure the runout at the end of the tailstock test bar.

NOTE: If these measurements are out of tolerance from top to bottom (0^0 and 180^0), proceed to the Tailstock Leveling Procedure. If this measurement is out of tolerance from side to side (90^0 and 270^0), the insert needs to be replaced and realigned as described in the Tailstock Insert Removal and Installation section.

Tailstock Leveling Procedure

This procedure should only be performed after the tailstock alignment has been checked.
Tools Required: Tenths Indicator, Tailstock Alignment Tool (Test Bar P/N T-1416), Tailstock Leveling Assembly (Leveling Stand P/N 93-6001), Spindle Alignment Test Bar (P/N T-1312)

1. Loosen the mounting bolts that attach the tailstock to the linear guide trucks, allowing the tailstock to rest on bolts. Place the leveling stand under the bottom edge of the tailstock and manually raise the jack bolts. (Refer to figure).
2. Attach a tenths indicator to the face of the turret. Level the tailstock by jogging the indicator along the test bar in the Z-axis and level to within .001" by adjusting the jack bolts.
3. Sweep the diameter of the test bar and note the vertical runout.



Tailstock Leveling Indicator Setup

4. Raise the tailstock and bring up to center by equally turning the jack bolts (do not turn one jack bolt more than 1/4 turn without turning the other). Adjust to within .0003" and lightly snug bolts during procedure.

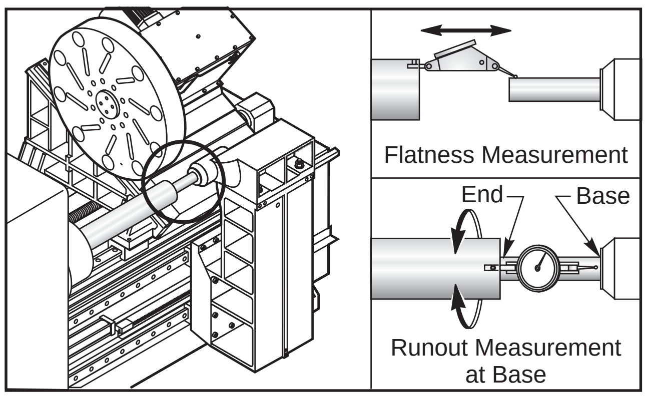
NOTE: Check tailstock parallelism each time the tailstock is raised.

5. Check for tailstock level change. Adjust by setting the indicator to zero at the right end of the test bar and jog the indicator over to left end of bar. Snug bolts in upper left corner and loosen the others. Adjust the right-hand jack bolt only and bring the indicator to within .001".
6. Once the tailstock is leveled, the mounting bolts should be torqued to 50 ft-lb in a clockwise fashion (first, the inner mounting bolts, then the outside). If the horizontal runout is unacceptable, the tapered insert may have to be reset as described in the following section

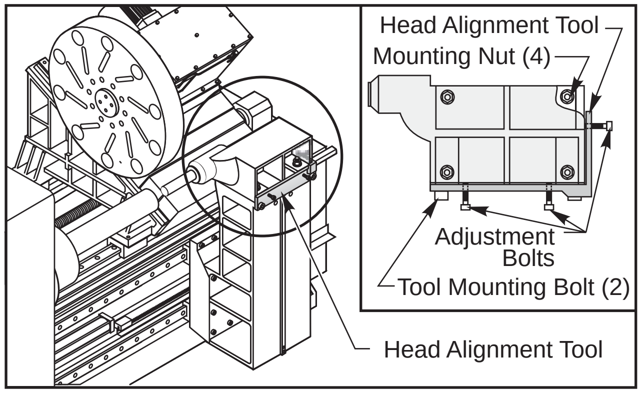
NOTE: These steps may have to be repeated to achieve proper alignment.

Two-Piece Tailstock Alignment

1. Using a spindle alignment tool and a Morse taper tool, indicate from spindle to tailstock. Measure flatness and TIR (total indicated runout). Determine in which direction the tailstock is out of alignment.



2. If the tailstock is out of alignment in both flatness and parallelism, remove the head from the tailstock base. Mark the shims so they can be installed in the same order, and inspect them. If the tailstock is only out of parallel alignment go to step 6.
3. Check the top surface of the tailstock base for parallelism to the Z-axis. Check for dents and lightly stone the top mating surface of the tailstock. Indicate from the turret to the top of the tailstock base. Readings must be no more than +/- .0004" for 10 inches of travel.
4. Install the shims, lightly stone and clean the shims before installing.
5. Install the head of the tailstock and snug the four retaining nuts.
6. Rotate the spindle and measure parallelism. Tap the head into place using a mallet. If flatness is within tolerance, proceed to step 8.
7. Measure flatness from base to end of tailstock. Add or remove shims, if necessary, using the tailstock head alignment tool. To adjust the number of shims, bolt on alignment tool, snug alignment bolts against the tailstock head, then remove the tool (see following figure). Loosen either the front or rear pair of tailstock retaining nuts and add or remove shims as necessary. This will keep parallelism. Re-tighten the nuts. If necessary, loosen the other end to add or remove shims as well. To re-align, install the alignment tool and position the tailstock against the adjustment bolts of the alignment tool. Snug the tailstock nuts and remove the tool.



8. Rotate the spindle and measure run-out at the base and the end of the tailstock. Tap into place using a mallet. Tolerance is less than .001" TIR.

9. Torque the tailstock head retaining nuts.

SL-10 Tailstock Alignment

1. Insert the tailstock alignment bar into the tailstock quill.

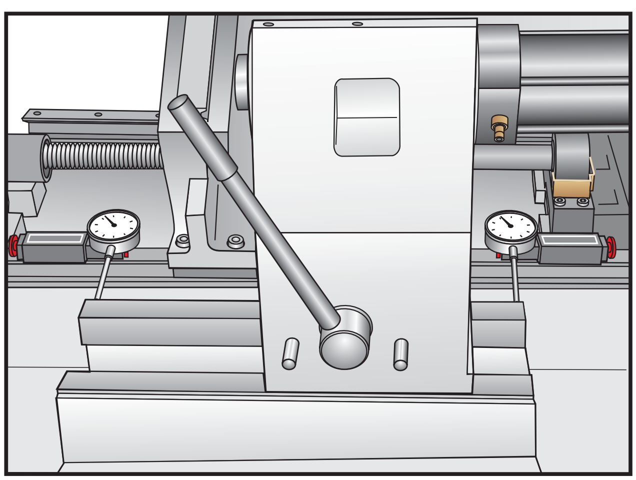
2. Place a 0.0001" indicator onto the turret. Position the X-axis so that the flatness and parallelism of the alignment bar can be measured.

3. Place the indicator stylus onto the side of the alignment bar and sweep along the Z-axis. The tailstock should be parallel with the Z-axis within 0.0004" over the length of the tailstock alignment bar. If the Z-axis parallelism is not within 0.0004", the tailstock foot will need to be adjusted.

4. Loosen the four SHCS that attach the tailstock foot to the lathe base and back out the set screws at the base of the foot. Push the tailstock foot as close to the turret as possible. Place the indicator stylus onto the machined surface along the backside of the tailstock foot. Jog the Z-axis to sweep along this surface. Adjust the position of the tailstock foot until the runout along this machined surface is less than 0.0001" along the entire length.

5. Install the spindle alignment bar onto the end of the spindle. Install a 0.0001" dial indicator into the end of the spindle.

6. Set up two travel dial indicators at the extreme ends of the tailstock foot.



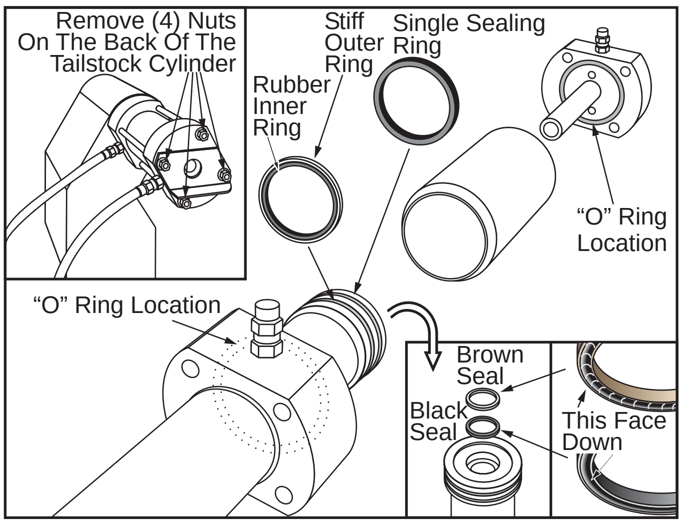
7. Measure the side to side runout of the concentricity of the spindle to the tailstock quill. The total side to side runout cannot exceed 0.0005".

8. Using the set screws in the tailstock base, move the entire tailstock assembly until the total side to side runout does not exceed 0.0005". Maintain the parallelism with the Z-axis by ensuring that the travel indicators move an equal amount.
9. Torque the SHCS that attach the foot to the lathe base in an even and gradual pattern to 200 ft-lb. Verify that the runout has been maintained after the tailstock foot is torqued.

SL10 Tailstock Seal Replacement

Disassembly

1. Remove the 4 nuts on the back of the tailstock cylinder.
2. Remove the back of the cylinder and then the cylinder housing.
3. Remove the two seals from the end of the cylinder. One of the seals is inside the bore of the cylinder.



Assembly

1. Install two seals to the end of the cylinder. Note the differences between, and orientation of, the seals; there is an apparent thickness difference, and they must be installed facing the proper direction.
2. Reinstall the cylinder in the housing, replace the back of the tailstock cylinder and secure with 4 nuts.

Tailstock Insert Removal and Installation

The following procedure is for one-piece tailstocks only.

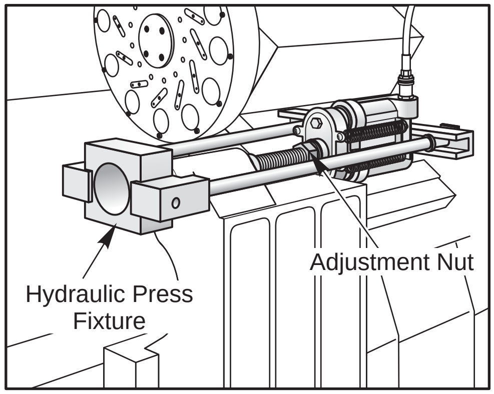
CAUTION! Contact Haas before attempting this procedure.

Tools Required:

Press Fixture and Spacer
Spindle Alignment Test Bar (P/N T-1312)
Tailstock Taper Alignment Bar (P/N T-1416)
Blow torch
Devcon liquid steel (P/N 99-4530)

Removal

1. Remove the six screws that mount the back plate to the tailstock insert.
2. Remove the 3 screws that mount the insert to the casting.
3. Run the screw nut completely down to its farthest travel (far right).



Tailstock Insert Press

4. Mount the fixture to the tailstock casting as shown.

5. Pump the hydraulic press a few times so that the fixture stabilizes itself against the tailstock.

WARNING!

Keep hydraulic lines away from the blow torch flame or serious injury could result.

6. Use the blow torch to heat the insert casting. This will take approximately 30 minutes.

7. Pump the hydraulic press to its maximum pressure while continuing to heat the casting.

NOTE: When the pressure on the gauge begins to drop, the insert should begin to slip out. Once the press is fully extended, run the nut down and repeat step 6.

NOTE: Use a spacer if the adjustment screw on the press is not long enough to remove the insert.

8. Once insert is removed, use a small screwdriver or chisel to remove any Devcon. Ensure fill hole is clear.

Installation

1. Clean the tailstock bore and all mounting surfaces.

2. Mount the spindle alignment test bar onto the spindle.

3. Mount a tenths indicator to the nose of the test bar.

4. Make sure the fill hole at the back of the tailstock casting is not clogged.

5. Install the tailstock insert and three mounting screws.

6. Insert the tailstock taper alignment bar.

7. Position the indicator tip at the base of the tailstock test bar.

8. Adjust insert until the runout at the base of the test bar is less than .0003" TIR. Tighten all three screws.

9. Install the rear insert plate. Tighten the three 1/4 x 20 bolts, but leave the three 10 x 32 bolts loose.

10. Position the indicator at the end (far left) of the tailstock taper alignment bar.

11. Insert a pry bar into the rear of insert and adjust the runout at the end of the shaft until the reading is .001" or less from centerline. Tighten the remaining screws.

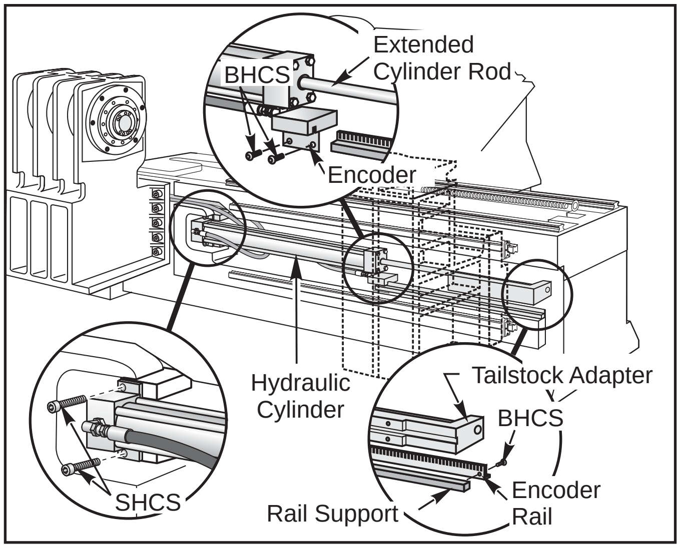
12. Inject the Devcon and let stand overnight.

WARNING!

Before performing any service the machine should be powered off.

Removal

1. Remove front and rear way covers. Move the tailstock to the middle of travel and disconnect the hydraulic lines from both ends of the cylinder.



Hydraulic Cylinder Replacement

CAUTION! Although the hydraulic system is not under pressure, oil will spill out of the hydraulic lines once disconnected from the cylinder. Have a bucket ready to catch any oil that spills out.

2. Remove the (2) SHCS that mount the cylinder rod end block to the rear of the hydraulic tailstock adapter.
3. Remove the 1/4-20 SHCS that mounts the encoder rail to the bottom of the cylinder rod end block
4. Extend the cylinder shaft so that you can place a wrench on the end of the cylinder rod in order to unscrew it from the end block.
5. Remove the (2) SHCS that mount the hydraulic cylinder body to the base casting.
6. Unscrew the end block from the cylinder. Collapse the hydraulic cylinder, then push the tailstock to the rear of travel.
7. Pull the hydraulic cylinder out from the front side of the tailstock.

Installation

1. With the new cylinder in position, push the tailstock to the front of travel.
2. Install the (2) SHCS that mount the cylinder body to the base casting. Before tightening, move the tailstock to the front end of travel.
3. Thread the end block onto the end of the cylinder rod and tighten.
4. Install the (2) SHCS that attach the end block, and install the 1/4-20 SHCS that hold the encoder rail to the bottom of the mounting block.
5. Attach the hydraulic lines to both the front and rear of the cylinder. Check for leaks.
6. Reinstall way covers. Check fluid level at hydraulic tank to determine how much fluid needs to be added.

Components

EC-300 Rotary Table - The rotary table is a Haas 210 equipped with a special platter compatible with the pallet changer operation. The table is mounted on the pallet changer casting, and a drive shaft bearing assembly is inserted into its spindle (on the brake side). A nut housing is inserted into the spindle of the table (on the platter side), and an air blast manifold is mounted onto the table platter.

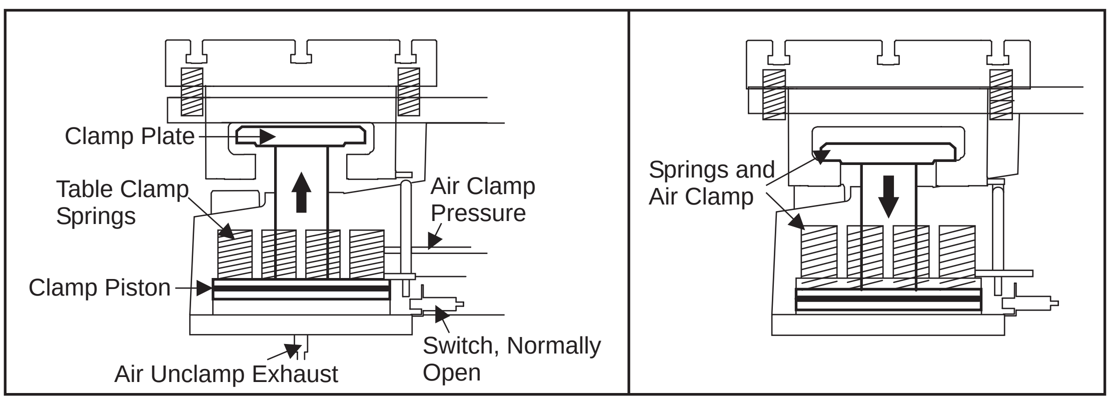
Load Station - The load station uses the 2 built-in rotary tables to index the part while in the load station. Hold the Pallet Index button and the pallet will rotate (in one direction only).

Power Supply Cables - The load station drawbar gearmotor and main drawbar gearmotor each have a power supply cable. Load station motor is equipped with extension cable to aid in motor replacement. The connector is about 12 inches from the gearmotor. Both power supplies are routed to their respective mounting locations from the central point of the solenoid mounting bracket (at rear of machine), where disconnects are located.

Air Supply Lines - The lifting cylinder has one large air supply line for lifting the pallets and their loads. No return line is required because the cylinder is vented to the atmosphere and the weight of the assembly and load will cause the cylinder to lower. The rotation cylinder is double-acting and has two smaller air supply lines for clockwise and counterclockwise rotation. The air blast system has one large air supply line, which is connected to the lube tube adapter. Each of the four air supply lines are routed to the solenoid mounting bracket (at the rear of the mill), where the air solenoid assembly is located. Four solenoid valves are used to provide the responses required for the pallet change operation.

Lubrication Supply Lines - An oil supply line from the lube/air panel (on the right side of the machine) attaches to the lube tube adapter. It provides lubrication to the rotary table drawbar, which carries oil mist from the air blast plug up the center of the main drawbar, to the drawbar and pallet nut.

Table Clamping



Operation

The table trips the clamp switch, not the clamp plate

1. Table indexes into position based on servo control parameters.

   • Clamp plate is in un-clamp position; it is held there by air pressure compressing the springs.

   • Clamp status switch plunger is away from the Normally Open (NO) proximity switch.

2. When table is in position, solenoid valve actuates to pressurize clamp side of piston. Air pressure and spring force combine to clamp table (approx. 10,000 pounds of clamp force depending on air pressure).

   • The table lowers and contacts the clamp status switch plunger. The plunger is pushed down and trips the normally open (NO) status switch to close contacts.

3. To unclamp, the solenoid switch shuttles to exhaust the clamp side and pressurize the unclamp side of the piston. The unclamp air pressure must compress the clamp springs to raise the clamp plate. For the first portion of the travel, the springs between the table and the H-frame aid in raising the clamp plate.

   • At the top of piston travel the clamp status switch plunger raises (it is pushed up by a spring) and comes clear of the proximity switch. The NO switch is now open and the table is ready to index.

Table Clamp Status Under Different Conditions

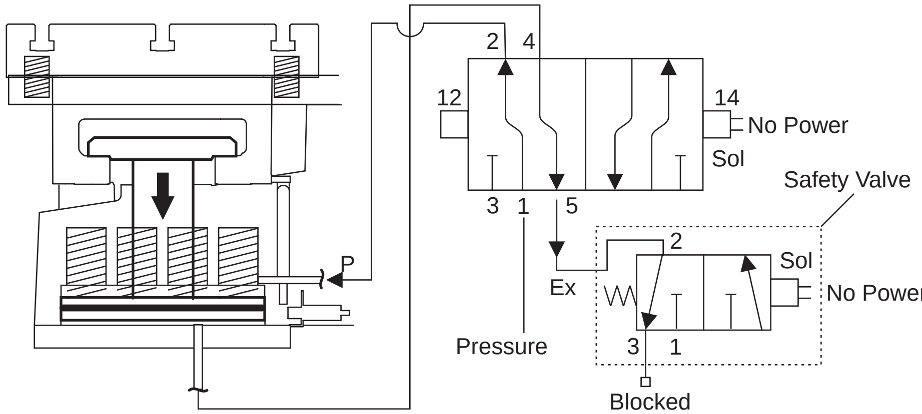
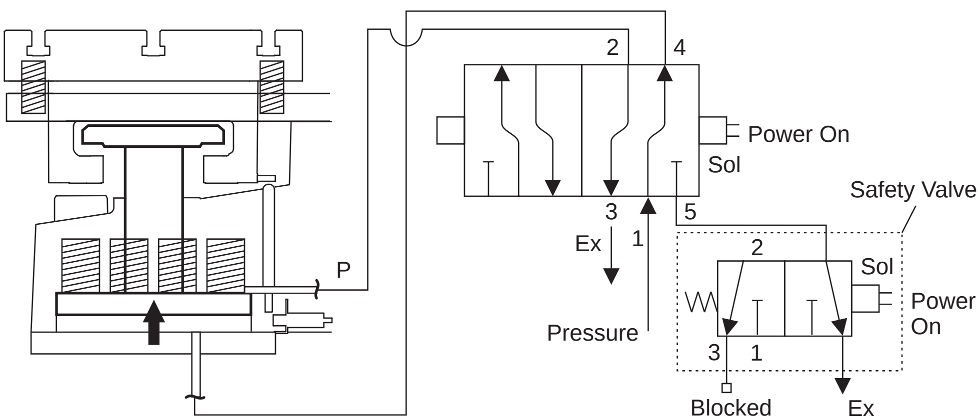
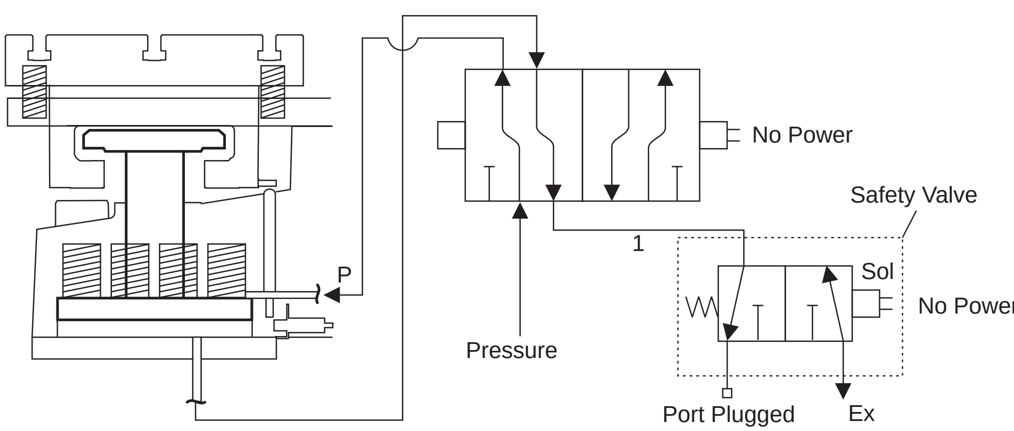


Table Clamp

A. Condition is clamped when machine is normally powered off or when first powered on or when table index is completed.



B. Condition when machine is unclamped. Note that the same condition applies if table is unclamped and the machine is emergency stopped in the middle of a table index. The table remains unclamped.



C. Condition when the table is unclamped and then power is lost.

• Main valve shuttles to clamp the table but the safety valve also loses power and blocks the exhaust port on the clamp side of the piston. This prevents the clamp plate from clamping immediately. The clamp plate will slowly move to its clamp position.

Troubleshooting

1. **Failure -** Clamp switch wires cut.

   Result - The control sees the switch as open at all times. The table can index into position and clamp. The control will not see the switch close and assumes the pallet is not clamped; an alarm generates.

   Comment - This is a safe condition; there is no threat of injury or machine damage. However, the machine will not function until the switch is replaced.

2. **Failure -** The clamp status plunger rod is stuck in clamp position (broken rod, broken switch, stuck rod). The same scenario if an errant piece of metal keeps the switch tripped closed.

   Result - The clamp plate unclamps, raising the pallet. The machine is ready to rotate the pallet, but the control does not receive a signal that the table has raised. Without the signal the control thinks the pallet is clamped. After a period of time an alarm will be generated.

   Comment - This is a safe condition; there is no threat of injury or machine damage. However the machine will not function until the plunger problem is corrected.

3. **Failure -** Table index (pallet change) starts and then is E-Stopped in the middle of indexing.

   Result - The clamp plate remains in the unclamp position.

   Comment - This is a safe condition. To resume machining, clear the alarms and Zero Return all axes. The machine will automatically home all axes and the clamp plate will clamp the table.

4. **Failure -** Table Indexer (pallet change) starts and then the machine is E-Stopped and powered off.

   Result - The clamp plate remains unclamped because the exhaust port on the unclamp side of the piston is blocked (closed). In other words the clamp plate is being pressurized in order to clamp, but as the exhaust port is blocked this prevents the pallet from being clamped.

   Comment - This is initially a safe condition, however, due to leakage on the exhaust side of the piston the clamp plate will eventually move to its fully clamped position. It is not safe to leave the table partially over the table locator teeth. It should be rotated fully off of the clamp plate. This can be done by manually rotating the pallet changer.

5. **Failure -** Clamp valve solenoid loses power or burns up while machine is running and table is clamped.

   Result - Table remains clamped upon attempting to unclamp the clamp plate will not rise and the clamp status switch will show the table as “clamped”. The machine will generate an alarm.

   Comment - This is a safe condition. The table will remain clamped. The machine will not function until the solenoid is replaced.

6. **Failure -** The solenoid on the safety valve burns out or loses power when the table is clamped and the machine is operating.

   Result - The machine will continue to function normally. It will clamp and unclamp without incident. In the event the machine is E-Stopped in the middle of a table index, the clamp plate remains unclamped. If power is lost or the machine is powered off during a table index, the clamp plate will clamp.

   Comment - A failed safety circuit valve is not detectable. This is an unsafe condition as it is found only when the machine has already crashed.

7. **Failure -** Table clamped and machine loses air pressure

   Result - The low air-pressure alarm will reach its time limit and alarm-out the machine. If air is lost while the machine is cutting, the table will remain clamped via the clamp springs.

   Comment - Clamp springs are adequate to prevent the table from moving grossly off of the locating fingers.

8. **Failure -** Table unclamped and the machine loses air during a pallet change.

   Result - The low air pressure alarm will not alarm out the machine until it has reached its time limit. At the time of air loss the clamp plate will lower to the clamped position via the clamp springs.

   Comment - This is a dangerous condition. If the table is partially on or partially off of the clamp plate; potential damage to the indexer can result. If the table is heading towards the clamp plate and the clamp plate lowers due to loss of air, a crash will result.

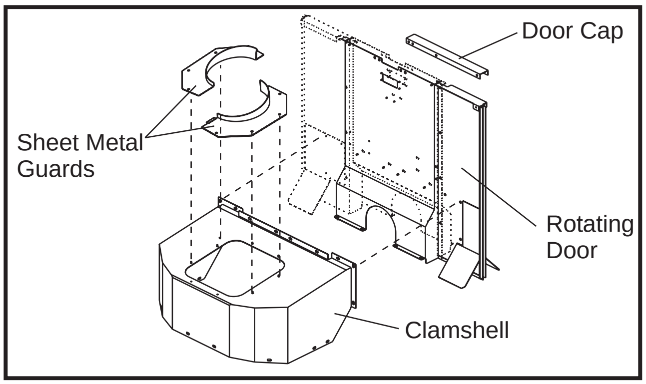
EC-300/Mill Drill Pallet Changer Disassembly

Pallet Changer Disassembly can be done from the Load Station of the EC 300/MDC without removing any enclosure parts.

1. Enter M-17 in MDI mode and press Cycle Start to unclamp the pallet (recommend 25% rapid). Wait until the assembly has fully risen to its highest point and begins to rotate and press Emergency Stop. Rotate the pallet as required to remove the components.
2. Remove the sheet metal guards on top of the clamshell cover.
3. Remove the clamshell by unbolting 20 screws in the rotating door and along the bottom of the clamshell.

CAUTION! The clamshell can be removed by simply lifting up and over the rotary table once the sheet metal guards have been removed. **Do not** remove or adjust the pallet on the rotary table.

4. Remove the two door caps on top of the door panel (rotate the door 90°).



5. Remove rotating doors and the white plastic cable fairlead (the doors come off in 2 halves). Keep cables out of the way. The harmonic drive assembly can be removed at this point by removing the six 3/8-24 SHCS holding the flange plate and servo motor to the frame support and lifting the entire assembly straight out. **Mark the orientation of the plate first, since it must be reassembled exactly as it was.**

NOTE: If the servo motor has been removed, the grid offset has to be recalculated in order to assure that there is no misalignment after reassembling the motor. Refer to "Pallet Changer Grid Offset".

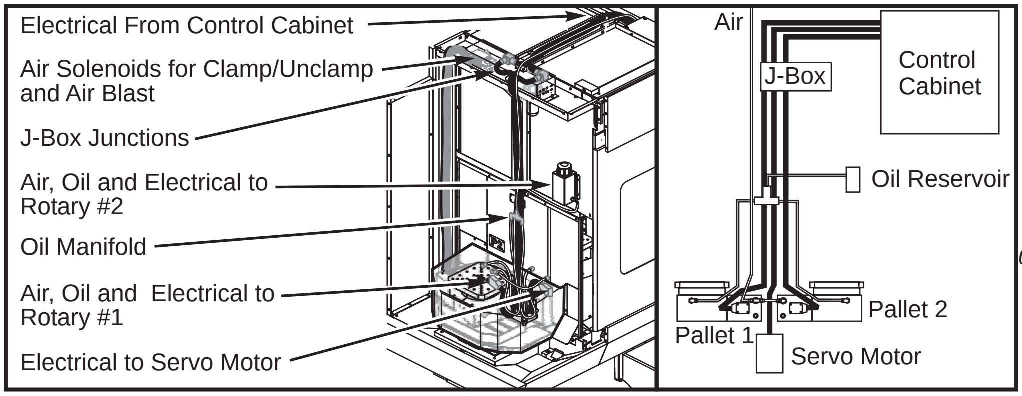
NOTE: Power off before disconnecting anything (and unscrew the power cables for the rotary tables from J-box for EC-300).

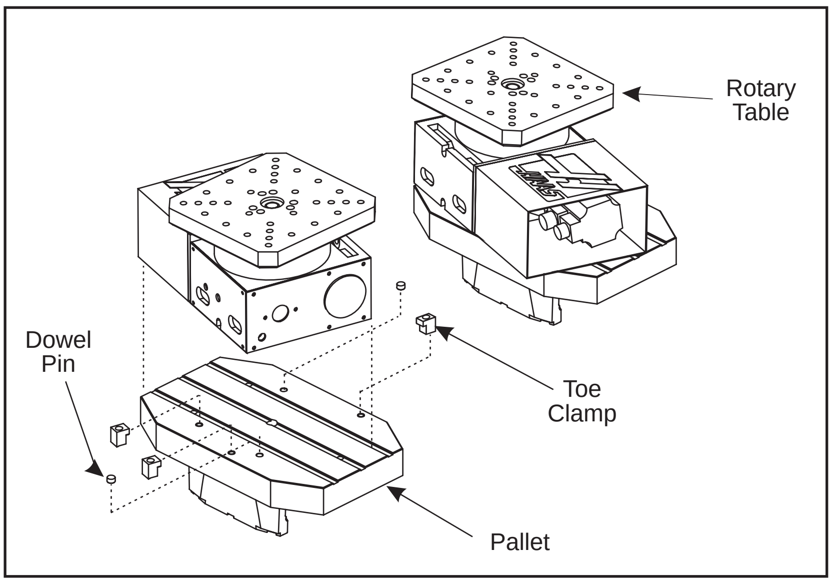
Steps 6-8 apply to the EC-300 only

6. The power wires are located on top of the machine for the two rotary tables and are routed through the table to the top of the machine via the center compartment within the rotating doors.

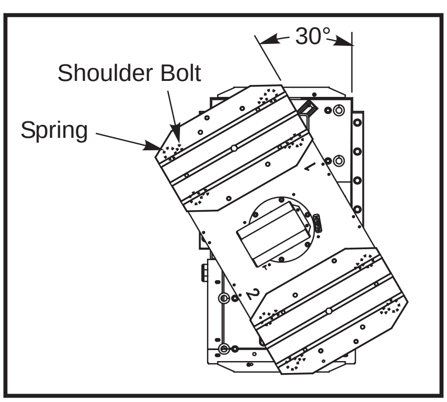
NOTE: There are 2 power lines and 2 air lines: one pair connected to each table. There is also an oil line that splits to each table.

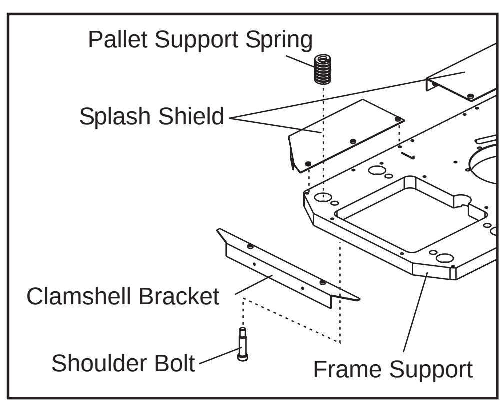
Remove the cable cover on the rotating door and pull the cables through. Disconnect the power cables from the J-box, remove the lubrication line and disconnect and crimp air lines leading to the rotary tables with a zip tie. There is a silk screen on the outside of the J-box that illustrates wire routing.





7. Remove the 3 toe clamps from the sides of the HRT-210 rotary tables and remove rotary tables with a lift.
8. Remove two ½" dowel pins (2 per pallet) that are seated in non-threaded holes in the pallet for proper orientation of the rotary tables. **Do not lose these pins.**
9. The pallet table assembly must be rotated approximately 30° away from the home position to access the 5/8" shoulder bolts underneath.





10. Remove the pallet changer tables by unbolting the four 5/8" shoulder bolts between the pallet changer and the frame support. After removing the shoulder bolts, the pallet is loose on the pallet support springs and can be lifted off by using 2 eye bolts. (Each table weighs approx. 160 lbs.)
11. Remove the 2 splash shields along with the bracket clamshell located under and around the table area.

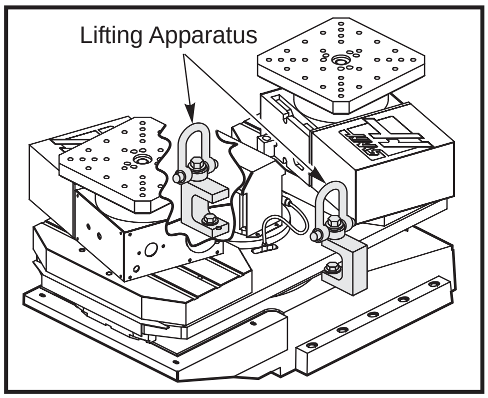
NOTE: Air pressure must stay connected throughout this process. **Do not** initiate a pallet change under any circumstance and only rotate assembly by hand.

Frame Support Removal: Remove the splash shields, the bracket shell, and disconnect the home switch. The frame support can be removed with the servo motor and flange plate still connected. The frame supports weigh approximately 195 lbs. and should be lifted out carefully.

To service the pallet clamp piston assembly, the entire pallet changer assembly must be removed.

1. Remove all front interior sheet metal pieces attached to the pallet changer.

NOTE: If enough lift capacity is available (2,000 lbs. on an extended arm) the rotary tables, pallets, and frame support may stay in place; otherwise, they must be removed (described in "Frame Support Removal").



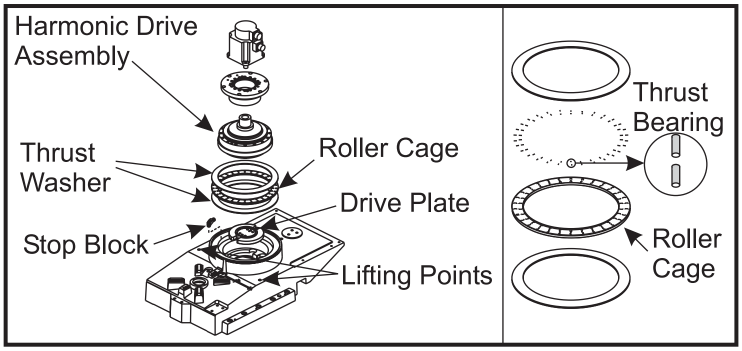
2. Disconnect the rotary table power cables **(EC-300)**, remove the air lines located on the lower left of the pallet changer base, and remove the 7 bolts that attach the piston to the shaft.

NOTE: Mark the air lines for proper re-assembly.

3. Disconnect the pallet clamp switch and remove the ten 5/8 –16 socket head bolts holding the pallet changer base to the main base casting.
4. Bolt-in lifting tools and lift out. Disconnect the Unclamp air fitting on the bottom side of the piston cover plate. Remove the piston cover, the pallet clamp piston and P.C. shaft to service the assembly.

To service the thrust bearing assembly, see "Frame Support Removal" and “Pallet Changer Disassembly and Replacement” sections, and remove the support frame, exposing the thrust bearings and thrust washers.

NOTE: The weight of the table rests on the thrust bearing.



If the thrust bearing and washers have to be removed, remove the unit as a whole so as not to lose the bearings. Inevitably, some bearings will fall out; therefore, it is advisable to have spare bearings for replacement.

To service the air blast assembly, the pallets must be rotated perpendicular to the home position and at least 1 pallet table must be removed. After removing the pallet, rotate the frame assembly with the empty pallet space back over clamp plate and remove the clamp plate, followed by the air blast ring.

To service the pallet clamp switch, follow steps above for servicing the air blast assembly, then unbolt the four socket screws and pull the assembly out.

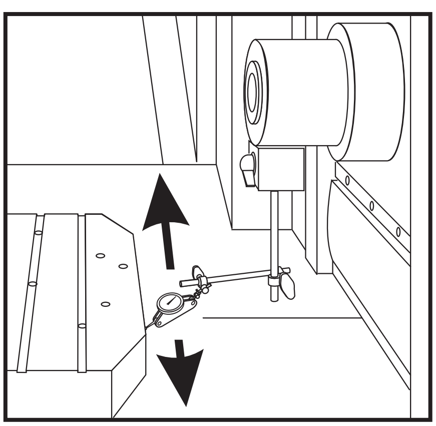
To service the air tubing, remove the motor, motor flange plate, and the harmonic drive assembly.

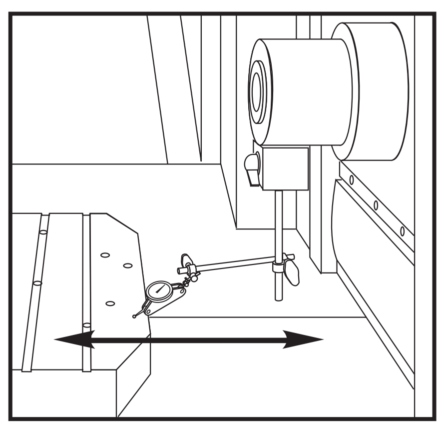
Re-assembly

APC Spring Seating Procedure (Pallet 1)

1. In MDI mode write a simple program (M17; M18;M99) to clamp and unclamp the pallet.
2. While P1 is clamped, loosen but do not remove shoulder bolt retaining springs
3. In single block mode, cycle the program to observe the direction of table movement.
4. Adjust spring location by gently tapping springs in the opposite direction of the table movement. Run the program to verify adjustment.
5. Repeat the previous step until all pallet movement is gone, then torque shoulder bolts to 75 ft-lb. Run the program again to verify the adjustment was not affected.
6. Repeat this procedure for the other pallet.

Squaring The Pallet





1. Loosen all bolts from the pallet changer to the base and align front-machined surface of pallet parallel to X-axis (NTE 0.002" overall). Perform a pallet change and verify the other side.

2. Level the pallet along the X-axis by indicating across the pallet in the X-axis direction. Both pallets should be parallel to within 0.002"/10" of each other.

3. If pallets are not level, shim between pallet changer and base, and tighten pallet changer base bolts.

4. Rotate the pallet changer and verify the other pallet.

5. **EC-300:** Level the pallet along the Z-axis by indicating across the pallet in the Z-axis direction.

6. **MDC:** Level the pallet along the Y-axis by indicating across the pallet in the Y-axis direction.

7. If necessary, adjust the shims between the pallet changer and base as required. Ensure all of the bolts are tight before continuing.

8. Rotate the pallet changer and verify the other pallet.

Align Rotary Tables (EC-300)

1. Clean and stone pallet changer surfaces before installing rotary tables.

2. Install the 2 dowel pins into the pallets and place the rotary tables accordingly.

NOTE: Make sure the dowel pins are seated in non-threaded holes in the pallet.

3. Connect the cables, lubrication lines, and air lines to the rotary table and ensure that the oil reservoir is full.

4. Install table clamps (3 per table) and fasteners and torque to 80 ft-lb.

5. Indicate the top of the rotary table and take readings at 0, 90,180, and 270°. If necessary, adjust the shims under the rotary table to align the rotary axis perpendicular to the XZ plane, not to exceed 0.0003".

6. Indicate across rotary table surfaces along the X- and the Z-axes. The indications should be parallel to within 0.0005"/10".

7. Rotate the pallet changer, and indicate the other rotary table as described above.

Pallet Changer Grid Offset

1. Make sure that Bit #28 in Parameter 209 has a value of 1. The pallet will stay up.

2. Verify that the pallet changer type in Parameter 605 is 3.

NOTE: The APC is on the B-axis on machines with single Mocon PC board or the W-axis on machines with two Mocon PC boards.

3. The grid offsets in Parameter 445 should be the W -axis, and the offsets in Parameter 170 should be the B-axis. Respectively, tool changer offsets in Parameter 451 should be the W-axis, and the offsets in Parameter 213 should be the B-axis.

4. Zero Return the appropriate axis, and set the grid offset for the individual axis only. Zero Return again.

5. Press the Emergency Stop button and manually rotate the APC so that the locators on Pallet 1 are aligned with the locators on the APC.

6. Lower the pallet onto the locators by lowering the air pressure at the main regulator. **Be careful** not to damage either the locators or the pallet.

7. Enter Debug mode, go to the Pos Raw Data page, and take the **actual** value from the appropriate axis. Enter this value into the tool change offset parameter.

8. Restore the air pressure and Zero Return the axis.

9. Verify that the pallet is aligned over the locators.

10. Change the value of Parameter 209 to 0.

When the automatic pallet changer (APC) is at rest, the pallet is clamped, the pallet at the load station is at home position, and the APC door is closed. The H-frame down solenoid is on, the safety solenoid is on, and the H-frame is down with the H-frame lock pin engaged in the bumper mount. The APC servo has been Zero Returned, using the APC home sensor.

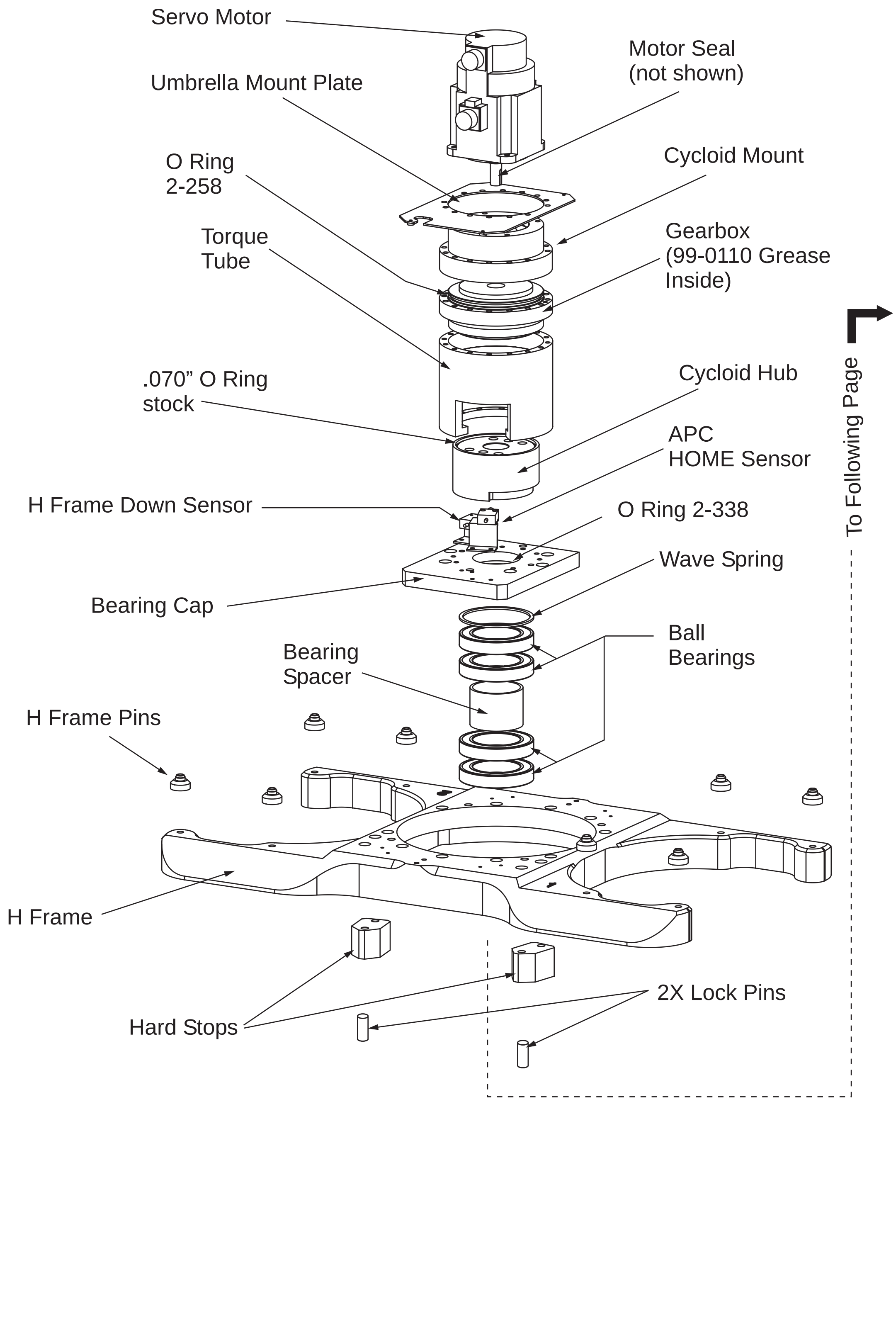
The load station is a 90° manual indexing station that holds a pallet securely into place while maintaining the ability to index freely. A manual indexing handle withdraws an indexing pin from the load station, which makes it possible to rotate the turntable (and the load) by hand. Four positions are available, at 90° increments, and at each increment the indexing pin will lock into position. Pallet must be in the home position before a pallet change can be commanded. When a pallet change is commanded the following events occur, in this order:

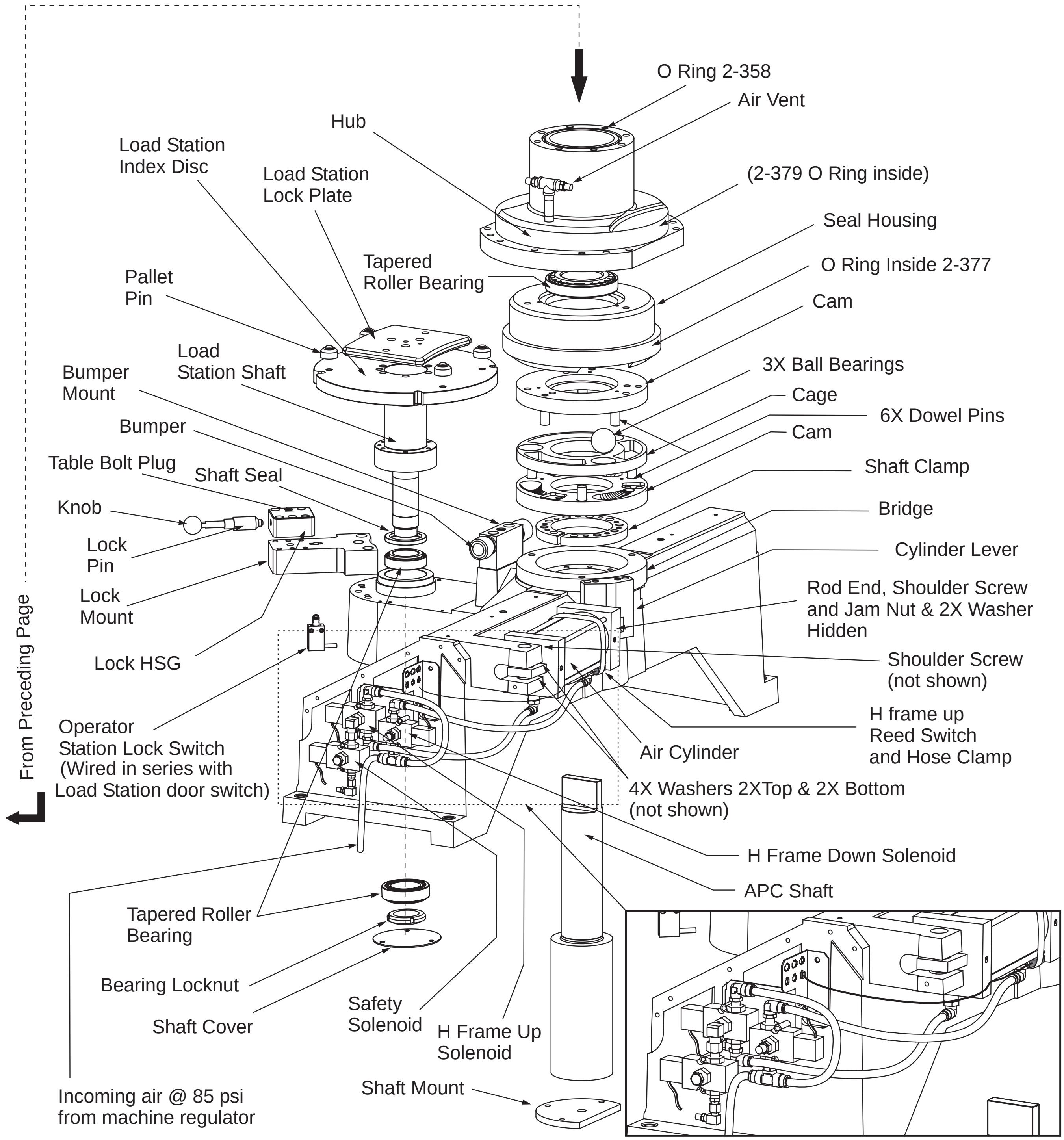
1. H-frame down switch is checked to verify down status.
2. Z-axis rapids, if necessary, to a position specified by the grid offset & Parameter 64.
3. A-axis rapids to position specified by grid offset & Parameter 224 (may involve raise/lower of pallet).
4. The lifting and lowering of the A-axis platter on indexer-style machines is monitored by a sensor assembly located on the bottom of the A-axis. There are no sensors monitoring the A-axis platter position on machines with the full 4^{th} axis option.
5. The A-axis is allowed to rotate, once the platter lift sensor is triggered.
6. When the A-axis moves to the home position and lowers, the platter down sensor is triggered and the platter lift sensor is turned off.
7. Power is turned on to the pallet clamp/unclamp solenoid located at the rear of the machine.
8. The clamp air pressure is released from the clamp side of the receiver piston and 100 PSI of air is applied to the unclamp side of the receiver piston.
9. The clamp plate rises.
10. When the clamp plate moves approximately .400" it will trigger the pallet unclamp sensor. The sensor sends a signal to the CNC control that the clamp plate is in the unclamp position. A sensor assembly located on the bottom of the A-axis monitors the clamp plate position.
11. APC door and load station lock switches are checked.
12. The H-frame down solenoid and safety solenoid turn off.
13. The H-frame up solenoid turns on.
14. Air pressure in the air cylinder rotates the top cam, by rotating the seal housing. The bottom cam does not rotate.
15. The cage and three balls rotate at half the speed of the cam, forcing the cams to separate.
16. The top cam raises the H-frame by lifting upward on the hub, using the tapered bearing as a thrust bearing.
17. The H-frame engages and lifts both pallets as it is raised.
18. The APC shaft does not rise. The hub slides up the shaft on the four ball bearings. The flat tang of the APC shaft slides inside a slot in the cycloid hub.
19. The H-frame up switch checks H-frame up status. As the H-frame rises, the lock pin comes out of the hole in the bumper mount, so the H-frame can rotate.
20. Once the H-frame up switch indicates up, the air blast solenoid is turned on, and sends air blowing through the air blast assembly at the top of the receiver.

21. The servomotor rotates the H-frame and pallets 180°, by driving through the gearbox, torque tube, and hub, while the APC shaft, cycloid hub, and part of the gearbox remain stationary. The servomotor rotates with the assembly.
22. The H-frame down switch gets a momentary false signal as it rotates past the tang on the APC shaft, approximately mid-stroke, which the software ignores.
23. The safety solenoid, which is off, prevents the H-frame from suddenly lowering in the event of a power failure by blocking the vent port of the H-frame up solenoid.
24. When it has rotated 180°, the servomotor stops, and holds position. The encoder on the servomotor determines the rotational position.
25. The H-frame up solenoid is turned off.
26. The H-frame down solenoid and safety solenoids are turned on, pressurizing the other side of the air cylinder while venting the side previously pressurized.
27. The top cam is rotated back to its original position, allowing the H-frame and pallets to lower. As the H-frame lowers, a lock pin under the H-frame drops into a hole in the bumper mount. It keeps the H-frame from being moved while the servo power is off.
28. The pallet in the machine is lowered onto the receiver and the pallet on the load station is lowered onto the index disc pallet pins.
29. Power is turned off to the clamp/unclamp solenoid and air blast solenoids located at the machine's rear.
30. The unclamp air pressure is exhausted from the unclamp side of the receiver piston and air blast is turned off while simultaneously applying 100 PSI of air pressure to the clamp side of the receiver piston.
31. The clamp plate moves down to clamp the pallet. The clamp plate will move approximately .400" and clamp the pallet. It will trigger the pallet clamp sensor, indicating that the pallet is clamped. The clamp plate position is monitored by a sensor assembly located on the bottom of the A-axis.
32. The load station lock plate prevents the load station pallet from falling off if it is rocked severely while loading parts.

Make sure the machine is turned off and the air pressure is discharged before attempting to work on this machine. The drive mechanism for the APC is located inside the rotating door. It can be accessed for trouble-shooting by removing either half of the door. APC disassembly requires removing the door. Disassembly is a top down process.

EC-400 Pallet Changer Exploded View

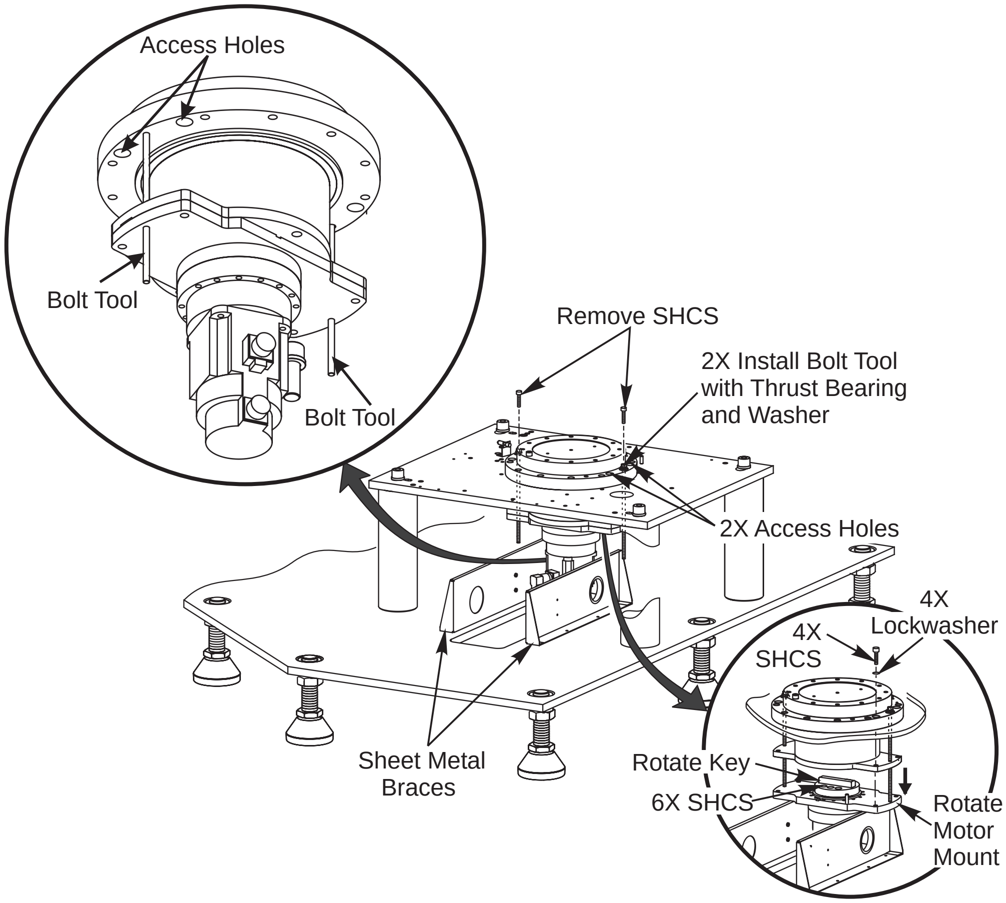




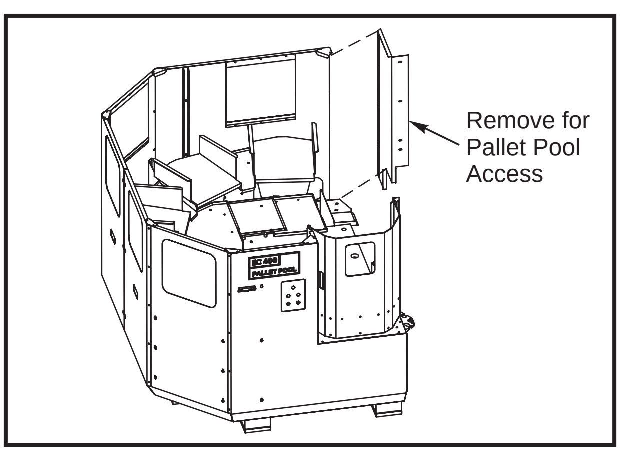
O Ring 2-358
Air Vent
Hub
Load Station
Index Disc
Load Station
Lock Plate
(2-379 O Ring inside)
Seal Housing
Tapered
Roller Bearing
O Ring Inside 2-377
Pallet
Pin
Cam
Load
Station Shaft
Bumper
Mount
3X Ball Bearings
Cage
6X Dowel Pins
Bumper
Cam
Table Bolt Plug
Shaft Seal
Shaft Clamp
Knob
Bridge
Lock
Pin
Cylinder Lever
Lock
Mount
Rod End, Shoulder Screw
and Jam Nut & 2X Washer
Hidden
Lock HSG
Shoulder Screw
(not shown)
From Preceding Page
Operator
Station Lock Switch
(Wired in series with
Load Station door switch)
H frame up
Reed Switch
and Hose Clamp
Air Cylinder
4X Washers 2XTop & 2X Bottom
(not shown)
H Frame Down Solenoid
APC Shaft
Tapered Roller
Bearing
Bearing Locknut
Safety
Solenoid
Shaft Cover
H Frame Up
Solenoid
Shaft Mount
Incoming air @ 85 psi
from machine regulator

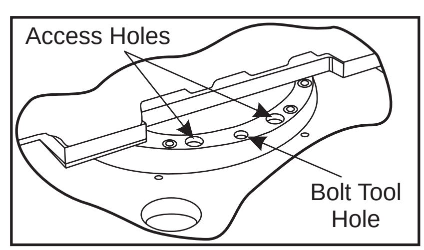
PALLET POOL MOTOR REPLACEMENT

Pallet Pool Motor Replacement is accomplished from beneath the Rotator/Slider of the EC-400 Pallet Pool.



1. Enter M17 in MDI mode and press Cycle Start to unclamp load station pallet (recommend 25% rapid). Wait until assembly has fully risen to its highest point and begins to rotate, then press Emergency Stop.
2. Remove sheet metal attaching the Pallet Pool to the EC-400 to gain access to the interior.





3. Manually rotate the rotator/slider to expose the large socket head screw access holes beneath it (two on each side).

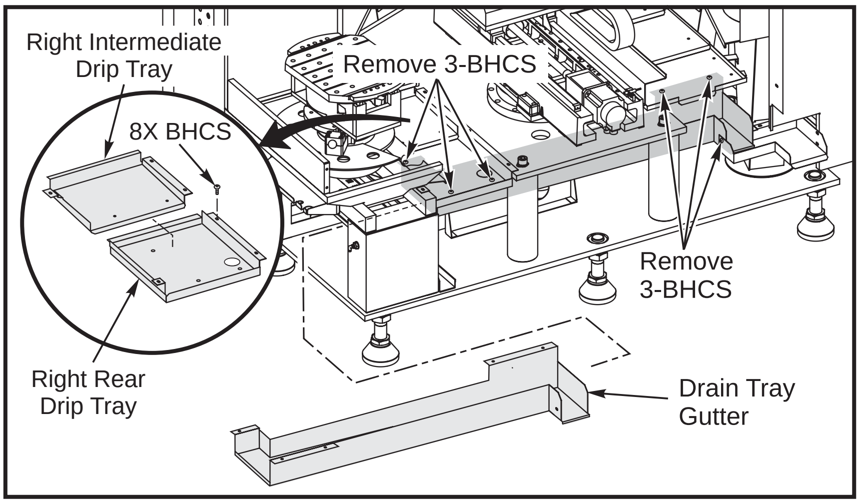
4. Insert a threaded bolt tool (contact Haas for tool) in the hole between the two access holes (one on each side of the rotator/slider to keep the motor from falling later in the procedure.

5. Using a special tool (contact Haas for tool), insert it into the access holes and remove the four bolts (two on each side of the rotator/slider) holding the motor in place.

6. Loosen the bolt tool between the access holes (one on each side) to lower the motor onto the two sheet metal braces beneath it. Lower the motor by alternately unscrewing the bolt tool until the motor is resting on the braces. If you fully unscrew a bolt tool on one side, it may bind.

7. Remove the two drip trays located below and to the rear of the rotator/slider.

8. Remove the drain tray gutter located below the rotator/slider, by unbolting it and pulling it out through the open area at the left side of the pallet pool.



9. Enter the open area at the left side of the pallet pool by crawling into it, make your way to the motor, and disconnect any cables and wires holding the motor to the rotator/slider.

10. To remove the motor, slide it down to the end of the sheet metal braces and lift it up and out through the space left by the removal of the drip trays and drain tray gutter.

Reverse Steps 1 through 9 to install the motor.

NOTE: There is an extruded slot (rotate key)on the motor that fits into a slot under the rotator/slider where the motor needs to be attached. Make sure they are fitted together before pulling the motor into place and tightening the bolts.

Pallet Changer Disassembly and Replacement

Disassembly

1. Remove the rotating door and the servo motor sheet metal cover.

2. Unplug electrical wires to servo motor. Dismount servo motor held to umbrella mount plate with four SHCS.

3. Remove SHCS that hold gearbox and cycloid tube to torque tube. Remove gearbox with the cycloid tube.

4. If the cycloid hub must be removed from the gearbox, cover the gearbox hole to prevent contamination.

5. Unbolt the torque tube from the bearing cap and lift it off of the dowel pins. Unbolt the bearing cap and lift it off of the dowel pins, exposing the wave spring, four bearings, and bearing spacer.

6. Remove the two hardstops from the H-frame. Remove the eight SHCS that hold the H-frame to the hub. Carefully lift off the H-frame from the dowel pins.

7. Lift the hub off of the APC shaft.
8. If the bearings need to be replaced, remove them from below the hub using a punch. If the bearings are removed, replace them. Pack the new bearings with moly grease.
9. Remove the air cylinder per the instructions in the air cylinder removal section.
10. Lift seal housing off the bridge. The heavily greased cam assembly may be stuck inside the seal housing.
11. Remove the cam assembly which consists of the cage and three balls.
12. Unbolt and remove the lower cam.
13. Remove the SHCS from the shaft clamp.
14. Loosen the tapered shaft clamp by loosening the mounting screws. Remove the shaft clamp.
15. Remove the 5/8” SHCS from the shaft mount located on the bottom of the shaft. Remove the shaft by lifting it straight up.

Reassembly

Reassemble the pallet changer in the order by which it was removed. Align the H-frame to the receiver pallet per the instructions in the Pallet Changer H-frame to Pallet Alignment section.

H-Frame Replacement

1. Remove the rotating door.
2. Remove the two hardstops from the H-frame.
3. Remove the SHCS that fasten the H-frame to the hub.
4. Raise the H-frame with an appropriate lifting device until the H-frame is above the dowel pins.
5. Carefully guide the opening of the H-frame around the servo motor, connectors, and umbrella mount plate, and remove the H-frame from the machine.
6. Replace the H-frame in the reverse order from which it was removed. Be sure that the servo motor electrical connections are on the same side as the hard stops on the H-frame.
7. Align the H-frame per the Pallet Changer H-frame to Pallet Alignment procedure.

H-Frame Switch Adjustment

H-frame up sensor

1. Remove the APC cylinder shield to access the up switch.
2. Loosen the switch clamp.
3. Find the correct position for the switch: Go to the APC diagnostics page. The status of H-Frame Up should be 0 for most of the air cylinder’s travel, but will change to 1 when the cylinder is within 1/16" of being fully extended. It will remain 1 for the last 1/16" of travel.
4. Slide the switch lengthwise on the air cylinder to its correct position, then tighten the clamp. Replace the APC cylinder shield.

H-frame down sensor - There is no adjustment for the H-frame down sensor.

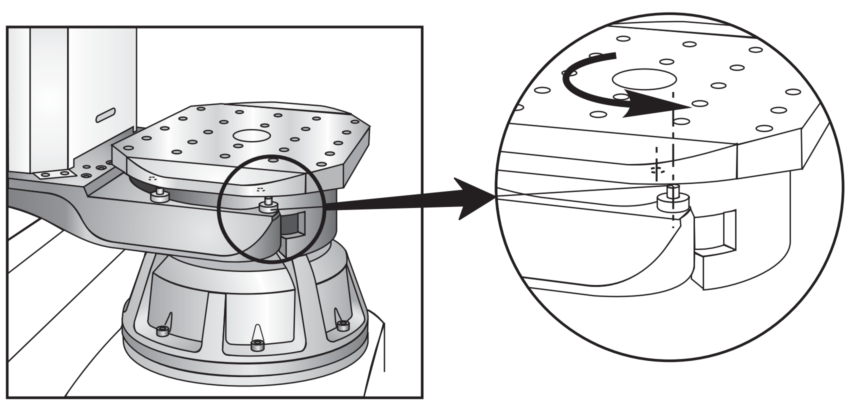
Air Cylinder

1. At the APC recovery page, confirm that the H-frame is commanded down.
2. Disconnect the machine’s air.

3. Remove the APC cylinder cover.
4. Remove the H-frame up reed switch. Disconnecting it is not necessary.
5. Disconnect the two air hoses.
6. Remove the shoulder bolts and washers that retain the air cylinder and remove the air cylinder..
7. Remove the air fittings, rod end, and jam nut and assemble them on to the new air filter. Leave the rod end loose.
8. Wrap the air fittings with teflon tape.
9. Mount the fixed end of the air cylinder to the bridge using a shoulder bolt and two washers on either side of the spherical bearing.
10. Rotate the APC cam lever, cams, and seal housing clockwise as viewed from the top, until it stops.
11. Adjust the rod end, as required, to easily insert the shoulder bolt with the cylinder fully retracted.
12. Unscrew the rod one full turn and tighten the jam nut. The air cylinder should reach the end of its travel before the cams do.
13. Attach rod end to the cylinder lever using the shoulder screw with one washer on each side of the rod end.
14. Torque both of the shoulder screws to 100 ft-lb.
15. Reinstall and adjust the H-frame up switch.
16. Reinstall the air lines and the cylinder shield.
17. After completion, run a sample program to test for proper operation.

Pallet Changer H-frame to Pallet Alignment

There are two stages to properly aligning the pallet changer H-frame and the pallets. The first is to align the pallets to the H-frame. The second is to align the pallet load station to the H-frame.



Stage 1

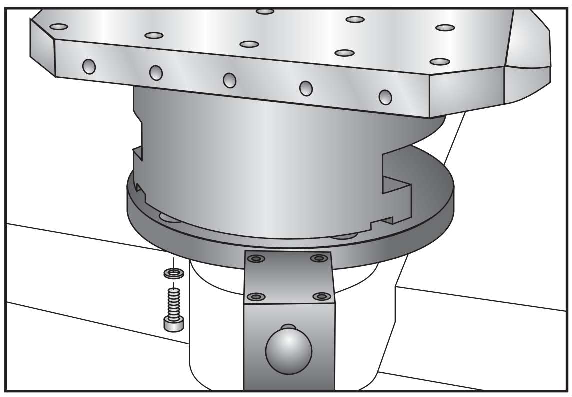
1. Go to the parameter page and scroll to find Parameter 76. Write down the current value. Adjust Parameter 76 to a large number (e.g. 99999999999), to delay the low air alarm.
2. Enter Debug mode (go to Alarms page, key in Debug and press Write/Enter) and scroll to Pos Raw Data.
3. Jog the Z-axis until the pins on the H-frame are aligned with the holes in the pallet. Enter the value of Z-axis Actual into Parameter 64.
4. Enter Pallet Changer Restore (press Tool Changer Restore and select the Pallet Changer Restore option).

5. Home the Z-axis and verify the pallet to H-frame alignment.
6. Unclamp the pallet and turn down the main air pressure regulator to approximately 10 PSI.
7. Press the key to raise the pallet. Turn up air pressure (at air regulator) slowly and verify that the H-frame and pallet are aligned. To lower the H-frame and pallet raise air pressure and press the pallet down button.
8. If the alignment is incorrect repeat the steps to set Parameter 64.
9. Once the alignment is complete, restore the main air pressure regulator to the correct pressure (85 PSI) and finish the pallet changer restore sequence.
10. Exit Debug (type Debug and press Enter from the alarms page).

Stage 2

Alignment of the pallet load station pins to the H-Frame. At this stage the H-frame has been aligned to the rotary axis (Stage 1 has been completed).

1. Loosen the four alignment pin bolts on the load station. Rotate the pallet at the load station to access all the bolts.



2. Rotate the pallet load station to home. Enter pallet changer recovery
3. Unclamp the pallet and raise the H-frame.
4. Reduce the main air pressure regulator to approximately 10 PSI.
5. Enter pallet changer restore and command the H-frame down.
6. Increase the air pressure at the main pressure regulator until the H-frame starts to lower. Verify the pallet is engaging the alignment pins.
7. Once the pallet is seated on the alignment pins, tighten them.
8. Increase the main air pressure regulator to 85 PSI and finish the pallet changer restore sequence.
9. Close doors and command several pallet changes to verify smooth operation.
10. Set Parameter 76 to the original number.

Note that pallet changer recovery reduces rapids to 25%. The pallet at the load station must always be re-turned to home before automatic pallet changes can occur.

Warning

The indexer will crash if the following procedures are not followed.
Read all material before proceeding.

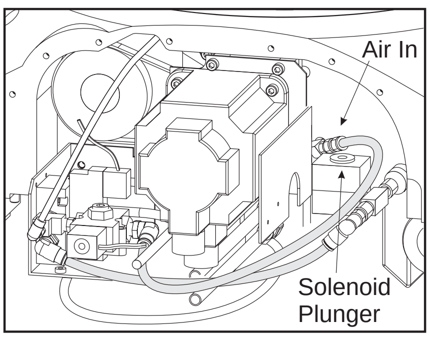
When the Indexer is replaced in the EC-400, it must have the lift switch adjusted and Parameter 212 set to zero before any other machine movement is attempted! Misalignment of the facegear at the home position will cause malfunction. Make sure that software version 12.08 or later is loaded and the table is initialized on the settings page. (This assures that all parameters are set for this option.)

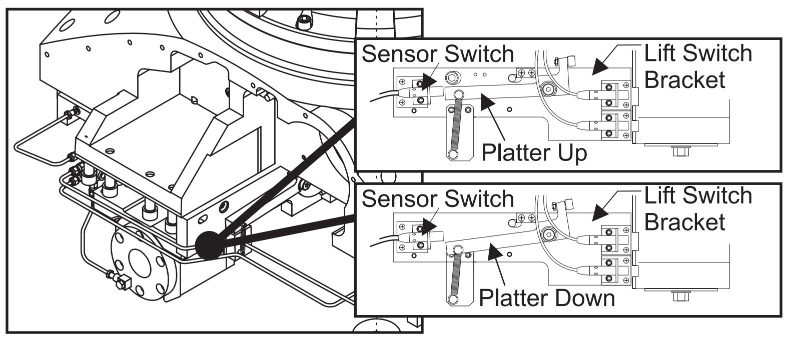
To perform all of the procedures in this section, the Z-axis way covers must be removed.

A-axis Indexer Lift Switch Setup

Lift Switch Setup

1. Disconnect the main air supply, then plug the air line to the brake solenoid.
2. Release the air pressure at the table by activating the clamp release solenoid plunger.
3. Connect the test air regulator (T-2150) to the shop air supply. Connect the outlet to the rotary table at the platter lift, air in connection (Air In). The main regulator adjustment knob must be fully unscrewed.





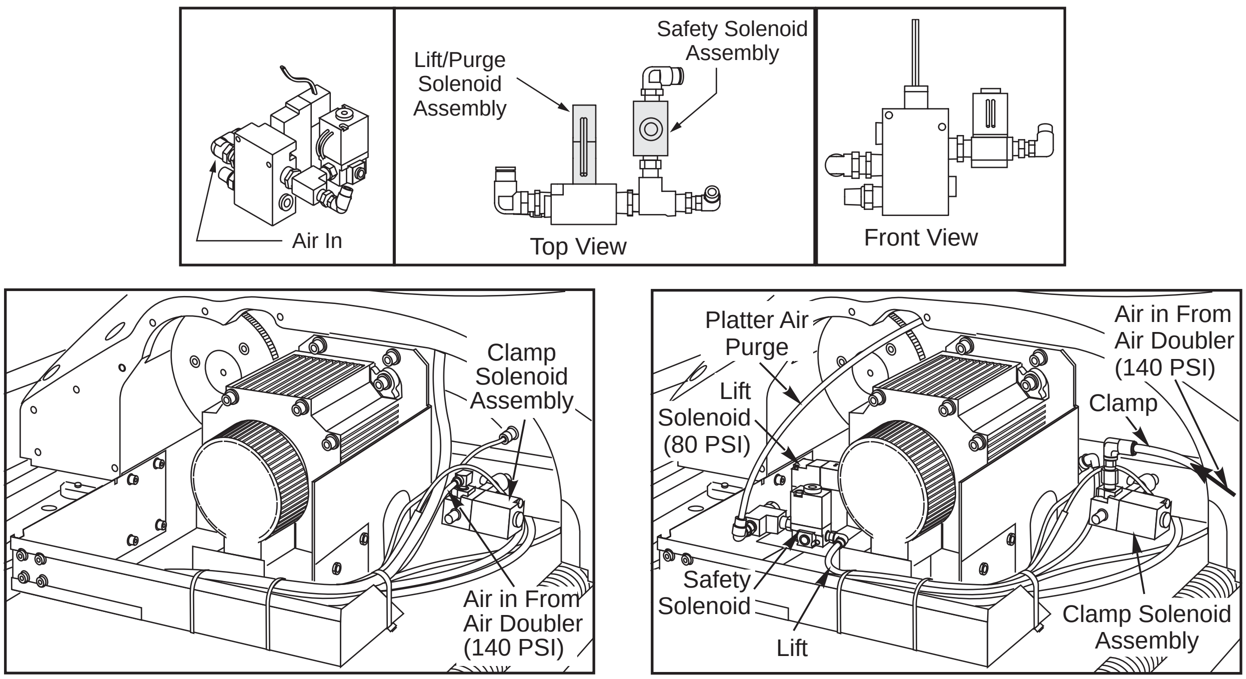
4. Turn the regulator adjustment knob to 20-40 PSI and toggle the air pressure to the clamp fittings.
5. Set an indicator on the machine with the stylus on the platter or pallet.
6. Go to the diagnostics page (Dgnos).
7. Slightly loosen the two mounting screws on the lift switch mounted on the lift switch bracket.
8. Raise and lower the pallet with the regulator adjustment knob. Note that the platter up state is at 0 when up and 1 when down. Adjust the position of the switch so that the platter lift state becomes 0 at .052" above the down position.
9. Tighten the switch mounting screws when this height is achieved.

Setting Parameters 212 and 128 (Indexer A Axis Offset)

1. In Debug mode, go to Parameter 212, enter “0”, then press Write/Enter. Repeat for Parameter 128.
2. Toggle air pressure to the lift piston using tool T-2150 so that the platter is at the top of its travel.
3. Zero the A-axis only by pressing the “Zero Ret” key, then the “A” key, then the “Zero Singl Axis” key.
4. Go to Parameter 128 and record the value.
5. Jog the A-axis to line up the front edge of the pallet with the X-axis as close as the coupling position will allow. E-Stop the machine.

6. Slowly discharge the air pressure to the A-axis and lower the platter into position.
7. Rotate the worm shaft pulley to the extent of its travel and record the value. The value at the middle of this range is the value for Parameter 212. Enter that value.
8. Remove tool T-2150 and replace the hoses.
9. To fine adjust the front edge of the pallet, it may be necessary to loosen the 16 SHCS that fasten the rotary body to the trucks and the ten SHCS for the Z-axis ball screw mount.
10. Tap the rotary body into position within .0005"/10.00".
11. Tighten, then torque the 16 SHCS that fasten the receiver body to the trucks. Tighten the five ball nut bolts, allowing the housing to re-align, then torque the ten housing bolts. After the housing bolts have been torqued, loosen the five ball nut bolts and run the ball nut away from and back to the motor. If no binding occurs, re-tighten the ball nut bolts.

EC-400 Rotary Indexer Air Diagram



Receiver Replacement

The following instructions detail the procedure for leveling and verification of the receiver geometry. Machine level must be verified and geometry must be checked for reference before replacing the receiver.

Receiver/Pallet Verification

Leveling: The machine must be level with absolutely no twist in the Z-axis.

1. Clean the pallet and precision level of all debris. (The level can also be placed on top of the pallet clamp plate, with the pallet off of the machine.) Center the X- and Z-axes.
2. Position the precision level on the center of the pallet parallel to X-Axis and note level.
3. Position the level in line with the Z-axis and note level. If necessary, loosen the center leveling screws and adjust rough level before proceeding.

Roll
1. Position the precision level on center of the table parallel to X-Axis. Jog the Z-axis, full travel in each direction, and note any deviation in the level.

Pitch
1. Position the precision level on center of the table parallel to Z-Axis. Jog the Z-axis, full travel in each direction, and note any deviation in the level.

2. Adjust for any deviation of pitch or roll as necessary.

Receiver Geometry Verification

NOTE: The receiver is never adjusted to correct pallet flatness. It is adjusted for runout and concentricity. Both need to be confirmed before the pallet is installed.

Indicate the receiver concentricity by first rotating the A-axis 45°. Then indicate the outside vertical edge, or outermost edge of the locating key that is facing the spindle. Set the Z-axis position to zero and move the indicator off in Z-axis to allow for A-axis rotation. Then rotate at 90° intervals until all four locating pads have been indicated. The specification is .0003" (.00762mm) or less.

Indicate the receiver runout by indicating the top of the locating pads on the receiver. On machines with 1 or 45° indexers, move off the pad in Z-axis, rotate A-axis 90° to next pad and come back in to the same Z-axis position and note the indicator reading. For a full 4th rotary it is not necessary to move off the pad because pop up on the rotary will only be .0003". Rotate until all four locating pads have been indicated. The specification is .0003" (.00762mm) or less.

Receiver Removal/Installation:
Removal
Home the A-axis before starting the removal procedure.

1. Remove the pallet from the receiver.

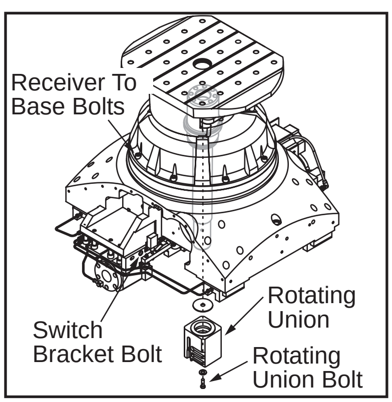
2. Remove the screws from the front and rear Z-axis way covers and slide them away from the rotary base.

3. Disconnect the air supply from the machine and bump up Parameter 76 to 999999.

4. Remove the single bolt securing the switch plate assembly and remove the switch plate assembly. Set safely aside.

5. For reference, label the three rotating union hoses. This will help when replacing them.

6. Remove the one bolt at the bottom of the rotating union. The rotary union is now loose and is pulled straight down to remove. Note that there are shim washers between the large fender washer and the bottom of the receiver shaft.

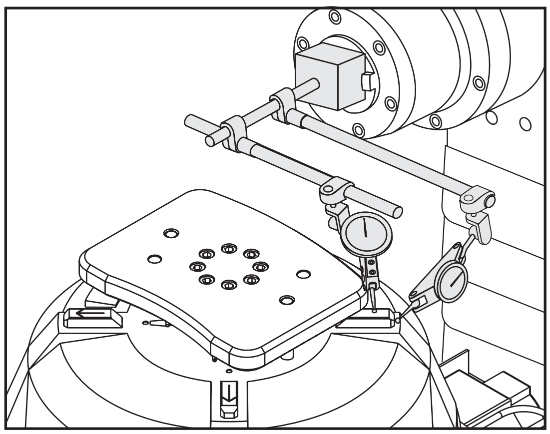


7. Remove the eight bolts securing the receiver to the rotary platter. The receiver is now ready to be removed from the machine.

8. Working through the operator door, use lifting equipment to remove the receiver. The receiver clamp plate has 1/2-13 tapped holes in it so that lifting eyes can be installed, or use straps to grip the top of the receiver. Remove the receiver assembly through the operator door.
9. Remove any shims that may be present on the rotary platter and put them aside for use later, if necessary.

Installation

1. Lift the receiver assembly into the machine.
2. Position the assembly, orienting the clamp plate, over the base and lower into place.
3. Loosely install the eight bolts in the receiver.
4. Install the rotary union at the bottom of the receiver shaft.
5. Reconnect the three hoses to the rotary union.
6. Install and align the switch plate assembly. Slide the assembly toward the rotating union center of the rotary as far as possible and tighten the mounting screw. Make sure that the proximity switches do not contact the union but are close enough to produce a sufficient reading.
7. Connect the air supply to the machine and reset Parameter 76 to 1500.



8. Indicate the receiver using the verification procedure utilized before removing the receiver. Adjust the receiver concentricity by snugging the eight bolts that attach the receiver to the rotary platter. If the concentricity changes, the receiver runout will also change. Because of this, the concentricity should be correct before indicating or adjusting the receiver runout.
9. If the receiver runout is not correct but the concentricity is, it will be necessary to shim under the receiver. It will only be necessary to lift the receiver just enough to install the shims. It is only necessary to remove the eight bolts on the receiver, there is at least 2" of travel for lifting the receiver before the union contacts the bottom of the rotary. Shims are replaced at a 2:1 ratio for the error indicated on the locating keys. **Example:** an indicated error of .001" would require a .002" shim. Install the shims as necessary and repeat the receiver verification procedure until the geometry is correct.

Indicating the pallet

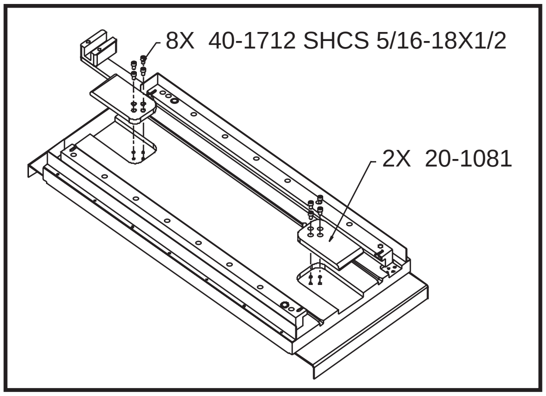
1. Install the new pallet on the receiver and indicate across the 45° angles on the receiver locating keys until they are parallel with the X-axis to within .0005". If the keys are not parallel, proceed to step 9.
2. To indicate the flatness of the pallet, attach a magentic base to the spindle nose and using a .0001" or .0005" indicator, indicate down the center of the pallet and note the reading at the front and back edge, about 1" from the edge of the pallet in the Z-axis. Repeat this in the X-axis and note the reading.

NOTE: Check both pallets before making any adjustments. The pallets should be within .0005" of each other.

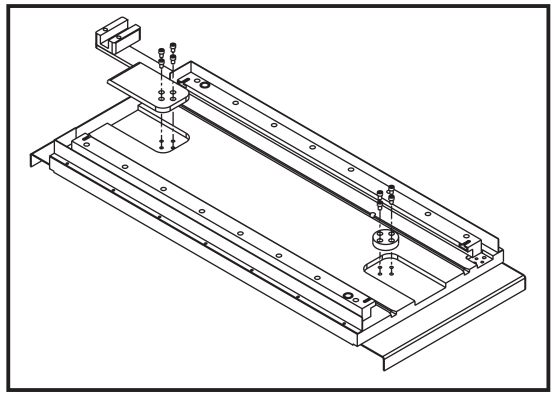
3. With magnetic base still on the spindle nose, place the indicator on the face of the pallet at the center and 1" from the front edge, toward the spindle. Zero the indicator dial and set the Z-axis position to zero.
4. Jog the Z-axis off of the pallet far enough to allow rotation of the A-axis.
5. Jog the A-axis 90° and return the Z-axis to zero position.
6. Repeat step 5 until you have indicated and noted the pallet runout at 0, 90, 180, and 270°.
7. If the flatness is correct, skip to step 9.
8. Pallet flatness is adjusted by shimming under the rotary, between the rotary casting and on top of the Z-axis linear guide pads. Note that any time adjustments are made in this area, the ball nut and ball nut housing need to be realigned, which is also true for the next step.
9. The pallet square in relation to X-axis is adjusted on the full 4th axis, by indicating the front edge of the pallet until parallel and adjusting Parameter 212. On the 1 and 45° indexers, the entire rotary casting needs to be rotated until the pallet is parallel. To do this, it is necessary to loosen the Z-axis ball nut housing, then the 16 bolts on the Z-axis linear guide pads, and physically shift the position of the casting. The specification when indicating the front of the pallet is .0005" (.0127mm) or less. Once this is achieved it is necessary to torque the 16 linear guide bolts, realign the ball nut housing and ball nut, and verify alignment.

APC Pallet Troubleshooting

There are two different designs of pallets for use with the APC. This difference in design is for locating the pallet onto the receiver. The earlier method uses two friction blocks to slow the pallet and locate it correctly as it enters the machine (20-0053, or 20-0579 for a metric pallet). The current design uses a pin and latch to locate the pallet (20-0053A, or metric 20-0579A). Current method pallets can be used on earlier machines by replacing the location stub (20-1082), with a friction block (20-1081). See the following figures.



Pallet Part number 20-0053 (metric 20-0579)



Pallet Part number 20-0053A (metric 20-0579A)

The spare pallet, PAL40, is shipped with two filler blocks (20-1081) and one APC Location Stub (20-1082). If the machine has an existing pallet with part number 20-0053 (Metric 20-0579), the two filler blocks (20-1081) will be used and the Location Stub (20-1082) will not be used. See the figures.

If the machine has an existing pallet with a part number 20-0053A (Metric 20-0579A), one filler block (20-1081), one Location Stub (20-1082) will be used. See the figures.

NOTE: Bolts for filler block are 40-1712 SHCS 5/16-18 X ½ (4). Torque to 35 ft-lb. Bolts for Location Stub are 40-16385 SHCS 5/16-18 X ¾ (4). Torque to 35 ft-lb.

Checking pallet repeatability on to the receiver

• Maximum tolerance is .+/-0005".

• Pallets are not considered repeatable from one to the other. Pallets should use separate offsets.

• If pallet is out of tolerance, check alignment pins on receiver base and bushings on bottom side of clamp rails for damage.

• Check the height of the alignment pins on the receiver base. The top of the pin should be .450" to .490" (11 to 12.5 mm) above the receiver base.

• If alignment pins are out of receiver body, check depth of hole. Depth should be .510" to .550" (13 to 14 mm).

Sticking Pallet

• Check for chips around the alignment pins or pallet clamp rail bushings.

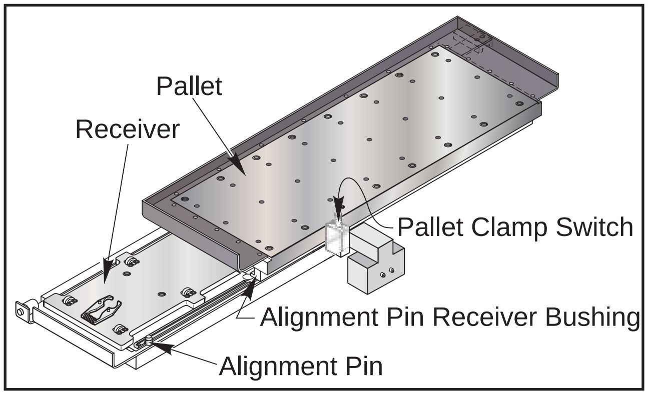
• Check the torque on bolts that fasten the clamp rails to the pallet. If the bolts are loose, realign the pallet.

APC not responding to controller commands

• If the APC does not run, but the mill does, check the APC control cable.

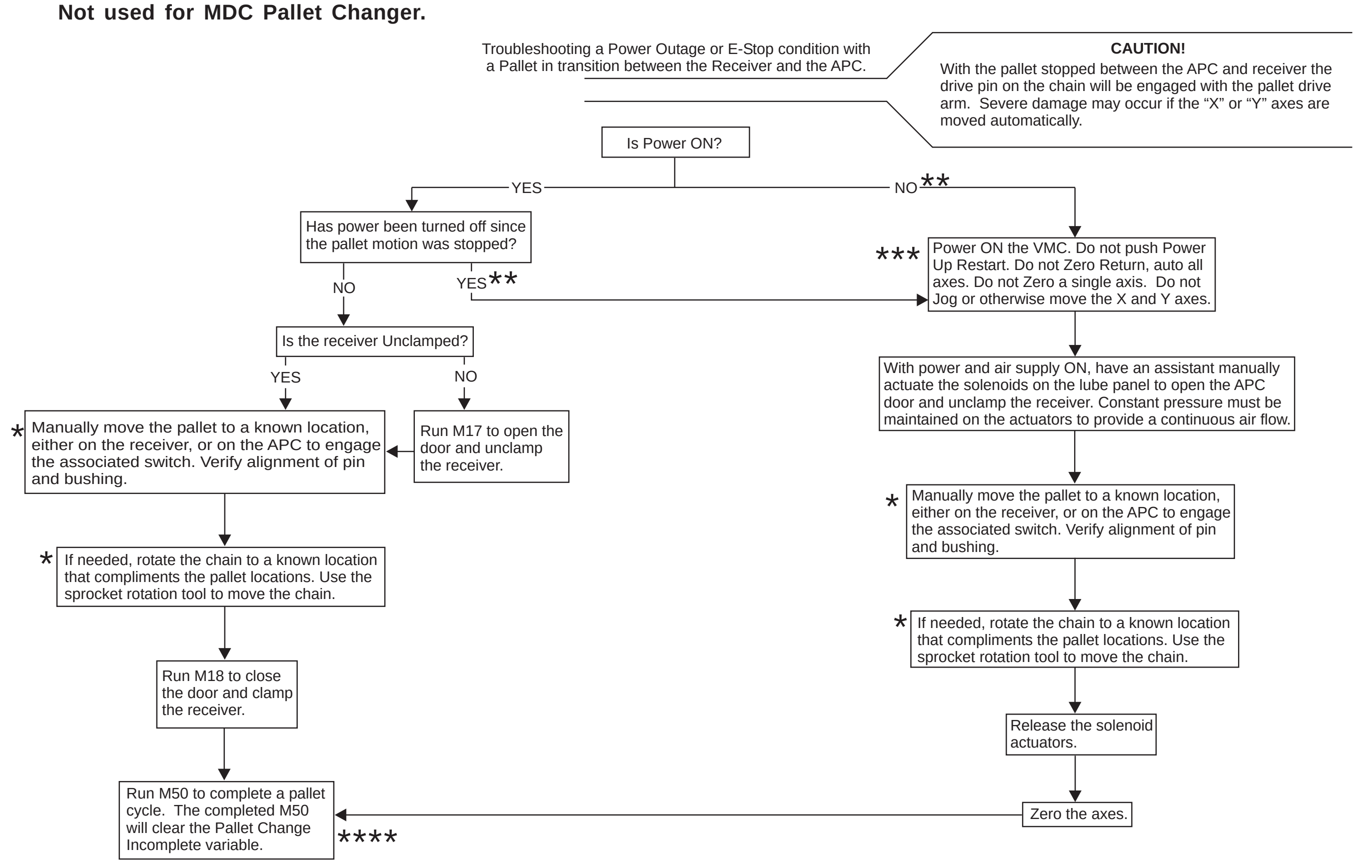
• Be sure the E-Stop jumper is removed and the APC control cable is plugged tightly into the 5th axis port.

The receiver is on the APC and engaging the pallet home switch under the control panel. Note that the alignment pin and receiver bushing alignment must be verified when manually positioning a pallet on the receiver.



Recovery from an E-Stop or power outage during a pallet change

Not used for MDC Pallet Changer.



Flowchart Notes

* There are 5 switches involved in the location of the pallets and chain.

1 pallet switch on the receiver (pallet clamp switch).
2 pallet switches on the APC (pallet home switches).
2 chain switches on the APC (pin clear switches).

** If the power to the mill has been shut down either intentionally or by power outage, damage may occur to the APC pallet, the receiver, or the drive chain if the X- or Y-axis is moved at power on.

*** At power on the mill will alarm if either an unknown chain location or unknown pallet location are detected.

**** At the beginning of the APC M50, a Pallet Change Incomplete variable is set to 1 and reset to 0 at the end. The mill will not operate properly if a pallet change (M50) has not been completed.

Pallet Replacement

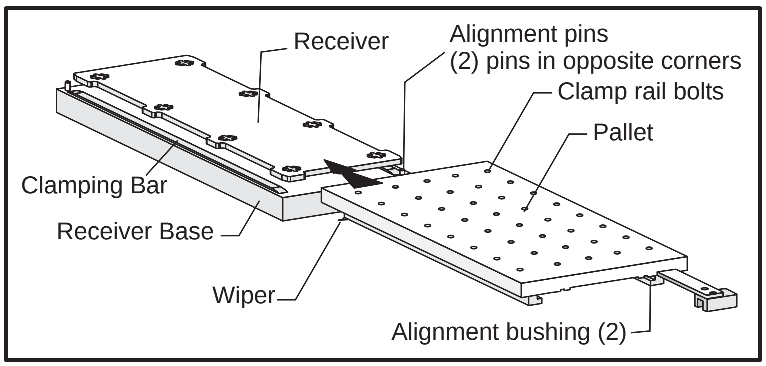
Disconnect the APC motor wire on the **left** side of the Quad APC mills. The pallets will be difficult to manually move if this is not done. The motor cable is located under the APC base.

Tools Required: Hoist, Straps or Chains, Eyebolts (2)

CAUTION! Be careful when changing out pallets, each pallet weighs approx. 300 lbs.

NOTE: Replaced pallets must be re-aligned to receiver. Pallets shipped with mill from the factory are machined perpendicular to the spindle. It is recommended that replacement pallets be machined after aligning them to the receiver.

1. Remove the old pallet from the APC using the supplied eyebolts and a hoist.
2. Set the new pallet on the APC, aligning roller grooves on the bottom of the pallet with rollers on the APC.
3. Loosen the clamp rail bolts on the new pallet (the bolts should be snug, but not overtightened).
4. Run new pallet into the receiver. Clamp and unclamp the pallet a few times (to allow the pallet to center on the guide pins). Torque the clamp rail bolts to 50 ft-lb while the pallet is clamped to the receiver.



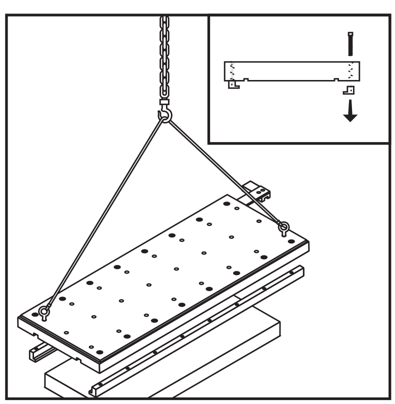
Pallet Replacement

Pallet Clamp Rail Replacement

Tools Required: Hoist, Straps or Chains, Eyebolts (2)

NOTE: This procedure must be performed with the pallets on the APC.

1. Loosen the clamp rail bolts. Screw the eyebolts into place and lift the pallet carefully.
2. Remove the clamp rails from the pallets.



3. Verify the condition of the wipers and determine if they need replacing.
4. Re-install the new rails, leaving the bolts loose.
5. Carefully place the pallet back onto the APC, using the hoist.
6. Position the pallet back onto the receiver, and clamp/unclamp the pallet several times to allow the rails to center themselves on to the guide pins.
7. Finish torquing the clamp rail bolts.

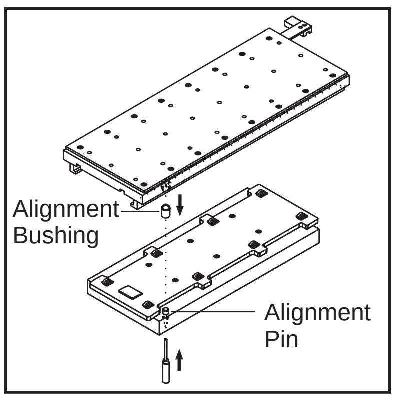
Alignment Pin Replacement

Tools Required: Hoist, Straps or Chains, Eyebolts (2)

CAUTION! Be careful when changing out pallets, each weighs approx. 300 lbs.

NOTE: The receiver must be removed in order to access the alignment pins.

1. Both pallets must be on the APC in order to access the receiver.
2. Position the receiver to the front of the machine.
3. Disconnect the air from the machine.



Alignment Pin Removal

4. Remove the six receiver mounting bolts.
5. Use a hoist and the two eyebolts supplied with the APC, and lift the receiver off the table.
6. Use a punch to remove the alignment pins.
7. Install the new pins using a brass hammer. The pins should bottom out in the holes. Pin height from the base of the receiver to the top of the pin should be within .450" to .490".
8. Position the receiver back onto the table.
9. Install the six mounting bolts.
10. Reconnect the air to the machine.
11. Position a pallet onto the receiver and clamp/unclamp the pallet to the receiver several times. Check for the pallets sticking during this process. If the pallets are sticking, loosen the clamp rail bolts and clamp/unclamp the pallet several times to center the alignment pin to the rails.

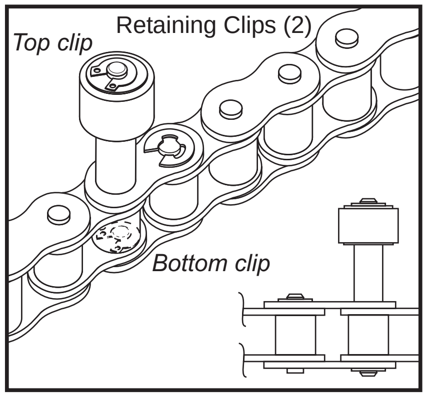
NOTE: Because the receiver has been removed from the mill, any tooling on the pallets must be re-aligned.

Drive Pin Replacement

NOTE: If the drive pin assembly is damaged due to a crash or from excessive wear, all components should be checked for damage and replaced.

NOTE: The chain must be loosened in order to remove the entire drive pin assembly.

1. Power off the machine.
2. Remove the drive pin retaining clip.

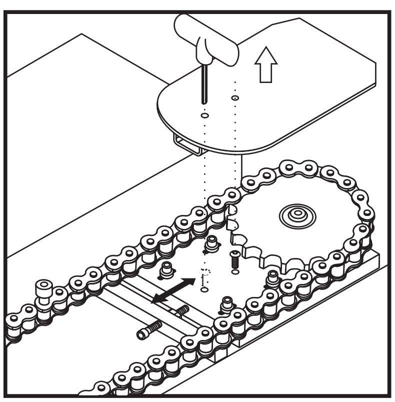


Drive Pin Assembly

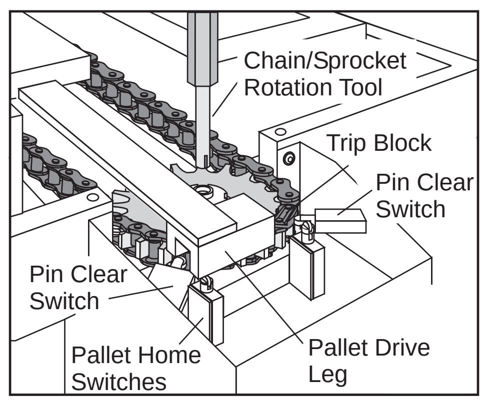
3. Remove 5/16" washer.
4. The cam follower is lightly pressed onto the pin. The spacer should slide off easily.

Loosening the Chain

5. Remove the two screws that mount the coverplate over the sprocket located at the far end of the APC.



Loosening Chain Sprocket



With the Pallet Clamped, the Trip Block Must Engage the Switch

6. Loosen the four bolts that mount the sprocket bracket to the casting.
7. Loosen the chain sprocket tensioner screw slightly.
8. At this point there should be enough slack in the chain to slide the drive pin out.
9. Re-assemble the drive pin assembly according to the assembly drawing.
10. Re-tension the chain in the reverse order. Note that the trip block must be engaging the switch as shown.

Setting the Offset Using the Grid Feature

The control will calculate grid offset parameters (125, 126, 127, and so on) using the Grid command. It is recommended that the Grid command be used on each axis separately. Do not use the Grid command on axes with linear scales or on a rotary axis.

1. Turn the machine off and back on. This will un-zero all the axes.
2. Select the Alarms screen and enter Debug mode.
3. Perform a Zero Single Axis on each of the desired axes individually. Ignore any Zero Ret Margin Too Small alarms. Note that if a Servo Error Too Large alarm was generated, it indicates that a Grid Offset parameter is out of range (make sure it is -138718 to +138718.)
4. Select the Positions screen, enter Grid and press Enter. The message Grid Ofset Done should appear and the grid offset parameters for the homed axes will have been updated. If the message "No Zero" appears, it indicates that none of the axes were zeroed.
5. Perform Auto All Axes and verify that the Dist to Go value for each of the selected axes is now close to 0.118". Note that on a lathe with a C-axis (such as a TL-15), the C-axis does not have a home switch. Consequently the Grid command will not alter Parameter 517, C-axis Grid Offset. The grid offset for the C-axis must be calculated by hand.

Calculating the Offset

These instructions only work on machines with 6 mm pitch ballscrews. Please read this section in its entirety before attempting to set the grid offset.

Guidelines

The encoder Z channel signal must occur between 1/8 and 7/8 revolution from where the home switch is released. If Distance to Go is less than 1/8 (.0295) or greater than 7/8 (.2065) of a revolution, it will alarm to "Zero Return Margin Too Small".

In Zero Return mode, the Distance to Go is the amount the encoder rotated from when the switch was released until it found the Z channel signal. The ideal amount for the Distance to Go is .118. (This equals ½ of a revolution of the motor.) For the Lathe series, these values are: X-axis = .236, Z-axis = .118, B-axis (TL-15) = .118.

Setting the Offset

1. Set the grid offset to zero. (Parameter 125,126, 127, 128, or 170, depending on the axis being set.) Setting #7 (Parameter Lock) must be off to reset grid offset.
2. Press Zero Ret, and Zero Singl Axis the axis you are setting (X, Y, Z, A, or B).
3. Calculate the grid offset using the following formula, and write the result in Parameter 125 (X-axis),126 (Y-axis), 127 (Z-axis), 128 (A-axis), or 170 (B-axis) (depending on the axis being set).

   (Distance to Go - .118) x Ratio = Grid Offset.
   Lathe (X-axis only): (Distance to Go - .236) x Ratio = Grid Offset

   The Ratio (steps/unit) for the X, Y, Z, A, and B axes are the values in Parameters 5, 19, 33, 47, and 155, respectively.

4. Zero Ret the axis again to use this offset.

NOTE: If Z-axis grid offset is reset, Parameter 64 should be checked and adjusted accordingly.

Hydraulic Counterbalance

Troubleshooting

Spindle head weight is balanced by upward pull of a hydraulic cylinder on machines without a Z-axis brake motor. Hydraulic oil forces the piston to retract into the cylinder body. The oil is then pressurized by a nitrogen reservoir. The system is self-contained and passive (no pump required to maintain lift). Normal Z-Axis of the gas/oil counterbalance has initial pressure to balance the weight at full system volume, plus an additional 50-75 PSI overcharge for longevity. Observable machine conditions, probable cause, and corrective action follows.

1. Machine alarms, pressure reading low.

   Cause: Cylinder or Fitting leaks

   Corrective Action:

   a. Check for sufficient oil in system: Block spindle head at top of travel. Attach charge/discharge kit to schrader valve, slowly turn T-handle clockwise to begin releasing pressure and look for the following:

   1) If oil is immediately present stop discharging, there is sufficient oil in the system. There are two courses of action, the first is to add nitrogen to the system to obtain top of travel pressure specification. Proceed to Corrective Action 2 if it is felt that the leak is substantial.

   2) If nitrogen gas is immediately present stop discharging; there is not enough oil in the system.

   b. Block spindle head at bottom of travel (if the cylinder is being replaced, block the head in the lowest position that will permit access to the rod attachment).

   1) Carefully drain remaining gas and oil.

   2) Replace faulty component(s). Note SAE straight thread o-ring fittings are lubricated with hydraulic oil prior to install. Machines built after August, 1999 use straight thread fittings with o-rings and sealed connectors on switch wires. Earlier machines have pipe thread connections. Replace all counterbalance components when changing an old style with new style system, including counterbalance cable.

   3) Fill tank with CASTROL HYSPIN AW46 (Anti-wear hydraulic oil) or MOBIL DTE 25 (Hydraulic oil (see chart for qty.) into system using Hydraulic Hand Pump Kit.

   NOTE: Make sure its mixed with the red dye 99-4839). Use only 20ML of dye per drum. Mix the Oil for about 1 minute.

Machine Tank Size	Tank Height	Quarts of Oil	# of Pump Strokes
40 cubic feet	23"	2 per tank	93
80 cubic feet	36"	3 per tank	140
110 cubic feet	42"	3 per tank	140

   4) Pressurize with nitrogen using charge/discharge kit to specification at top of travel.

2. Machine alarms, pressure reading OK, alarm does not reset.

   Cause: I/O Board failure, bad cable or dirty contacts, switch setting too high and/or system is under-pressurized due to inaccurate gauge.

   Corrective Action:

   a. Check I/O board and replace if necessary.

   b. If the counterbalance system pressure is correct and there is an E-Stop alarm that will not reset, check the cable for dirty contacts. Loose connections or a broken wire is tested by disconnecting the cable at the switch and adding a jumper across the connector pins of the cable and clear the alarm. If the alarm does not clear the cable is defective; repair or replace the cable if necessary.

3. No alarm, pressure reading low (at or below switch setting).

   Cause: Cylinder or Fitting leaks, shorted cable, switch setting too low and/or inaccurate system gauge.

   Corrective Action: As described for leaks in 1.

   a. Test for short in cable. Repair or replace if necessary.

4. Spindle Head drifts up.

   Cause: Over-pressurized due to inaccurate gauge.

   Corrective Action:

   a. Invert tank to bleed about 50 PSI of nitrogen gas. Re-evaluate machine condition.

5. Spindle Head drifts down, no alarm.

   Cause: Cylinder or fitting leaks, switch setting too low and/or system under-pressurized due to bad gauge.

   Corrective Action: As described for leaks in 1. above.

   a. Add 50 PSI of nitrogen to the system at top of travel. Does the alarm clear?

   1) **Yes:** Check if the spindle head drifts up more than 1" upon E-Stop at the bottom of travel. If it does, replace the switch.

   2) **No:** Add another 50 PSI to the system at top of travel. If the alarm still does not clear, replace the switch. If the alarm clears, check if the head drifts up more than 1" upon E-Stop at the bottom of travel. If it does, the switch is faulty.

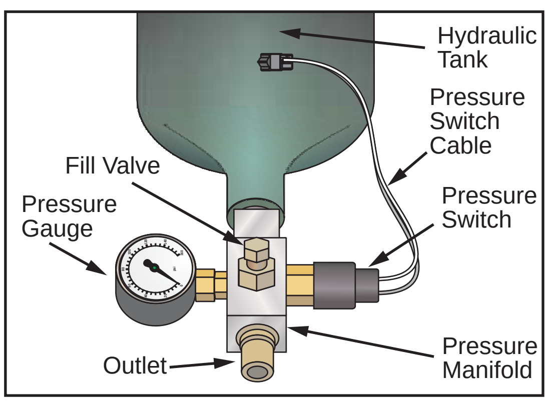
   b. Does spindle head drift down from top of travel upon E-Stop?

   1) **Yes:** Replace the switch.

   2) **No:** Replace the pressure gauge.

Tools Required: (1) 4 x 4 x 14" head support block.

Hydraulic counterbalance service kit, consisting of:
Pressure tank with manifold assembly, prefilled with (2) quarts DTE-25 hydraulic oil.
Hydraulic cylinder with hose attached (if necessary).



Hydraulic Tank Assembly

A placard on each machine states the correct pressure for each machine/system. Use this as a guide when troubleshooting the counterbalance system. The pressure must be set accurately in order for the system to function properly.

Leak Failures

Leaks can occur at any fitting connection, at the hydraulic cylinder's rod seal (where the rod enters the cylinder), at the cylinder's piston seal, or through hose failures. Inspections for leaks are visual, although rod seal leaks may be inconclusive because of way-oil spatter. Piston seal leaks, if advanced, exit the top end of the cylinder and oil can be seen at the vent area. Early piston leaks accumulate over time on top of the piston to about ¾" high before they are pushed out the cylinder at top of travel. Leaks are normally very slow and machines can operate until the pressure switch sends an E-Stop alarm.

Mechanical Diagnosis

Important! Hydraulic counterbalance oil contains red dye for easier recognition.

Noise in the system

- Slight moan or creaking at slow speeds is normal for rubber seals.
- While Z-axis is in motion, a whistle sound at tank location is normal fluid flow.
- Verify cylinder is seated correctly in counterbore. If not, reseat the cylinder.
- Bumping or grinding noise indicates a mechanical cylinder failure. Replace cylinder assembly.
- Look for galling and wear on cylinder shaft. If so, replace the cylinder assembly.

System is not holding pressure and/or has an E-Stop (Alarm 107) that cannot be reset. Check for accurate pressure readings. If low, the following items need to be checked:

- Check for leaks at all cylinder fittings. If leaking, replace cylinder assembly.
- Collapse the lower Z-axis way cover and look for any red oil pooled at the bottom of the base. If so, fittings or seals could be damaged. Replace cylinder assembly.
- Remove cylinder vent fitting. If red oil is inside the vent cavity, cylinder assembly needs replacement.
- Check for leaks at all hydraulic tank fittings. If leaking, tank assembly needs replacement.

Over Current alarms

- Pressure is set too high/low.
- Too much oil has been added (insufficient gas volume causes large pressure rise).
- Hydraulic cylinder is binding or is misaligned. Replace cylinder assembly.
- Length of replacement cylinder incorrect.

Hydraulic Tank Replacement

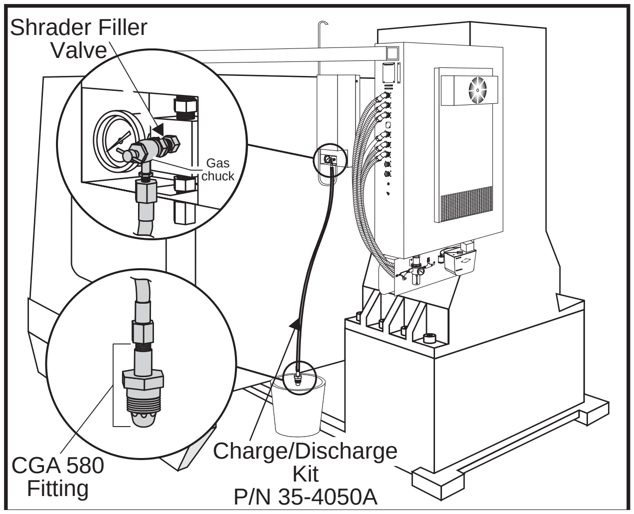
Removal

CAUTION! Spindle head may drop if the control loses power or alarms.

1. Handle Jog spindle head up to 14.5" above the table. Insert wood block and lower head casting onto it. Emergency Stop the machine. Head should rest securely on table block. Power off the mill.

NOTE: Do not lower spindle onto block.

2. Disconnect the two-pin end of the pressure sensor cable(s) to the pressure sensor(s), if equipped.



Hydraulic Counterbalance Charge/Discharge Kit (Shown in Place to Discharge System)

3. Remove cap to Schrader filler valve.
4. Ensure T-handle of the gas chuck is turned completely counterclockwise. Attach charge/discharge kit by tightening gas chuck to the Schrader valve finger tight, then wrench lightly to tighten (see previous figure).
5. Place CGA 580 end of charge/discharge kit into bucket to contain hydraulic oil while discharging system.
6. Slowly turn the T-handle clockwise until the system begins to discharge. Complete discharge may take up to 10 minutes. Verify tank gauge reads 0 PSI.
7. Turn T-handle completely counterclockwise and remove the charge/discharge kit from the Schrader valve.
8. Disconnect the hydraulic hose from the tank assembly.
9. Remove the tank assembly from the column by removing the four SHCS from the tank mount.

Installation

1. Connect the hose to the tank before mounting the tank in the inverted position. This prevents oil spillage.

NOTE: For a positive seal, ensure hose-to-tank connection is straight, not skewed.

2. Mount the tank assembly to the column with the tank mount and four SHCS. Ensure the hydraulic hose is not twisted.
3. Connect the two-pin end of the pressure sensor cable(s) to the pressure sensor(s).
4. Use cable ties to secure the cable to the hydraulic hose.

NOTE: For this step, use regulated dry nitrogen gas (welding grade acceptable) that accepts a right-hand thread CGA 580 fitting.

5. Attach the CGA 580 fitting end of the charge/discharge kit to the source pressure. Ensure T-handle of the gas chuck is turned completely counterclockwise. Attach charge/discharge kit by tightening gas chuck to the Schrader valve finger tight, then wrench lightly to tighten. Pressurize the system to required pressure as listed in the following tank pressure requirements chart.

NOTE: For VF-6/8, follow installation procedure for each hydraulic tank.

NOTE: Do not use compressed air, oxygen, or flammable gas. Refer to the table below and verify pressure according to machine and spindle head position, and verify cylinder is seated in counterbore.

	VF-3/4	VF-6-11	VF-6/7/10 w/50T Spindle	VF-8/9/11 w/50T Spindle	VF-5 w/40T Spindle	VF-5 w/50T Spindle	VR	VS
Machine at Top of Travel	1150 psi	750 psi	1150 psi	1550 psi	875 psi	1100 psi	1800 psi	1250 psi

Tank Pressure Requirements

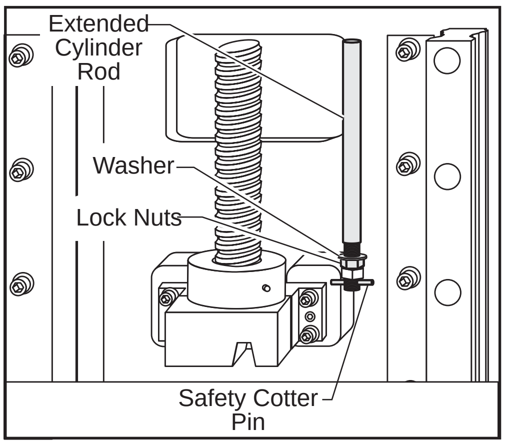
6. Power on the machine and zero return (Zero Ret) Z-axis only. Check for any leaks or abnormal noises. Verify tank pressure at top of travel. Remove charging system and replace valve cap.

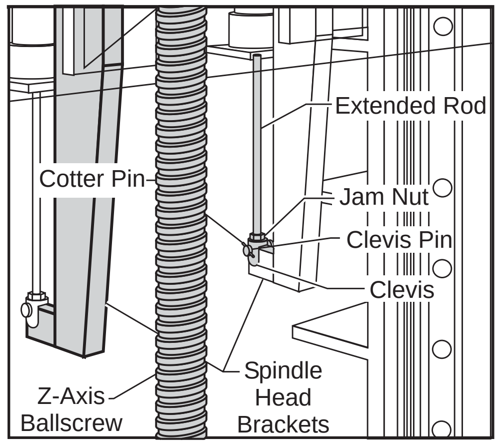
NOTE: If there is an E-Stop alarm that will not reset, check for correct system pressure and the correct tank assembly.

Hydraulic Cylinder Replacement

Removal

1. Remove the hydraulic tank as described in previous section.
2. To gain access to the cylinder rod, remove the three SHCS holding Z-axis way cover to spindle head.
3. Remove the cotter pin and lock nuts from the threaded end of the cylinder rod.

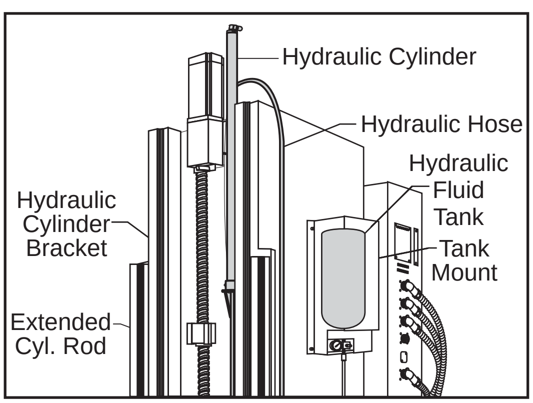




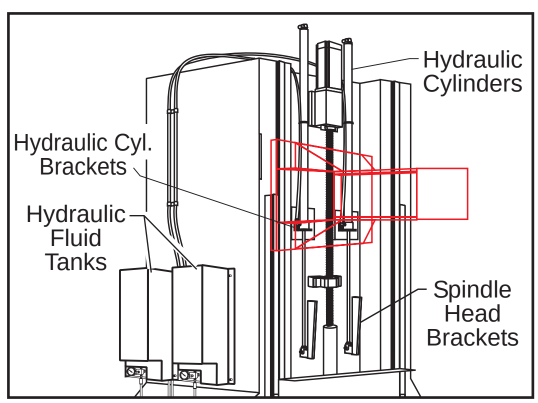
Hydraulic Cylinder Rod Installation for VF-1 through 4 and (VF-6/8)

NOTE: For VF-6/8 loosen jam nut from clevis, then remove the cotter pin, clevis pin, clevis, and jam nut.

4. Remove the band clamp that holds the cylinder to the stabilizer bracket. Loosen the two SHCS that attach the bracket to the column and remove the hydraulic cylinder from the top of the column.



VF-Series Hydraulic Counterbalance - Right Side View



VF-Series Hydraulic Counterbalance - Left Side View

NOTE: Do not disassemble unit. Keep the hose attached to the cylinder.

6. Return complete assembly to the Haas factory.

Installation

1. Install cylinder with cylinder rod extended from top of column.

NOTE: Cylinder rod should pass through column bracket and spindle head bracket. Cylinder body must rest in column bracket counterbore.

2. Orient cylinder body with hydraulic hose facing away from ballscrew.

NOTE: For VF-6/8, orient cylinder bodies with hydraulic hose facing the ballscrew.

3. Install lock nuts, at threaded end of cylinder rod, wrench tight. Install safety cotter pin.

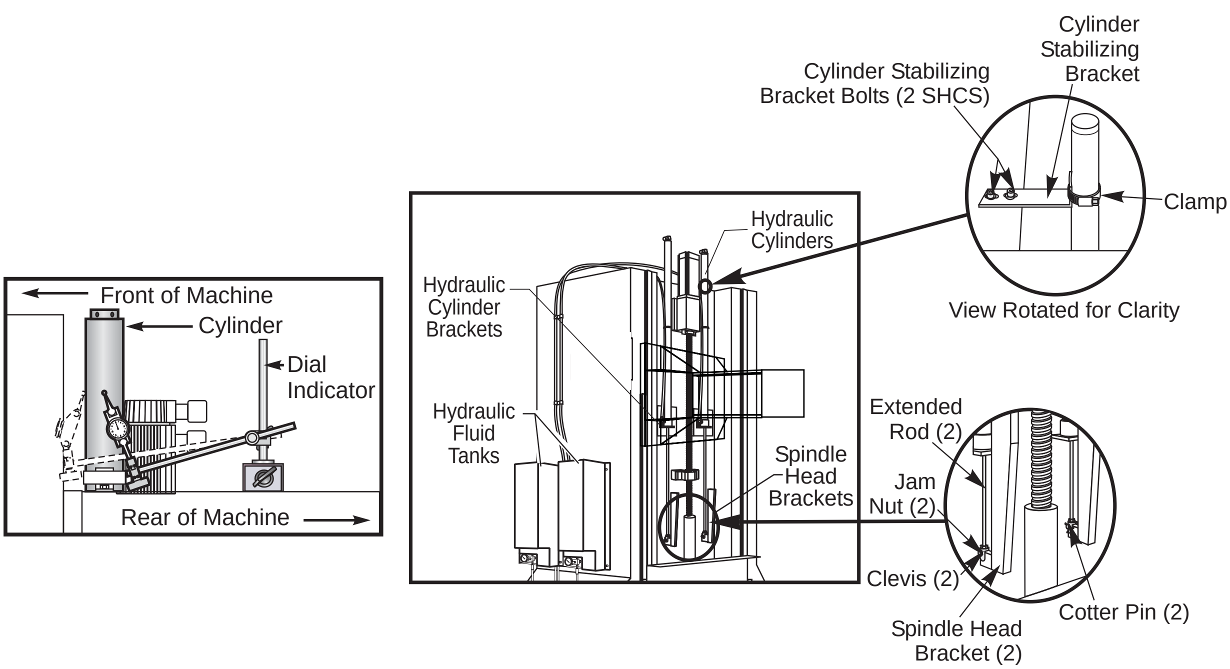
NOTE: For VF-6/8, install jam nut and clevis at end of cylinder rod, then attach to spindle head bracket with clevis pin. Install safety cotter pin and lock the clevis by tightening the jam nut.

4. Install the hydraulic tank as described in the previous section, but **do not power up the machine**.

5. Power on the machine and zero return (Zero Ret) Z-axis only. Observe cylinder body for motion or abnormal noises. Check for fluid at manifold, cylinder hose connection and cylinder rod. Verify tank pressure at top of travel. Remove charging system and replace valve cap.

6. Loosely install the band clamp and tighten the two SHCS that attach the stabilizer bracket to the column.

7. Place a mag base with a dial indicator on top of the column (not the spindle head). Position the tip of the indicator on the front of the cylinder and jog the Z-axis up and down to verify alignment. Note that when jogging the Z-axis the counterbalance will shift in the bracket. The cylinder shift should not exceed .015 in.



8 If the spindle head brackets have been moved from the original location it will be necessary to check for side to side alignment. Place a dial indictor the same as in step 7 and position the tip of the indicator on the side of the cylinder. Jog the Z-axis up and down to verify alignment. The cylinder shift should not exceed .015 in.

9. When the side to side alignment of the cylinder is correct, tightening the spindle head brackets. Be careful not to move the cylinder out of alignment while tightening the spindle head brackets.

10. When the cylinder has been aligned correctly, finish tightening the band clamp. Be careful not to move the cylinder out of alignment while tightening the band clamp.

11. Zero return (Zero Ret) machine. Handle Jog Z-axis in 0.1 increments. Verify full Z travel.

12. Cycle Z-axis, using the following program, for five minutes, and check for oil leaking at top of cylinder and cylinder rod.

G28, G54, Z-14.
M99
50% Rapid

13. If Z-axis overcurrent alarms occur during travel, verify and correct system pressure.

NOTE: If Z-axis overcurrent alarm at top or bottom of travel, call Haas Automation Service Department immediately for assistance. If fluid leaks from hydraulic fittings, check that fittings are tight. If leaking continues, call Haas Automation Service Department for assistance.

14. Reinstall Z-axis way cover with three SHCS that hold it to the spindle head.

Hydraulic Power Unit (HPU) (Lathe)

Troubleshooting

Hydraulic Pressure - "Low hydraulic pressure" Alarm (134)
- Check for any leaks.
- Check that the oil level is above the fill line.
- Check that the temperature is less than 150°.
- Voltage phasing changes cause the HPU to change directions, resulting in Alarm 134.
- Make sure the filter has been replaced within the last 6 months.
- If pressure drops below 40 PSI during activation of chuck or tailstock, an alarm will occur.

Hydraulic Chuck - Chuck won't clamp/unclamp.
- Check for alarm condition.
- Check display for "Low Hydraulic Pressure" Alarm (134).
- Use a voltage meter to check the solenoid circuit breaker; replace if faulty.

Noise in HPU

NOTE: Noise in HPU should decrease a few minutes after start up

- Check for leaks in hose.
- Check that the oil level is above the fill line.
- Check for loose pieces/hardware, or debris in motor/cooling fins.
- Remove, clean, and reinstall adjustment valves.

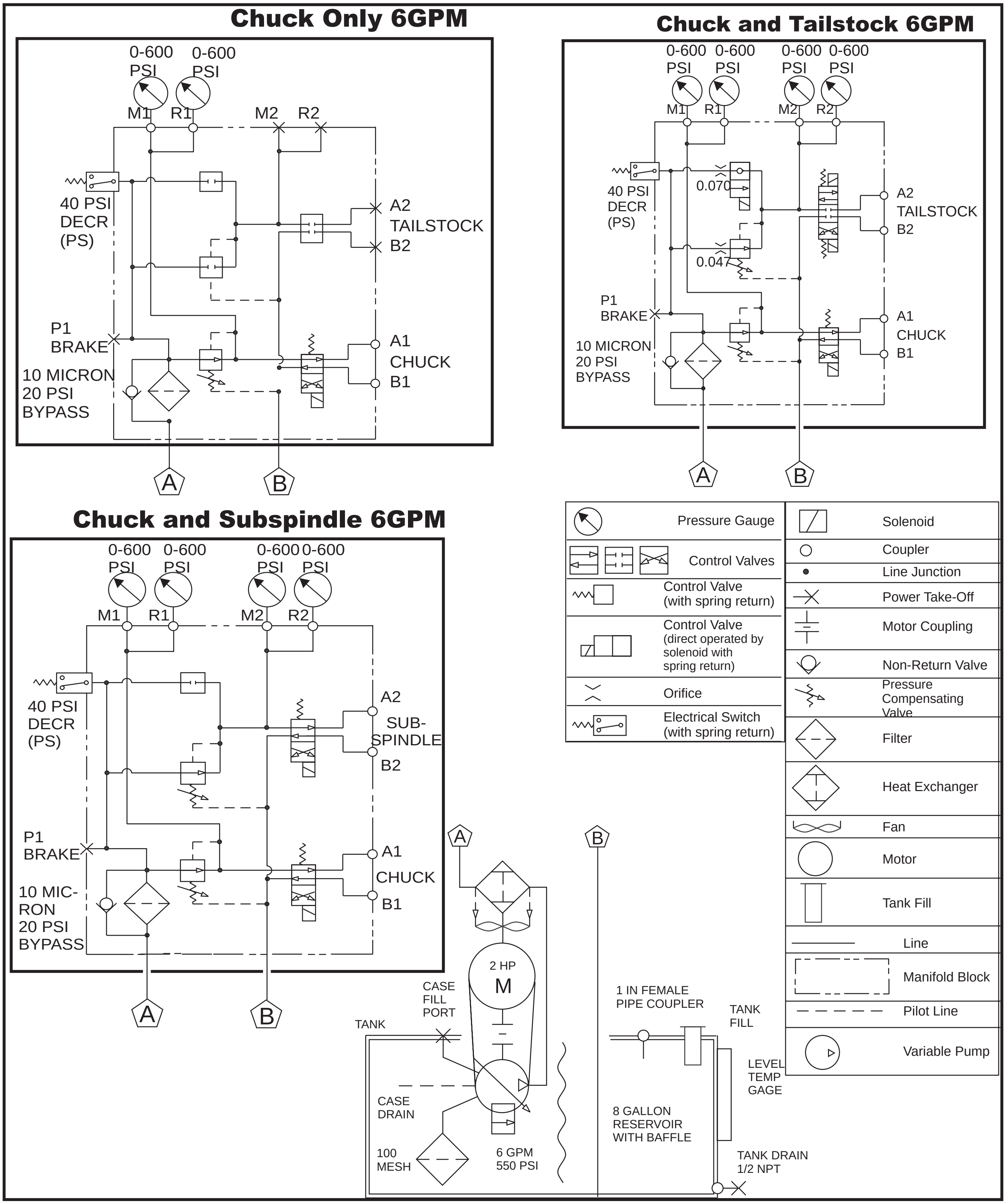
Tailstock pulsates as it moves
- Check operating pressure (**minimum operating pressure is 120 PSI.**).
- Check for leaks at hydraulic cylinder.
- Check for leaks at hose fittings.

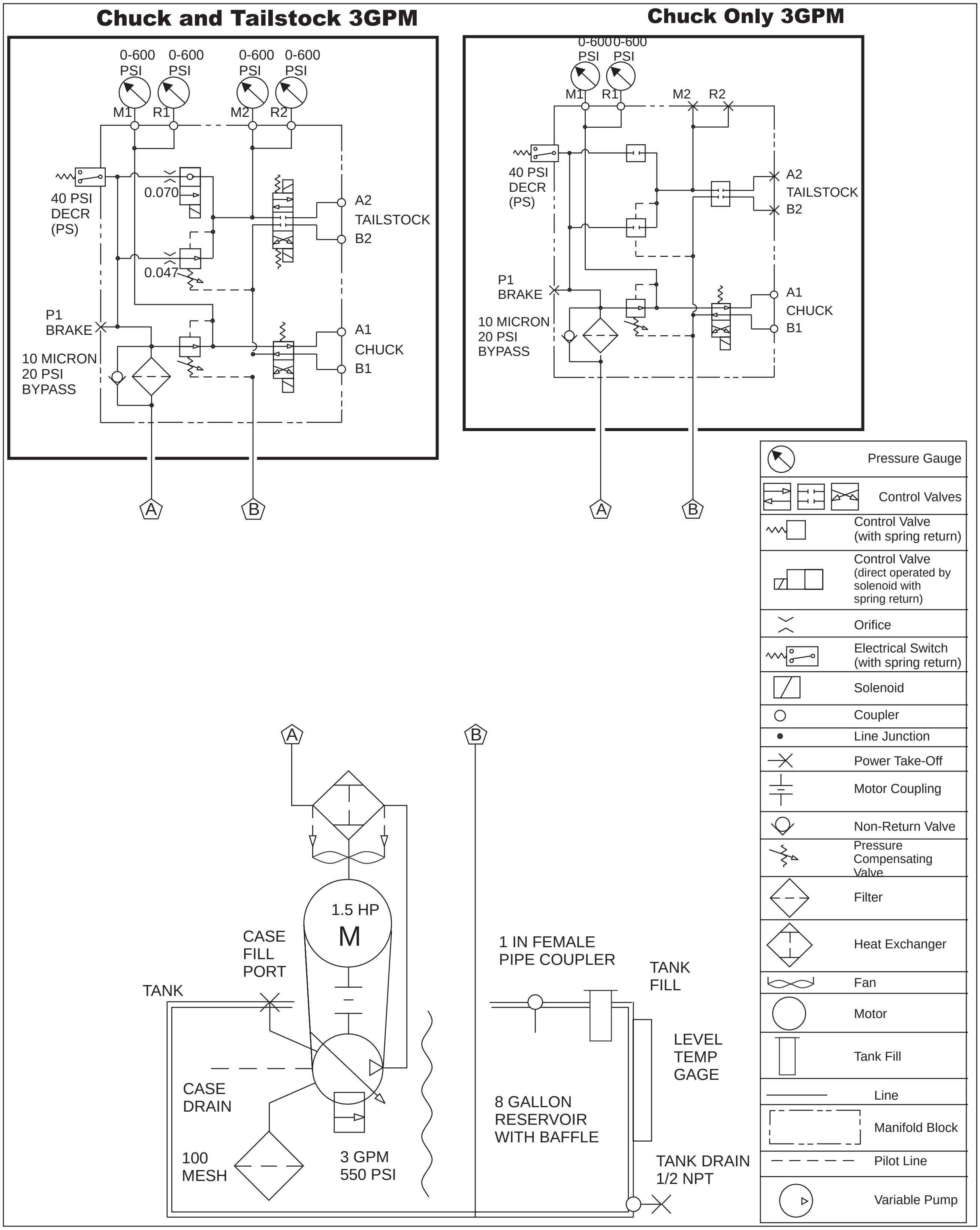
HPU Removal/Installation

CAUTION! **Power off** the machine before removal or installation.

Removal
1. Remove necessary panels to access the HPU and Drain the hydraulic fluid.
2. Disconnect the hydraulic hoses. Be sure to mark the positions of the hoses so they can be put back to their original fittings
3. Disconnect the cables.
4. Remove the four bolts from base of unit, then slide HPU out.

Installation
1. Position the HPU in place, and secure with four mounting bolts.
2. Connect pump motor, pressure switch, and solenoid valve cables
3. Replace the hydraulic hoses.
4. Fill the HPU with DTE25 to the top of the sight glass.
5. Replace any panels that were removed to access the HPU.


Chuck Only 6GPM
0-600 PSI
0-600 PSI
M1
R1
M2
R2
40 PSI DECR (PS)
A2
TAILSTOCK
B2
P1 BRAKE
10 MICRON 20 PSI BYPASS
A1
CHUCK
B1
A
B
Chuck and Tailstock 6GPM
0-600 PSI
0-600 PSI
0-600 PSI
0-600 PSI
M1
R1
M2
R2
40 PSI DECR (PS)
0.070
0.047
A2
TAILSTOCK
B2
P1 BRAKE
10 MICRON 20 PSI BYPASS
A1
CHUCK
B1
A
B
Chuck and Subspindle 6GPM
0-600 PSI
0-600 PSI
0-600 PSI
0-600 PSI
M1
R1
M2
R2
40 PSI DECR (PS)
A2
SUB-SPINDLE
B2
P1 BRAKE
10 MIC-RON 20 PSI BYPASS
A1
CHUCK
B1
A
B
Pressure Gauge
Control Valves
Control Valve (with spring return)
Control Valve (direct operated by solenoid with spring return)
Orifice
Electrical Switch (with spring return)
Solenoid
Coupler
Line Junction
Power Take-Off
Motor Coupling
Non-Return Valve
Pressure Compensating Valve
Filter
Heat Exchanger
Fan
Motor
Tank Fill
Line
Manifold Block
Pilot Line
Variable Pump
A
B
2 HP
M
CASE FILL PORT
TANK
CASE DRAIN
100 MESH
6 GPM 550 PSI
1 IN FEMALE PIPE COUPLER
TANK FILL
LEVEL TEMP GAGE
8 GALLON RESERVOIR WITH BAFFLE
TANK DRAIN 1/2 NPT


Chuck and Tailstock 3GPM
0-600 PSI
0-600 PSI
0-600 PSI
0-600 PSI
M1
R1
M2
R2
40 PSI DECR (PS)
0.070
0.047
A2
TAILSTOCK
B2
P1 BRAKE
10 MICRON 20 PSI BYPASS
A1
CHUCK
B1
A
B
Chuck Only 3GPM
0-600 PSI
0-600 PSI
M1
R1
M2
R2
40 PSI DECR (PS)
A2
TAILSTOCK
B2
P1 BRAKE
10 MICRON 20 PSI BYPASS
A1
CHUCK
B1
A
B
A
B
1.5 HP
M
CASE FILL PORT
TANK
CASE DRAIN
100 MESH
3 GPM 550 PSI
1 IN FEMALE PIPE COUPLER
TANK FILL
LEVEL TEMP GAGE
8 GALLON RESERVOIR WITH BAFFLE
TANK DRAIN 1/2 NPT
Pressure Gauge
Control Valves
Control Valve (with spring return)
Control Valve (direct operated by solenoid with spring return)
Orifice
Electrical Switch (with spring return)
Solenoid
Coupler
Line Junction
Power Take-Off
Motor Coupling
Non-Return Valve
Pressure Compensating Valve
Filter
Heat Exchanger
Fan
Motor
Tank Fill
Line
Manifold Block
Pilot Line
Variable Pump

4th Axis Repair (Horiz.)

Ring Gear Installation

1. Lubricate and stone the mating surfaces of the platter and ring gear. Wipe clean to remove grease and contaminents.
2. Clean the mating surfaces of the platter and ring gear with alcohol.

CAUTION! The ring gear is a precision-machined piece. Take care in handling it. Do not drop it or set it heavily on the teeth.

3. Install eyebolts into the top of the ring gear. With an assistant, lift the ring gear by the eyebolts and place over the platter.
4. The ring gear is an interference-fit item and will need to be clocked properly prior to the next step. If necessary, adjust the position of the ring gear so that all the bolt holes line up exactly.
5. Apply a drop of Loctite to each of the 16 SHCS and insert into the holes in the ring gear. Start each SHCS by hand to ensure proper alignment of the ring gear and to prevent crossthreading tapped holes.
6. Tighten the SHCS incrementally in a star pattern to slowly pull the gear down onto the platter. Do not tighten each SHCS completely in one attempt. This will foul the location of the ring gear.
7. When the ring gear is fully seated on the platter, tighten the SHCS to full torque value.

Pallet Receiver Disassembly (EC-630)

1. Remove the pallet and all fixtures from the rotary body.
2. Disconnect air supply. Ensure that the rotary table is in the home position (arrow points toward pinion gear in the platter drive motor assembly) and that the rotary assembly is in the clamped position.
3. Remove the four shaft guide bushings from pallet receiver top by removing ball clamp retainer spring and the three clamping balls from each bushing. Remove the six 5/16 x .75" SHCS to remove each bushing.

NOTE: Check for and clear the air blast holes of any debris.

4. Remove the 12 5/8 x 2" SHCS from the receiver cap and lift it using two eye bolts in the holes in the top of the cap. This exposes the piston assembly.
5. Remove the piston assembly by first removing the rotary union from the bottom of the piston shaft (see the following instructions). Using two eye bolts in the top of the piston, lift it out with its four guide shafts and main shaft attached. This exposes the rotary platter.

Removing the Rotary Union (EC-630)

1. Ensure that the rotary table is in the home position and that the rotary body is in the clamped position (down). Disconnect air supply.
2. Remove the bottom splash cover.
3. Disconnect the two pneumatic lines from the union.
4. Remove bolt and hard washer from bottom of the rotary union, and lower the union off of the piston shaft.

1° Indexer Platter Assembly (EC-630)

With the pallet receiver removed and the platter exposed (see the previous procedures), remove the center seal plate for access to the piston adapter plate.

NOTE: The piston adapter plate is precisely concentric to the platter and piston assembly. If it is ever removed, it must be recentered.

To remove the piston adapter plate:

1. Remove ten (10) 1/2-13 x 1.5" SHCS in the piston adapter plate that are exposed when the center seal plate is removed.
2. Lift the rotary platter using two eye bolts placed in any two opposing holes on the top edge of the platter. The piston adapter plate will come up with the platter.
3. Remove sixteen (16) 3/8 x 1.25" SHCS from the underside of the platter to remove the piston adapter plate.

The hydraulic clamp assembly should be replaced as a unit.

Replacing the 4th Axis Brake Assembly

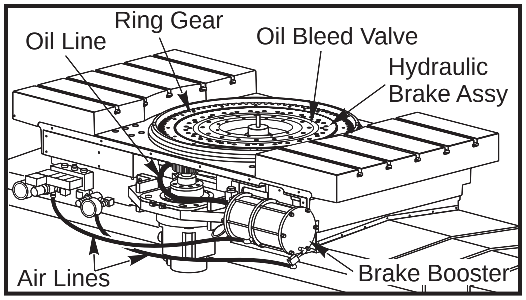
1. Command the A-axis brake to disengage. Enter MDI and command an M11. Do not disconnect air to machine. Power-down the machine.
2. Remove the rotary platter from the table using a suitable lifting device, chains and lifting plates. Do not use synthetic lifting straps or eyebolts.
3. Disassemble existing brake assembly, hoses, and air/hydraulic booster. Leave air lines that were attached to the booster to be reused. Remove all fasteners and dowel pins used with the old brake assembly.
4. Clean the brake mounting surface, verifying that there are no chips or burrs before proceeding. Stone the surface if necessary.
5. The brake/booster sub-assembly is assembled and bled at the factory. Do not attempt to bleed. After installing the brake and replacing the booster and regulator, all that is necessary is to connect the hose at the quick disconnect. The system should not need further bleeding. Do not loosen fittings at either the brake or the booster or the factory bleeding will be lost.
6. Separate the brake/booster hose at the quick disconnect fittings. Install the new brake assembly onto the table, making sure the hose is routed through the hole in the bottom of the table.
7. Install and hand-tighten sixteen (16) 3/8-16 bolts to secure the brake.
8. Replace the old booster and fittings with the new booster assembly. Trace the air line back to the solenoid and replace the regulator with the new regulator.
9. Power up the machine and reconnect air.
10. When the platter is reassembled, actuate the brake to center the assembly. Torque the sixteen (16) bolts to 50 ft-lbs. in a star pattern through the access holes in the platter. Plug the access holes when torquing is complete to prevent chips and coolant from contaminating the encoder/brake area under the platter.

Bleeding the Hydraulic Brake

It will take about 1 hour to properly bleed the hydraulic brake assembly.

1. Power off the machine and remove the indexing platter from the table using a proper lift and lifting plates. The brake assembly and fly-wheel will be exposed underneath.
2. Disconnect all oil/air lines and remove the fly-wheel and clamp ring from the table. Set the clamp ring on a firm work surface and reconnect the air/oil lines.
3. Slightly loosen bleed valve on clamp ring and elevate the brake assembly to let air bubbles escape.
4. Set air pressure to 1000 PSI or less. If air pressure is set to more than 1000 PSI, the clamp will become permanently damaged.

5. Pressurize the clamp ring, forcing air and air bubbles out of the oil through the bleed valve. Re-pressurize every five minutes for about 10 - 12 cycles or until the oil is **completely clear** of any air bubbles. Re-tighten the bleed valve.



4TH AXIS AIR VALVE ASSEMBLY

This section applies to machines with serial number 51004 and later.

The Air Valve Assembly has three main components: 3-Way Air Valve, High-Pressure Fixed Regulator, and Low-Pressure Regulator.

The air valve assembly actuates the rotary table brake. Supplied air flows though the high-pressure regulator (45 PSI) to supply the high-side of the brake valve pressure booster. This supplies 40:1 hydraulic pressure boost to expand the hydraulic pump. When the clamp is released, a valve switches the supplied air into the low-side of the pressure booster. This action returns the pressure booster piston to its original position and refills the hydraulic cylinder from the reservoir. This is a closed hydraulic system. A 45/20 PSI pressure differential is used to prevent air leaking into the pressure booster.

Assembly

Individual assembly of the 3-Way Air Valve, the High-Pressure Regulator, and the Low-Pressure Regulator component parts is necessary and is not detailed in this Service Manual.

1. Apply a small amount of thread sealant to the threads of the high-pressure regulator assembly and attach to the 3-way air valve. Orient the regulator to match the position of the part removed.
2. Apply a small amount of thread sealant to the threads of the low-pressure regulator assembly and attach to the 3-way air valve. Orient the regulator to match the position of the part removed.
3. Attach this assembly to the mounting plate using Loctite and supplied SHCS.

Installation

1. Place the air valve assembly at its air-lube panel mounting location. Route all air tubing to the air valve.
2. Cut each air tubing line to fit and insert into the appropriate regulator/outlet on the air valve assembly.
3. Position the air valve assembly properly, then thread four SHCS into the mounting holes and tighten.

4TH AXIS BRAKE CYLINDER PRESSURE BOOSTER

The pressure booster gives the ability to develop and use high hydraulic pressure without incurring the cost of an on-board HPU. The pressure booster has a high-pressure side, a low-pressure side, and a fluid fill-port on the front of the unit. The pressure booster assembly is located in the bottom of the rotary table. There is a cutout underneath the rotary table to provide access for service and replacement of the pressure booster and component parts.

Pressure Booster Assembly

Prior to installation of the pressure booster assembly, a test of this system should be performed. This will identify leaks and allow for the system to be bled while it is still easily accessible. Set the air valve assembly on top of the table or other high work surface. Set the pressure booster assembly onto the floor.

Bleed the Pressure Booster:

- The booster should be filled to the top fill line before starting.
- Use a manual vacuum pump to draw the air bubble out of the hose. Stop before the fluid reservoir is full.
- Release the pressure valve on the pump (depress small needle-like feature on the bottom), empty the reservoir, and repeat procedure.

It can take 5 to 8 vacuum cycles to remove all the air from the hose. Take caution to refill the booster before the fluid level falls below the lower fill line, or air will be introduced into the system. It is critical to remove all air from booster hose, failure to do so will introduce air into the clamp ring.

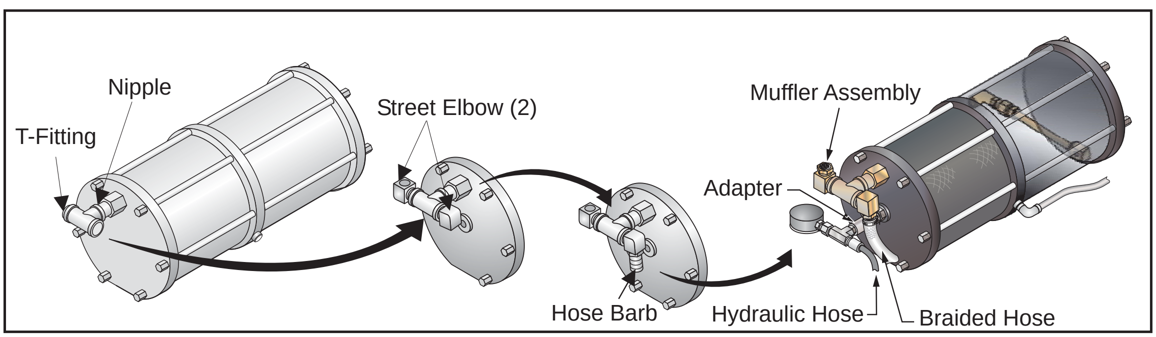
1. Identify the low and high pressure tubing lines coming from the pressure booster. Connect them to the respective low and high pressure ports on the air valve assembly regulator.
2. Attach an air supply line (45 PSI) to the air valve assembly. Supplied air is preset to 45 PSI.
3. Using appropriate regulator adjuster on the air valve assembly, set the low-pressure regulator to 20 PSI and the high-pressure regulator to approximately 5-10 PSI. Remember that the pressure booster provides 40:1 pressure boost.

CAUTION! During the following steps, spillage of hydraulic oil may occur. Wear eye protection and have sufficient rags on hand to clean up any leaked oil.

4. Apply air pressure to the pressure booster by pressing the yellow pin-button on the air valve assembly. Do not activate the pressure booster for more than five seconds at a time.
5. If any air leaks have been noticed during this operation, take appropriate measures to fix them before installing the assembly.

The pressure booster comes packaged with extra components not needed for its proper operation in this application. Where applicable in the following steps, use a small amount of thread sealer on all pipe threads.

1. The pressure booster is shipped full of hydraulic oil. Tilt the pressure booster on end before removing the plug from the container.
2. Thread the adapter into the pressure booster and tighten.
3. Thread the nipple (new part) into the adapter.
4. Thread the T-fitting onto the nipple and tighten so that it is oriented as shown in the following figure.

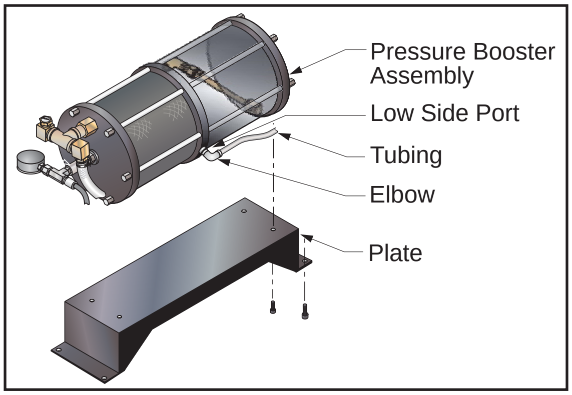


5. Thread nipple into right side of T-fitting. Thread street elbow into left side of the T-fitting. Tighten all parts.
6. Thread the 90° elbow onto the nipple, and add another nipple to the elbow, as shown.
7. Thread the hose barb into the last 90° elbow and attach it to the pressure booster assembly as shown.
8. Attach the braided hose to the hose barb using the supplied hose clamp. Use caution when moving the pressure booster assembly, since the internal hydraulic fluid can spill from the braided hose.

9. Remove the plug in the center hole of the pressure booster. Thread a #4 SAE to NPT female adapter (new part) into the center hole.
10. Thread the hydraulic hose into the adapter.
11. Thread the reducer into the street elbow. Thread the muffler and reducer together, then attach to the street elbow. Tighten all parts. This will act as a snorkel for the system.

Final Assembly

Orient the plate as shown and attach to the bottom of the pressure booster.



Pressure Booster Final Assembly (Bottom View)

Pressure Booster Installation

Position the pressure booster and air valve assemblies near the working areas.

1. Thread the 3/4 NPT elbow (new part) into the fill port machined into the right side of the table. The elbow must be installed from the inside. Orient the elbow so that it points down.
2. Thread a hose barb into the elbow. Tighten with a 1-1/16" socket.
3. Lift the pressure booster assembly into the area underneath the right front of the table. See the following figure for the approximate location. Route the hydraulic hose and high- and low-pressure tubing through the mouse hole. Secure to the table with four 1/2" SHCS using the outermost holes in the plate.
4. Cut the braided hose to length and attach to the hose barb with a clamp.

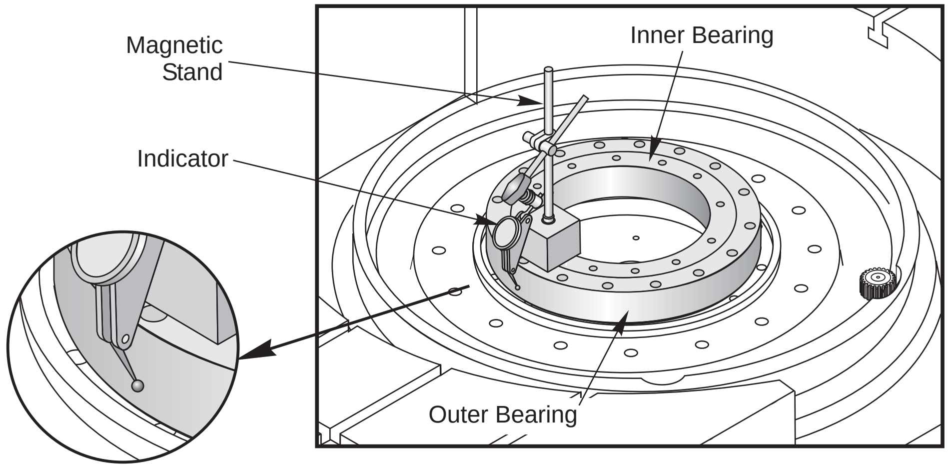
Bearing Installation

1. Place the bearing retainer ring onto the rotary table, flat side down. Orient the holes in the ring so that they line up with the threaded holes in the rotary table.
2. Stone the table mating surface. Clean with a lint-free rag.
3. With an assistant, lift and place the bearing onto the table, on top of the spacer.
4. Align the bolt holes in the table with the countersunk holes in the outer bearing race. Make sure the spacer will pull up into the inner bearing diameter. There should be no interference-fit problems.
5. Insert the SHCS by hand through the bearing and into the table.
6. Tighten the SHCS in a star pattern until the screws are snug. Evenly tighten the screws to seat the bearing, then back off each SHCS 1/16 turn.

NOTE: If installing the bearing by yourself, it will be useful to have a mirror positioned to see the indicator when it is on the far side.

7. Remove four of the SHCS that lie along the X- and Y-axis.

8. Attach a magnetic indicator stand (MIS) to the inner bearing race. Adjust the indicator to point to the side of the outer bearing surface as shown.



9. Turn the inner race to find high and low spots. To ease this procedure, place a long bolt into one of the holes in the inner race. Do not use the MIS to rotate the bearing.

NOTE: The acceptable tolerance for the bearing is .0002”. This is due to the 3:1 distance differential between the platter diameter and the bearing diameter.

NOTE: During the following adjustment procedure, adjust the bearing runout only from the high spots, adjust out only 1/2 of needed measurement. The high side will shrink by half, the low side will grow by half, and periodically rotate the bearing to realign the bearing rollers after adjustment.

10. Turn the bearing until the lowest spot is encountered. Zero the indicator. Turn the bearing until the high spot is encountered (this should be 180° opposite the low spot).

11. Insert a long T-handle hex wrench into the bolt hole in the outer bearing nearest the high spot. Place pressure on the hex wrench toward the low side to adjust the bearing.

NOTE: This will move the top part of the outer bearing in the direction pressed, placing leverage against the bottom part of the outer bearing.

NOTE: During this procedure, it will be necessary to tighten selected bolts in the outer race to keep your adjustments. This is not exactly defined, depending upon adjustments necessary during this process.

12. Perform Steps 9 through 11 until the bearing reads within .0002" of true. Torque the SHCS to 20 ft-lb in a star pattern (there should be very little effort needed to reach this value if you have tightened bolts during the previous steps). Torque the SHCS in sets of four, rotating the bearing between each screw. Each SHCS of the set should be 90° from each other.

13. Recheck bearing runout. Ensure the bearing remains within at least .0002" of true. If the bearing has slipped out of true, repeat Steps 9 through 11.

14. Torque the SHCS in 5 ft-lb increments to 45 ft-lb. Recheck bearing runout after each torque sequence.

15. Recheck bearing runout. Make sure the bearing has not shifted after the final torque sequence.

Removal

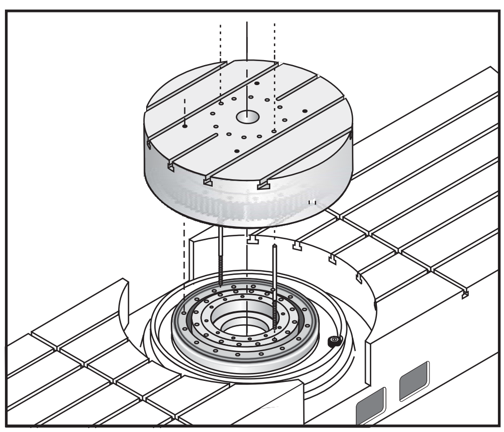
1. Command A-axis brake to disengage. Enter MDI and command an M11. Do not disconnect air to machine.
2. Remove the encoder cover plate. Remove the encoder shaft plate. **Important:** There are two set screws in the encoder shaft plate.
3. Remove the plastic bolt cover plugs and the bolts that secure the table to the bearing.

NOTE: Damage to the encoder will result if the plugs and bolts are not removed.

4. Fasten lifting plates to platter. Do not use T-nuts and eyebolt; slippage can occur and platter could fall. Use chains to lift rotary table. **Do not** use synthetic lifting straps; they have a tendency to stretch, causing the platter to be lifted off unevenly. An unevenly lifted platter may cause damage to the components beneath it.

Installation

1. Generously apply red grease to outer ring of brake, completely filling the two grooves. Apply moly grease around stud flex nuts, filling counterbores on brake ring. Apply moly grease to pinion gear and ring gear.
2. Stone and clean the platter where it will mate with the bearing. Rotate the inner bearing holes so they line up on the X- and Y-axis.
3. Use the backlash adjusting screws to fully retract the pinion gear/harmonic drive assembly.
4. Cut the heads off of two 3/8-16 x 7" threaded rods (40-0021). Insert each through a bearing mounting hole in the platter so that they are 180° apart. Use these to rotate the platter to align it with the holes in the inner bearing. Install the threaded rods into the bearing, use them as a guide when lowering the platter.



5. Hoist platter over the table using a chain fall. Do not use synthetic lifting straps to move or position platter.
6. Carefully lower the platter over the pilot rods and onto the bearing. Thread the rods (from step 4) into the bearing retaining ring. Ensure the bolt holes in the platter line up with the bolt holes in the bearing.
7. When the ring gear attached to the platter contacts the pinion gear, manually jog the A-axis so that the teeth mesh and the pinion gear does not force the platter into position.
8. Slowly guide the platter down the remaining distance.

CAUTION! Do not crash platter against table. These components are machined to very close tolerances and can be damaged by hard metal-to-metal contact.

9. Remove the threaded rods from Step 4.
10. Install the 12 3/8-16x4" (40-16430) SHCS to fasten the platter to the bearing.

NOTE: You will need a T-handle wrench or a 6" long hex socket to tighten the SHCS in the platter. Socket extensions will not fit.

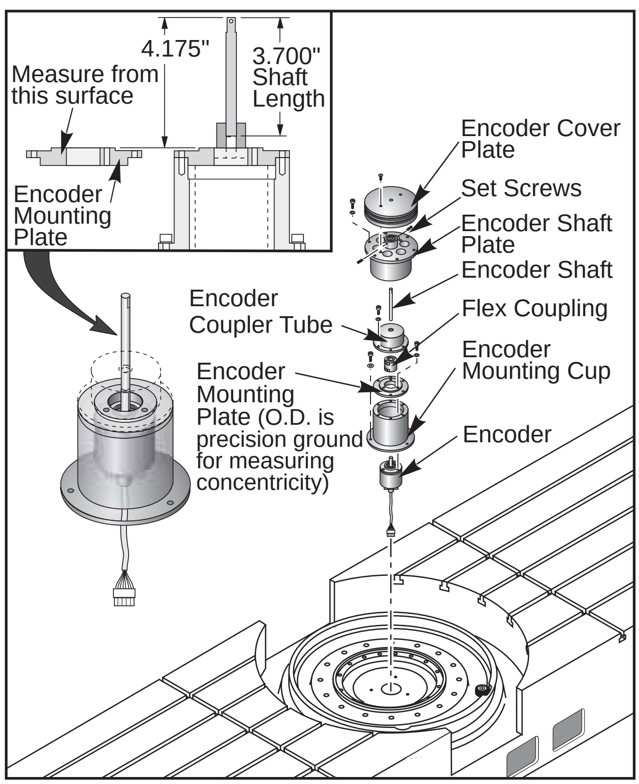
11. Tighten the SHCS incrementally in a star pattern to avoid misaligning the Bearing. Torque the SHCS in stages up to a final torque of 45 ft./lbs.
12. Before replacing the encoder shaft plate, make sure the set screws are loose.
13. Tighten the screws securing the encoder shaft plate to the platter. Tighten the set screws to clamp the shaft plate to the encoder shaft.
14. Replace the encoder cover plate.

Encoder Installation

Pre-assembly Verification

Before assembling the encoder mounting parts, perform the following checks:

1. Verify the encoder mounting plate inserts into the encoder mounting cup without binding. The contacting surfaces must be burr-free.
2. Verify the encoder shaft has no detectable side-to-side play. Perform this test by hand.
3. Verify the encoder boss inserts into the encoder mounting plate without binding. The contacting mating surfaces must be flat and free of burrs.
4. Verify the encoder shaft inserts into the encoder shaft plate to the full depth of the bore without binding.
5. Verify the encoder shaft plate inserts into the platter bore without binding. The contacting surfaces must be flat and burr-free.



Assembly

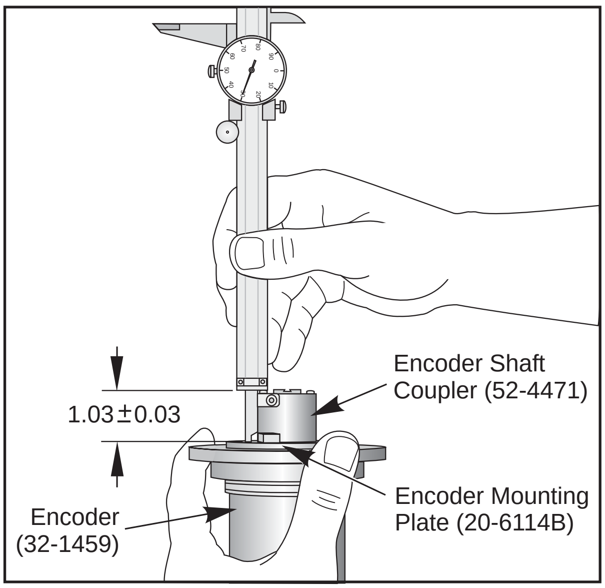
1. Install the encoder mounting cup with one 0.005 shim washer (45-0057) under each screw location.

2. Install the encoder onto the bottom of the encoder mounting plate. Install the encoder mounting plate assembly onto the top of the encoder mounting cup. Use three screws at 120° spacing to mount plate. The remaining three threaded holes are for the encoder coupling tube.

3. Attach a magnetic base and indicator to the inner race of the cross-roller bearing and indicate off the top face of the encoder mounting plate. Add or subtract shims to adjust the face runout of the top face of the encoder mounting plate, flatness NTE 0.0005". Shims are available in the following thickness: 0.001 (45-0054), 0.002 (45-0055), 0.003 (45-0056), and 0.005 (45-0057).

4. Adjust the indicator to indicate off the outer diameter of the encoder mounting plate. Sweep the outer diameter of the encoder mounting plate concentric to the cross-roller bearing, concentricity NTE 0.0005".

5. Before proceeding, test fit the encoder shaft into the encoder shaft plate to ensure that it fits in completely without binding, and that the set screws have been completely backed out or removed. Install flex coupling. Install encoder shaft to the dimension shown in the assembly*. Install encoder coupling tube.
***Failure to install encoder shaft to correct height will result in damage to flex coupling.**



6. Install the rotary table platter and indicate its bore concentric with the cross-roller bearing, concentricity NTE 0.0005".

NOTE: Be careful not to deflect the encoder shaft - damage to the flex coupling may result.

7. When installing the encoder shaft plate, ensure that the flats on the encoder shaft are lined up with the set screw holes in the shaft plate. Set screws **must** be removed before performing this operation.

8. After seating the encoder shaft plate, tighten the screws securing the encoder shaft plate to the platter. Then install and tighten the set screws. Install o-ring onto the top of the encoder shaft plate.

9. Install the encoder shaft plate by greasing o-rings and installing them onto the encoder cover plate. Install the encoder cover plate into the platter bore.

A-Axis Alignment and Parameter Settings

1. In Debug mode, go to Parameter 212 (224 for EC-1600 and HS series) and enter "0", then press Write/Enter. Repeat for Parameter 128. For a 5-degree indexer table, on an EC-1600, leave the sixteen (16) SHCS that hold the platter to the rotary body loose.

2. Toggle air pressure to the lift piston using Haas tool P/N T-2150 so that the platter is at the top of its travel. To lift the EC-1600 indexer, select the A-axis, doing so will raise the platter

3. Zero the A-axis only by pressing the Zero Ret key, then the A key, then the Zero Singl Axis key.

4. Jog the A-axis to line up the front edge of the pallet with the X-axis as close as the coupling position allows. For a 5-degree indexer table, align the T-slots on the platter with the T-slots on the table as close as possible.

5. Slowly discharge the air pressure to the A-Axis and lower the platter into position.

6. Rotate the worm shaft pulley to the extents of its travel and record the values. The value at the middle of this range is the value for Parameter 212. Enter that value.

7. Remove tool T-2150 and replace the hoses. To lower the EC-1600 indexer, select an axis, other than the A-axis, to jog and the platter will lower.

EC-400/500 1-degree Indexer Fine Adjustment

1. To fine adjust the front edge of the pallet, it may be necessary to loosen the sixteen (16) SCHS that fasten the rotary body to the trucks and the ten (10) SHCS for the Z-axis ballscrew mount.

2. Tap the rotary body into position within .0005/10.00". EC-400/500: The keys on the reciever will be parallel to the X-axis. See the “Receiver Replacement” section

3. Tighten, then torque, the sixteen (16) SCHS that fasten the rotary body to the trucks. Tighten the 5 ball nut bolts allowing the housing to re-align, then torque the 10 housing bolts. After the housing bolts have been torqued, loosen the 5 ball nut bolts and run the ball nut away from and back to the motor. If no binding occurs, re-tighten the ball nut bolts.

EC-1600/2000/3000 5-degree Indexer Fine Adjustment

1. Tap the platter into position within .001" alignment between the platter and the table T-slots.

2. Torque the sixteen (16) SHCS to 45 ft-lbs in a star pattern and re-verify alignment.

3. Place plugs in the fastener holes in the platter to prevent coolant and chips from contaminating the encoder/clamp area.

Full 4th A Axis Offset (EC-400/500/630/1600/2000/3000, HS-3R/4R/6R/7R)

1. In Debug mode (Pos-Raw Dat screen), go to Parameter 212 (224 for EC-630/1600/2000/3000), enter "0" and press Write/Enter.

2. Zero the A-axis only by pressing the Zero Ret key, then the A key, then the Zero Singl Axis key.

3. Go to debug mode and type "GRID" followed by a space and then "A".

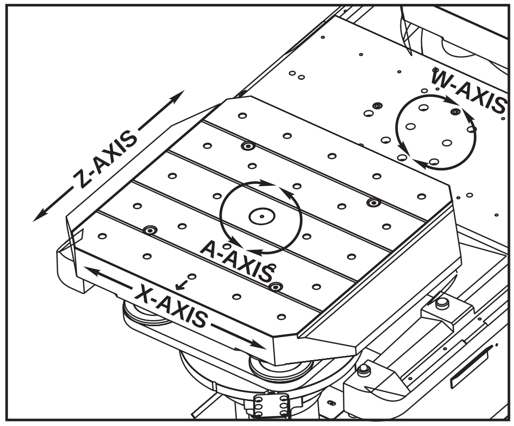
4. Jog the A-axis to line up the front edge of the pallet (EC-400/500) or the T-slots (EC-630/1600/2000/3000, HS-3R/4R/6R/7R) with the X-axis to a value of .0005/10.00".

5. Enter actual value from Pos-Raw Dat screen into Parameter 212 (224 for EC-630/1600/2000/3000).

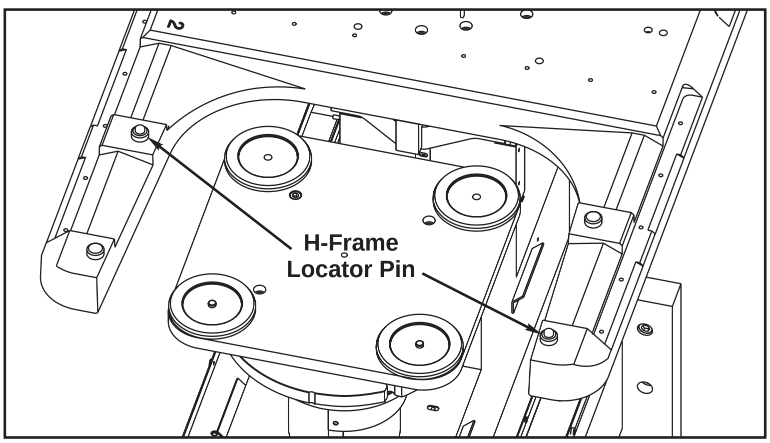
H-Frame Pallet Alignment (EC-630)

Horizontal machine axes:

X, Y, Z - Traditional HMC machine axes. A - Rotary table rotation. W - APC H-Frame rotation.



CAUTION! A, W and Z axes must be zeroed as described. Zero-position greatly influences pallet location relative to the H-Frame. Machine damage results if the H-Frame attempts to lift a pallet without being properly aligned.



A-Axis Alignment and Parameter Settings (EC-630)

Prior to aligning an A-Axis, verify and record Setting and Parameters for the appropriate configuration.

- Run Parameter Checker to call out any incorrect parameter settings for the machine's configuration.
- Verify that the Setting 30 value is USER1 for all configurations (1 and 45 deg. indexers and Full 4th).
- Verify Parameter 647 for Indexers (1 deg. = 1000; 45 deg. = 45000).
- Set Parameters 128 & 224 to zero for all configurations.

NOTE: For Full 4th Rotary Axis Alignment, see Full 4th A Axis Offset on previous page.

Indexer Rotary Axis Alignment

The rotary indexer incorporates a 1 deg. Hirth coupling to accurately position the pallet in 1 deg. increments. This alignment procedure must be followed to properly align the teeth on the 2-piece coupling so that they engage smoothly without any noise or jerky motion.

1. Attach the Lift Fixture
   - Tool 15-1304 is required to manually raise and lower the A-Axis platter.
   - Disconnect the Air Dump Solenoid Assy cable (36-5630) from under the front of the machine and connect it to the tool, using the adapter cable supplied with the lift tool.
   - Disconnect the Hydraulic Valve Power cable (33-1544) from the connection in the cable tray alongside the pallets and connect it to the tool.
2. Set GRID (Parameter 128).
   - Change Parameter 605 - Pallet Type from 5 to 0.
   - Raise the A-Axis platter with the lift tool to separate the indexer gear teeth.
   - Place the machine in 'DEBUG' mode.
   - Perform a Single Axis Zero Return on the A-Axis.
   - Display the Posit screen, type 'GRID A' and press Write/Enter.
   - Perform a Single Axis Zero Return on the A-Axis.
   - Verify that a value was automatically entered into Parameter 128.
   - Leave the A-Axis platter in the raised position.
3. Set Tool Change Offset (Parameter 224).
   - Handle jog the A-Axis so the front edge of the pallet is parallel to the X-Axis, within .0004" over 10".
   - Press E-Stop.
   - Lower the A-Axis platter with the lift tool and verify that it seats properly. It should lower smoothly, without unnecessary noise or rotational shifting when the coupling teeth engage.
   - Draw an alignment line between platter and rotary body. This is used later in the alignment process.
   - Display Pos Raw Data screen, read A-Axis actual encoder count and enter value into Parameter 224.

NOTE: Change the value to the opposite sign, i.e., if (+) value, enter (-) and vice versa. This determines which direction the axis homes and rotates.

   - Raise the A-Axis platter with the lift tool and perform a Single Axis Zero Return on the A-Axis.
   - Verify that the lines marked on the platter and rotary body are still aligned, and lower the platter.
   - If the coupling is fully meshed, the fuse reading should stay constant and begin to drop. Verify this in the Pos Raw Data screen (fuse level for A-Axis).
   - If the fuse level is climbing, immediately press E-Stop and repeat previous steps for Tool Change Offset.
4. Set Pinion Gear Position to middle of mechanical backlash.
   - Change Parameter 647 - Indexer Increment from 1000 to 0.

CAUTION! This allows platter rotation in lowered position and can damage the motor.

   - Change Parameter 52 - Fuse Level from 3000000 to 500000.
   - Go into Handle Jog mode for the A-Axis and set the jog increment to its lowest value.
   - Display the Pos Raw Data screen and monitor the A-Axis fuse level before jogging the axis.
   - Handle Jog A-Axis slowly 'clockwise' (negative direction on Jog Handle) watching fuse value of A-Axis.
   - When the value begins to increase, stop and back up until the fuse value stays constant and record the A-Axis actual encoder count.
   - Handle Jog the A-Axis slowly 'counterclockwise' watching the value of the fuse for the A-Axis.

- When the value begins to increase, stop and back up until the fuse value stays constant and record the A-Axis actual encoder count.
- Add the two readings, divide by two, and subtract or add as required to the value in Parameter 224.
- Repeat the handle jogging until the difference between encoder error counts is less than 100.
- If the pallet is off by a full degree, add or subtract 4511.1 to the value in Parameter 224.
- Reset Parameter 605 to 5, Parameter 647 to 1000 and Parameter 52 to 3000000.
- Indicate the front edge of the pallet in the X-Axis to check for parallelism. The pallet and the X-Axis parallelism should read within .0004" over 10”; if not, redo step 4.
- Disconnect the lift tool.
- Connect the Air Dump Solenoid Assy cable (36-5630) to the connector bracket under the machine front.
- Connect the Hydraulic Valve Power cable (33-1544) to its mating cable in cable tray alongside pallets.

Z-axis Alignment to Pallet Changer H-Frame

1. Zero Return the Z- and A-axis.

2. Enter Debug mode and go to the Pos Raw Data page.

3. Jog the rotary table (with pallet) in the Z-axis until H-Frame Pins are visually aligned with locating holes in the bottom of the pallet.

4. Note the Z-axis encoder count.

5. Enter this encoder count into the Tool Changer Offset parameter for the Z-axis (always as a positive number).

6. **IMPORTANT!** W-axis alignment (following section) must be completed before attempting a pallet change.

W-axis Alignment (Pallet Changer H-FRame Rotation Axis)

1. Jog the rotary table with the pallet, in the Z-axis, all the way forward toward the spindle (the pallet must be out of the way when the H-Frame is rotated) and disable the Z-axis by setting Parameter 29, bit 4, to one (1).

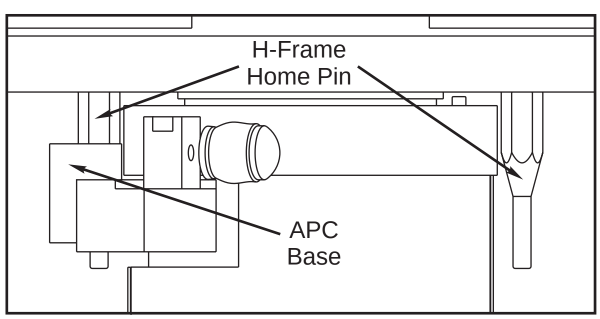
2. Make sure bit 28 in Parameter 209 is set to one (1). The H-Frame stays up until the bit is changed back.

3. Verify that the pallet changer type in Parameter 605 is 5.

4. The grid offsets in Parameter 445 and the tool changer offsets in Parameter 451 are for the W-axis.

5. Zero Return the W-axis and set the grid offset. Zero Return the W-axis again.

6. Press E-Stop. Manually rotate H-Frame until Home Pin is centered over locator hole in pallet changer base.



7. Change the value of Parameter 209 to zero (0).

8. Enter Pallet Changer Recovery (press Recover, then F2). Lower the H-Frame by pressing the down arrow. Watch closely to make sure that the H-Frame Pin lowers into the base in the correct position.

9. E-Stop the machine. Enter Debug mode and go to the Pos Raw Data page. Manually rotate the H-Frame in one direction as far as possible and note the encoder count. Rotate it in the other direction as far as possible and note the encoder count.

NOTE: Since the H-Frame Home Pin is smaller in diameter than the clearance hole in the base, the H-Frame can be rotated a small amount in each direction.

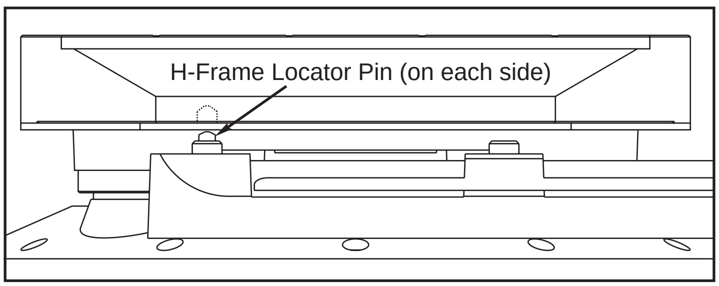
Calculate the number midway between these two values and enter it as the tool change offset parameter.

10. Zero Return the W-axis to verify that the H-Frame Home Pin is on center; if not, repeat step 8.

11. Enable the Z-axis by setting Parameter 29, bit 4, to zero (0).

12. Zero Return the Z-axis.

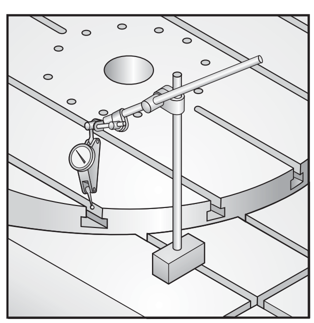
13. Before attempting a pallet change, verify all four (4) H-Frame pins (2 per pallet) are aligned with holes in the bottom of the pallet. Small adjustments in both Z- and W-axis may be necessary to complete this alignment. It is critical that all four (4) pins are aligned to safely lift the pallets. Repeat step 8 to verify pin alignment before continuing. Use pallet changer recovery to lift and lower the pallet and ensure pins are aligned with the pallet; the pins should engage smoothly into the holes in the pallet and not cause the pallet to shift.



14. Perform the first pallet change at a 25% rapid. Watch closely as the H-Frame lifts the pallet for the first time to be sure that the locator pins properly align in the pallet. Watch the pallet closely as the pallet change is completed, and make sure that it lowers properly onto the load station.

A-axis Backlash

1. Command A-axis brake to disengage. Enter MDI and command an M11. Do not disconnect air to machine.
2. Set Parameter 269 bit 0 (lin scale en) to 0. This disables the rotary table position encoder and enables the drive motor encoder. The drive motor gear now holds position, allowing backlash to be measured between the ring and pinion gear. (Power must be cycled when enabling and disabling any scale parameters.)
3. Verify the brake is disengaged, by ensuring the platter can be rotated a slight amount.
4. Set up an indicator on the non-rotary part of the table and set the needle against a T-slot on the rotary portion of the table (see the following figure).

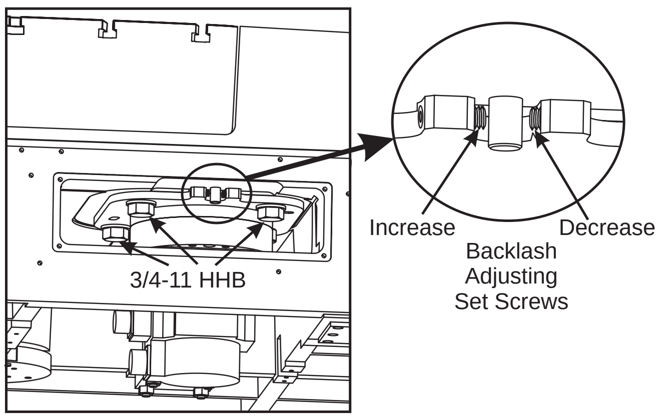


5. Manually rotate the platter back and forth. At times additional force is required to overcome the friction. Use platter lifting plates or a fixture on the platter with a bar between them, if necessary, to move the platter.

6. Take readings from the indicator every 10° for 360°. Reposition the indicator each time. Backlash should be between .0005" and .0007". If it is not within this range, perform the following adjustment procedure.

Backlash Adjustment (EC630-1600-3000)

1. Command A-axis brake to disengage. Enter MDI and command an M11. Do not disconnect air to machine.
2. Disable the A-axis encoder by setting the Parameter 43 bit 3 to 1. Note that this will disable the rotary table position encoder and enable the drive motor encoder. The drive motor gear will now hold position allowing backlash to be measured between the ring and pinion gear.
3. Loosen the 3/4-11 hex head bolts that secure the cam backlash adjuster (motor plate) to the underside of the table. It is not required to remove these bolts completely, only loosen them. The SHCS that bolts through the plate is a shoulder bolt and does not need to be loosened.
4. Loosen the one adjustment set screw and thread it back away from the pin. Tighten the other screw. This will alter the backlash between the drive and ring gear.



Backlash Adjusting Set Screws (HS3-7R)

5. Verify the brake is disengaged and that backlash exists by manually moving the platter back and forth. At times additional force is required to overcome friction. Use platter lifting plates or a fixture on the platter with a bar between them, if necessary, to move the platter within the allowable backlash.
6. Back the right set screw all the way out.
7. Set up an indicator on the non-rotary part of the table and set the indicator needle against a T-slot as shown in the previous figure. For the EC-630, place the magnetic base on the rotary body and set the indicator needle against the flat front surface of the pallet.
8. Begin tightening left adjusting set screw and check backlash. Using the bar between lifting plates or fixtures, nudge table CW and CCW. Take readings from indicator. Once readings come close to .003", rotate table and take readings every 10° for 360°. Find tightest of spots and set indicator up as before.
9. Tighten the left adjusting set screw until the backlash is between .0005" and .0007".
10. Snug the right adjusting set screw against the pin.

NOTE: Be sure that each set screw is tightened snugly against the pin.

11. Tighten the 3/4-11 hex bolts that mount the cam backlash adjuster (motor plate).
12. Recheck backlash. If adjustment is necessary, loosen the plate's hex bolts and adjust with the set screws.

EC-400 A-Axis Backlash Adjustment (Full 4th)

1° indexer instructions are different, see the instructions at the end of this section.

1. Remove all parts and fixtures from the platter.
2. Check and record backlash near the outer edge of the platter face, using approximately 15-20 ft-lb. The factory specification is 0.0003" to 0.0007".

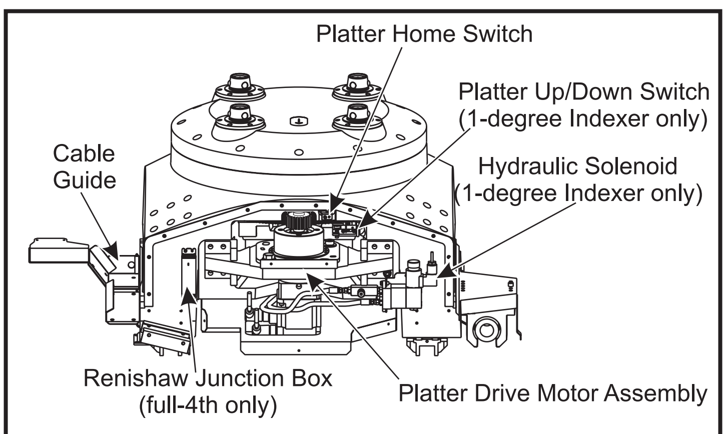
NOTE: Check backlash in each of the four quadrants (every 90°).

3. Remove 10-32 BHCS that retain worm housing cover. Place drip pan beneath black bearing housing cover to catch any gear oil (keep in place for step 4). Remove bearing housing cover. It may be necessary to use channel lock pliers on the bearing housing to remove it; if this is necessary, use a rag to prevent marring.
4. Note position of the dimple located on the flange of the bearing housing. Mark this position on an adjacent part of the casting for reference. Remove the four 5/16-18 cap screws. Do not pull the housing out or gear oil will pour out of the housing. Put two screws part way in housing holes and turn housing with lever.
5. Index bearing housing one set of holes. Move to next set of holes by rotating hole set upward (toward the platter), either CW or CCW. Bolt bearing housing flange down. Torque bolts to 25 ft-lb. Check backlash in each of the four quadrants. Factory specification is 0.0003" to 0.0007". If necessary, repeat Steps 4 and 5.
6. Replace the bearing housing cover. Replace the side cover sheetmetal and reattach with the four BHCS removed in step 3.
7. Remove the oil filler pipe plug. If the oil level covers less than half of the sight glass, refill the gear case with Mobil SHC-630 gear oil to the midpoint of the oil level eye and reinstall the oil filler pipe plug.

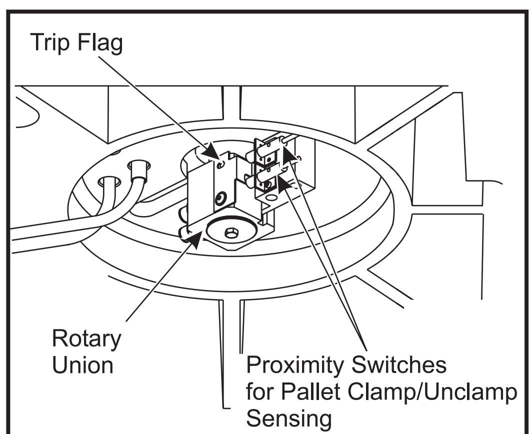
A-axis backlash adjustment for optional 1° indexer

The facegear must be disengaged before checking backlash. First raise the platter by applying air to the lift piston with tool T-2150. Disconnect the A-axis and connect tool T-2150. Toggle air to the lift piston with the regulator set between 20 to 40 PSI [138-276 kilopascals]. Check backlash at each quadrant (every 90°). Backlash on the 1° indexer option is .0007"-.0015" (nonstandard). Adjust as necessary. See the previous adjustment description.

EC-630 A-Axis Service



EC-630 Rotary Body Rear View (Rear Cover Removed)



Rotary Body Underside

Motor Assembly Removal

1. Intiate a pallet change and remove the pallet and all fixtures from the rotary body.
2. Remove the rear cover (25-8083) at the spindle side of the rotary body. If necessary, the way covers can be released and moved aside by removing the three screws on each side of the rotary body.

3. The motor, gearbox (1-degree indexers only), harmonic drive assembly (full 4th rotary only), backlash plate and pinion gear are removed as a unit along with the platter drive motor mount. Disconnect the motor cables, remove the eight 1/2-13 x 1.75" SHCS that hold the motor mount in place, and slide the assembly back, off of the alignment dowel pins.

CAUTION! This assembly weighs over 100 lbs. Do not attempt to remove it without assistance.

Pallet receiver clamp/unclamp solenoid (52-0159) (1° indexer only)

This solenoid is mounted to the main casting of the rotary body, to the right of the platter drive motor assembly. The hydraulic flow control valve, mounted between the hydraulic pressure line and the solenoid, is factory-set and should not require adjustment.

Replacing the solenoid:

1. Shut off hydraulic power and ensure that no pressure remains in the system.

2. Disconnect the pressure and return lines from the solenoid.

3. Remove 1/4-20 x .75" SHCS that secure the solenoid to the mounting bracket. Install the new solenoid.

4. Reattach hydraulic lines and bleed the hydraulic system (See EC-1600 procedure).

Platter Up/Down Switch (69-1601 switch) (20-2533 plunger) (1° indexer only)

This switch is located beneath the ring gear, to the right of the index drive assembly. It indicates to the control that the rotary table has been lifted for indexing or lowered to the clamp position by sensing the position of the plunger mounted to the switch assembly bracket. The switch is held by a bracket to the switch assembly.

Pallet Clamp/Unclamp Trip Switch Assembly

This switch is located at the bottom end of the pallet receiver shaft. Two switches are activated by a trip flag attached to the rotary union at the end of the shaft to indicate pallet clamped or unclamped conditions.

Adjust the switch trip flag by loosening the 1/4-20 x 0.5" BHCS, moving the trip flag, then tightening the BHCS.

When replacing switches, make sure that the clamped (lower) and unclamped (upper) switches are in the appropriate positions, and that they are plugged into their appropriate locations at the control.

Harmonic Drive (Horiz)

The Harmonic Drive unit is used to drive the rotary table on machines such as the HS 3, 4, 6, 7 and the EC630-1600-3000. It is a self-greasing unit, prepacked with appropriate grease, and requiring no maintenance.

The Harmonic Drive Assembly is made up of the following components:

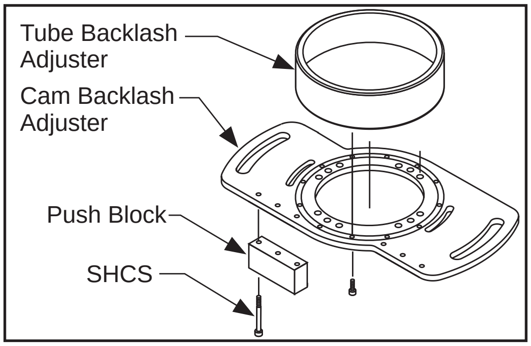
Housed Harmonic	DriveGearbox Adapter	O-Ring Pack	Pinion Gear, 22 Tooth
Wave Generator	Cam Backlash Adjuster	Yaskawa Sigma Motor	

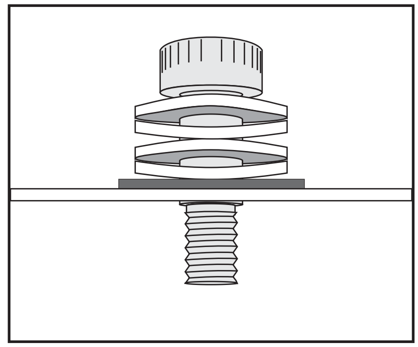
Backlash Tube and Plate Assembly

1. Place the tube backlash adjuster onto the cam backlash adjuster plate. Turn the tube so that the holes line up with the holes in the plate. This is an interference-fit item. Insert the 12 SCHS into the tube and thread into the plate. Tighten the SCHS in a star-pattern to ensure proper positioning of the tube.

2. Attach one push block to each side of the plate, using existing drilled holes and six supplied SCHS.

NOTE: The backlash plate assembly is not attached to the motor at this point to ease assembly into the table during installation.





Spring Washers

Installation

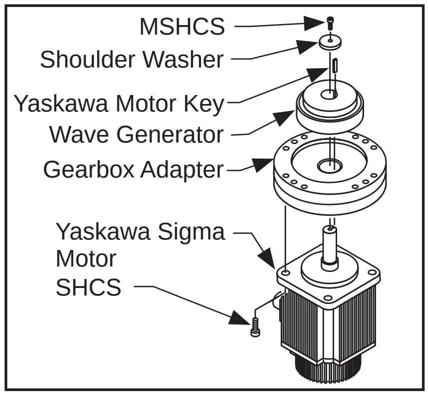
1. Apply grease to the outer side of the tube and top side (as installed) of the plate. Also apply grease to the counterbore for the tube and the machined surface underneath the table the plate will move against.
2. Assemble four Spring Washers in series and one 3/8" hard washer onto each shoulder screw. They should be assembled so that a small space appears between the top and bottom pairs of washers.
3. Orient the backlash plate so the push blocks face the access holes of the table. Insert the backlash tube/plate assembly into the counterbore from under the table. Be careful to not mar the tube surface.
4. Insert the shoulder screws through the slots in the plate closest to the tube (place the hard washer against this plate) and thread into the table. Tighten with a hex wrench to standard torque.
5. Place a flat washer (45-1725) and a lock washer (45-1720) onto each HHB. Thread the HHB up into the table through the outer slots of the plate. Leave loose until final adjustment.

Motor/Wave Generator Assembly

1. Sweat pinion gear (positioned so groove is away from flange) over shaft of sigma adapter and set aside.
2. Examine the spindle of your Yaskawa sigma motor. If your motor has the motor shaft spacer already sweated onto the shaft, skip to step 4.
3. Sweat the motor shaft spacer over the shaft of the motor. Ensure the chamfer on the inner diameter spacer faces the motor.
4. Turn the motor so that the shaft faces upward. Place the gearbox adapter over the motor shaft. Insert the four SHCS through the tabs of the motor case into the gearbox adapter and tighten.
5. Place the wave generator over the motor shaft. Align the keyway in the wave generator with the keyway in the motor's shaft.
6. Insert the Yaskawa motor key into the combined keyway. Use a press to fit the key into the keyway. Do not use the Haas motor key.

CAUTION! Do not use a hammer or other forceful method of inserting the key. You will damage the fragile bearings and components of the wave generator.

7. Place the shoulder washer over the motor shaft. Apply Loctite, insert the MSHCS and tighten.

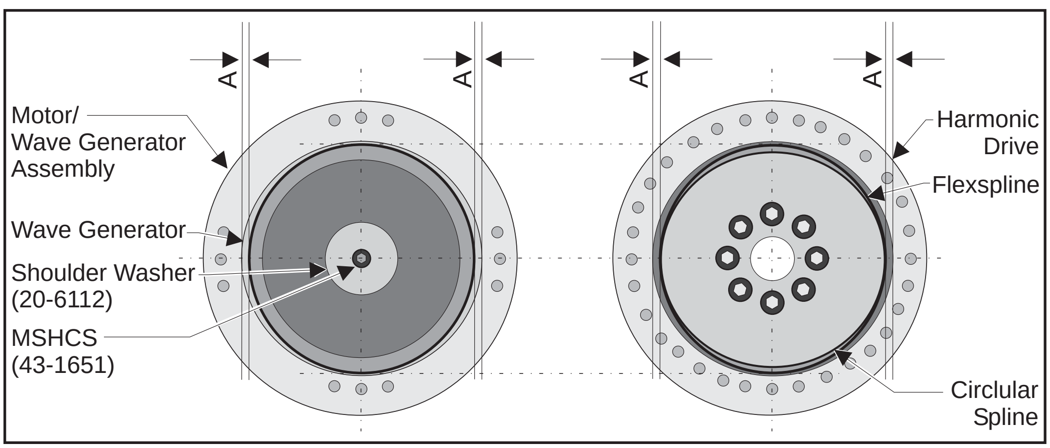


Harmonic Drive Assembly

1. Cover your work area with a clean shop rag and place the harmonic drive with the smaller-diameter end down on the work surface. You should see the grease cavity of the harmonic drive.
2. Remove large o-ring from included package and lightly grease. Place in groove in face of harmonic drive.

NOTE: For proper operation of a harmonic drive, it is essential that the ring of the wave generator be concentric with the ring of the harmonic drive. The rings of the wave generator and harmonic drive are ellipses; they are not circular. Incorrect assembly will result in an off-center or "dedoidal" condition, resulting in **poor performance** and **reduced service life**.

3. Place the motor/wave generator assembly next to the harmonic drive. Turn the harmonic drive elliptical ring until the ring is closest to the front of the harmonic drive. Orient the wave generator elliptical ring until it matches the positioning of the harmonic drive exactly.

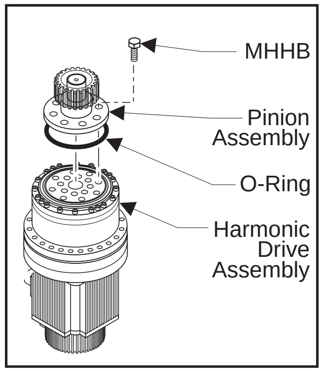


Phasing the Wave Generator to the Harmonic Drive (View from Above)

4. Turn the motor/wave generator assembly over and set lightly on the harmonic drive. If the two elliptical rings are in phase, they will mesh. If they do not mesh easily, remove the motor/wave generator assembly and verify correct alignment of the elliptical rings and repeat this step.
5. Bolt gearbox adapter to harmonic drive by inserting four SHCS into countersunk holes in gearbox adapter.

NOTE: Test for dedoidal (out of phase) condition, by turning harmonic drive/motor assembly over and setting it on motor casing, harmonic drive up. Insert 5mm hex wrench through center hole in harmonic drive into MSCHS. Turn hex wrench with a drill. For one complete revolution of input there should be two equal deflections, or pulses, felt through drill.

6. Turn complete assembly over to expose harmonic drive. Keep this free of contaminents. Lightly grease and install remaining o-ring into groove. O-ring seals harmonic drive from coolant during machine operation.
7. Install the pinion assembly ("Motor/Wave Generator Assembly") onto the harmonic drive. Be sure to orient the pinion assembly so that the bolt holes line up with the holes in the harmonic drive (interference-fit item).
8. Place sealer on the eight MHHB and thread into the holes of the pinion assembly. Tighten in a star pattern.

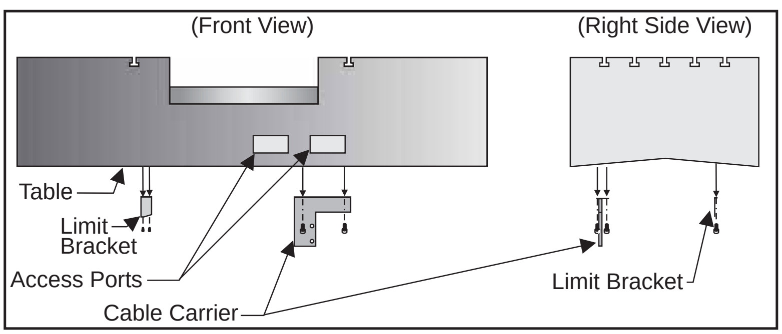


Installation

1. Thread an eyebolt into the pilot hole in the shaft of the harmonic drive assembly.
2. Connect a rope or hoist line to the eyebolt. Have an assistant lift the rope up through the counterbore and raise the harmonic drive.
3. Orient the harmonic drive so that the motor connectors can be accessed from the right of the table. Insert eight 70mm SHCS through the gearbox adapter into the table. Torque to 35 ft-lb.

Carrier Mount Bracket Installation

1. Orient the carrier mount bracket so the edge side faces forward and the flush side is toward the center of the table. Turn the carrier bracket so the mounting holes face the table's bottom surface (shown below).



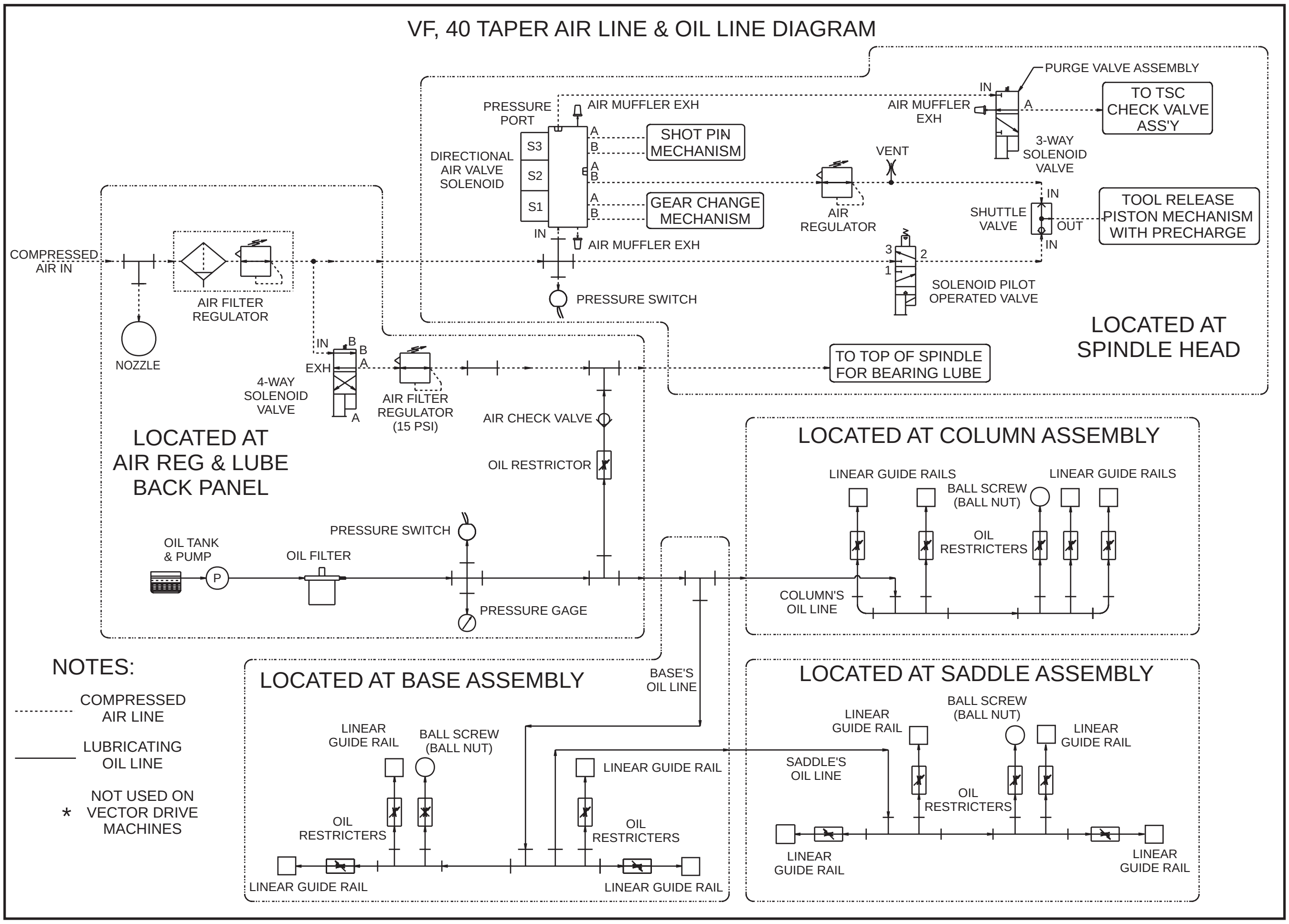
Cable Carrier and Bracket Installation

2. Place the carrier bracket against the bottom side of the table where indicated and insert the four SHCS through the bracket, to the table, and tighten.
3. Orient the limit bracket so that the angled bottom edge faces to the right and the mounting tab faces toward the rear of the table as shown in the previous figure. Mount using two SHCS.

Cable Box Encoder Installation

1. Place the cable box encoder into the left rear corner of the accessory box of the table. Orient the cable box with the open sides against the casting of the table for the encoder cable.
2. Install the three SHCS and insert through the cable box into the table. Tighten.
3. Apply Sikaflex around any gaps to prevent encoder cable from popping out when pushed down into box.

The lubrication system is a resistance type system which forces oil through metering units at each of the lubricating points within the machine. The system uses one metering unit at each of the lubricating points: one for each linear guide pad, one for each lead screw and one for spindle lubrication. A single oil pump is used to lubricate the system. The pump is powered only when the spindle and/or an axis moves. Once powered, the pump cycles approximately 3cc of oil every 30 minutes throughout the oil lines to the lube points. The control monitors this system through an internal level switch in the reservoir and and external pressure switch on the lube panel.



The lube pump and spindle fan are on the same circuit, which is turned on whenever a program is running, and remains on after a program is stopped for the time specified by Spin Fan Off Delay (Parameter 208).

Low Lubrication/Pressure Sense Switches

There is a low lube sense switch in the oil tank. When the oil is low, an alarm will be generated. This alarm will not occur until the end of a program is reached. There is also a lube pressure switch that senses the lube pressure. Parameter 117, Lube Cycle Time, controls the lube pressure check. If Parameter 117 is not zero, the lube pressure is checked for cycling high within that period. Parameter 117 has units of 1/50 seconds; so 30 minutes gives a value of 108000 (at 60Hz - the time interval will be 36 minutes at 50Hz). Parameter 57, Oiler on/off, indicates the lube pump is only powered when the spindle fan is powered. The lube pressure is only checked when the pump is on.

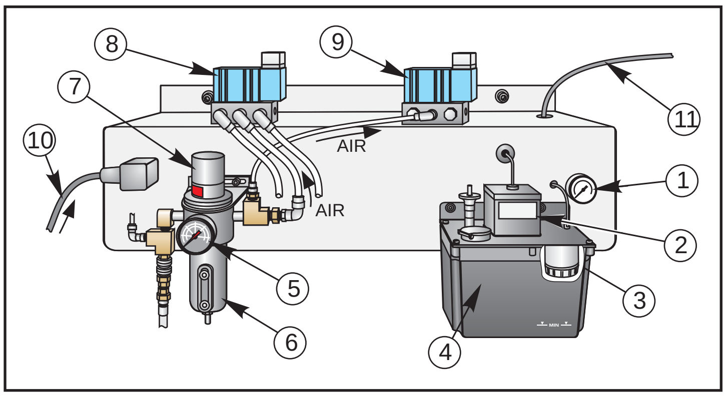
Air Supply Lines

The lifting cylinder has one large air supply line for lifting the pallets and their loads. No return line is required because the cylinder is vented to the atmosphere and the weight of the assembly and load causes the cylinder to lower. The rotation cylinder is double-acting and has two smaller air supply lines for clockwise and counter-clockwise rotation. The air blast system has one large air supply line, connected to the lube tube adapter. Each of the four air supply lines is routed to the solenoid mounting bracket where the air solenoid assembly is located. Four solenoid valves are used to provide the responses required for the pallet change operation.

Lubrication Supply Lines

An oil supply line from the lube/air panel (on the right side of the machine) attaches to the lube tube adapter. It provides lubrication to the rotary table drawbar, which carries oil mist from the air blast plug up the center of the main drawbar, to the drawbar and pallet nut.

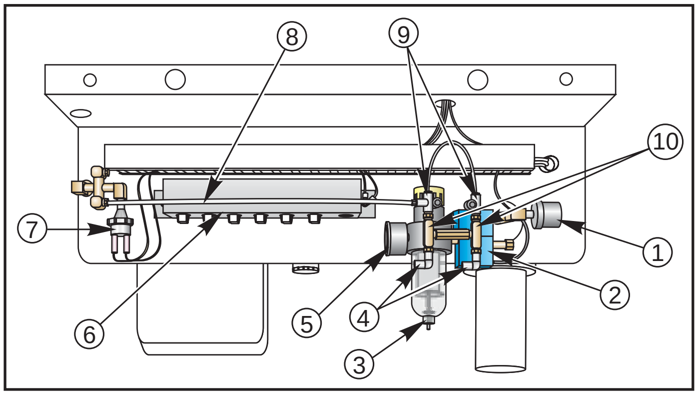
Components



Lube Air Panel (Front View)

The following is a list of the Lube Air Panel assembly components.

1. **Oil Pressure Gauge -** Indicates the pressure (in psi) at which the oil is pumped from the reservoir.
2. **Oil Pump** - Pumps the oil from the reservoir to various parts of the lathe. Every 30 minutes the pump cycles and pumps approximately 3cc of oil (at approximately 20 PSI).
3. **Oil Filter** - Filters the oil from the reservoir before it is pumped to the necessary areas.
4. **Oil Reservoir** - Stores the oil (Vactra #2) that is used for lubrication in the linear guides and ballscrews. Oil is also mixed with air and sent to the spindle bearing for lubrication and cooling.
5. **Air Pressure Gauge** - Indicates the pressure (in PSI) at which the air is being regulated.
6. **Air Filter -** Filters the air and removes moisture before it is sent to the solenoid valves.
7. **Air Pressure Regulator** - Maintains the air supplied from the outside source (via the main air line) at a constant, desired pressure (approximately 85-90 PSI).
8. **Air Solenoid Assembly -** 4-way 2-position valve that controls the air to the turret air cylinder.
9. **Air Solenoid Assembly-** 3-way 2-position valve that controls the air to the parts catcher air cylinder. This assembly is only on machines equipped with a part catcher.
10. **Power Cable -** Supplies power to the Lube Air Panel from the main control box and carries signals from switches to control box.
11. **Foot Pedal Cable -** Connects chuck actuator foot pedal to the lube air panel.



Lube Air Panel (Rear View)

The following is a list of the Lube Air Panel assembly components on the rear of the panel.

1. **Air Pressure Switch -** Monitors the air supply pressure, and sends a signal to the control panel to “alarm out”, or stop, the machine when the air pressure falls below 70 PSI.
2. **Solenoid Valve -** Opens when the spindle is turning to permit air to be sent to the spindle bearings.
3. **Air Regulator** - Maintains the correct air pressure (10-12 PSI) being sent to the spindle bearings.
4. **Oil Mist Ports** - Connect to nylon tubing that carries the oil-air mist to the spindle bearings. One port supplies the front spindle bearing, and one supplies the rear bearing.
5. **Air Pressure Gauge** - Indicates pressure of air being mixed with oil and supplied to the spindle bearings.
6. **Connector Plate -** Contains all of the connectors for the Lube Air Panel.
7. **Pressure Switch -** Monitors the oil supply pressure, and sends a signal to the control panel to stop the machine if the pressure drops below the minimum level for a set period of time.
8. **Oil Line -** Carries oil to the ports for the ballscrews, linear guides, and spindle bearings.
9. **Oil Ports** - Connect to nylon tubing that carries the oil to the ballscrews and linear guides.
10. **Flowmeters -** Maintain the correct amount of oil dropping from the upper ports to the lower ports where they are mixed with air and sent to the spindle bearings.

Lube Panel Removal

CAUTION! Power off the machine before performing the following procedure.

1. Remove the rear panel and disconnect the main air line.
2. Disconnect limit switches from lube panel, the spindle air lines, and disconnect oil line at lube panel.

NOTE: All plastic ties must be cut in order to remove the lube air panel.

3. Remove all conduits.
4. Disconnect main oil line.
5. Remove the mounting screws located at the top of the lube panel.

CAUTION! Disconnect or shut off air supply and exhaust the primary and secondary pressure before servicing unit. Turning the adjustment knob counterclockwise **does not** vent downstream pressure. Downstream pressure must be vented before servicing the regulator.

NOTE: Use mineral based grease or oil only. Do Not use synthetics or silicones.

NOTE: After servicing unit, turn on air supply and adjust regulator to the desired downstream pressure. Check for leaks. If leakage occurs, do not operate – conduct repairs.

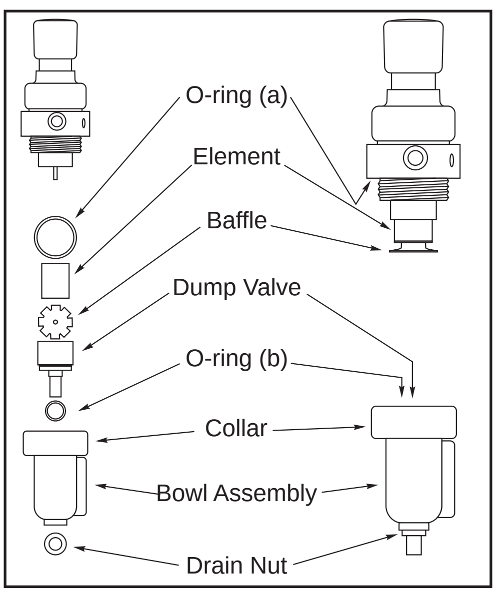
Servicing the Filter Element and Cleaning the Bowl Assembly

1. Unscrew the bottom threaded collar and remove the bowl assembly. Use care as not to lose the o-ring.
2. Unscrew the baffle and then remove the element.
3. Clean the internal parts and bowl assembly before reassembling. To clean the bowl assembly use mild soap and water only! Do not blow with air as loss or damage may occur to o-rings.

   a. Remove the drain nut from the dump valve and remove it from the bowl assembly. Use care to not lose the o-ring.

   b. Soak the dump valve in a mild soap and water mix to clean. Rinse in water and allow to air dry.

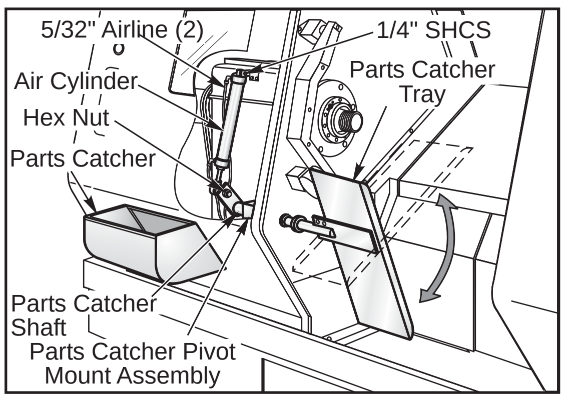
   c. After cleaning the bowl assembly, reassemble the dump valve in the bowl assembly. Care should be taken to not pinch the o-ring. Do not over tighten the plastic drain nut.
4. Install the new element.
5. Attach the baffle and finger tighten firmly.
6. Inspect/replace o-ring. Lightly lubricate o-ring to assist with retaining it in position.
7. Install the bowl assembly into the body and tighten the collar; hand tight, plus ¼ turn.



Removal

CAUTION! Power off the machine before performing the following procedure.

1. Disconnect the main air line. Remove necessary panels to access the parts catcher unit
2. Loosen 1 1/2" shaft collar that locates the parts catcher tray, and slide out tray and inner shaft.
3. Unclamp outer retaining ring that retains the shaft collar on the outer shaft, remove shaft collar and inner retaining ring. Remove rubber seal from outer shaft.
4. Detach 5/32" airlines attached to the barrel end and rod end ports of the air cylinder.
5. Remove 7/16" hex nut that attaches the air cylinder to the parts catcher shaft.
6. Loosen and remove 1/4" SHCS and washer that attaches air cylinder to cylinder mount and remove air cylinder.
7. Remove 3/8" SHCS holding the parts catcher pivot mount assembly to the spindle head casting and slide out mount assembly.



Parts Catcher/Tray (Front View)

Installation

1. Slide parts catcher pivot mount assembly through the sheet metal seal and attach to spindle head casting using 3/8" SHCS.
2. Install air cylinder to cylinder mount using 1/4" SHCS and washer. Attach air cylinder rod, in its fully retracted position, to parts catcher shaft with the hex nut. Connect air lines to air cylinder ports.
3. Install rubber seal on outer shaft. Place inner retaining ring on outer shaft, slide shaft collar on and attach outer retaining ring. Connect the main air line.
4. Power on the machine and program an M36, in MDI mode, to fully extend the air cylinder. Slide the inner shaft of the tray assembly into outer shaft of pivot assembly. Locate tray assembly far back enough to catch the part and clear chuck.
5. Rotate the tray position to open the sliding door of the collector. Tighten the shaft collar to the parts catcher shaft. Step through MDI program and check tray operation
6. Install necessary panels that were removed.

Lathe Tool Probe

Probe Setting

1. Power off the machine and remove the forward end panel on the left side of the machine.
2. Loosen all fasteners and the set screw on the mounting block.
3. Lower tool setter arm to horizontal position. Install a turning tool in the cutting position pocket on the turret and jog the Z-axis in slow motion until the tool tip touches the square tip of the probe.
4. Adjust the height of probe so the tip of the turning tool touches the middle of the side of square tip by tightening 1/4-20 set screw on the mounting block. After proper alignment, tighten all four 3/8-16 screws on mounting block and torque them to **50 ft-lb**. Also tighten the 1/4-20 nut on the set screw.
5. Install .0001" indicator on a safe place on the turret, align the tip of probe within **.0005"** to X- and Z-axes by loosening the four 4-40 clamping screws and rotating the probe body. Tighten the clamping screws.
6. Rotate tool setter arm to vertical position (home position) and check the alignment of probe, ball stud and home switch actuator groove to home assembly. If there is misalignment, loosen the two 1/4-20 BHS and let the home assembly self-center to the ball stud. Tighten screws after proper alignment.
7. Home position verify by jog functions normal on X- and Z-axes.
8. Move turret away and pull down tool setter arm. Control should switch to Tool Set Offset screen. X and Z will jog only in slow motion. Using your finger, trigger the probe. The speaker should beep and diagnostics input should change from 0 –> 1 –> 0. Using the slow jog button, move X or Z clear of the part, and tap the probe. The motion in current direction should stop, and the offset should update.

Probe Tip Replacement

1. Install stylus tip with supplied wrenches. Additional information is found in the manufacturer's manual.
2. Install .0001" indicator on a safe place on the turret, align the tip of probe within **.0005"** to X- and Z-axes by loosening the four 4-40 clamping screws and rotating the probe body. Finally tighten the clamping screws.

Lathe Tool Presetter Setup (LTP)

This procedure measures probe faces and sets parameters based on the actual distances. If a diameter difference greater than the tolerance of +/- 0.002" is noticed, preforming this procedure will correct the setup without any mechanical changes.

1. Parameter 254, Spindle Center Distance, must be set correctly before setting LTP.
2. Install 1" diameter axial reference tool in position 1. Select YASNAC for Setting 33 coordinate system. Offset G54 must be set X = 0, Z = 0. Tool wear #1 must be set to 0.
3. Handle Jog to a position for clear X travel. In Offset page, use F2 to set tool 1 work shift to centerline.
4. Enter this program in MDI:

   ```
   G54
   G50 T5100
   X0
   ```

   Run the MDI program; the tool will move to spindle center
5. Select Handle Jog mode, Distance to go will read X = 0.0000, Z = 0.0000. Manually jog in Z to a position clear of the LTP arm. **Don’t move the X-axis.**
6. Lower the LTP arm, the display will switch to Offsets. Select Position display again in order to view Distance to Go Display.

7. Manually jog to probe tip and “probe” the 1" dia reference tool in the -X direction (move down) using 0.0001 feed rate. Record the X distance to go. (e.g.; 4.9993). Subtract 1" from the number (e.g.; 4.9993 - 1.0000 = 3.9993). Enter this number in Setting 59 (**Probe Offset X+**).
8. Manually jog the tool and “probe” the 1" reference tool in the X+ direction (move up) using 0.0001 feed rate. Record the X distance to go for this position. (e.g. 2.2309). Add 1" to the number (e.g. 2.2309 + 1.0000 = 3.2309). Enter this number in Setting 60 (**Probe Offset X-**).
9. Subtract the number in Setting 60 from Setting 59 (e.g. 3.9993 - 3.2309 = 0.7684). Divide this number by 2 (e.g. 0.7684/2 = 0.3842). This is the effective width of the probe head; the actual width is 10 mm or 0.3937. Enter this number (effective probe width, not actual) in Setting 62 and Setting 63.

Verification

(Method assumes cut geometry is smaller than tool probe setting diameters.)

O.D.

1. Using Handle Jog and an OD turning tool, OD turn a diameter. Set Distance to Go to X = 0.000. Measure the diameter (e.g. 2.125).
2. Jog away in Z direction and lower tool presetter. Jog to probe OD tool in X direction using 0.0001 feed rate.
3. Record X Distance to Go number (e.g. 1.8743). Add number to the measured diameter from step 1 (e.g. 2.125 + 1.8743 = 3.9993). The sum should equal the number in Setting 59 (**Probe Offset X+**) +/- 0.0020".

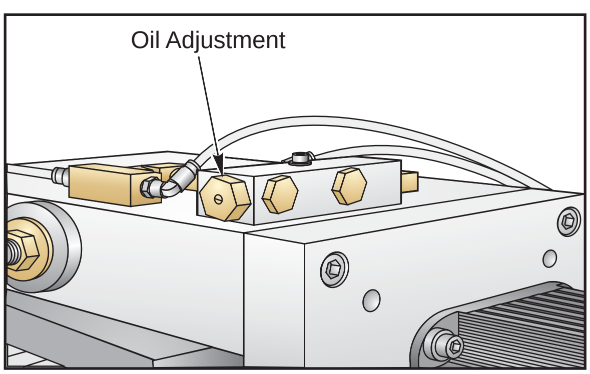
I.D.

1. Using Handle Jog and an ID boring tool, ID bore a diameter. Set Distance to Go to X = 0.000. Measure the bore diameter (e.g. 1.750).
2. Jog away in Z direction and lower the tool presetter. Jog to probe the ID tool in the X+ direction using the 0.0001 feed rate.
3. Record the X Distance to Go number (e.g. 1.4809). Add this number to the measured diameter (e.g. 2.125 + 1.4809 = 3.2309). The sum should equal the number in Setting 60 (**Probe Offset X-**) +/- 0.0020".
4. If verifying tool setter arm settings with cut diameters larger than tool probe setting diameter, subtract the X Distance to Go from the measured diameter and compare result to the appropriate X +/- Setting (59 or 60).

C-Axis (Lathe)

Lubrication

The C-axis gears are lubricated by the automatic lube system. The gears are lubricated with one drop of oil every ten engagements. The amount of oil used is adjusted by a slotted screw on the side of the oiler block. Turn the screw in (clockwise) for less oil. For a base line adjustment, turn the screw in completely, then back out 1/2 turn. Check lubrication frequency and adjust for approximately one drop every ten engagements.

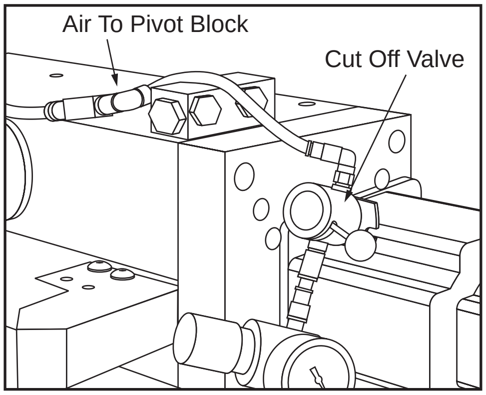


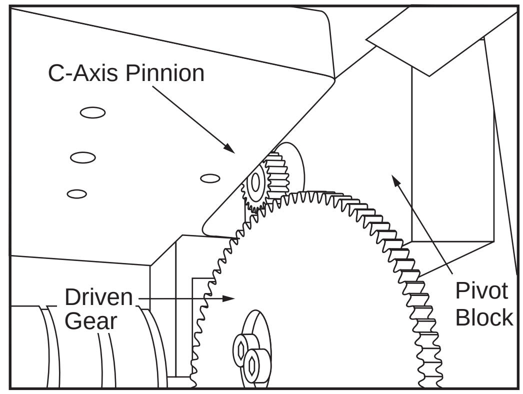
Setting Grid Offset

NOTE: This option uses a second MOCON PCB; take care tracing signals.

NOTE: Grid offset must be checked and reset if the drive gear or the "C" drive servo motor is replaced.

1. Disconnect air supply to C-axis actuator block and install an in-line regulator, with a cut off valve.





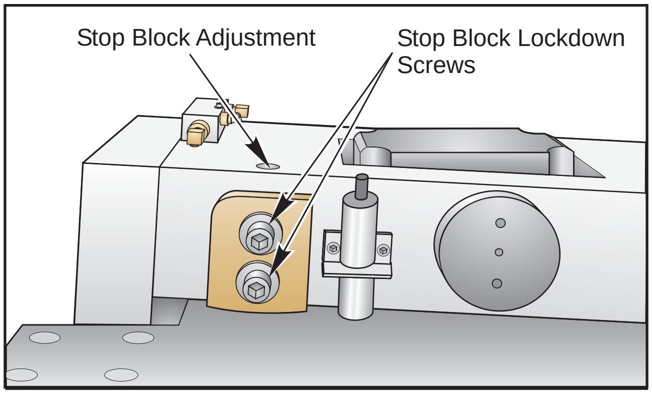
2. Press Setng/Graph and turn Setting #7 Off. Press Alarm/Mesgs, type Debug, and press Write/Enter. Change Parameter 517 to zero.
3. Press Zero Return, type "C" and press Zero Single Axis.
4. Set Parameter 278 (C-axis drive) to zero, which will prevent the actuator block from engaging the C-axis. Set Parameter 498 (C-axis Disable) to one.
5. Command M19 (spindle orient) in MDI mode.
6. Engage the actuator block by applying pressure to the in-line regulator. Set the pressure to 45 PSI. Observe the mesh gear contact, ensuring full contact and smooth mesh of gears. If necessary, move the drive gear by hand to ensure full gear mesh.
7. Press Posit, and use page up or down to find "Pos-Raw Dat 1 data page. Locate the "C" Axis Actual column and record the value. Replace the value in Parameter 517 (C-axis Grid Offset) with this number. This value should be between 0 and 1260.
8. Release the air from the actuator block and set Parameter 498 back to zero. Zero Return the C-axis; the value in the raw-data page Actual column should now read zero.
9. Engage and disengage the actuator block several times and insure that the gears are meshing smoothly, observe the raw data Actual column to ensure it remains at zero.
10. Disconnect the regulator from actuator block and reconnect normal air supply, enable Parameter 278 bit 27 C-axis drive.
11. Press MDI/DNC and enter the following program:

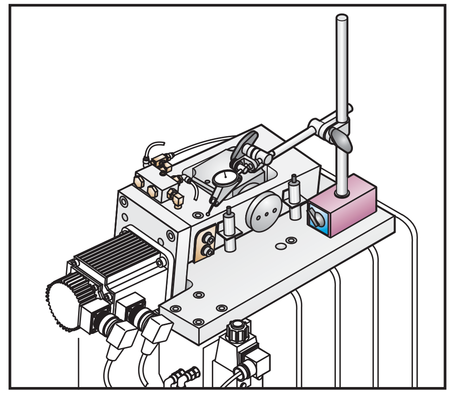
    M154;
    M155;
    M99;

12. Press Reset then Cycle Start. The machine should orient the spindle, and engage and disengage the C-axis without fault. If the machine displays an alarm, double check the grid offset and spindle encoder pulley for proper operation.

Setting Gear Mesh Contact Load

1. Install the in-line air regulator to the actuator block, adjust the air pressure on the regulator to 45 PSI. Activate the air supply to the C-axis pivot block.
2. Loosen the two stop block lockdown screws, located on the side of the pivot stop block. Remove stop block adjustment set screw and apply one drop of Loctite to the threads.





3. Install the set screw, but do not put pressure on the stop block. Place a magnetic base indicator on top of the spindle head and rest the indicator finger on top of the pivot block.
4. Handle Jog the C-axis and observe the indicator. If runout is over .0001" in 360° check the grid offset and/or servo motor installation. If the grid offset and servo motor installation are correct and the runout is still over .0001" in 360°, inspect the driven gear for damaged teeth.
5. Once the proper runout is achieved, set the indicator finger to zero at the lowest point of the runout. Screw down the adjustment set screw until the pivot block is .0005" from the gear mesh contact point.
6. Tighten the two SHCS stop block lockdown screws, located on the side of the pivot stop block. Torque to 35 ft-lb. Reconnect the C-axis air supply from the C-axis solenoid.

Auto Door Removal and Replacement (Lathe & Vert.)

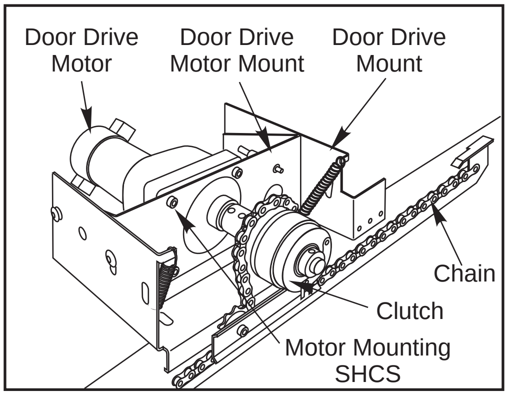
The following section describes the removal and replacement of the Auto-Door motor, clutch, and chain, and how to adjust the action of the door.

Motor Replacement

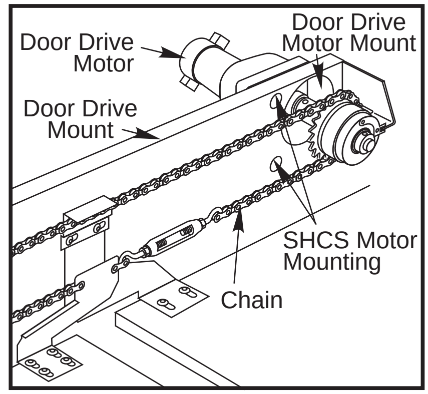
Motor Removal

1. Shut off power to the machine.
2. Detach the motor cable from the extension cable (33-1312 for Lathe, 33-1320 for Vert.).
3. a. **Lathe:** Loosen the front two FBHCS on the door drive mount. This will loosen the tension on the chain.

   b. **Vert:** Rotate the turn buckle to loosen the tension on the chain and remove the chain from the clutch sprocket.
4. Detach the clutch and shaft adapter from the motor shaft by loosening the two SSS on the shaft adapter.
5. Remove the four SHCS and lock washers that mount the motor to the door drive motor mount and remove the motor.



Lathe



Vertical Mills

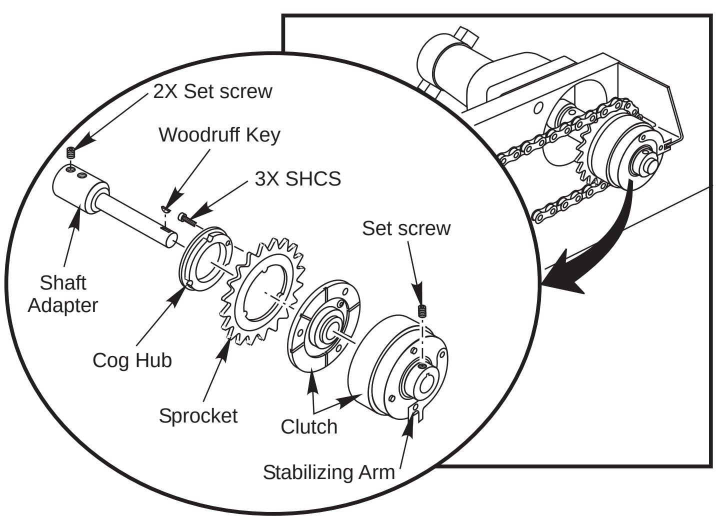
Motor Replacement

1. Remount the motor to the motor mount in the same manner in which it was removed.
2. Remount the clutch with the shaft adapter to the new motor. **Lathe:** Hook the stabilizing arm of the clutch to the prong on the door drive chain retainer.
3. Reassemble the chain to the motor assembly (see the Chain Replacement and Adjustment section).
4. Reattach the motor cable to the extension cable (33-1312 for Lathe and 33-1320 for Vert.).

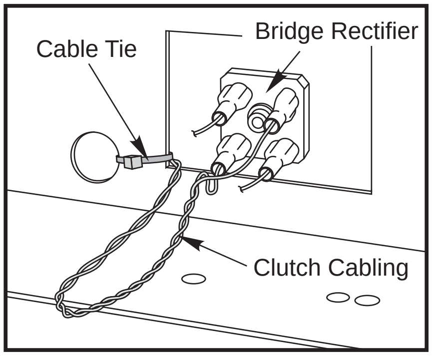
Clutch Replacement

Clutch Removal

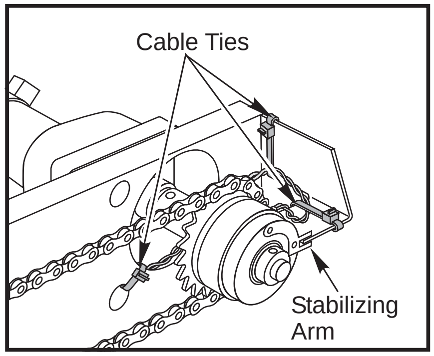
1. Turn off power to machine. Unplug both of the clutch cables from the bridge rectifier on the motor mount.
2. **Lathe:** Loosen the front two FBHCS on the door drive mount. **Vert:** Turn the turn buckle. This will loosen the tension on the chain. Remove the chain from the sprocket on the clutch assembly.
3. Cut the cable ties that fasten the clutch cable to the motor mount. Loosen the two set screws on the shaft adapter and remove the clutch assembly.
4. Loosen the set screw on the front end of the clutch assembly and dismantle the clutch with the sprocket from the shaft adapter. Be careful not to lose the woodruff key on the shaft.
5. Remove the three SHCS that fasten the sprocket and cog hub to the clutch (the clutch is in two parts).



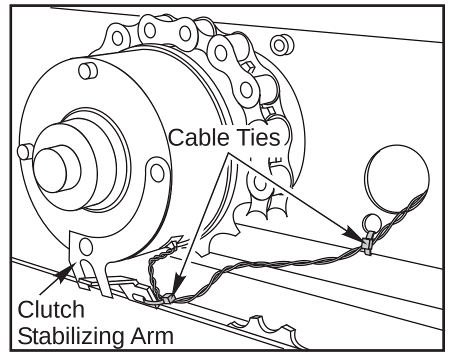
Vertical Machine Clutch Replacement



Bridge Rectifier and Cable Ties



Vertical Machines



Lathe

Clutch Replacement

1. Replace the clutch in the same manner as which it was removed. When tightening the set screw on the clutch, make sure that the sprocket turns freely.

   Lathe: Hook the stabilizing arm of the clutch to the prong on the door drive chain retainer.

   Vert: Hook the stabilizing arm of the clutch to the flange on the right side of the door drive mount.

2. **Lathe:** The clutch sprocket should be aligned with the nylon derailers (sprockets) on the chain rail.
3. Fasten the clutch cable with ties.
4. See the Chain Replacement and Adjustment section to reattach the chain.
5. The clutch must be run-in after the clutch has been installed and the chain adjusted properly. To do so, manually open the door. While holding the door open command the door to close. This can be done by pushing a button on the side of the pendant or executing a program. Hold the door open until the machine alarms out. Repeat this three times; this will seat the clutch.

Chain Replacement and Adjustment

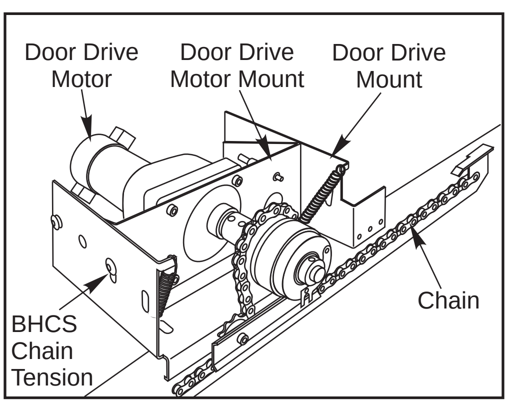
Chain Removal

1. Shut off power to the machine.
2. a. **Lathe:** Loosen the front two FBHCS on the door drive mount. This will loosen the tension on the chain.

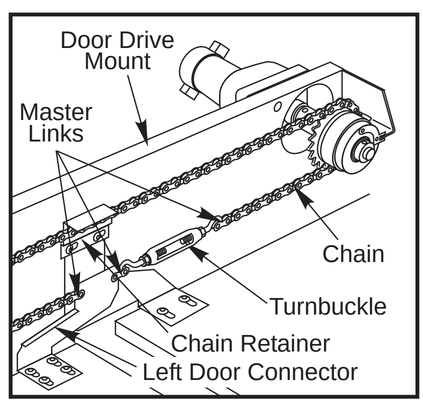
   b. **Vert:** Remove the two FBHCS that fasten the chain retainer to the right door connector.

3. a. **Lathe:** Detach the master chain link from both sides of the chain rail and remove the chain.

   b. **Vert:** Detach master chain link from left door connector and from turn buckle, and remove the chain.



Lathe Chain



Vertical Chain

Chain Replacement

1. a. **Lathe:** Replace the chain by fastening the left and right master links to the chain rail on both ends.

   b. **Vert:** Reattach the chain to the left door connector and to the turn buckle. Make sure that the chain is placed over the sprocket on the left end of the rail and over the sprocket on the motor assembly.

2. **Lathe:** Run the chain under the nylon derailers (sprockets) and over the sprocket on the motor assembly.
3. **Vert:** Replace the chain retainer.
4. a. **Lathe:** Adjust the chain tension by pivoting the motor assembly on the back two screws and tighten the front two FBHCS on the door drive mount. There should be about 1/8" [32 mm] clearance between the chain and the chain rail.

   b. **Vert:** Adjust the tension with the turn buckle.

5. Actuate the door manually to test the door movement. If the chain can be heard grinding on the sprockets, it is too tight. Adjust the chain tension as necessary.

Auto Door Parameters

The movement of the Auto-Door is controlled by Parameters 235, 236, and 251 for the Lathe, and Parameters 292, 293, and 251 for the mill. See the Parameters chapter in the Electrical Service Manual.

Adjust the parameters to assure that the door opens and closes properly:

1. Be sure that Setting 131 is set to on.
2. Set Parameters 235, 236 (lathe) or 292 and 293 (mill) to a value of 3 (50ths of a second).
3. Set Parameter 251 to a value of 3000. This number means that the door travel time will be 3 seconds. The time needed to fully open or close the door depends on the size of the machine.
4. Test the door by running a short program:
   ```
   G04 P3.;
   M30;
   ```
5. When closing, the door should stop about one inch [25.4 mm] before reaching the end. Adjust Parameter 251 as necessary.
6. Adjust parameters 292 and 293 (mill), 235 and 236 (lathe) or as necessary for proper closure.

Enclosure Replacement (Vert.)

Please read this section in its entirety before attempting to replace the doors or windows.
Tools Required: Trim installation tool (dull-edged knife or caulking spatula).

Door Replacement

CAUTION! Doors are heavy; have two people performing this operation, if possible.

Removal

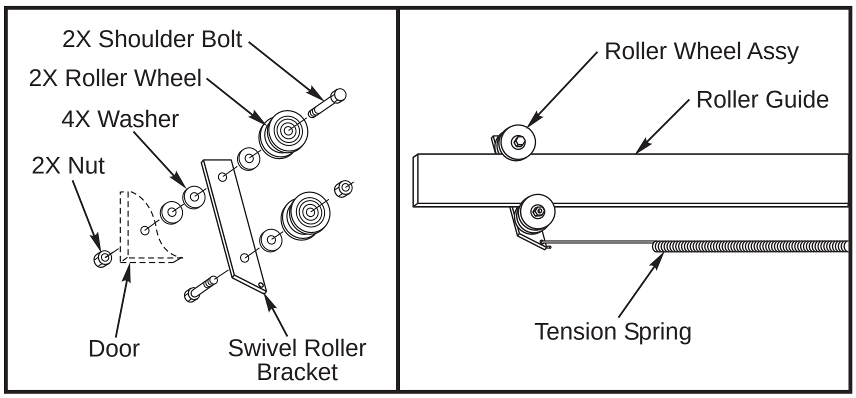
1. Turn the machine power off.
2. Slide the doors to the full open position.
3. Remove the tension springs (2) connecting the two swivel roller brackets at the top and bottom of the door.
4. Slide the door to the fully closed position. Loosen the two upper roller hex nuts, and disengage the upper swivel roller brackets from the top roller guide.
5. Lift the door from the bottom roller guide and remove.

Installation

1. Ensure that the lower roller hex fasteners are tight and the upper roller fasteners are loose and in the middle of their adjusting slots. Place the door into the enclosure, and position with the lower rollers resting on the lower roller guide.
2. Rotate the door to the upright position, and engage the top rollers onto the top roller guide.
3. Replace the tension springs onto upper and lower roller swivel brackets. Tighten the upper roller fasteners.
4. Verify that the door travels smoothly. If it does not:

   • Check that all roller wheels are seated and roll on their tracks.

   • If all roller wheels are seated on their tracks, it will be necessary to adjust the door travel by loosening the upper and lower roller hex fasteners.



Roller/Roller Guide Assembly

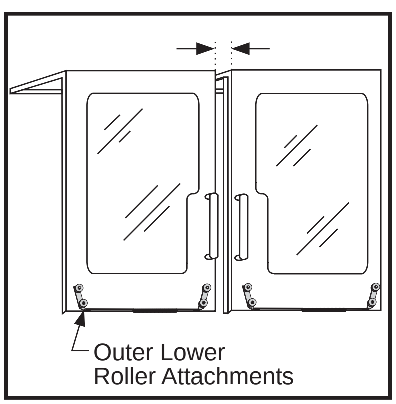
Door Adjustments

5. Close both doors and check that the vertical gap between them is uniform. If it is not:

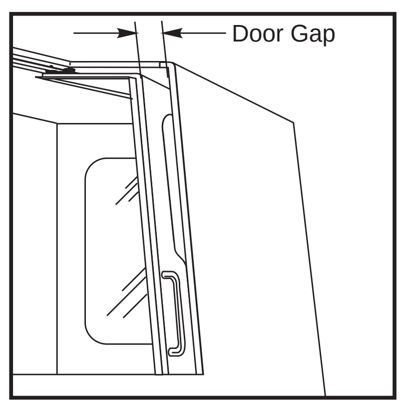
   • Determine which door must be adjusted.

   • Loosen the door's outer lower roller attachment and pivot the door on the inner lower roller wheel.

   • When door is in the desired position (the vertical gap is uniform), tighten the lower outer roller fastener.



Vertical Gap Between Front Doors



Gap Between Front of Door and Front Panel Flange

6. Check the gap between the door and the front panel flange, and verify it is 5/8" throughout the travel of the door. If it is not, loosen door's upper roller fasteners and tilt door forward or back, as necessary, to adjust position.

Door Open Sense Switch

The Door Open sense switch is a magnetic reed switch type. These switches are normally closed and wired in series. When a door is open, the switch(es) will open and the machine will stop. When the door is closed again, operation will continue normally.

CAUTION! A door hold will not stop a tool change operation or a tapping operation, and will not turn off the coolant pump.

Also, if the doors are open, the spindle speed will be limited to 750 RPM (500 RPM for lathes).

The Door Hold function can be temporarily disabled with by turning Setting 51 **On**, if Parameter 57 bits Door Stop SP and Safety Circ are set to zero, but this setting will return to Off when the control is turned off.

Switch Adjustment

1. Move the door to the fully closed position. Go to the Diagnostics page on the control panel, and ensure Door S reads 0. Open the door, and ensure Door S reads 1. If either reading is incorrect:

   • Loosen the SHCS that mounts the switch actuator bracket to the top of the door. Note that it is possible to access this bracket from the side window.

   • Move the bracket in its slot to the proper position and tighten the SHCS.

Steady Rest Alignment and Adjustment

If the clamp handle does not properly lock the steady rest in place, the tension bar needs to be adjusted.

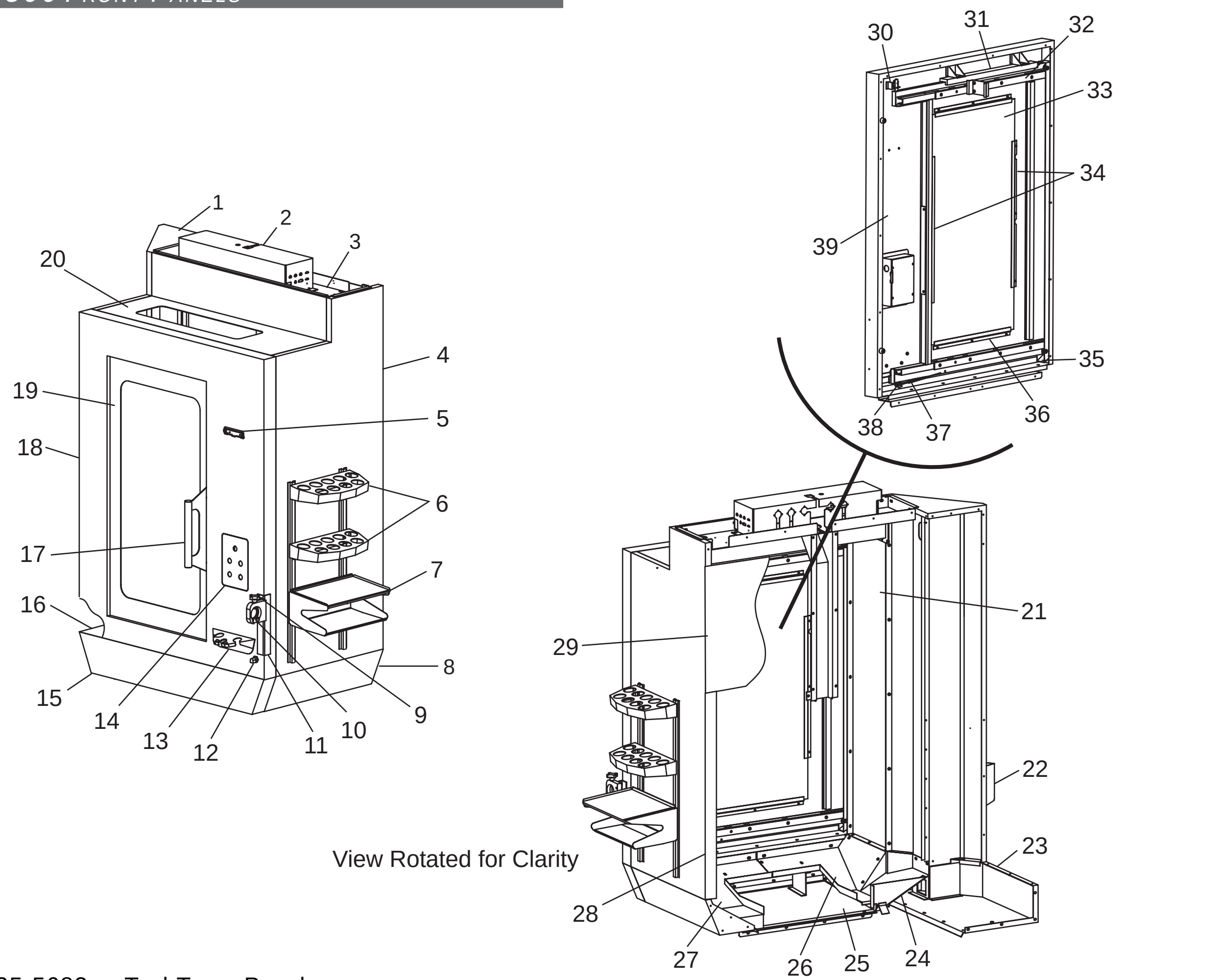
1. Remove the 1 1/8" cap nut from the clamp handle and orient the handle in the un-clamped (vertical) position.
2. Grip the tension bar and adjust in a counterclockwise direction so that the clamp will move closer to the base, creating more tension.

NOTE: Make sure that the tension bar is not so tight that the steady rest will still move in the unclamped position, but will properly lock in the clamped position.

3. Re-install the cap nut.

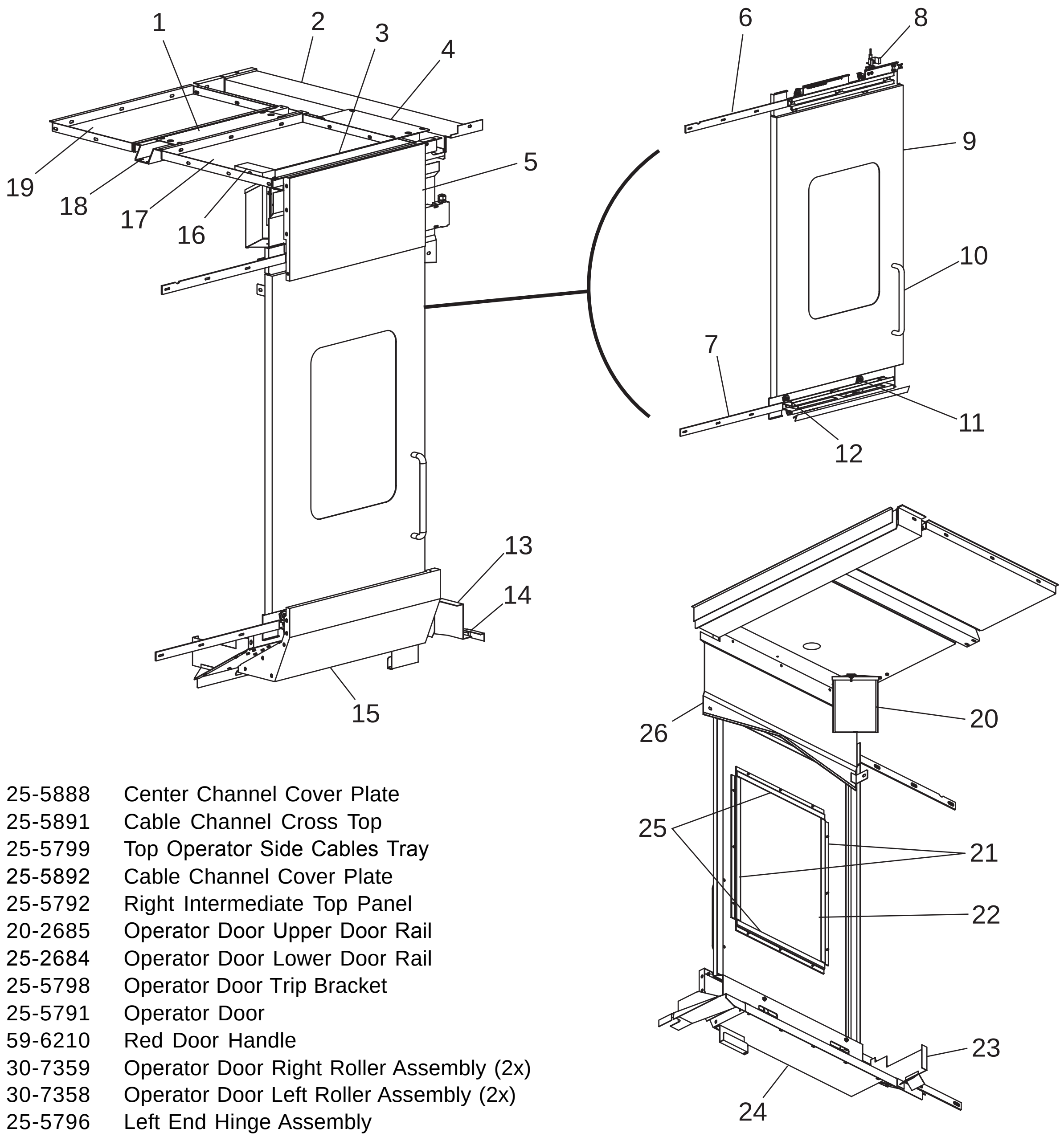
HORIZONTAL MILL ASSEMBLY DRAWINGS AND PARTS LISTS

EC-300 Front Panels



1.	25-5682	Tool Trays Panel
2.	25-5683	Intermediate J-Box Top Cover
3.	25-5681	Intermediate Top Cover
4.	25-5678	Front Right Panel
5.	59-0123	Sanders K 18 Wire Clip
6.	25-0440	Tool Tray (2x)
7.	25-6182	Front Table
8.	25-5740	Front Right Pan
9.	59-0278	Knob Head 3/8-16 x 1-1/4 Dog Point Screw
10.	20-1341	Tool holder Block
11.	25-0798	Tool Holder Bracket
12.	58-1671	Nipple 1/8 NPT x2
	58-3618	Street Elbow ¼, 90 degree
13.	25-5412	Nozzle Holder Bracket
14.	25-1257	Front Panel Switch Box
15.	25-5741	Front Center Pan
16.	25-5739	Front Left Pan
17.	25-1292	Door Handle
18.	25-5809	Center Front Panel
19.	30-7148	Front Door Assembly
20.	25-5680	Front Panel Top Cover
21.	25-5679	Front Left Panel
22.	25-0563	Tool Box Assembly
23.	25-5738	Left Intermediate Pan
24.	25-5786	Left Chip Shield Pan
25.	25-5742	Center Bottom Pan
26.	25-5784	Front Left Chip Shield Pan
27.	25-5785	Front Right Chip Shield Pan
28.	25-5806	Operator Door Tunnel
29.	25-5893	Panel Top Partition
30.	32-2300	Proximity Limit Switch –Door Open
31.	20-2696	Front Door Guide Bar
32.	20-2317	Rail Load Station (2x)
33.	28-0165	Front Door Window
34.	25-0668	Side Window Retainer (2x)
35.	59-6400A	Guide Wheel
	49-2015	PTHS ¼-20x7/8
	49-0015	NVT
	45-16390	Washer
36.	25-0669	Top-Bottom Window Retainer (2x)
37.	59-9743	Front Door Spring
38.	30-2009	Lower Right Corner Roller Assembly
39.	25-5810	Front Door

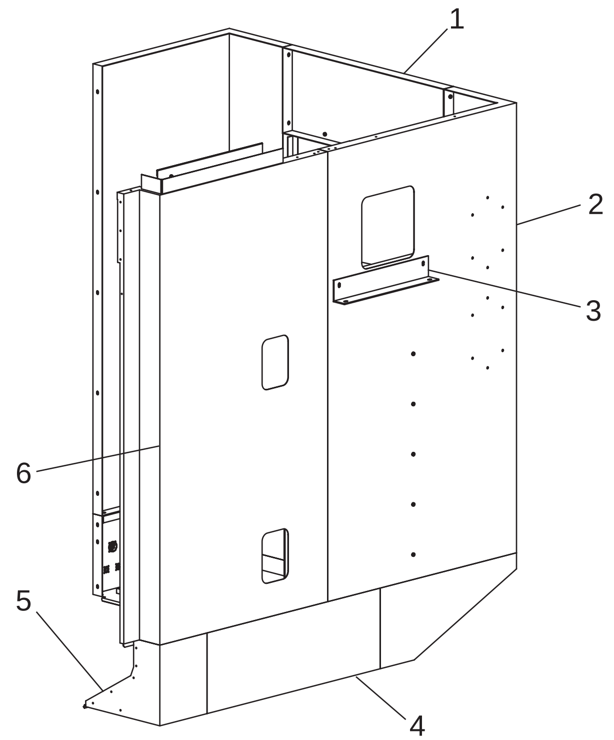
EC-300 Operator Door Panels

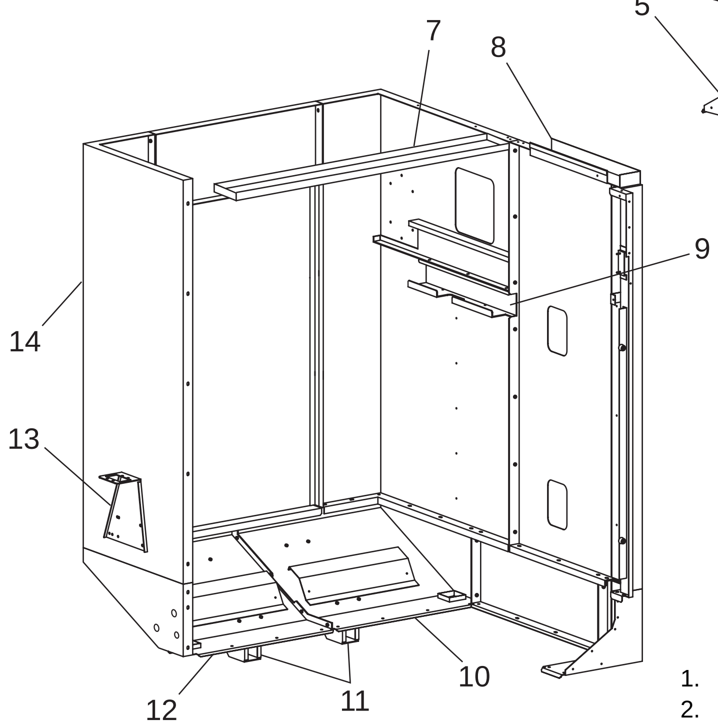


View Rotated 180° (Looking Up)

1.	25-5888	Center Channel Cover Plate
2.	25-5891	Cable Channel Cross Top
3.	25-5799	Top Operator Side Cables Tray
4.	25-5892	Cable Channel Cover Plate
5.	25-5792	Right Intermediate Top Panel
6.	20-2685	Operator Door Upper Door Rail
7.	25-2684	Operator Door Lower Door Rail
8.	25-5798	Operator Door Trip Bracket
9.	25-5791	Operator Door
10.	59-6210	Red Door Handle
11.	30-7359	Operator Door Right Roller Assembly (2x)
12.	30-7358	Operator Door Left Roller Assembly (2x)
13.	25-5796	Left End Hinge Assembly
14.	25-5926	Auger Motor Cable Tray
15.	25-5788	Right Intermediate Pan
16.	25-4521	Cover Lamp Connector
17.	25-5889	Operator Side Top Cover
18.	25-5887	Top Center Channel
19.	25-5890	Tool Changer Side Top Cover
20.	32-0227	Mylar Reflector Lamp Assembly
	25-4789	Adjust Work Light Bracket
21.	25-5793	Operator Door Side Z-Frame
22.	28-0151	Operator Door Side Window
23.	25-5787	Right Chip Shield PC Wing
24.	25-5789	Operator Side Lower Chip Shield
25.	25-5228	Door Window Z-Frame (2x)
26.	25-5800	Operator Side Top Chip Shield

EC-300 Rear Panels

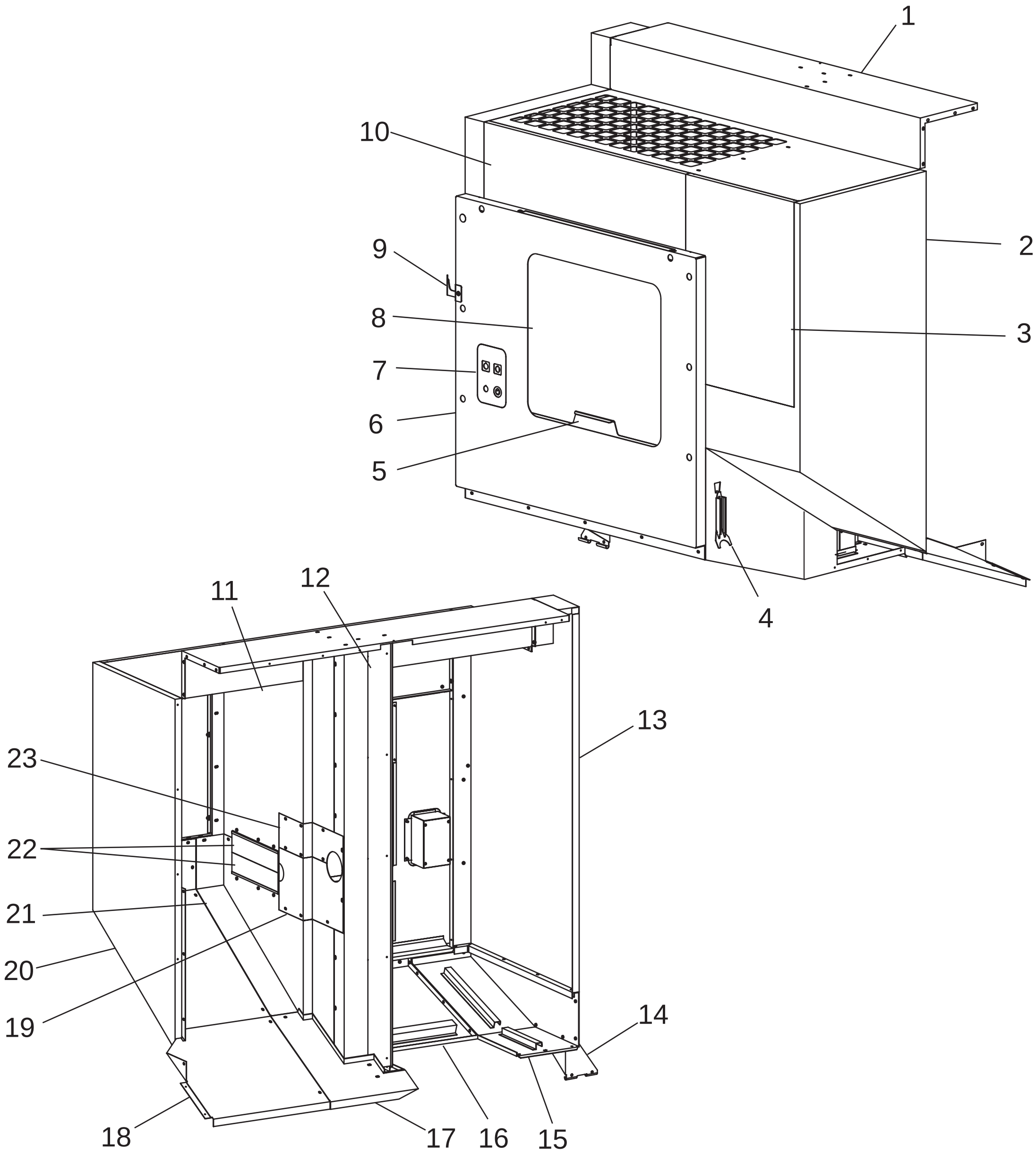




View Rotated 90° CCW

1. 25-5720 Rear Header
2. 25-5666 Rear Control Box Panel
3. 25-5722 Control Support Mounting Bracket
4. 25-5924 Control Intermediate Pan
5. 25-5665 Front Control Pan
6. 25-5667 Front Control Box Panel
7. 25-5721 Top Panel Support Brace
8. 25-5912 Control Top Panel Tray
9. 25-5896 Control Box Panel Tray
10. 25-5925 Rear Control Pan
11. 25-5897 Rear Panel Support Bracket (2x)
12. 25-5664 Rear Left Pan
13. 25-7581 TSC Filter Bracket
14. 25-5718 Rear Left Panel

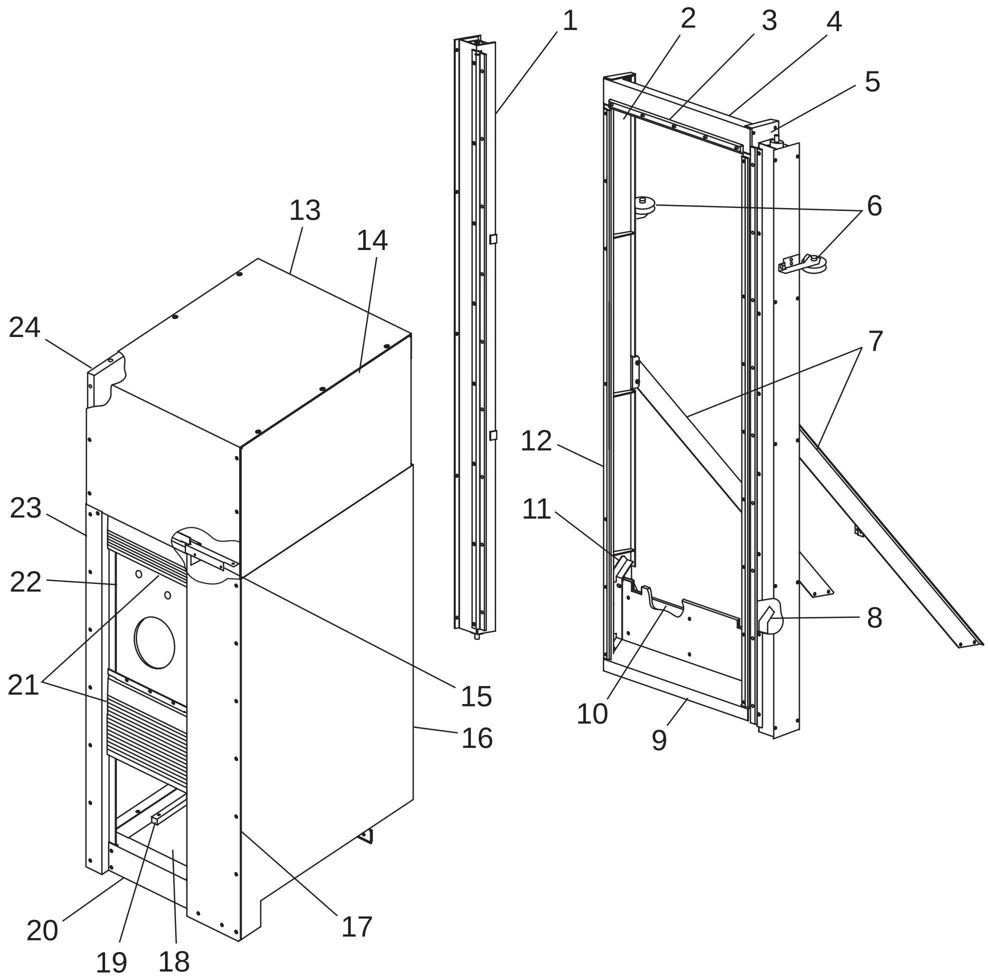
EC-300 Tool Changer Panels



View Rotated 90° CW

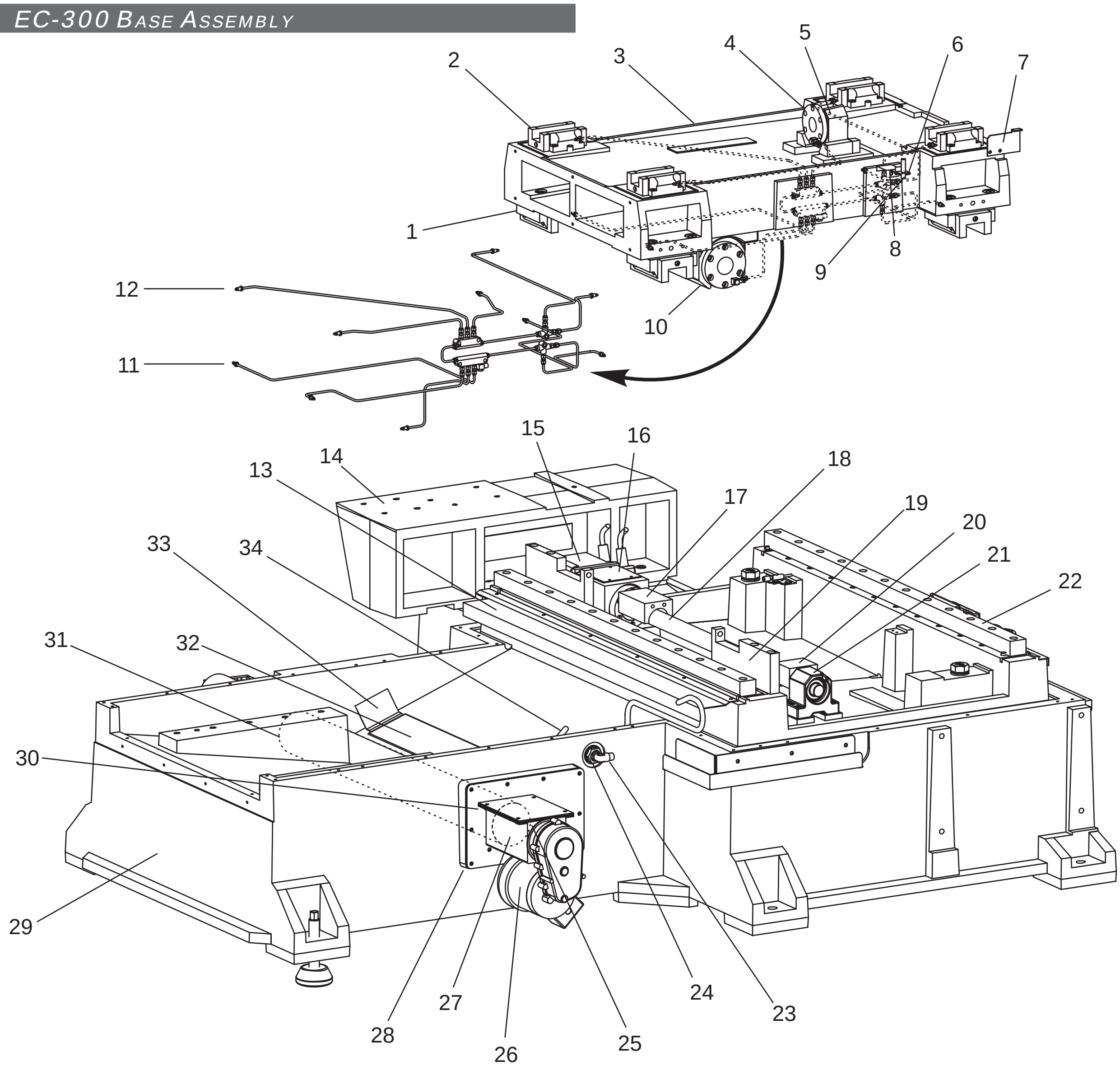
1.	25-5881	Tool Changer Top Cover
2.	25-5706	T.C. Front Panel
3.	25-5779	T.C. Side Panel
4.	25-6682	Removal Tool 40T Holder
5.	25-9248	Plate Window Handle
6.	25-5885	T.C. Access Panel
7.	32-0097	Remote Switch Box
8.		T.C. Access Window
9.	25-9262	Wash Handle Holding Bracket
10.	25-5927	T.C. Header Panel
11.	25-5777	Top Bulkhead
12.	25-5778	Mounting Bulkhead
13.	25-5709	T.C. Rear Panel
14.	25-6730	Separator Return Line Bracket
15.	25-5705	T.C. Rear Pan
16.	25-5707	T.C. Front Pan
17.	25-5804	T.C. Top Chip Shield
18.	25-5716	T.C. Front Chip Shield
19.	25-5957	T.C. Access Bottom Bulkhead
20.	25-5706	T.C. Front Panel
21.	25-5776	Lower Bulkhead
22.	26-0155	Nylon Strip Brush (2x)
23.	25-5956	T.C. Access Top Bulkhead

EC-300 Column and Frame Panels



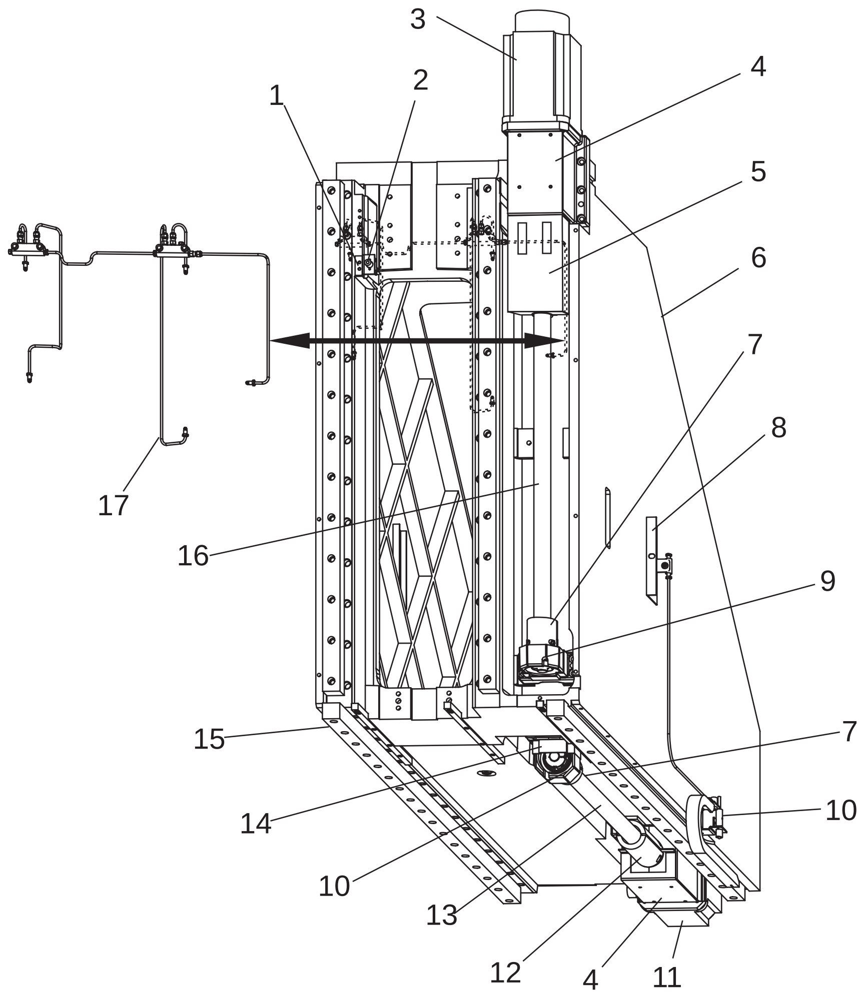
1. 59-0706 Shade Roller- 70.5" x 21" (2x)
2. 25-5833 Shade Roller Left Frame
3. 25-5837 Top Column Clamp Wiper
   26-0173 Top Column Wiper Felt
4. 25-5834 Shade Roller Top Frame
5. 25-5832 Shade Roller Right Frame
6. 30-7214 Column Frame Roller Assembly
7. 25-5773 Shade Roller Frame Brace (2x)
8. 25-5767 Right Corner Seal
9. 25-5765 Saddle Cover Front Seal
10. 25-5766 Wiper Backing Plate
    25-0169 Saddle Wiper Felt
11. 25-5768 Left Corner Seal
12. 25-5836 Column Felt Wiper Clamp (2x)
    26-0172 Column Felt Wiper
13. 25-5826 Column Top Cover
14. 25-5825 Column Top Side Cover
15. 25-5831 Gordillo Top Bracket
16. 25-5823 Column Right Cover
17. 25-5827 Gordillo Right Guide
18. 25-5829 Bottom Chip Cover Plate
19. 20-2615 Bottom Plate Bar (2x)
20. 25-5830 Bottom Gordillo Cover
21. 59-0714 Y-Axis Gordillo (2x)
22. 25-5911 Y-Axis Waycover Center Cover
23. 25-5828 Gordillo Left Guide
24. 25-5824 Column Left Cover

EC-300 Base Assembly



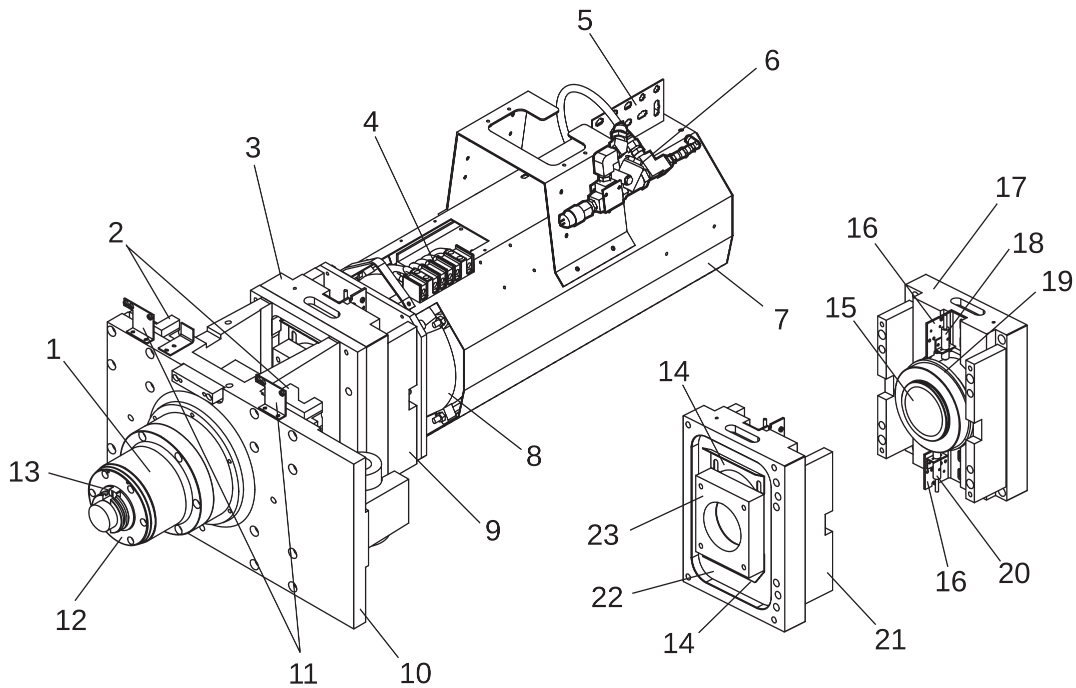
1. 50-9011 Linear Guide (truck)
2. 50-0017 Linear Guide (35mm truck)
3. 20-2587 Saddle Casting
4. 58-3600 3/8" Nipple
5. 20-7008 Nut Housing
6. 25-7267 Prox. Switch Bracket
7. 25-5780 Y-Axis Trip Bracket
8. 25-5919 Cable Carrier Bracket
9. 20-2593 Prox. Switch
10. 20-0150 Nut Housing
11. 30-7140 Base Lube Assembly
12. 30-7138 Saddle Lube Assembly
13. 25-5953 Chip Shield
14. 20-2687 ATC Mount
15. 62-0014 Servo Motor
16. 25-9203 Motor Mount Cover Plate
17. 20-2733 X-Axis Bumper
18. 30-3107 Ballscrew Assembly
19. 20-2593 X-Axis Ship Block
20. 20-2676 Ballscrew Bumper
21. 20-0152 Bearing Housing
22. 50-9011 Linear Housing
23. 58-1680 Parker Fitting
24. 58-0097 90° Fitting
25. 57-9265 Chip Conv. Bracket
26. 32-6626 Chip Conv. Motor
27. 25-5669 Auger Box
28. 57-0360 Box Gasket
29. 20-2586 Base Casting
30. 57-9265 Conveyor Gasket
31. 20-2592 Chip Auger
32. 25-5670 Auger Box Cover
33. 25-5673 Strainer Base
34. 58-0807 Coolant Nozzle Base

EC-300 Column Assembly

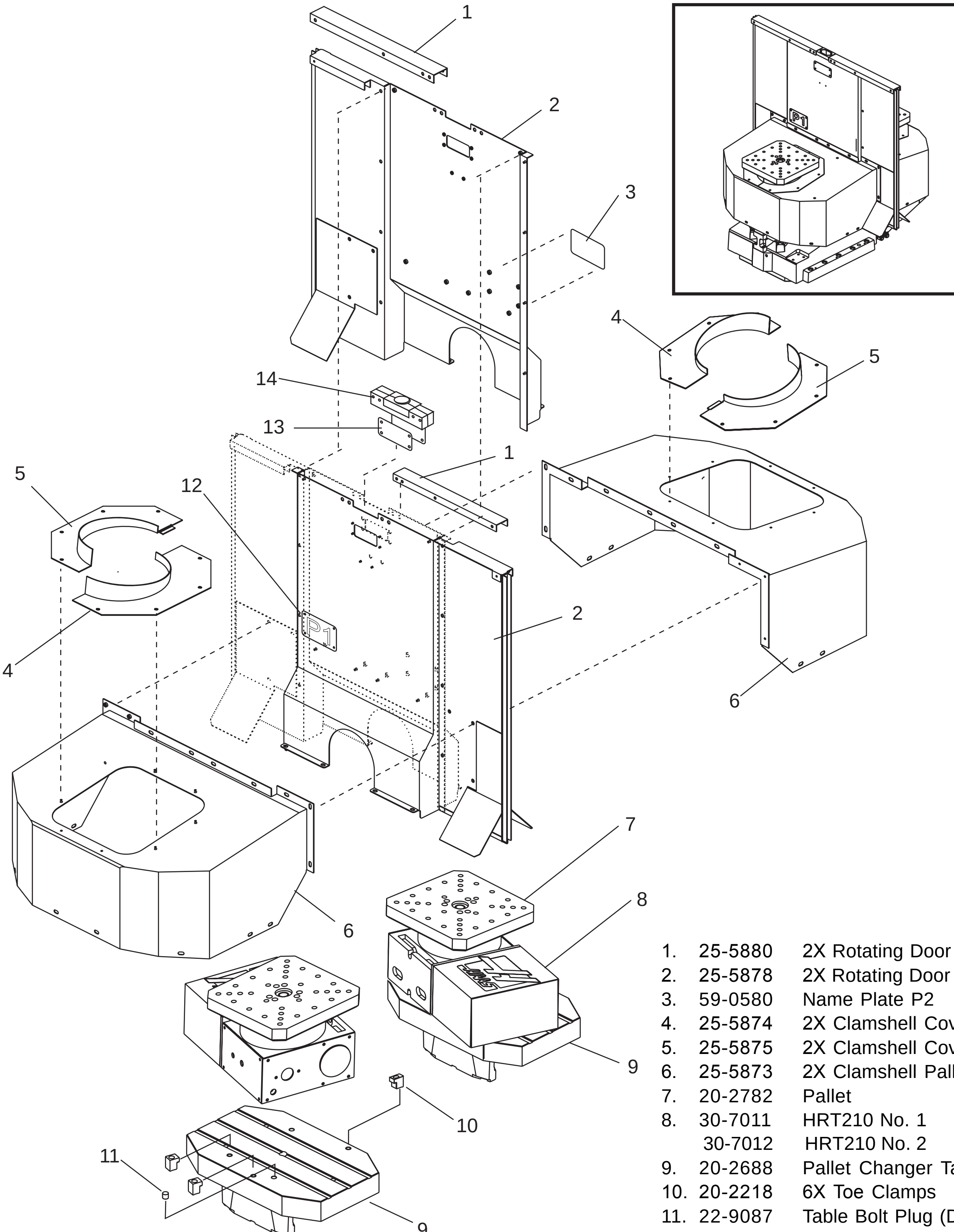


1. 25-2767 Mounting Bracket
2. 32-2130 Prox. Switch
3. 62-0017 Servo Motor
4. 25-7042 Cover Plate
5. 20-2686 Ballscrew Bumper
6. 20-2588 Column Casting
7. 20-6361 Y-Axis Bumper
8. 25-5732 Column Cover
9. 20-7009 Bearing Housing
10. 21-2131 Prox. Switch
11. 62-0014 Servo Motor
12. 20-2734 Bumper Cover
13. 24-0023 Ballscrew Assembly
14. 25-7080 Bracket
15. 50-3400 Linear Guides
16. 24-0041 Ballscrew
17. 30-6403 Y-Axis Lube Line Assembly

EC-300 Spindle Head Assembly



1.	20-7016	Spindle Housing	15.	20-1691	Shaft Inline
2.	50-0017	Linear Guide (35mm Truck)	16.	25-4648	Bracket Switch Mounting
3.	30-7441	TRP	17.	20-1693	Cylinder Inline
4.	73-3055	Terminal Buss	18.	30-2200	Prox. Switch “Unclamp”
5.	25-5242	Shroud Bracket	19.	20-1696	Spring Retain Inline
6.	30-6465	TSC Fitting Assembly	20.	30-2233	Prox. Switch “Clamp”
7.	25-6733	Motor Shroud	21.	20-2520	Standoff Inline
8.	62-3013	Spindle Motor	22.	20-1692	Piston Inline
9.	20-2520	Stand Off	23.	20-2521	Striker Plate Inline
10.	20-2674	Spindle Head			
11.	25-6592	Junction Bracket			
12.	20-7022	Spindle Lock			
13.	20-2512	Incline Spindle Shaft			
14.	25-5970	Shim			

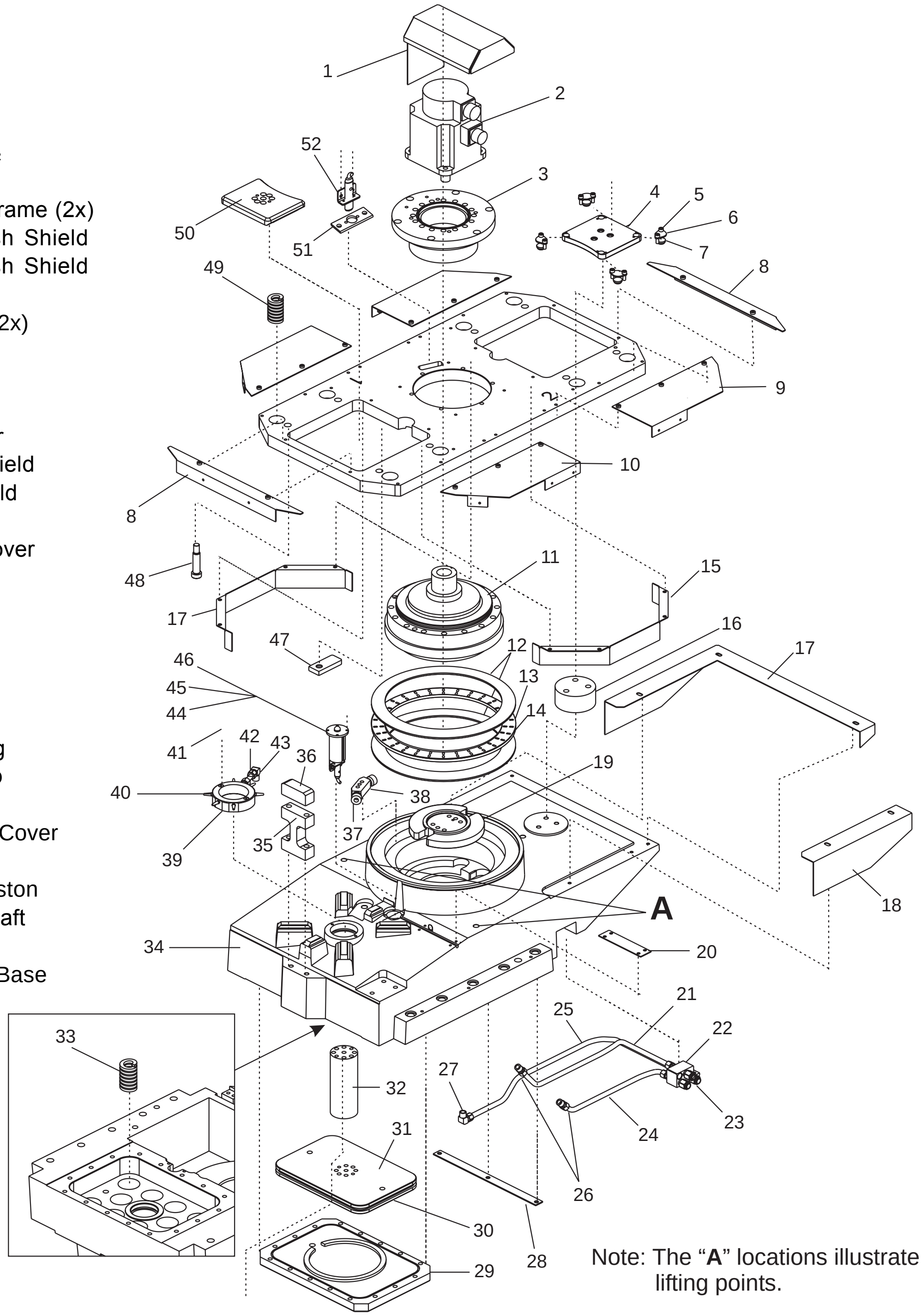


1. 25-5880 2X Rotating Door Cap
2. 25-5878 2X Rotating Door
3. 59-0580 Name Plate P2
4. 25-5874 2X Clamshell Cover Access
5. 25-5875 2X Clamshell Cover Access
6. 25-5873 2X Clamshell Pallet Cover
7. 20-2782 Pallet
8. 30-7011 HRT210 No. 1
   30-7012 HRT210 No. 2
9. 20-2688 Pallet Changer Table
10. 20-2218 6X Toe Clamps
11. 22-9087 Table Bolt Plug (Dowel Pin)
12. 59-0579 Name Plate P1
13. 25-5883 2X Rotating Access Cover
14. 20-2695 2X Rotating Door Fairlead

EC-300 Pallet Changer

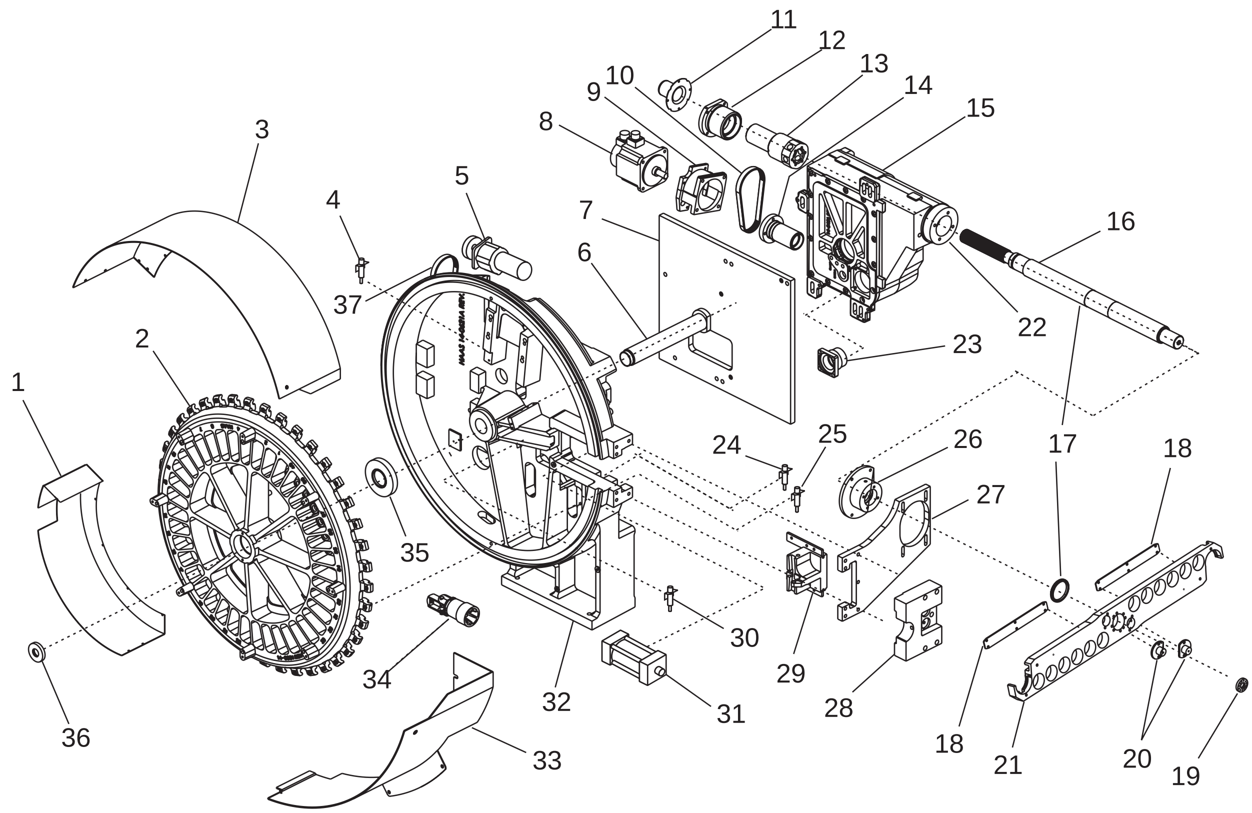
1. 25-6845 Motor Cover
2. 62-0014 Servo Motor
3. 20-2724 Motor Flange
4. 20-2812 Stabilizer Plate
5. 25-5934 Retainer Button
6. 40-1640 SHCS 10-32 x ½
7. 20-2814 Stabilizer Button
8. 20-2729 Pallet Support Frame (2x)
9. 25-5876 Clamshell Splash Shield
10. 25-5877 Clamshell Splash Shield
11. 59-0724 Harmonic Drive
12. 25-5916 Thrust Washer (2x)
13. 25-5915 Roller Cage
14. 51-0018 Bearing Roller
15. 25-5900A APC Skirt (2x)
16. 20-2813 Stabilizer Spacer
17. 25-6793 Right Clamp Shield
18. 25-6794 Left Clamp Shield
19. 20-2783 Drive Plate
20. 25-6827 Switch Cable Cover
21. 58-0779 Air Blast Tube
22. 20-2726 Bulkhead
23. 58-1693 LBO Fitting
24. 58-0778 Clamp Tube
25. 58-0777 Unclamp Tube
26. 58-3087 Comp Fitting
27. 58-3052 90° Comp Fitting
28. 25-5899 APC Cable Strap

29. 20-2719 Clamp Cylinder Cover
30. 57-2986 Piston "O" Ring
31. 20-2700 Pallet Clamp Piston
32. 20-2716 Pallet Clamp Shaft
33. 59-0727 Die Spring
34. 20-2690 Pallet Changer Base

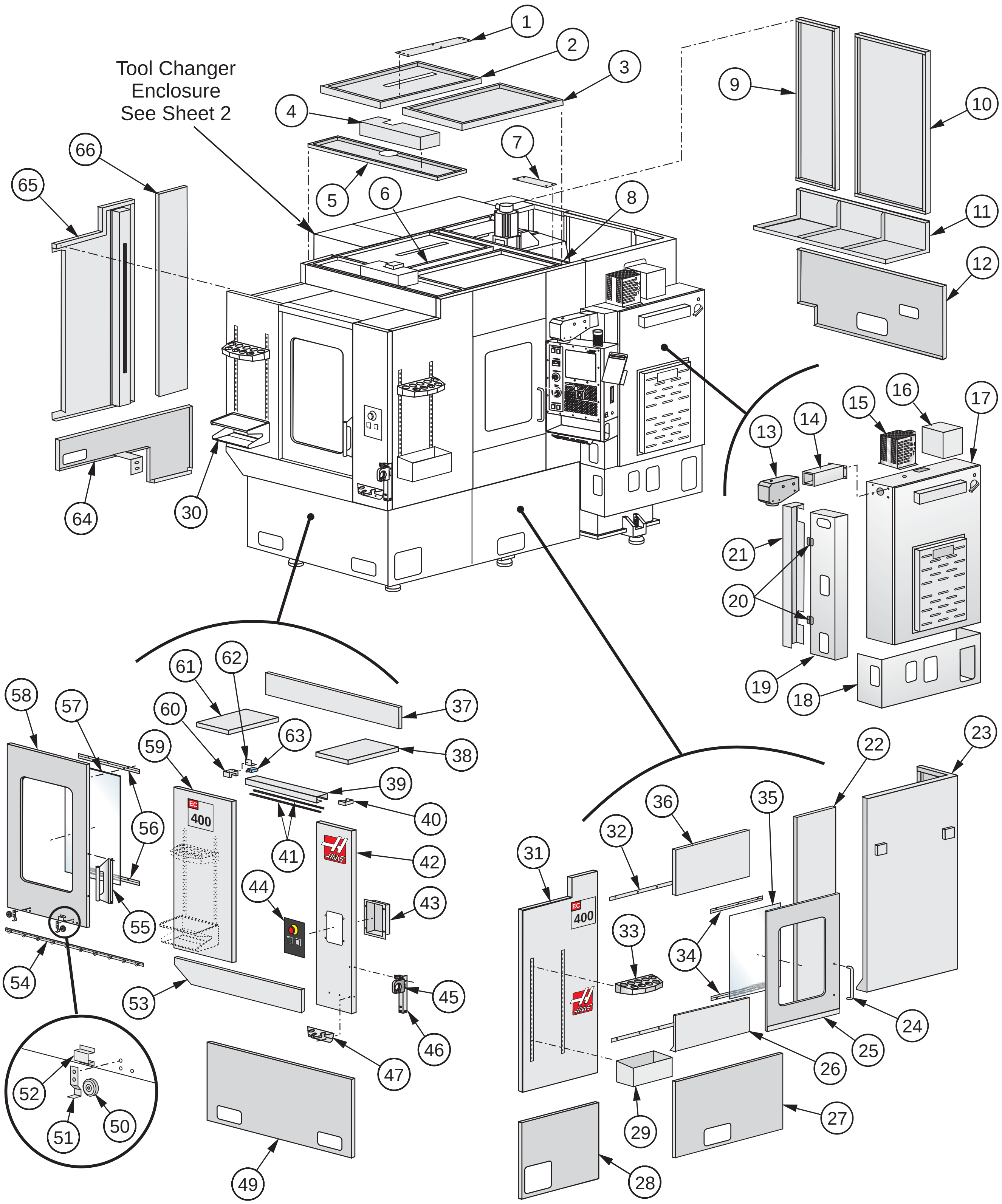


Note: The "**A**" locations illustrate lifting points.

35. 20-2785 "H" Frame Pad
36. 20-2809 Frame Button
37. 59-0725 Bumper
38. 20-2728 Stop Block
39. 20-2727 Air Blast Ring
40. 20-2582 Air Blast Nozzle
41. 40-1705 FHCS
42. 58-2070 Hex Fitting
43. 58-0780 90° Fitting
44. 20-2699 Pallet Up Plunger
45. 20-3073 Clamp Switch Housing
46. 32-2236 Prox. Switch Unclamp
47. 20-2698 Pallet Flag
48. Shoulder Bolt (2x)
49. 59-0726 Pallet Support Spring
50. 20-2715 Pallet Clamp
51. 25-5903 Prox. Pallet Mount
52. 32-2130 Prox. Home 1.5'



1. 25-4153 Rear Cover
2. 20-0731 Carousel
3. 25-4152 Front Cover
4. 32-2295 Prox. Carousel Mark
5. 32-1875 Carousel Motor
6. 20-0809 Carousel Shaft
7. 20-2759 Mounting Plate
8. 62-0014 Servo Motor
9. 20-0772 Motor Mount
10. 54-0036 Drive Belt
11. 22-0001 Output Shaft Cad
12. 20-0224 Star Bearing Housing
13. 20-0223 Star Gear
14. 20-0225 Bearing Housing
15. 30-4008 Cam Box
16. 20-2694 Output Shaft
17. 57-0059 Seal
18. 25-5805 Cover Plate
19. 20-0240 Arm Hub
20. 20-0245 Arm Cap
    20-0246 Arm Cap
21. 30-7234 Double Arm Assy.
22. 20-0238 Bearing Cap
23. 20-0226 Bearing Housing
24. 32-2251 Prox. Pocket Down
25. 32-2252 Prox. Pocket Up
26. 20-2732 SMTC Shaft Support
27. 20-2731 SMTC Support Plate
28. 20-2730 Pocket Stop
29. 20-0807 Tool Pocket Slide
30. 32-2253 Prox. Switch Tool One
31. 59-0078 Air Cylinder
32. 20-2735 ATC Housing
33. 25-0800 Shroud Corner
34. 20-0458 Tool Pocket
35. 59-0290 Lock Nut
36. 20-0392 Carousel Washer
37. 54-0045 Belt Drive


Tool Changer
Enclosure
See Sheet 2
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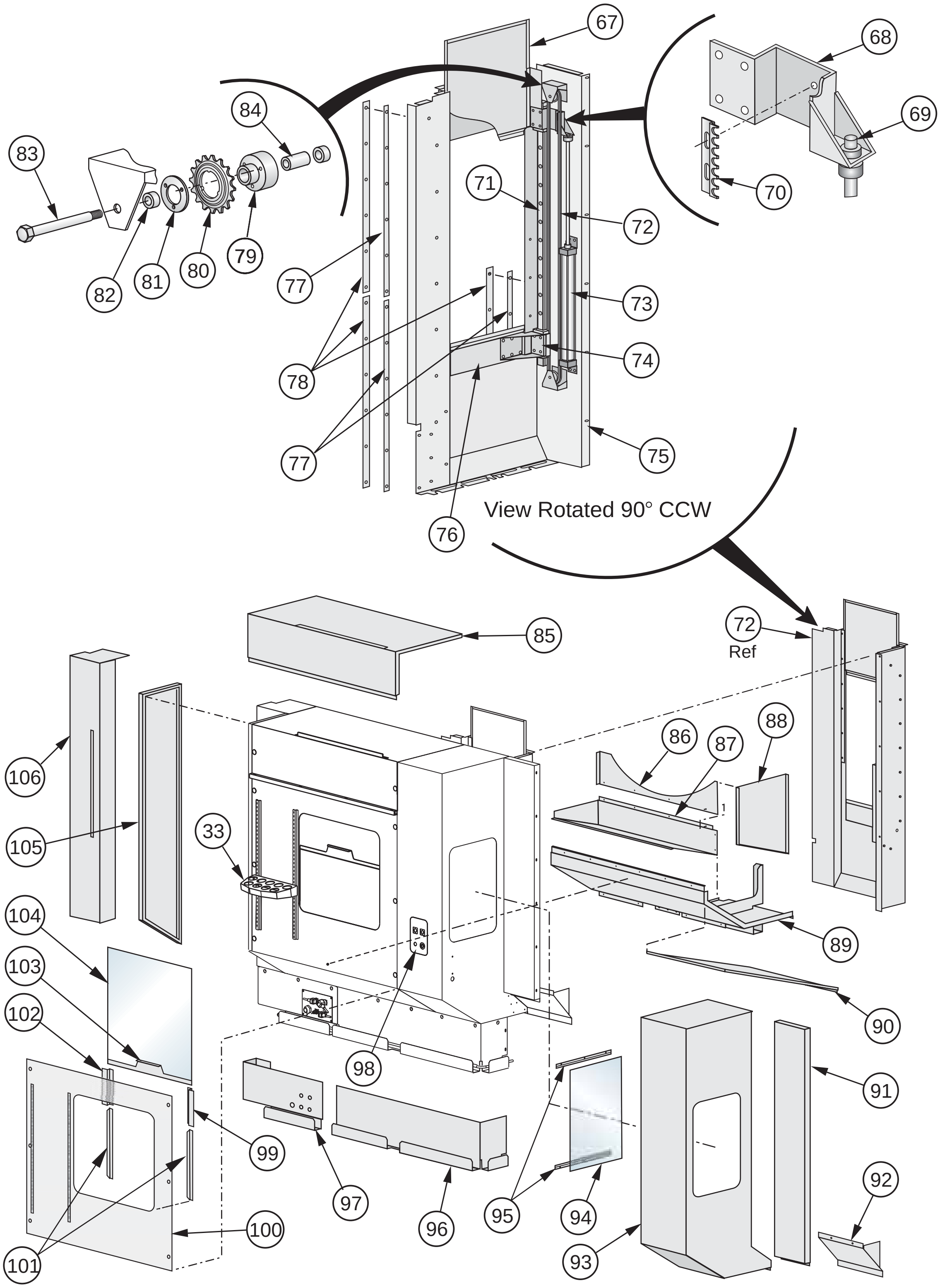
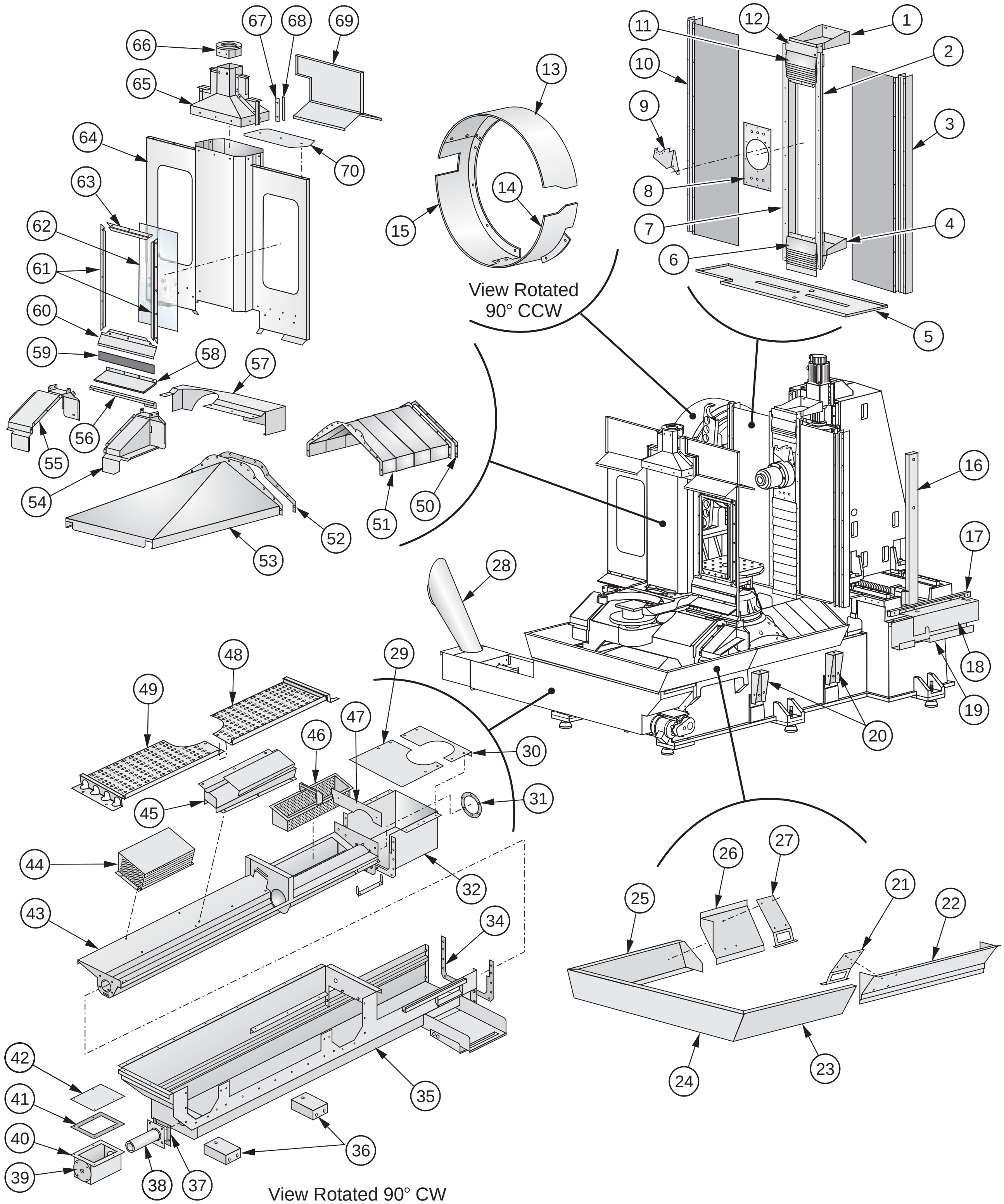
Sheet 1 of 2



Tool Changer Enclosure
Sheet 2 of 2

1.	25-4984	Wire Channel Top Cover
2.	25-4965A	Left Top Cover
3.	25-4964A	Right Top Cover
4.	25-4953B	J-Box Top Cover
5.	25-4952	Front Top Cover
6.	25-4980	Wire Channel Top Cover
7.	25-5253	Brace Top Cover
8.	25-4963	Intermediate Top Brace
9.	25-4957	Rear Center Panel
10.	25-4977	Rear Panel Access Cover
11.	25-4958	Rear Pan
12.	25-5035	Rear Apron
13.	25-6661	Pendant Levelling Assy
14.	20-1592	Pendant Arm
15.		Regen Assy
16.	25-5261	J-Box
17.		Control Box Assy
18.	25-5421	Control Box Skirt
19.	25-1133	Connector Door
20.		2X Door Hinge
21.	25-1132	Door Mounting Bracket
22.	25-4956	Right Intermediate Panel
	25-5200	Operator Door Rear chip Shield
23.	25-4938	Right Rear Corner Panel
24.	59-6210	Door Handle
25.	25-4966	Operator Door
	30-7653	4X Door Roller Assy
	59-0604	Door Spring
26.	25-5198	Operator Lower Panel
27.	25-4982	Right Rear Apron
28.	25-4970	Right Front Apron
29.	25-0563	Tool Box
30.	25-6182	Tool Tray
31.	25-4948B	Right Side Panel
32.	20-2036	Upper Operator Door Track
	20-2038	Lower Operator Door Track
33.	25-0440	Tool Crib
34.	25-5228	2X Operator Door Window Z-Frame
35.	28-0151	Operator Door Window
36.	25-4954	Right Side Header
	25-4973	Header Chip Shield
	32-2313	Door Close Switch
	25-4990	Door Trip Bracket
37.	25-4999A	Enclosure Header
38.	25-4951	Front Corner Panel Stiffener Bracket
39.	25-5456	Front Door Guide Rail
40.	20-2411	Door Stop Block
41.	59-0053	2X Edge Trim
42.	25-4969A	Front Right Panel
43.	25-1257A	Switch Box
	25-1258	Switch Box Cover
	57-0195	Switch Box Cover Gasket
44.		Switch Assy
45.	20-1341	Tool Holder
	59-0278	Knob and Screw
46.	25-0798	Tool Holder Mounting Bracket
47.	25-5412	Nozzle Holding Bracket
49.	25-4969	Front Apron
48.	Not Used50.	54-00302X Guide Wheel
51.	25-5402A	2X Door Hook
52.	25-4043	Door Stop
53.	25-4950B	Front Upper Pan
54.	20-1433	Door V-Track
	20-6016	Rail Spacer
55.	59-6210	Front Door Handle
	25-1292	Door Handle Mount
56.	25-5260	2X Front Door Window Z-Frame
57.	28-0152	Front Door Window
58.	25-4997A	Front Door
59.	25-4947A	Front Left Panel
60.	20-2410	Door Guide Block
61.	25-5420	Left Panel Stiffener Bracket
62.	25-5415	Door Guide Bracket
63.	32-5074A	Front Door Close Switch
64.	25-4971	Left Front Apron
65.	25-4949A	Left Top Side Panel
66.	25-4979	Left Intermediate Panel
67.	25-5030	TC Top Door
68.	25-5032	Top Connect Bracket
69.	59-0641	Rod Aligner
70.	25-0974	Chain Retainer
71.	50-0012A	Linear Guide
72.	54-0072	Chain 96 in.
73.	59-0612	Air Cylinder
74.	25-5033	Bottom Connect Bracket
75.	25-5029	TC Internal Panel
76.	25-5031	TC Bottom Door
77.	25-5034	3X Door Guide Spacer
78.	20-2087	3X Door Guide
79.	20-1005	2X Sprocket Adapter
80.	54-0074	2X Chain Cog 16T
81.	20-0548	2X Cog Hub
82.	22-9673	4X Spacers
83.		2X Shaft
84.	50-0075	2X Bearing
85.	25-4960B	TC Panel Header
86.	25-5284	Left Chip Shield
87.	25-4976	Coolant Drip Pan
88.	25-5283A	TC Front Chip Shield
89.	25-4961	TC Pan
90.	25-4985	Chip Shield Lower Panel
91.	25-4979	TC Intermediate Left Panel
92.	25-4987	Lower Left Panel Chip Shield
93.	25-4962	TC Panel
94.	28-0151	TC Window
95.	25-5228	2X TC Window Z-Frame
96.	25-4972	Right Rear Apron
97.	25-5247	Left Rear Apron
98.	32-1114	TC Remote Switch Box
	25-6719	Switch Box Cover
99.	25-4220	Window Rest
100.	25-5991	TC Side Panel
101.	28-0167	TC Window Extrusion
102.	25-4221	Window Rest Opposite
103.	25-9248	Window Plate Handle
104.	28-0168	TC Access Window
105.	25-4978	TC Rear Panel
106.	25-4959C	Left Rear Corner Panel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View Rotated
90° CCW
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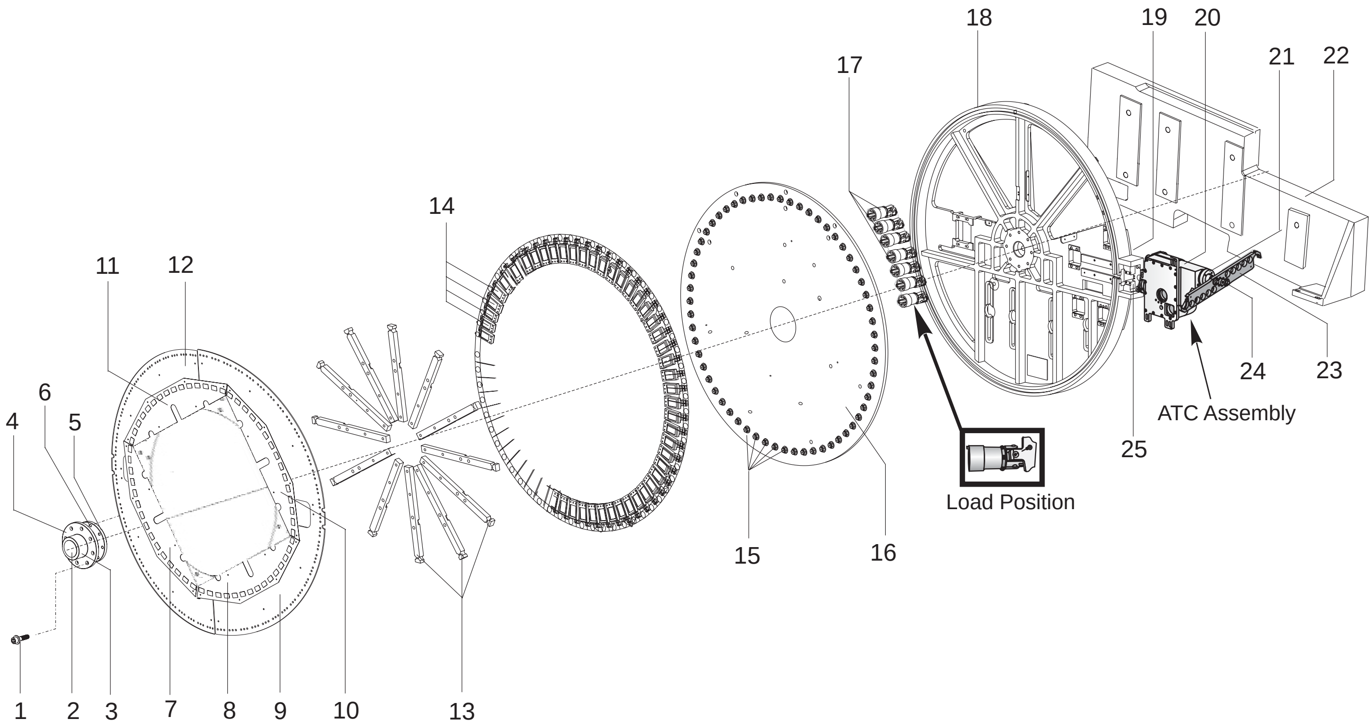
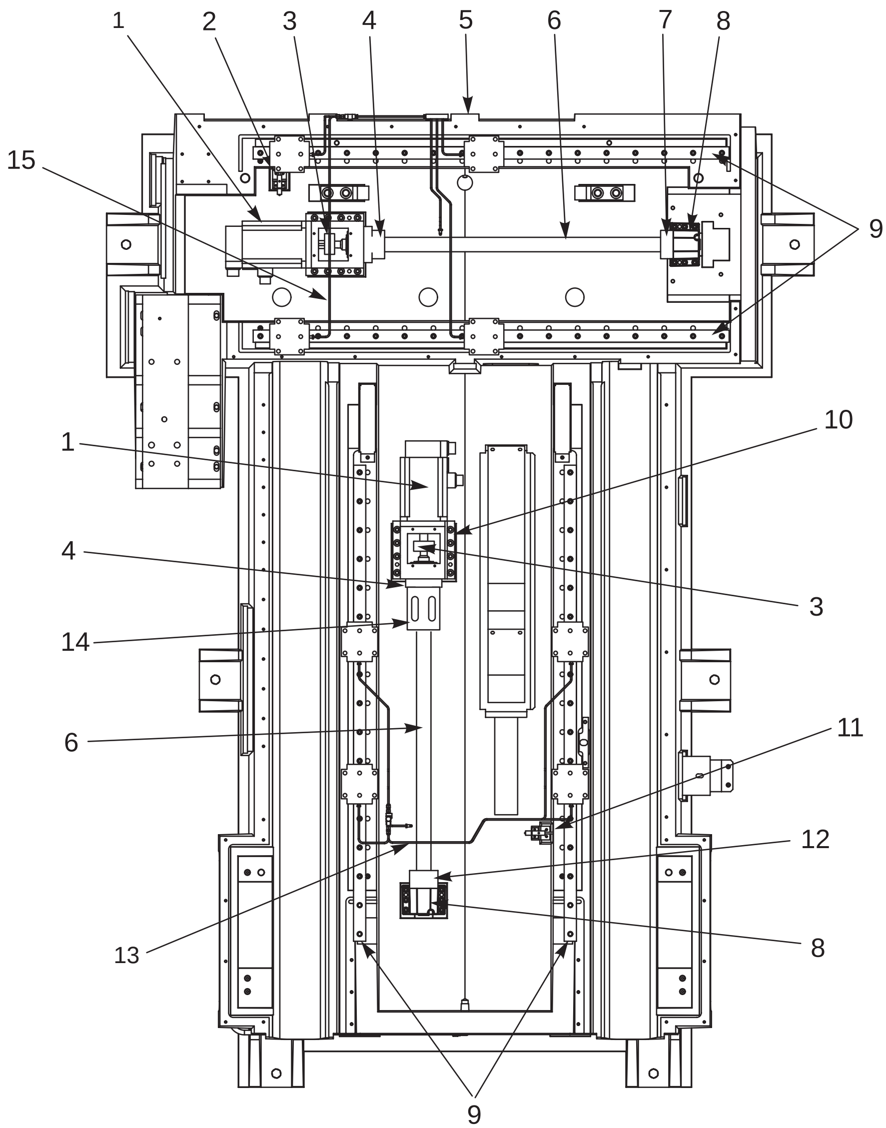
View Rotated 90° CW

1. 25-5007 Y-Axis Frame Top Bracket
2. 25-5001 Y-Axis Right Guide
3. 59-0608 Right Roll-up Waycover
4. 25-5008 Y-Axis Frame Bottom Bracket
5. 25-5006 X-Axis Bottom Shield
6. 59-0606 Y-Axis Lower Waycover
7. 25-5000A Y-Axis Left Guide
8. 25-5002 Spindle Cover
9. 25-5327 P-Cool Mounting Bracket
10. 59-0607 Left Roll-up Waycover
11. 59-0605 Y-Axis Upper Waycover
12. 20-2319A Y-Axis Frame Plate Filler
13. 25-4152A SMTC 40-40 Front Cover
14. 25-0800 SMTC 40-40 Corner Shroud
15. 25-4153A SMTC 40-40 Rear Cover
16. 20-3035 GR Ram Machined
17. 20-2031 Control Box Support Bar
18. 30-6316 Lube Panel Assy
19. 25-4942 Wire Channel Panel
20. 25-4940A 2X Panel Side Brace
21. 25-5360 Auger Keeper Right Bracket
22. 25-4967 lower right Front Chip Shield
23. 25-4994 Right Front Pan
24. 25-4981 Lower Front Pan
25. 25-4995 Left Front Pan
26. 25-4987 Lower Left Panel Chip Shield
27. 25-5361 Auger Keeper Left Bracket
28. 25-0548 Auger Chute
29. 25-5301 Coolant Trough Extension Cover
30. 25-5300 End Chute Cover
31. 57-9846 Auger Chute Gasket
32. 25-5025 Coolant Trough Extension
33. Not Used
34. 57-0334 Coolant Trough Extension Gasket
35. 25-5288 Coolant Trough
36. 25-4944 2X Auger Trough Brace
37. 57-0333 Extension Box Gasket
38. 20-2322 Auger Coupler Extension
39. 57-9265A Conveyor Motor Gasket
40. 25-5289 Auger Motor Extension Box
41. 57-0332 Extension Box Top Gasket
42. 25-5290 Extension Box Top
43. 25-5024 Auger Trough
44 25-5299 Auger Trough Screen
45. 25-5297 Coolant Channel
46. 25-5291 Chip Basket
47. 25-5521 Rear Auger Trough Seal
48. 25-5256 Front Left Auger Guard
49. 25-5255 Front Right Auger Guard
50. 57-0304 Bulkhead Waycover Gasket
51. 25-5011 Bulkhead Waycover
52. 57-0327 Waycover Gasket
53. 25-5231 Z-Axis Front Waycover
54. 25-5229 Right Bridge Chip Shield
55. 25-5230 Left Bridge Chip Shield
56. 25-5235 2X Rotating Door Right Step Shield
57. 25-5046 APC Cylinder Shield
58. 25-5237 4X Z-Axis Rotating Door Shade Seal
59. 20-2283A 2X Rotating DF Support Bar
60. 25-5233 2X Rotating Door Z-Channel
61. 25-1262 4X Partition Top z-Frame
62. 28-0043 2X Window
63. 25-4149 4X Window Z-Frame
64. 25-5232 Rotating Door Panel
65. 25-5234 Rotating Door Cover
66. 20-2284 2X Rotating Door Cable Fairlead
67. 25-5239 2X Rotating Door Retainer Seal
68. 57-0330 2X Rotating Door Cover Seal
69. 25-4983 2X Rotating Door Splash Shield
70. 25-5238B 2X Rotating Door Top Shade

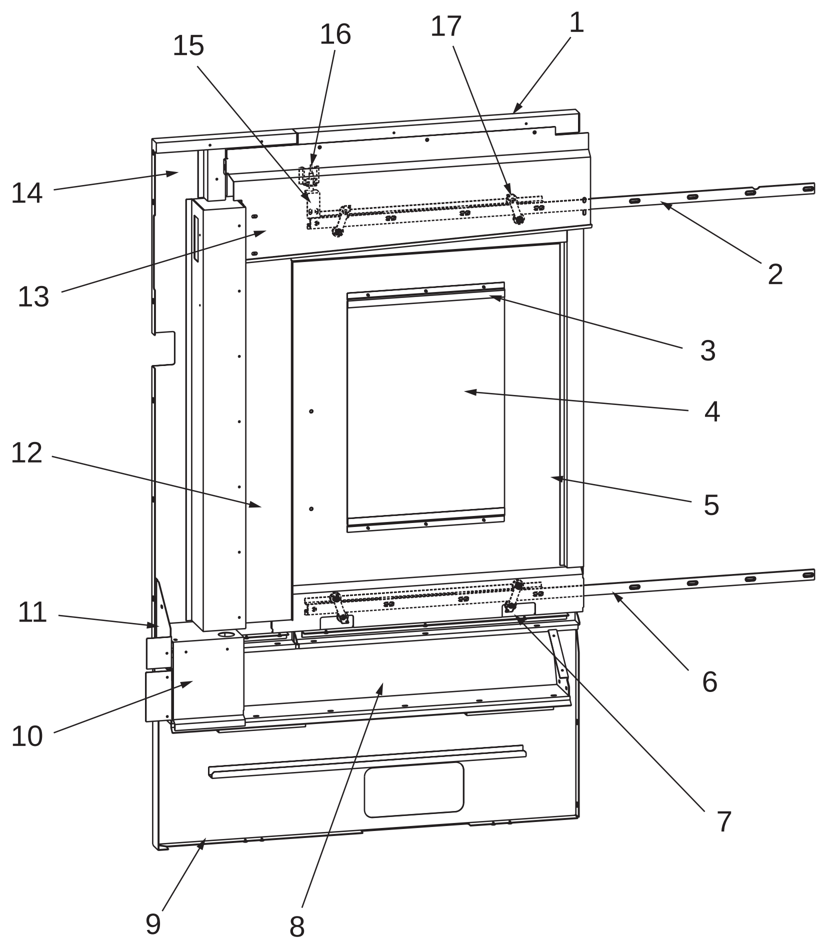


1. 40-0226 SHCS ¾"x3"
2. 59-0737 Plug Hole
3. 20-2911A Hub Index Plate
4. 20-2911A Hub Index Plate
5. 20-2868A Shaft Assembly
6. 40-1663 SHCS ½"-13x1¾"
7. 25-6029 Panel Tools (31-45)
8. 25-6030 Panel Tools (46-60)
9. 25-5998 Disk Section (1)
10. 25-6021 Panel Tools (1-15)
11. 25-6022 Panel Tools (16-30)
12. 25-5998 Disk Section (2)
13. 20-2966 Carousel Ribs
14. 20-2864A Pivot Packet
15. 51-0045 Cam Follower
16. 20-2913 Plate Index
17. 20-0458A Tool Pockets
18. 20-2828 Pocket Carousel
19. 30-0145 Cambox Assembly
20. 20-0455 ATC Cambox
21. 20-0238 Bearing Cap
22. 20-2825A Machining Mount
23. 20-2121 Double Arm
24. 20-0240F Hub Arm
25. 20-2867 Stop Pocket



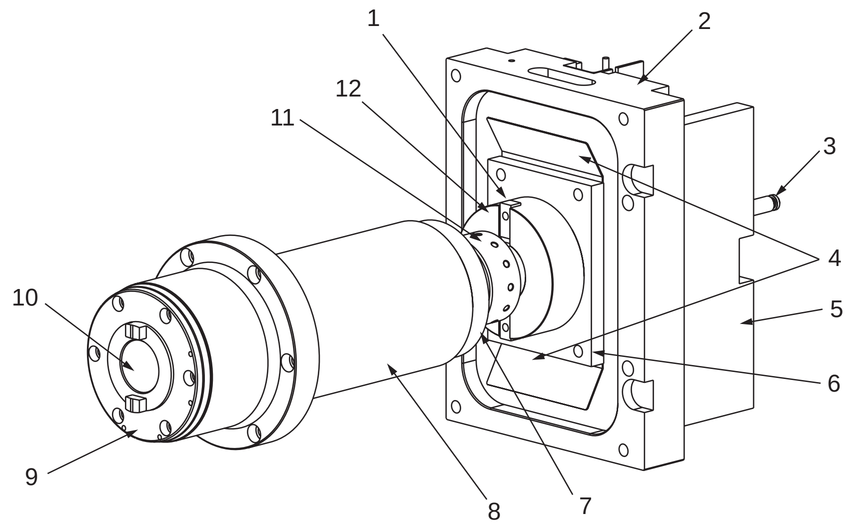
1. 62-0016 Motor
2. 32-2130 Limit Switch
3. 30-1215 Ball Screw Coupling
4. 20-9212 Bearing Housing
5. 20-2042 Casting
6. 24-0026 Ballscrew
7. 20-2084 Hard Stop X-Axis
8. 20-0152 Bearing Housing
9. 50-3400 Linear Guides
10. 20-0151 Motor Mount Assy.
11. 32-2134 Limit Switch
12. 20-2450 Z-Axis Bumper
13. 30-6336 Z-Axis Lube Assy.
14. 20-1992 Bumper
15. 30-6337 X-Axis Lube Assy.

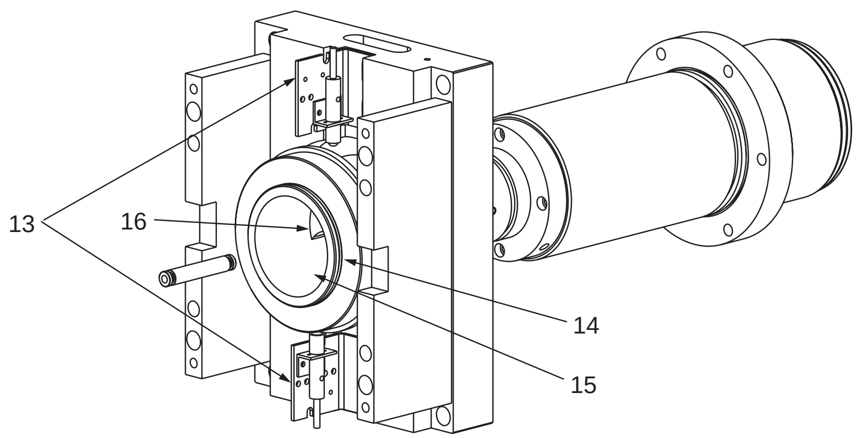
EC-400 Operator's Door



1. 25-4954 Right Side Header
2. 20-2036 Operator Door Upper Track
3. 25-5228 2X Operator Door Window Z-Frame
4. 28-0151 Operator Door Window
5. 25-4966 Operator Door
6. 20-2038 Door Track Lower
7. 25-5198 Operator Lower Panel
8. 25-4955 Right Intermediate Pan
9. 25-4982 Right Rear Apron
10. 25-5246 Chip Shield
11. 25-5245 Chip Shield Lower Operator Panel
12. 25-5200 Chip Shield Rear Operator Door
13. 25-4973 Chip Shield Header Operator Door
14. 25-4956 Right Intermediate Panel
15. 25-4990 Trip Bracket Operator Door
16. 32-2313 Operator Door Close Switch
17. 30-7653 Door Roller Assembly
    59-0604 Operator Door Spring

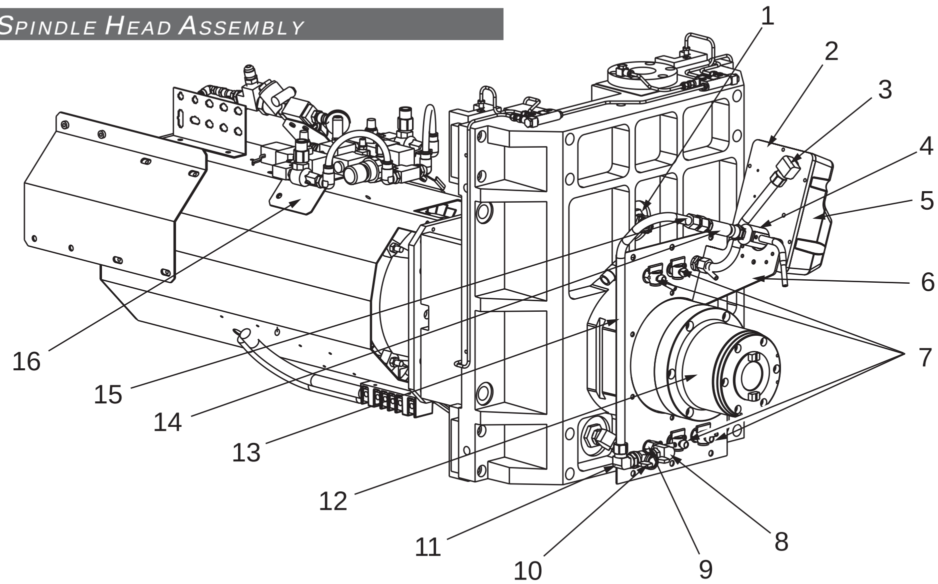
EC-400 In-Line Spindle Assembly

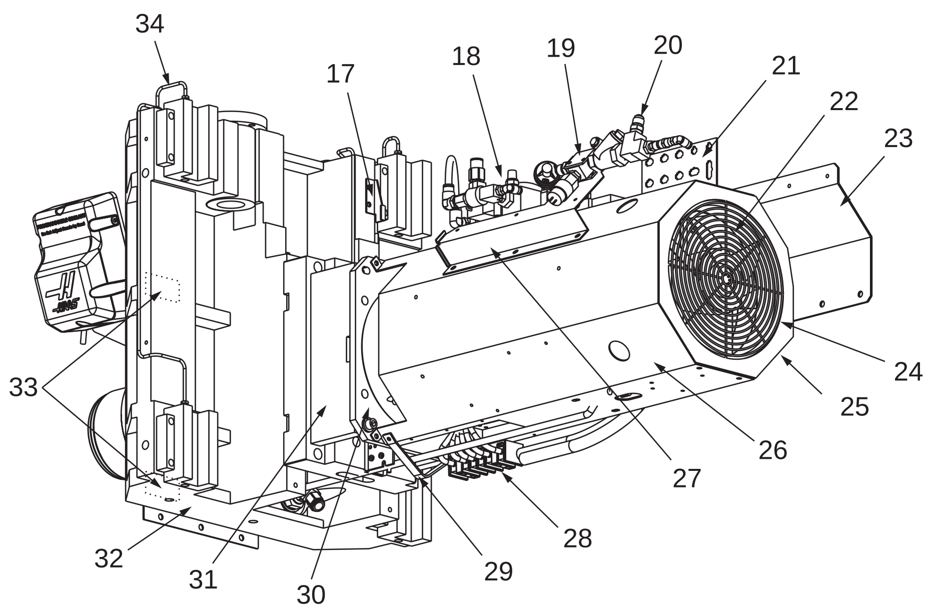




1. 20-1686A Key Drawbar Inline
2. 20-1693B TRP Cylinder In-Line
3. 20-1688 Transfer-Tube In-line
4. 25-4761 2X Shim TRP In-Line
5. 20-1694A Standoff Motor In-Line
6. 20-1690 Striker Plate Inline
7. 20-7422D Oil Injector Cover
8. 20-7016C Spindle Houseing 40T
9. 20-9763C Spindle Lock Tapered
10. 20-7018M Spindle Shaft 40T
11. 20-1684A Adapter Shaft In-line
12. 20-1687A Guide Release In-line
13. 25-4648B 2X Bracket Switch Mounting In-line Spindle
14. 20-1696A TRP Spring Retain Inline
15. 20-1691 TRP Shaft In-Line
16. 52-0040 Shaft Coupling

EC-400 Spindle Head Assembly

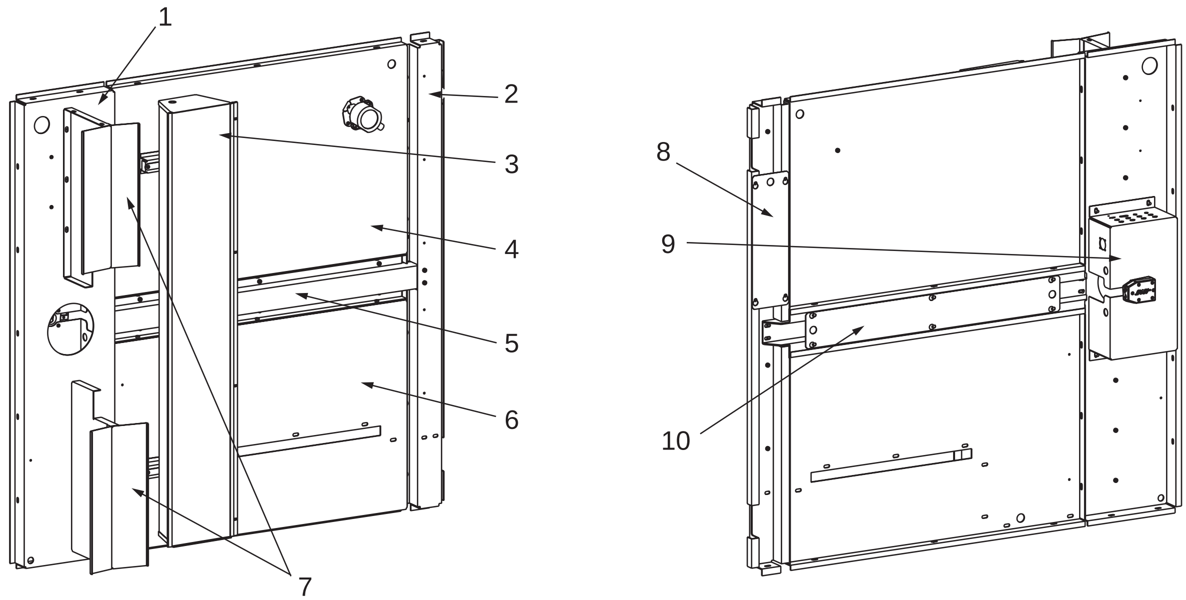




View Rotated 180° Looking Up

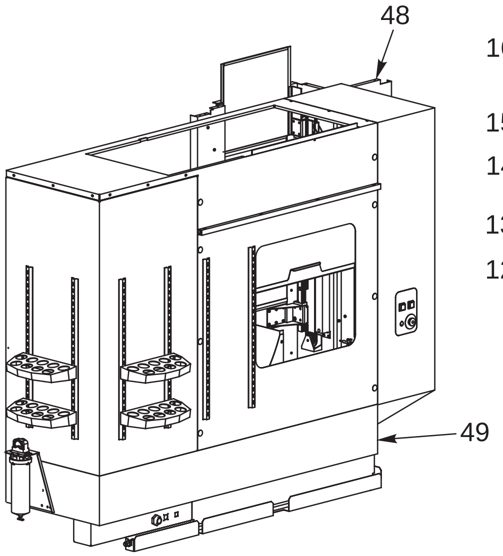
1.	58-1680	Fitting Bkhd NPT 1/2x1.125 Dia.
2.	20-7381A	Plate, Prog Coolant
3.	32-0199	Condit Assembly P-Cool
4.	20-7384A	Nozzle Body
5.	14-1905	P-Cool Cover
6.	25-5327	P-Cool Mounting Bracket
7.	58-3694	1/4 Valves Loc-Line
8.	58-1722	Fitting NPT 3/8F x NPT 3/8M 90 Degree
9.	58-1686	Fitting NPT 1/4M x NPT 3/8F
10.	58-0326	3/8 Full Pivot Ball Valve
11.	58-3052	Fitting Comp 1/2 x NPT 3/8M 90 Degree
12.	30-6460	Spindle Assmbly 12K in-Line
13.	58-0674	Tube Coolant P-Cool
14.	52-0035	P-Cool Hose
15.	58-3049	Fitting Comp 1/2xNPT 3/8 Str
16.	25-5366	Brkt Mounting Air Soleniod Assembly
17.	25-5012	Trip Bracket Y-axis
18.	30-4095	TRP Soleniod Assembly
19.	25-5241	Bracket Clamp TSC
20.	30-6465	TSC Switch Assembly
21.	25-5242	Bracket Shroud
22.	36-3035	Fan Assembly Spindle
23.	25-5264	Brkt Cable Carrier Y-Axis
24.	59-0144	Fan Guard 8.75 in.
25.	25-5215	Bracket Fan In-Line Spindle
26.	25-5213	Shroud Motor In-Line
27.	25-5017	Cable Tray Spindle Head
28.	73-3055	Therm Blk 6-Pole
29.	25-5216	Strap Spindle Motor Lift
30.	20-2248	Plate Motor
31.	20-1694A	Stand Off Motor In-Line
32.	20-2044	Spindle Head Machined
33.	20-2063	Coolant Block
34.	30-6338A	Oil Line Assembly Y-Axis

EC-400 Top Cover

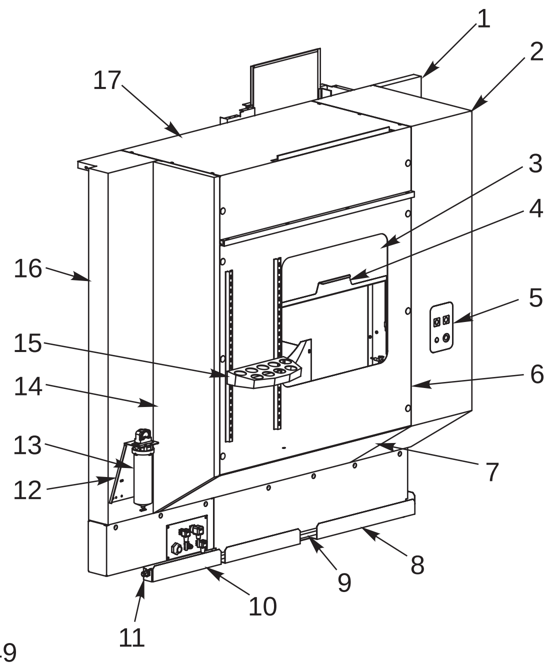


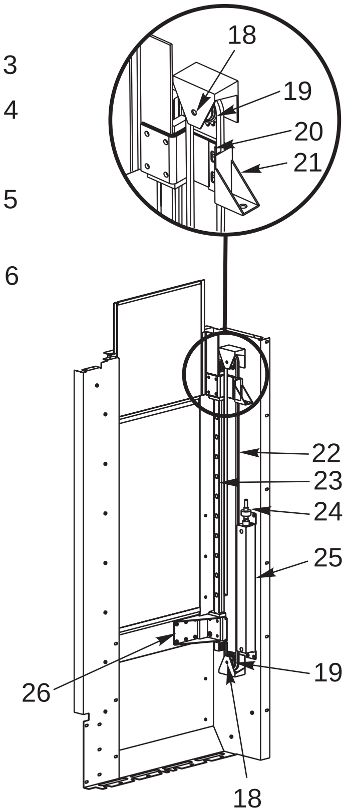
1. 25-4952 Top Cover Front
2. 25-4963 Brace Top Intermediate
3. 32-0196 Worklight Assembly
4. 25-4964 Top Cover Right
5. 25-4980 Wire Channel Top Cover
6. 25-4965 Top Cover Left
7. 25-4983 Splash Shield Rotating
8. 25-5253 Cover Brace Top
9. 25-4953 J-Box Top Cover
10. 25-4984 Cover Wire Channel Top

EC-400 60 and 70-Tool Tool Changer Panels

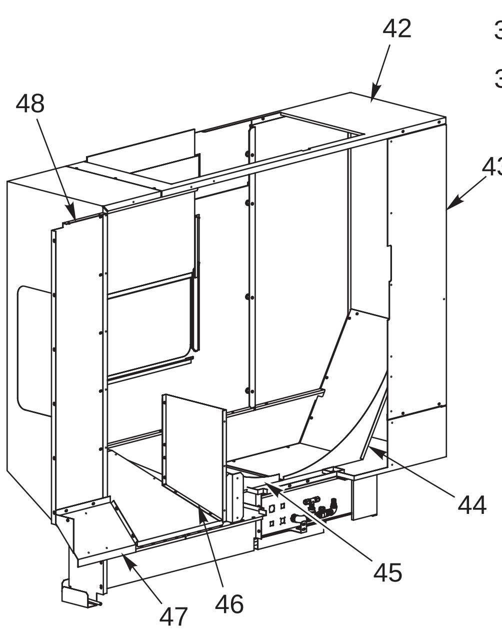


SMTC 60 Pocket Only

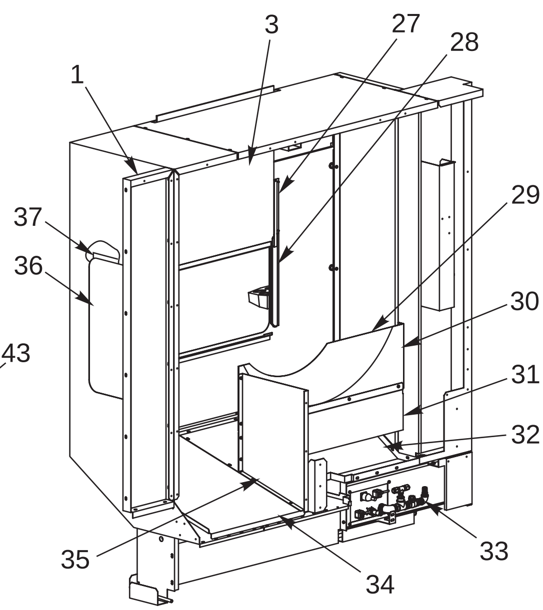


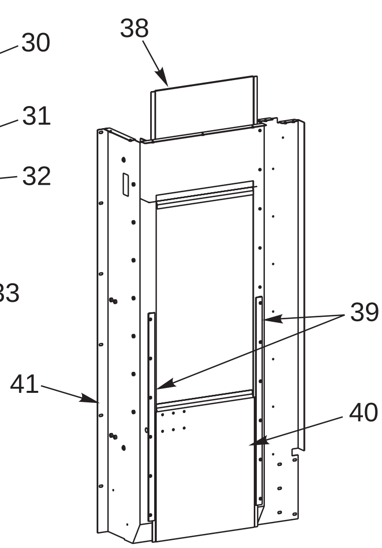


TC Door Assembly



SMTC 60 Pocket Only
(View Rotated 180°)

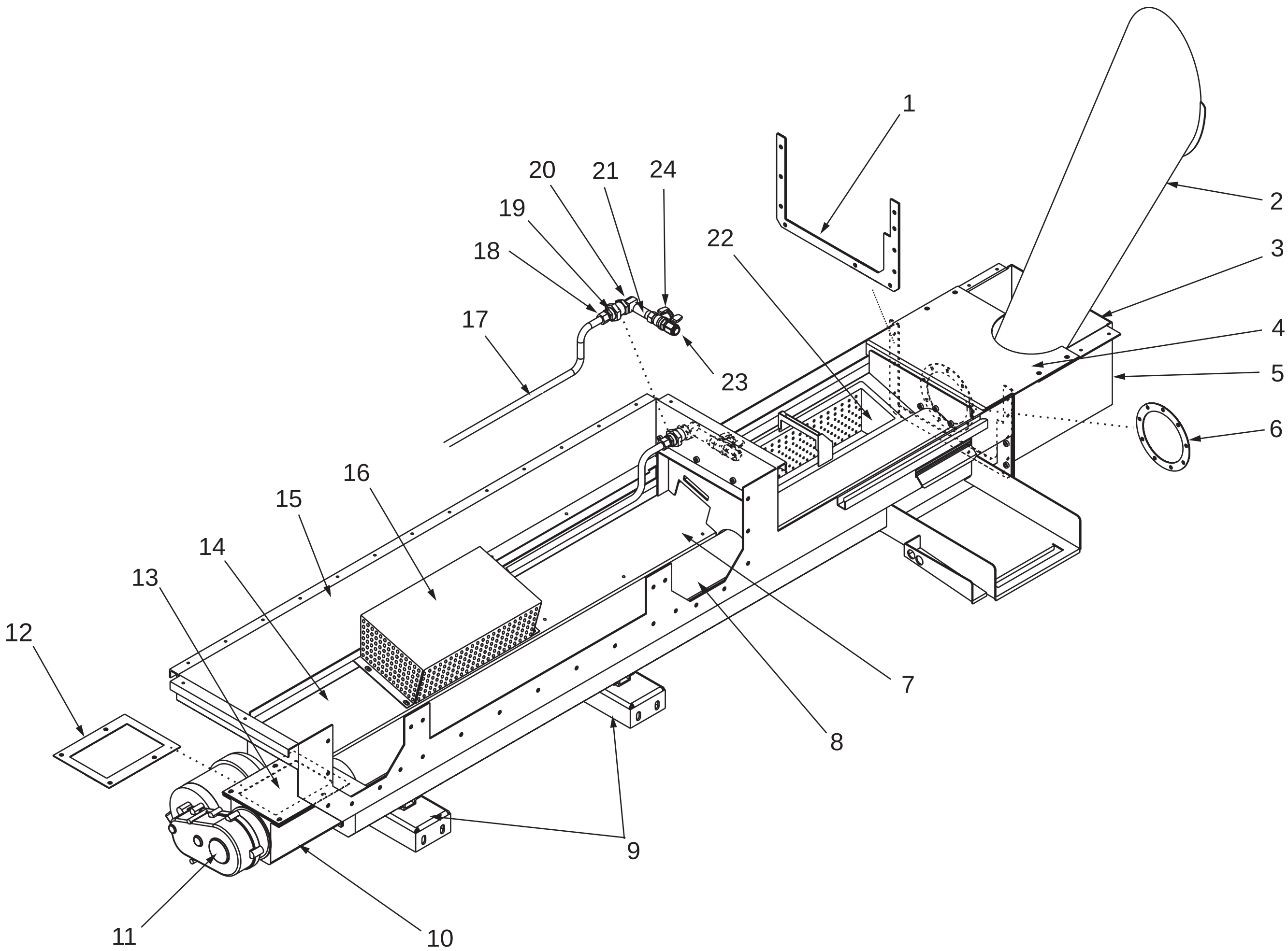




TC Door Assembly
(View Rotated 180°)

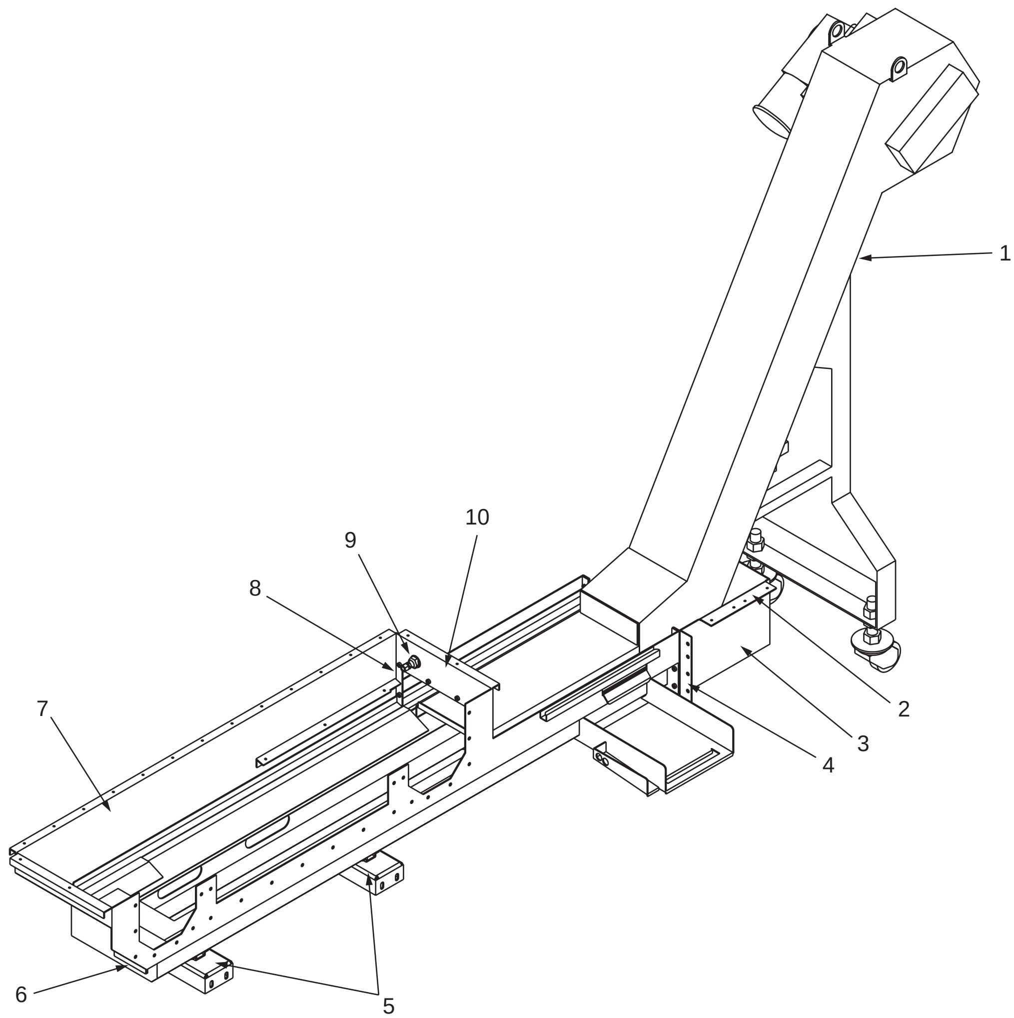
1. 25-4979 Left intermediate panel
2. 25-4962B Tool changer panel
3. 28-0168 TC access window
4. 25-9248 Plate window handle
5. 25-6718A SMTC switch box
   25-6719 SMTC switch box cover
6. 25-5991A SMTC side panel
7. 25-4961A TC pan
8. 25-4972 Left rear apron
9. 55-0671 Coolant drain tube
10. 25-5247 TC panel rear apron
11. 58-1679 Bulkhead fitting
    58-1693 LBO fitting (2)
12. 52-6042 TSC filter
13. 25-7581B TSC filter bracket
14. 25-4978A TC rear panel
15. 25-0440A Tool tray
16. 25-4959C Left rear panel
17. 25-4960B TC panel header
18. 22-9673 Spacer (2)
19. 30-2464 Idler assembly
20. 25-0974 Chain Retainer
21. 25-5032 TC door top connect bracket
22. 54-0072 Chain
23. 50-0012A Linear guide
24. 59-0641 Cylinder rod aligner
25. 59-0612 Air cylinder
26. 25-5033 TC door bottom connect bracket
27. 25-4221A Opposite window rest (2)
28. 28-0167 TC window extrusion (2)
29. 25-5284A TC left chip shield 24TL
30. 25-5295 TC left chip shield 40TL
31. 25-4976 TC coolant drip pan
32. 25-4961 TC pan
33. 30-6753 Coolant fitting assembly
34. 25-4985 TC panel lower chip shield
35. 25-5283 TC front chip shield
36. 28-015 Window TC panel operator door
37. 25-5228 TC operator door window Z-frame
38. 25-5030 Top door
39. 20-2087 Door guide
    25-5034 Door guide spacer
40. 25-5031 Bottom door
41. 25-5029 TC internal panel
42. 25-5992A SMTC60 top panel
43. 25-5994A SMTC70 rear panel
44. 25-5996A SMTC70 rear chip shield
45. 25-5995 SMTC60 front chip shield
46. 25-5283A TC front chip shield
47. 25-4987 Left lower panel chip shield
48. 25-4986 Left upper panel chip shield
49. 25-5993B SMTC70 bottom pan

EC-400 Front Trough Assembly (Auger System)



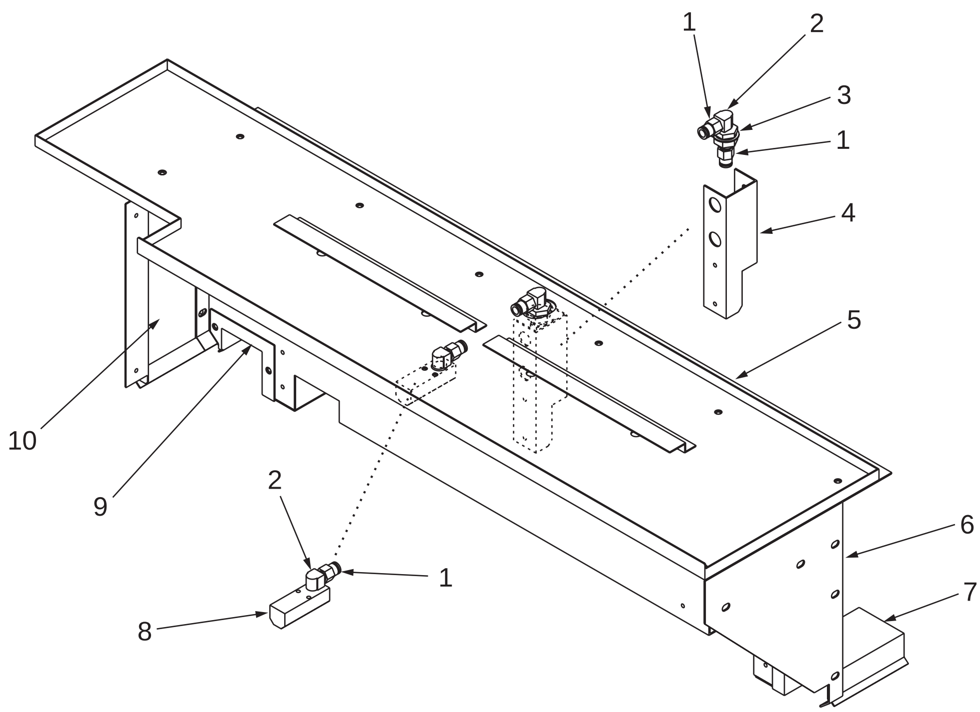
1. 57-0334A Gasket Coolant Trough
2. 25-0548 Chute Discharge
3. 25-5300 End Chute Cover
4. 25-5301 Coolant Trough Extension Cover
5. 25-5025 Extension Box Front Trough
6. 57-9846C Gasket Discharge
7. 25-5297A Coolant Channel
8. 20-2039 Auger Front
9. 25-4944 (2X) Brace Auger Trough
10. 25-5289 Extension Box Auger Motor
11. 62-0050 Motor 115V 1/4HP 15 RPM
12. 57-0332 Gasket Extension Box Top
13. 25-5290 Extension Box Top
14. 25-5024A Front Auger Trough
15. 25-5288A Coolant Trough
16. 25-5299A Auger Trough Screen
17. 59-0661 Nozzle Assembly Screen Washdown
18. 58-2071 Fitting Comp 1/2 x NPT 1/2M
19. 58-1679 Fitting BKHD NPT 3/8 x 1 Dia
20. 58-1722 Fitting NPT 3/8F x NPT 3/8M 90 Brass
21. 58-3644 Nipple 3/8 NPT x 2 1/2 Brass
22. 25-5291A Chip Basket
23. 58-1693 Fitting LBO 1/2 NPT 3/8M STR
24. 58-1693 Fitting LBO 1/2 NPT 3/8M STR

EC-400 Front Trough Assembly (Chip Conveyor System)

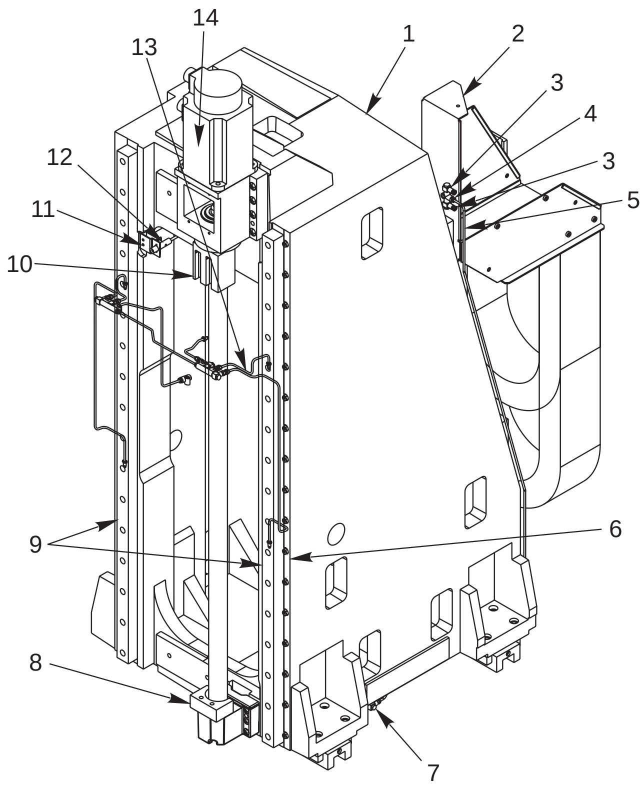


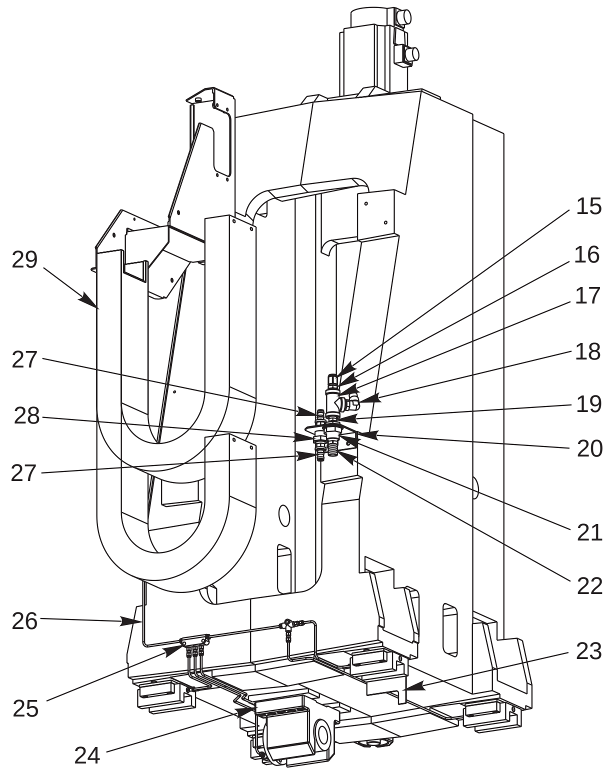
1. 30-6477B Chip Conveyor
2. 25-5309 Chip Conveyor Extension Cover
3. 25-5025A Coolant Trough Extension
4. 57-0334A Coolant Trough Gasket
5. 25-4944 2X Auger Trough Brace
6. 25-5292 Motor Access Cover
   57-0333 Extension Box Gasket
7. 25-5288A Coolant Trough
8. 58-0336 Pipe Plug 3/8 Brass
9. 58-1679 Fitting Bulkhead NPT 3/8 x 1
10. 25-5308A Conveyor Chip Shield

EC-400 Bulkhead



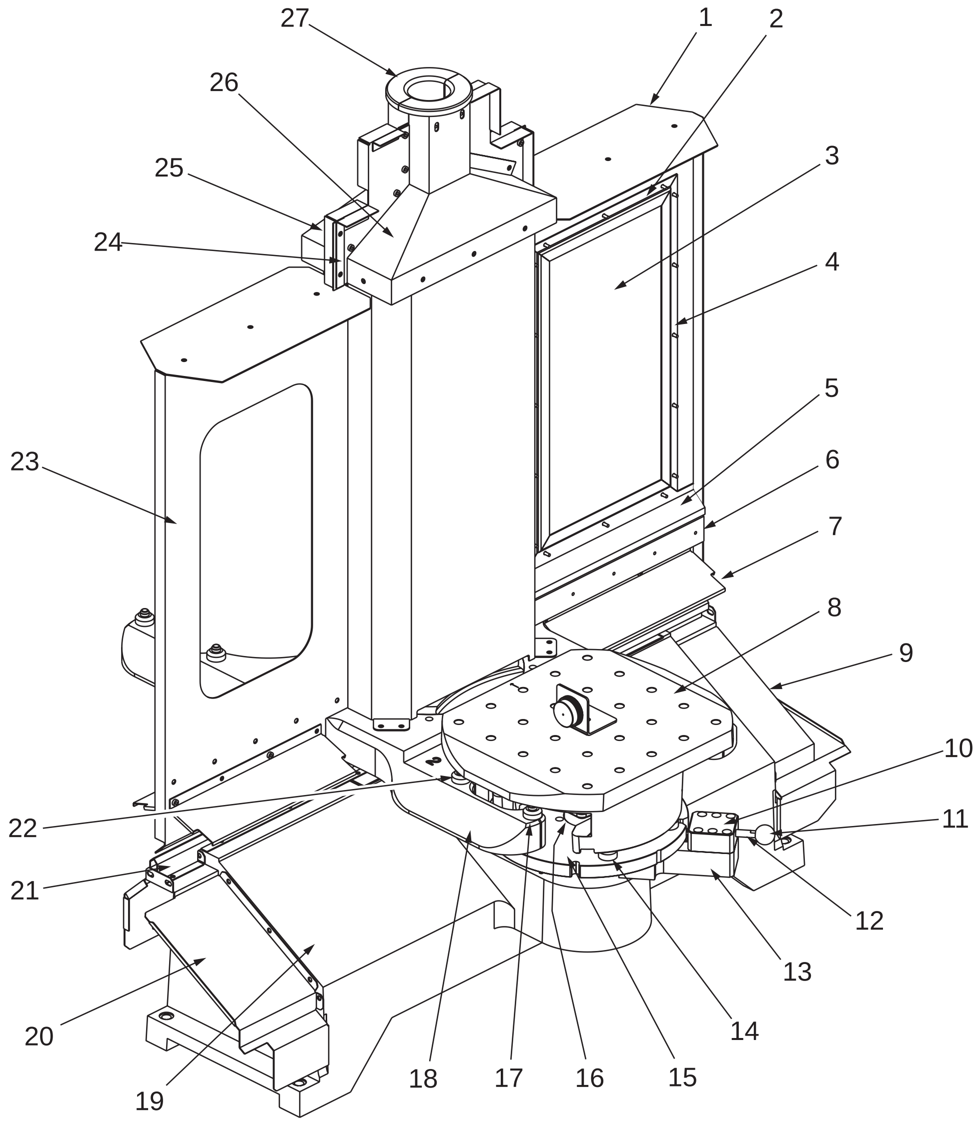
1. 58-3680 3X Fitting, LBO 3/8 x NPT 1/4 M STR
2. 58-3618 2X Fitting, NPT 1/4F x NPT 1/4M 90 Brass
3. 58-1677 Fitting, BKHD NPT 1/4 x .750 Dia
4. 25-5009 Base Cover Bracket
5. 25-5006 X-Axis Bottom Shield
6. 25-5003 Base Cover
7. 25-5004 Right Trough Cover
8. 20-6413A Manifold Washdown
9. 25-5005 Left Trough Cover
10. 25-5010 Left Base Cover Shield





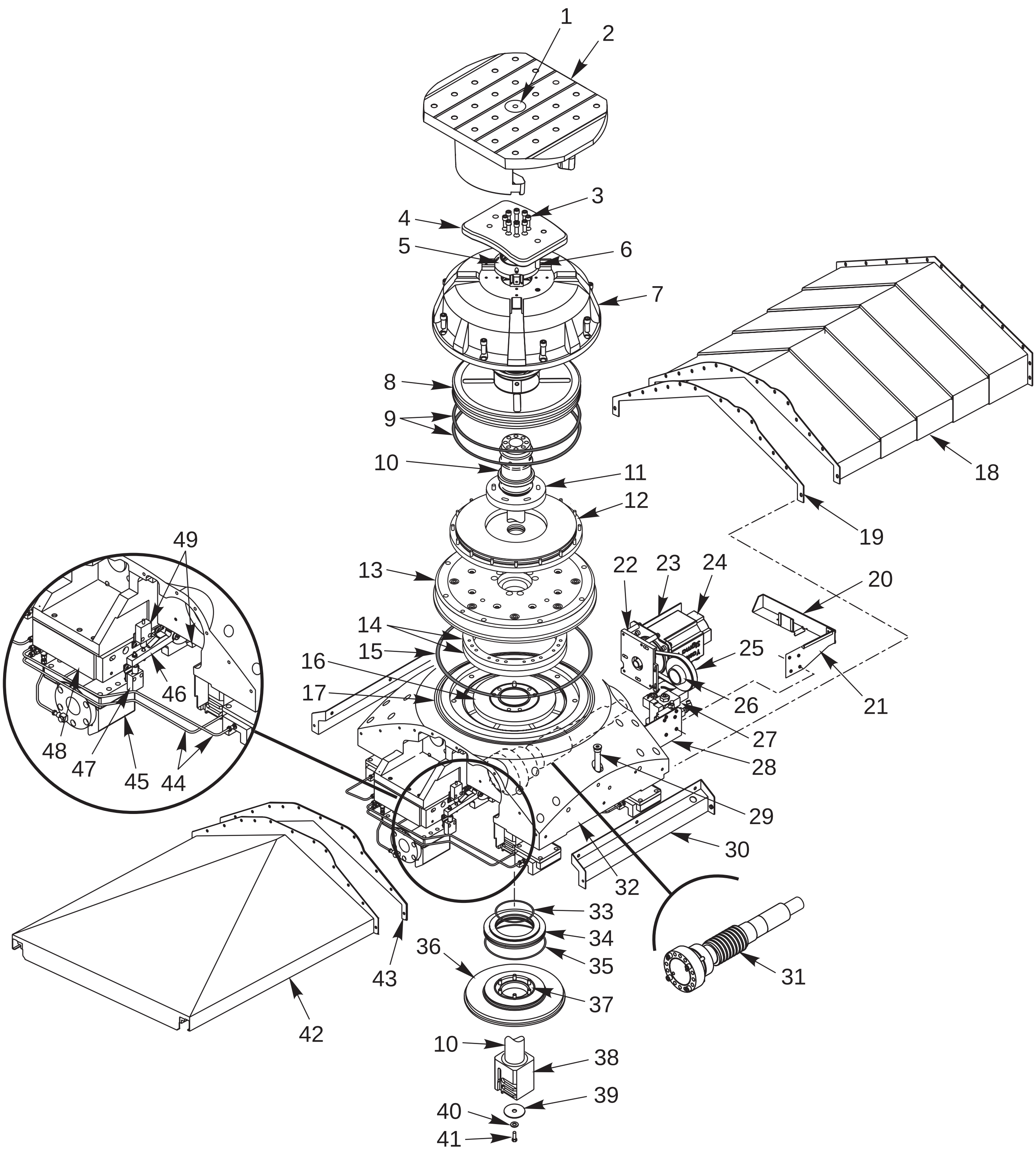
Back View (Looking Up)

1.	20-2043	Column Machined
2.	25-4996	BRKT Carrier Column
3.	58-3045	Lube Fitg Adaptor
4.	58-3045	Lube Fitg Adaptor
5.	58-0634	Copper Tubing Column
6.	22-7458	Cam Linear Guide
7.	58-3031	Lube Fitg Adaptor
8.	20-0166	Bumper
9.	50-3400	Linear Guide
10.	20-2058	Hardstop Y-axis
11.	25-7267	Mounting Bracket
12.	32-2131	Home Switch
13.	30-6338A	Lube Line Assy.
14.	62-0017	Servomotor YASK 13
15.	58-1693	Fitg LBO
16.	58-3625	Fitg Reducer
17.	58-3650	Fitg
18.	58-0097	Fitg LBO
19.	58-0287	Hex Nipple
20.	25-5294	Bracket TRP
21.	58-1680	Fitg Bkhd
22.	58-2066	Fitg Hose Barb
23.	25-4937	Trip Bracket X-Axis
24.	20-0150	Nut Housing
25.	30-6337	Oil Line Assembly X-Axis
26.	58-0634	Copper Tubing Column
27.	58-0029	Fitg Hose Barb
28.	58-1679	Fitg Bkhd
29.	59-0640	Cable Carrier Y-Axis

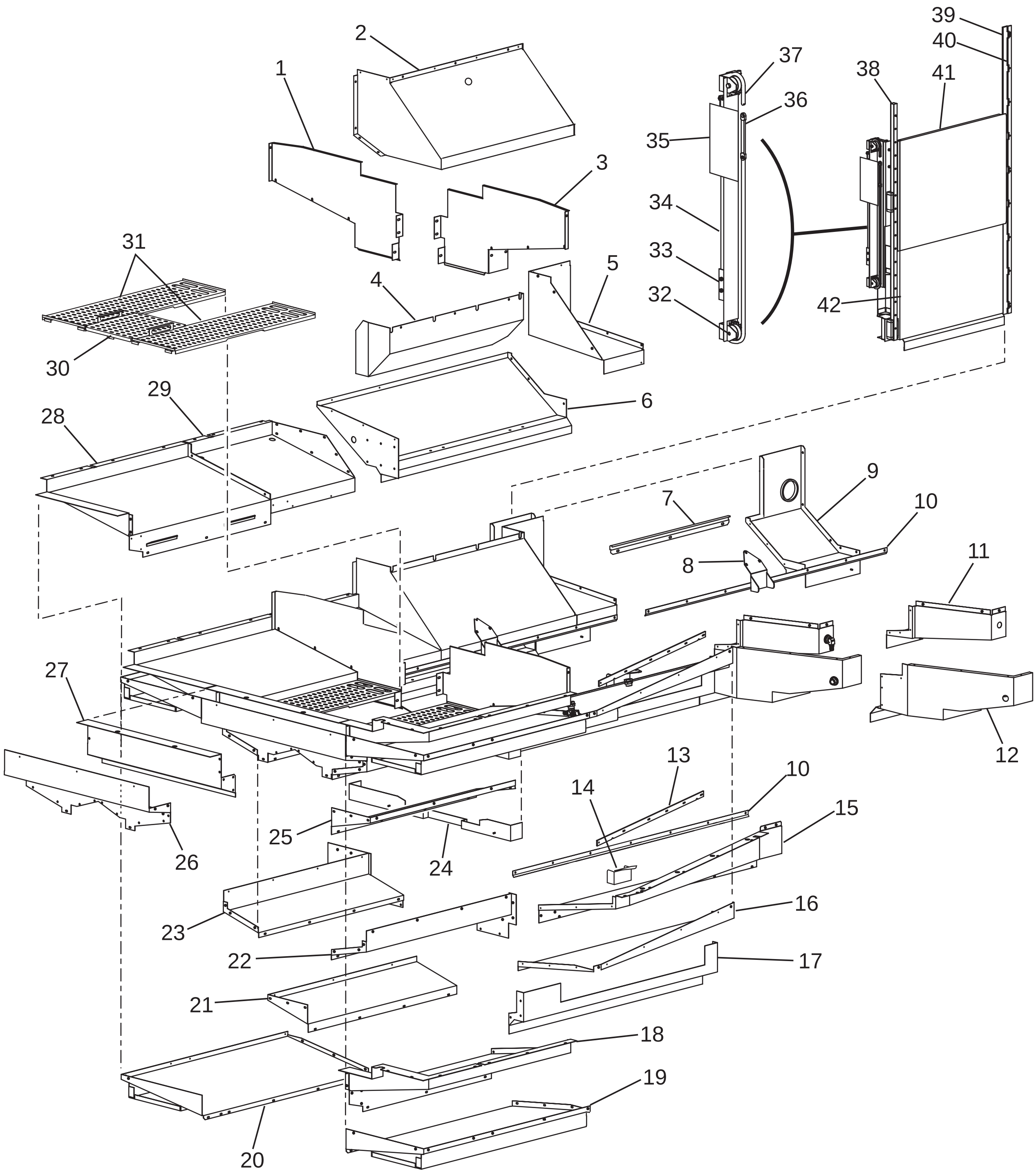


1.	25-5238B	Shade Rotating Door Top
2.	25-4149	Z-Frame Window SMTC
3.	28-0043A	Window Partition
4.	25-1262A	(2X) Z-Frame Partition Top
5.	25-5233A	(2X) Z Channel Rotating Door
6.	20-2283A	(2X) Support Bar Rotating Door
7.	25-5237	(4X) Shade Rotating Door Seal
8.	20-2048	Pallet
9.	25-5229	Chip Shield Bridge Right
10.	20-2254	Load Station Lock Housing
11.	59-6225	Knob
12.	20-2255	Load Station Lock Pin
13.	20-2253	Load Station Lock Mount
14.	20-2249	Load Station Pallet Pin
15.	20-2256	Load Station Index Disc
16.	20-2258	Load Station Shaft
17.	20-2154B	APB H-Pin
18.	20-2115	H-Frame APC
19.	20-2046	Bridge Machined
20.	25-5230	Chip Shield Bridge Left
21.	25-5235	Step Right Rotating Door Seal
22.	20-3208	Pin Short APC H-Frame
23.	25-5232B	(2X) Panel Rotating Door
24.	25-5239A	Retainer Seal Rotating Door
25.	57-0330	(2X) Seal Rotating Door Cover
26.	25-5234B	Rotating Door Cover
27.	20-2284B	(2X) Cable Rotating Door

EC-400 Receiver Assembly



1.	20-1123A	Pallet plug
		Parker O-ring 2-135
2.	20-2048A	Pallet machined
3.	40-1639	SHCS 3/8-16x1 (8)
4.	20-1995	Receiver clamp plate
5.	30-6551	Air blast assembly
6.	48-1667	Dowel pin 1/2x3 ½ (2)
7.	20-2041	Receiver body machined
	57-0328	O-ring 2-339 viton (2)
	25-5252	Receiver wear surface (2)
	57-0337	V-ring seal
	40-16575	SHCS (8)
8.	20-1994	Receiver piston
	25-5250	Piston wear surface
9.	57-0329	O-ring (2)
10.	20-1996A	Receiver shaft
	57-0328	O-ring (3)
	57-5148	O-ring
11.	20-1997	Receiver nut
12.	20-1999A	Receiver seal plate
	40-1500	SHCS (16)
13.	20-2022A	Rotary table platter
	43-1600	SHCS (8)
	45-0114	Washer (8)
	40-1646	SHCS (8)
	45-0038	Washer (8)
14.	2-4285	Face Gear (2)
15.	57-0337	O-ring
16.	35-4284A	Spindle gear assy
	48-0035	Dowel pin 3/8 x ¾
	57-2121	O-ring 2-161
17.	57-0337	O-ring
18.	25-5011	Right tele Z-axis way cover
19.	57-0326	Right tele way cover gasket
20.	25-6305	Z-axis Cable tray
21.	25-6304	Cable tray bracket
22.	20-2071	Rotary motor mounting plate
23.	25-5018A	Receiver solenoid mount
24.	62-0016	Servo motor
25.	54-4505	Drive belt PGGT 5Mx15
26.	20-4506	Driven pulley 310-64T
	20-4229	Driven pulley lockring
27.	30-6774A	Rotary index solenoid assy
28.	25-5027	Z-axis cable carrier bracket
29.	20-1991	Z-axis shipping pin
30.	25-4968	Rotary table side chip shield
31.	35-4210	Worm shaft assembly
32.	20-2045B	Rotary table index machined
33.	57-4282	O-ring 2-248
34.	20-4286	Lift piston
	51-4285	Thrust washer (2)
	51-4286	Thrust bearing
35.	57-0139	O-ring 2-263
36.	20-4213	Disc brake
	57-2144	O-ring 2-256
	57-4288	Thrust bearing
37.	20-4236	Spindle spacer
	40-1636	SHCS (6)
38.	20-1998A	Receiver rotary union
39.	20-2344	Rotary union lower washer
40.	45-0075	Steel washer 5/16
41.	43-0023	HHB 5/16-18x1 ½ pltd
42.	25-5231	Front way cover Z-axis
43.	57-0327	Fixed way cover gasket
44.	30-6336	Oil line assy Z-axis
45.	20-0150	Ballnut housing machined
46.	20-2330B	Rotary axis switch arm
47.	20-2473	Bar-spring mount assy
48.	20-2023A	Ballnut spacer Z-axis
49.	69-1700	Proximity switch (2)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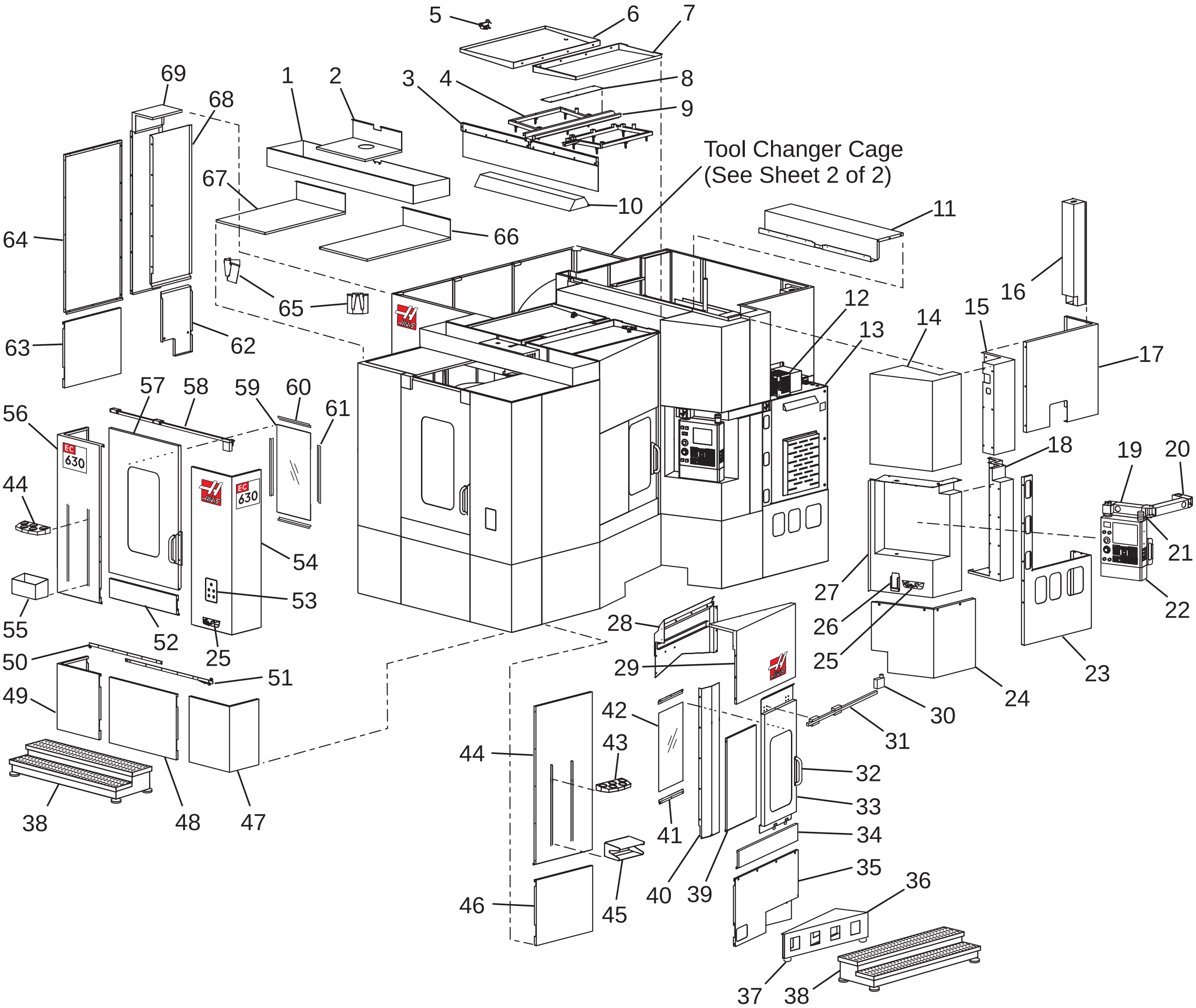
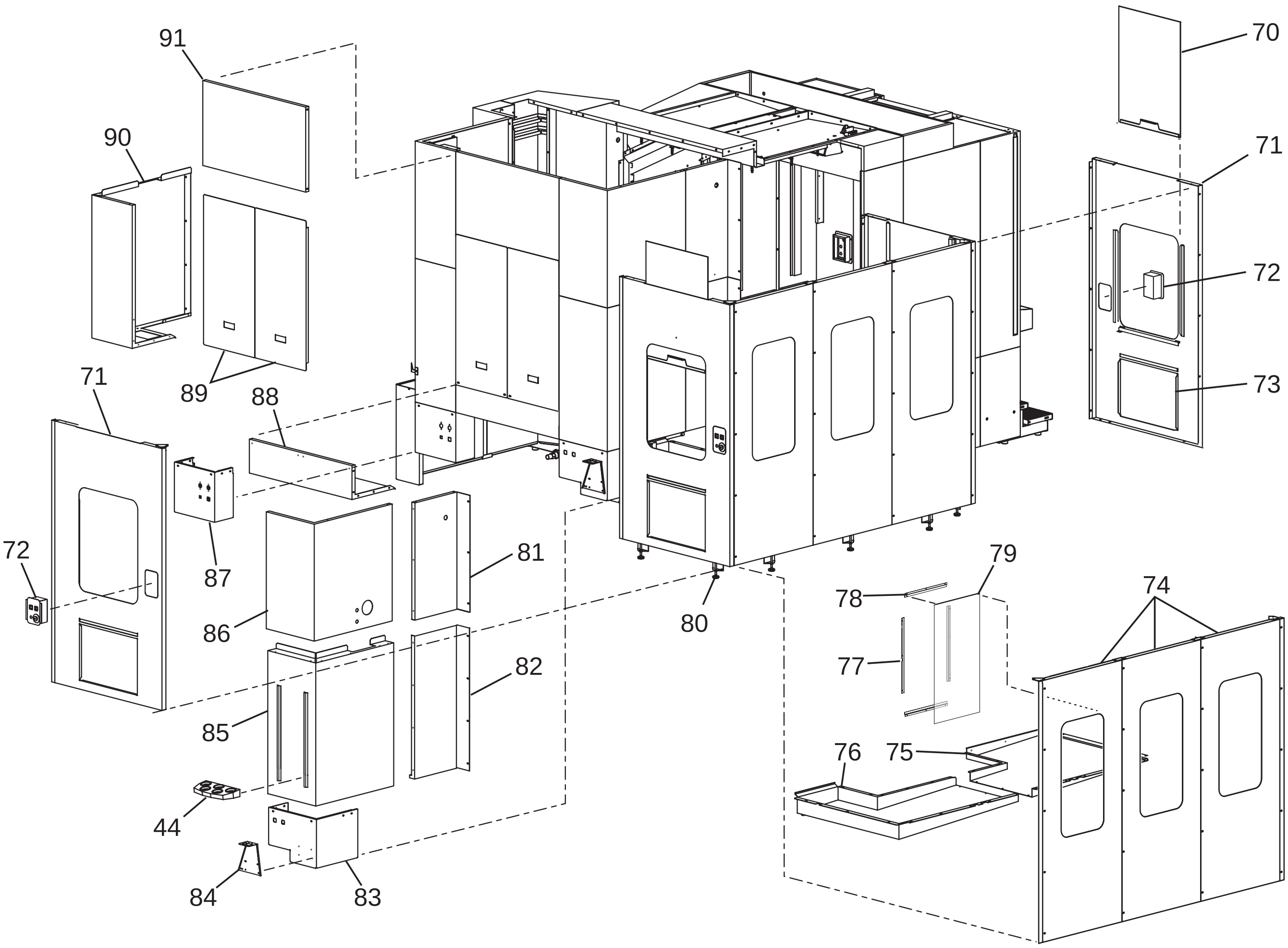
EC-630 Internal Sheet Metal

1.	25-8140	APC TC Splash Shield
2.	25-8205A	TC Door Lower Panel
3.	25-8139	APC Operator Splash Shield
4.	25-8131A	X-Axis TC ChiShield
5.	25-8220A	TC Door Frame Corner Panel
6.	25-8196	Base Casting TC Drip Pan
7.	25-8474B	X-Axis TC Drip Pan Mounting Bracket
8.	25-8996A	TC Side Chip Raker
9.	25-8198A	TC Side Rear Drip Pan
10.	25- 8226	4X Waycover Side Splash Shield
11.	25-8204	Operator Side Chip Shield Frame
12.	25-8199A	Operator Side Rear Drip Pan
13.	20-2684	Operator Door Upper Door Rail
14.	25-8995	Operator Side Chip Raker
15.	25-8225A	Operator Side Intermediate Chip Shield
16.	25-8197	Operator Side Drip Pan
17.	25-8221A	Operator Side Base Casting Drip Pan
18.	25-8223	Operator Side Front Panel Chip Shield
19.	25-8194	OperatorSide Base Front Drip Pan
20.	25-8195	TC Side Base Front Drip Pan
21.	25-8227A	TC Side Top Front Wiper
22.	25-8193	Operator Side Front Wiper Support
23.	25-8192	TC Side Front Wiper Support
24.	25-8040	Center Front Drip Pan Base
25.	25-8228A	Operator Side Front Top Wiper
26.	25-8134	Front Panel Splash Shield
27.	25-8137	Front Panel Upper Chip Shield
28.	25-8222	TC Side Front Panel Chip Shield
29.	25-8224	TC Panel Chip Shield
30.	25-8418	Load Station Front Grate
31.	25-8417	2X Load Station Side Grate
32.	30-8049	Idler Sprocket Assy
33.	25-0974	Chain Retainer
34.	59-0946B	Air Cylinder 2 in. Dia.
35.	25-8398	Turn Buckle Access Cover
36.	59-0966	Turn Buckle Jaw and Eye
37.	54-0072	Chain .50 x .125” BMX
38.	50-0102	X-Axis Linear Guide 30 x 1420
39.	25-7978	TC Door Guide Comb
	25-7980	TC Door Guide Spacer
40.	25-7979	BTM Door Track
41.	93-1523	ATC Top Door
42.	25-7977B	ATC Bottom Door

EC-630 External Sheet Metal



Sheet 1 of 2

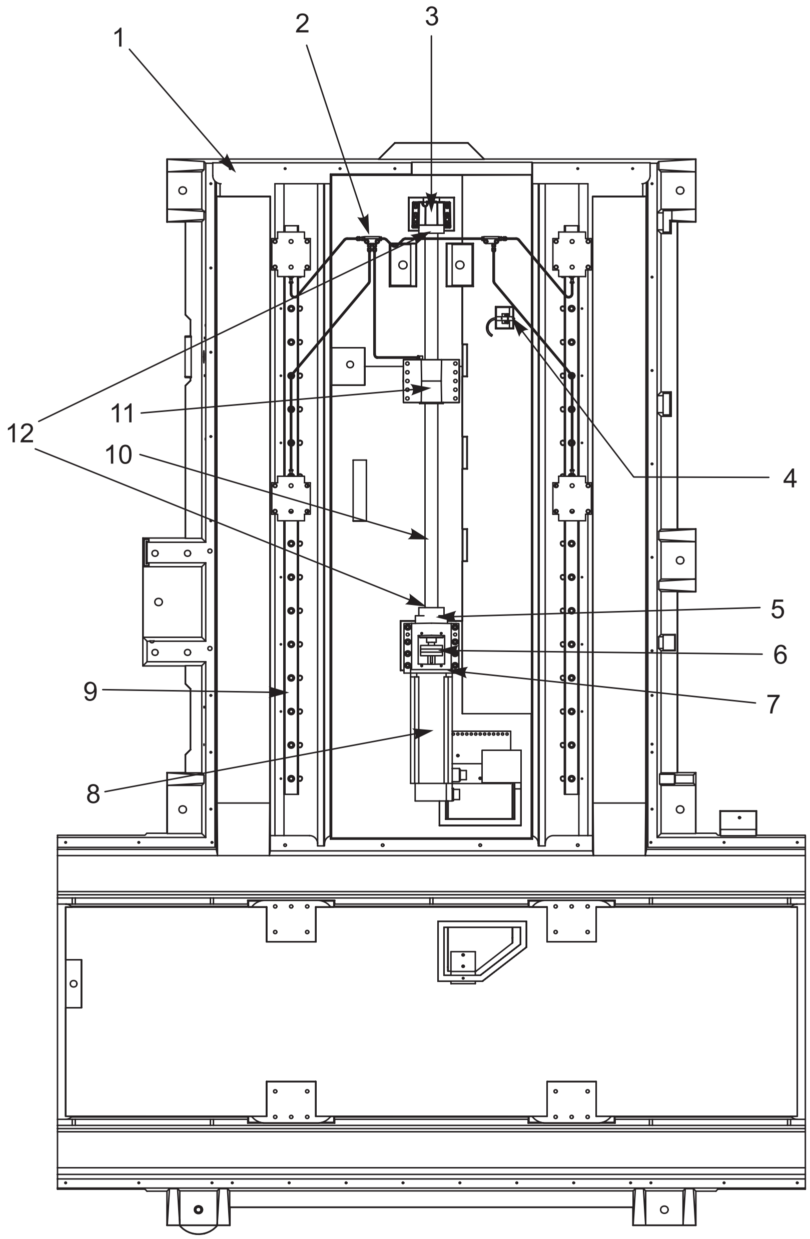


Sheet 2 of 2
(View Rotated 180°)

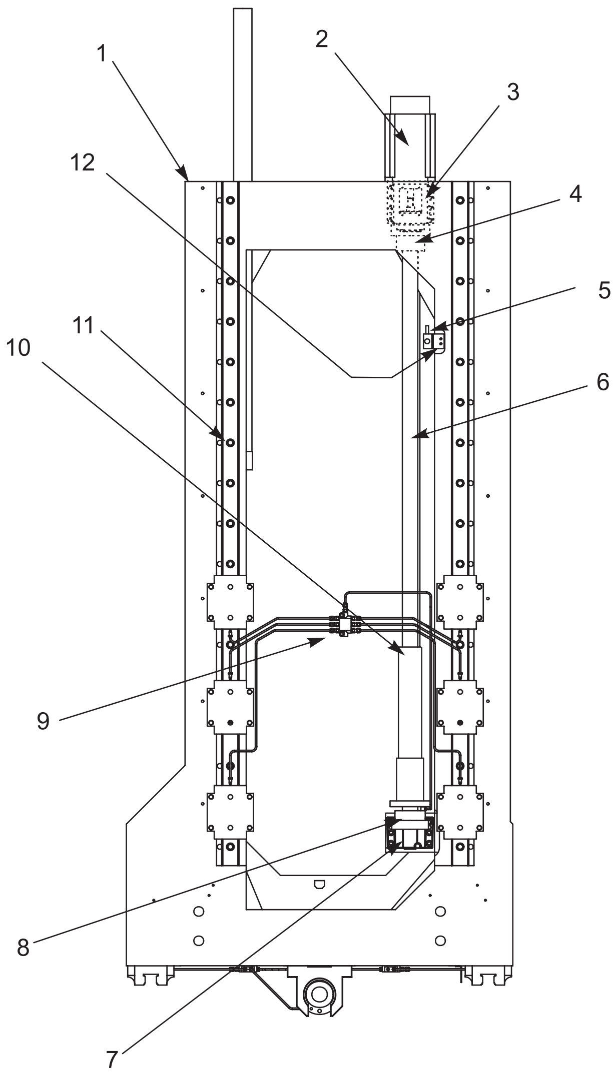
EC-630 External Sheet Metal

1. 25-8315A Front Top Panel Stiffener
2. 25-8313 Front Top Center Panel
3. 25-8324 Seal Mounting Plate Top Cover
   26-0231 Rotating Door Coolant Seal
4. 30-9098 Coolant Wash Down Kit
   20-3868 Coolant Wash Down Top Nozzle-Operator Side
   20-3869 " " " " " -TC Side
5. 32-0039 Solenoid Valve Assy
6. 25-8322A Top Cover-TC Side
7. 25-8321A Top Cover-Operator Side
8. 25-8323 Top Cable Channel Cover
9. 25-8328A Intermediate Panel-Operator Side
10. 25-4160 Body Light Fixture
11. 25-8187A Center Frame Top Cover
12. Regen Assy
13. Electrical Control Box Assy
14. 25.8186B Upper Pendant Panel
15. 25-8179A Control Panel Upper Frame
16. 25-6035C CB Tank Box
17. 25-8173 Upper Rear Control Panel
18. 25-8178 Control Panel Lower Frame
19. 20-3732 Pandant Support Arm
    20-7109A Arm Swivel Mount
    93-0282 Control Swivel Mount
20. 20-3803A Control Support Arm
21. 59-0990 Recessed Bumper O.D. 1.13 x 1" H
22. Control Pendant Assy
    25-9907 Monitor Handle
23. 25-8238 Control Box Access Panel
24. 25-8237 Control Panel Apron-Operator Side
25. 25-5412 2X Nozzle Holder Bracket
26. 25-8120A ERJH Cradle
27. 25-8185A Lower Pendant Panel
28. 25-8332A Top Splash Shield-Operator Side
29. 25-8327 Upper Panel -Operator Side
30. 61-0006B CE Door Interlock
31. 50-0102 X-Axis Linear Guide 30 x 1420
32. 25-7412 2X Door Handle Bracket
    22-8895 2X Door Handle-Chrome
33. 25-8326A Operator Door
    30-2009 2X Door Roller Assy
    59-9743 Door Spring
34. 25-8329 Lower Panel-Operator Side
35. 25-8200 Apron-Operator Side
36. 25-8349A Operator Loading Station
37. 59-0956 3X Recessed Bumper
    45-1665 3X Washer .375"
    40-1639 3X SHCS .375 x 1"
38. 30-9158 2X Platform Assy
39. 25-8328A Intermediate Top Side Panel
40. 25-8420A Operator Intermediate Splash Shield
41. 25-0818 2X Door Frame_Top-Bottom
42. 28-0015 Operator Door Window
    26-0041 Window Gasket
43. 30-1936 Tool Tray Assy 50T
44. 25-8276A Front Right Side Panel
45. 25-6182D Front Writing Table
46. 25-8236A Front Right Side Apron
47. 25-8233 Front Right Corner Apron
48. 25-8231 Front Center Apron
49. 25-8232 Front Left Corner Apron
50. 20-3094 Door Rail End
51. 22-9181A Door Lower Guide Rail
    30-2009 2X Door Roller Assy
    59-9743 Door Spring
52. 25-8277 Front Center Panel
53. 25-1257A 2X Switch Box
54. 25-8240A Front Right Corner Panel
55. 25-0563B Tool Box Assy
56. 25-8239A Front Left Corner Panel
57. 25-8278 Front Enclosure Door
58. 50-0101 Linear Guide 30 x 1930
    25-8280 Front Door Rail Support
59. 28-0165 Front Door Window
60. 25-0669 2X Window Retainer_Top-Bottom
61. 25-0668 2X Window Retainer_Side
62. 25-8201 TC Intermediate Apron
63. 25-8234 Front Left Side Apron
64. 25-8275A Front Left Side Panel
65. 25-6286 2X Twin Lamp Bracket
    32-0228 2X Lamp Assy Twin Mylar Reflector
66. 25-8311B Front Top Right Panel
67. 25-8312A Front Top Left Panel
68. 25-8419 TC Intermediate Panel Splash Shield
69. 25-8202 TC Lower Intermediate Panel
    25-8203 TC Upper Intermediate Panel
70. 28-7472 2X Side Panel Window-Plastic Enclosed
    25-9248A 2X Plate Window Handle
71. 25-8127A 2X TC Door Panel
72. 25-6718A 2X SMTC Switch Box
    25-6719 2X SMTC Switch Box Cover
73. 25-8766 TC Cage Access Cover
74. 25-8128A 3X TC Side Panel
75. 25-8129B Right TC Front Drip Pan
76. 25-8130A Left TC Front Drip Pan
77. 25-0668 6X Window Retainer_Side
78. 25-0669 6X Window Retainer_Top-Bottom
79. 28-0165 3X Window
80. 59-1050 7X Leveling Feet
    46-1721 9X Jam Nut .50-13
81. 25-8181A TC Panel Upper Frame
82. 25-8180 TC Panel Lower Frame
83. 25-8184 Rear Left Corner Apron
84. 25-7581C TSC Filter Bracket
85. 25-8176 Lower Rear TC Panel
86. 25-8177 Upper Rear TC Panel
87. 25-8183A Rear Right Corner Apron
88. 25-8174 Rear Lower Center Panel
89. 25-8189 2X Rear Access Panel
90. 25-8172A Rear Lower Control Panel
91. 25-8175 Rear Upper Center Panel

EC-1600 Base Assembly

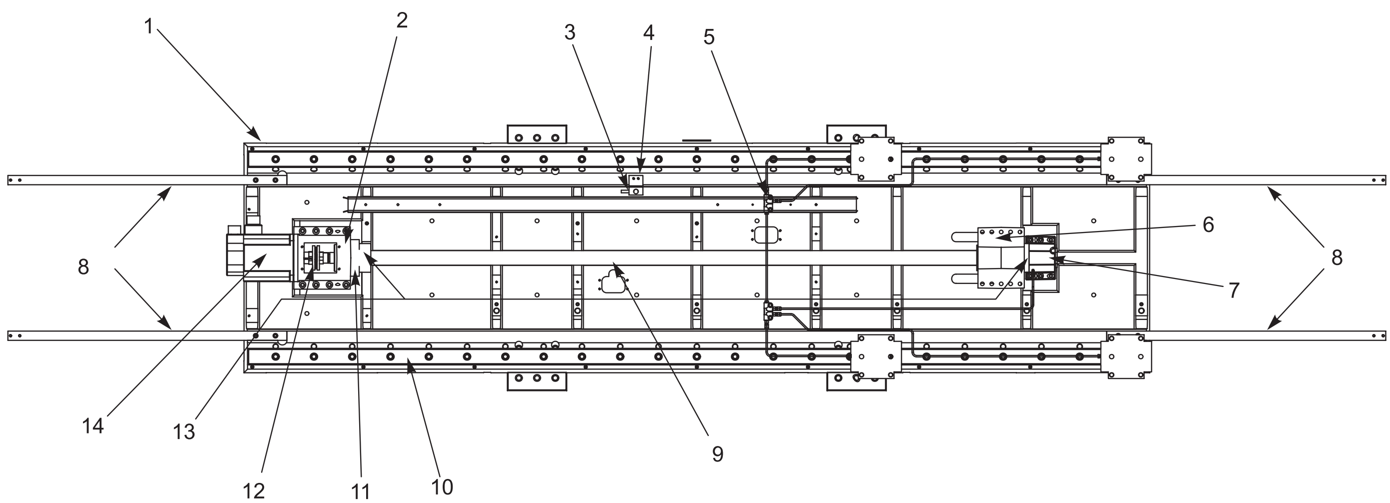


1. 20-2509 Casting
2. 30-6953 Lube Line Assy
3. 30-0472 Bearing Assy
4. 32-2133 Limit Switch
5. 30-1222 Bearing Assy
6. 30-3988 Coupling
7. 20-0151 Motor Mount Assy
8. 62-0008 Motor
9. 50-9010 Linear Guides
10. 24-9960A Ballscrew Assy
11. 20-0150 Nut Housing
12. 20-0156 Bumper

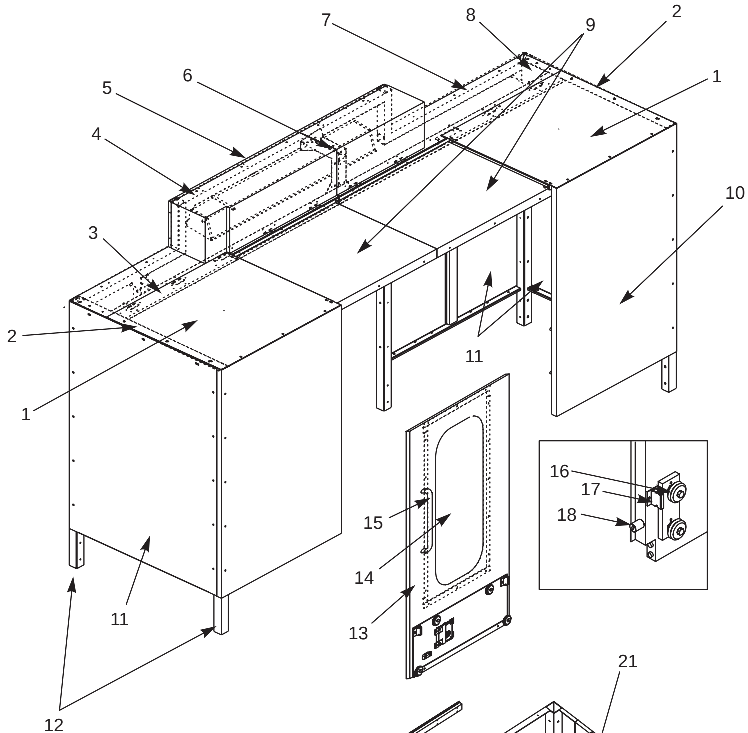


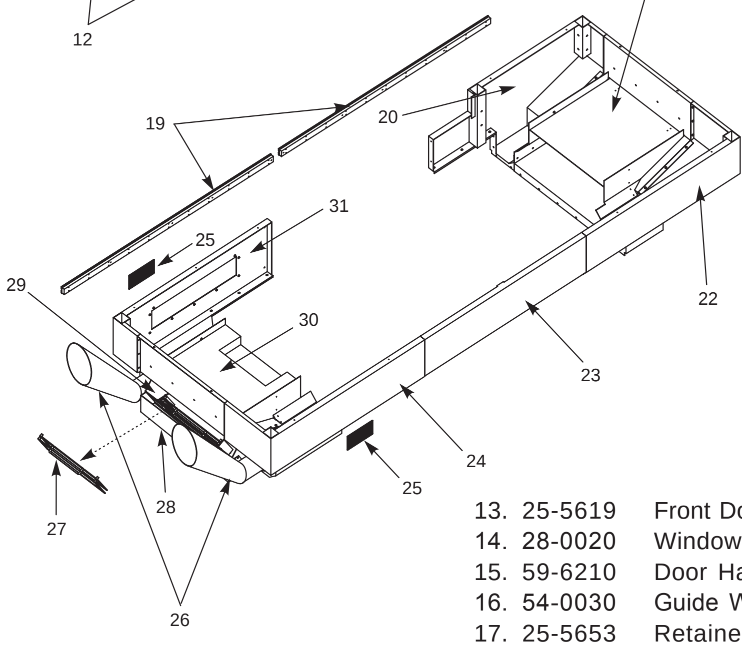
1. 20-2506 Casting
2. 62-0017 Motor
3. 30-1517 Coupling
4. 30-0764 Bearing
5. 32-2131 Limit Switch
6. 24-0003A Ballscrew
7. 30-0472 Bearing Assy
8. 20-0156 Bumper
9. 30-6954 Lube Line Assy
10. 20-267 Bumper
11. 50-9010 Linear Guides
12. 25-7267 Switch Brkt

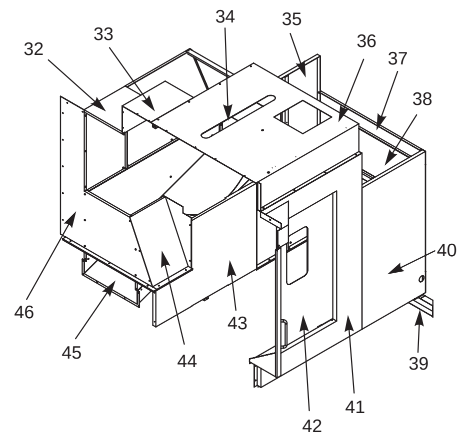
EC-1600 Saddle Assembly

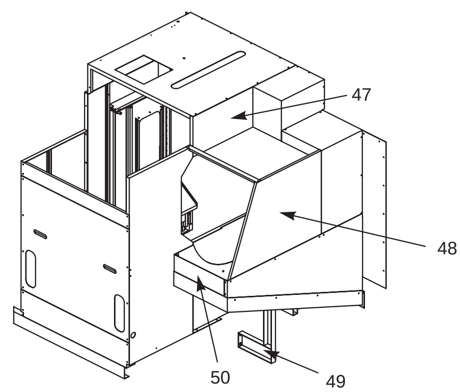


1. 20-2536 Casting
2. 20-0151 Motor Mount Assy
3. 32-2133 Limit Switch
4. 25-7267 Switch Brkt
5. 30-7410 Lube Line Assy
6. 20-0150 Nut Housing
7. 20-0152 Bearing Housing
8. 20-9822 Guide Bar
9. 24-9961C Ballscrew
10. 50-9806 Linear Guides
11. 30-1222 Bearing Assy
12. 30-1215 Coupling Assy
13. 20-0166 Bumper
14. 62-0016 Motor



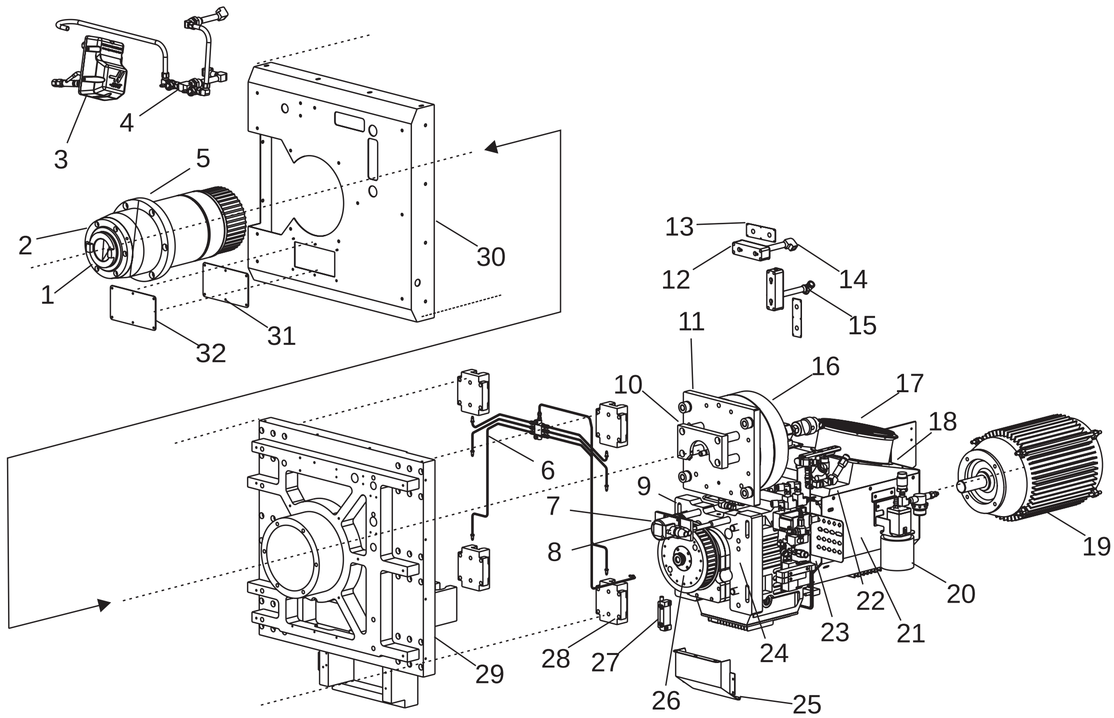




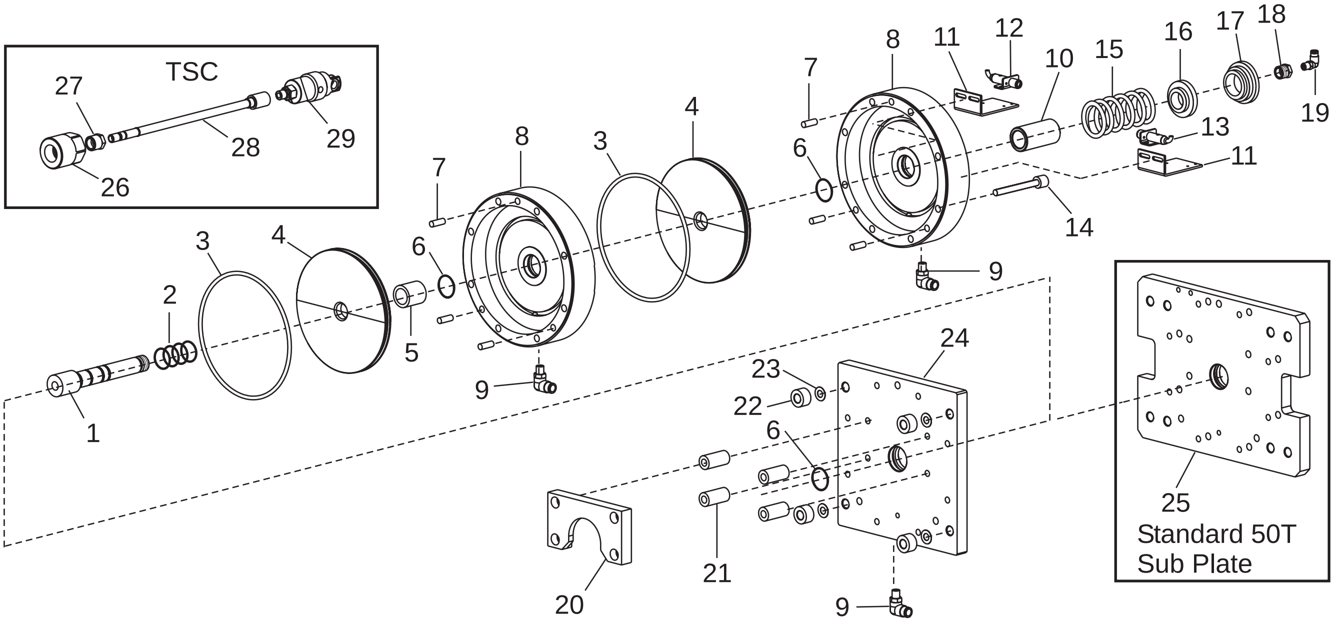


1.	25-5615	Panel Encl Top
2.	25-5621	Post Encl Top Cross
3.	25-5622	Track Encl Door Roll
4.	25-5623	Post Encl LT Top
5.	25-5625	Cover Encl Top LT
6.	25-5627	Cover Encl Top RT
7.	25-5624	Post Encl RT Top
8.	25-5629	Header Support
9.	25-5618	Panel Encl Top Door
10.	25-5614	Panel Encl Top
11.	25-5616	Panel Encl Side
12.	25-5617	Main Post Encl
13.	25-5619	Front Door
14.	28-0020	Window
15.	59-6210	Door Handle
16.	54-0030	Guide Wheel
17.	25-5653	Retainer
18.	20-2579	Stand-off Bumper
19.	20-2573	Track, Front Door
20.	25-5608	Saddle Back RT
21.	25-5638	Saddle End Cover
22.	25-5610	Saddle Front RT
23.	25-5611	Saddle Front Mid
24.	25-5612	Saddle Front LT
25.	25-5643	Silt Plate
26.	25-5640	Trough Drain
27.	25-0548	Discharge Chute
28.	19-8612	Screen, Chip Tray
29.	25-5639	Plenum Drain
30.	25-5609	Saddle End Cover LT
31.	25-5613	Saddle Back LT
32.	25-5597B	Panel Encl
33.	25-5596B	Panel Encl
34.	25-5585B	Dip Pan T/C
35.	25-5601C	Panel Encl L R
36.	25-5594B	Panel Encl Top
37.	25-5588B	Panel Encl R Upper
38.	25-5587C	Panel Encl Rear Mid
39.	25-5590	Panel Cbl Encl
40.	25-5592B	Panel Encl RT Rear
41.	25-5593A	Panel Encl RT Side
42.	25-5591A	Door, Operator
43.	25-5600B	Panel Encl Left Side
44.	25-5599B	Panel Encl LT Side F
45.	25-5582B	Drip Pan T/C Bottom
46.	25-5598B	Panel Encl R L
47.	25-5595B	Panel Encl T/C Fillet
48.	25-5642B	Panel T/C Back
49.	25-5586B	Support, T/C D Pan
50	25-5581B	Retainer

EC-1600 Spindle Assembly

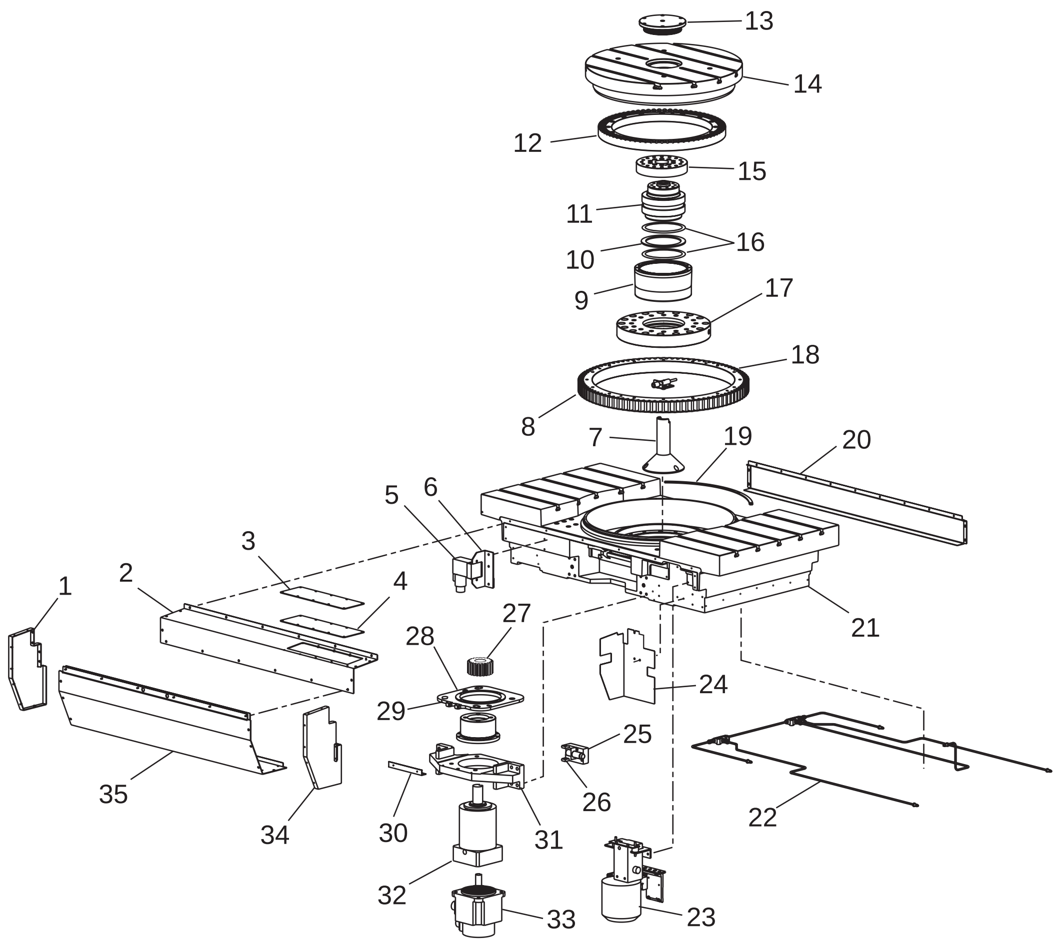


1. 20-0011A 50T Shaft Spindle
2. 20-0001A Spindle Lock
3. 30-7395 EC-1600 P Cool
4. 30-7394 Plumbing Assembly
5. 20-0004 50T spindle Housing
6. 30-6954 Lube Line Assembly-Y Axis
7. 32-1457 Encoder
8. 60-1813 Encoder M23 Short
9. 20-2965B Standoff Rod
10. 20-0726 Transmission Subplate
11. 20-0017 Air Cylinder Subplate
12. 20-6097 Coolant Manifold
13. 25-6096 Manifold Cover
14. 58-3062 3/8 NPT Elbow
15. 58-1725 3/8 NPT Tee
16. 30-0013 TRP Assembly
17. 59-0144 Fan Guard
18. 25-5649 Fan Mounting Shroud
19. 62-4010 20HP Spindle Motor
20. 30-3260C Gear Oil Pump Assembly
21. 25-5647 Spindle Motor Shroud
22. 30-7255 Check Value Assembly
23. 30-7280 TRP/TSC Solenoid Assembly
24. 20-2549 Trans Plate
25. 25-6292 Spindle Sound Shield
26. 20-1455 50T Pully
27. 20-2962 Read Head Mount
28. 50-9010 Linear Guide
29. 20-2507 Spindle Head
30. 57-0372 Head Cover
31. 57-0372 Encoder Cover Gasket
32. 25-5565 Encoder Cover



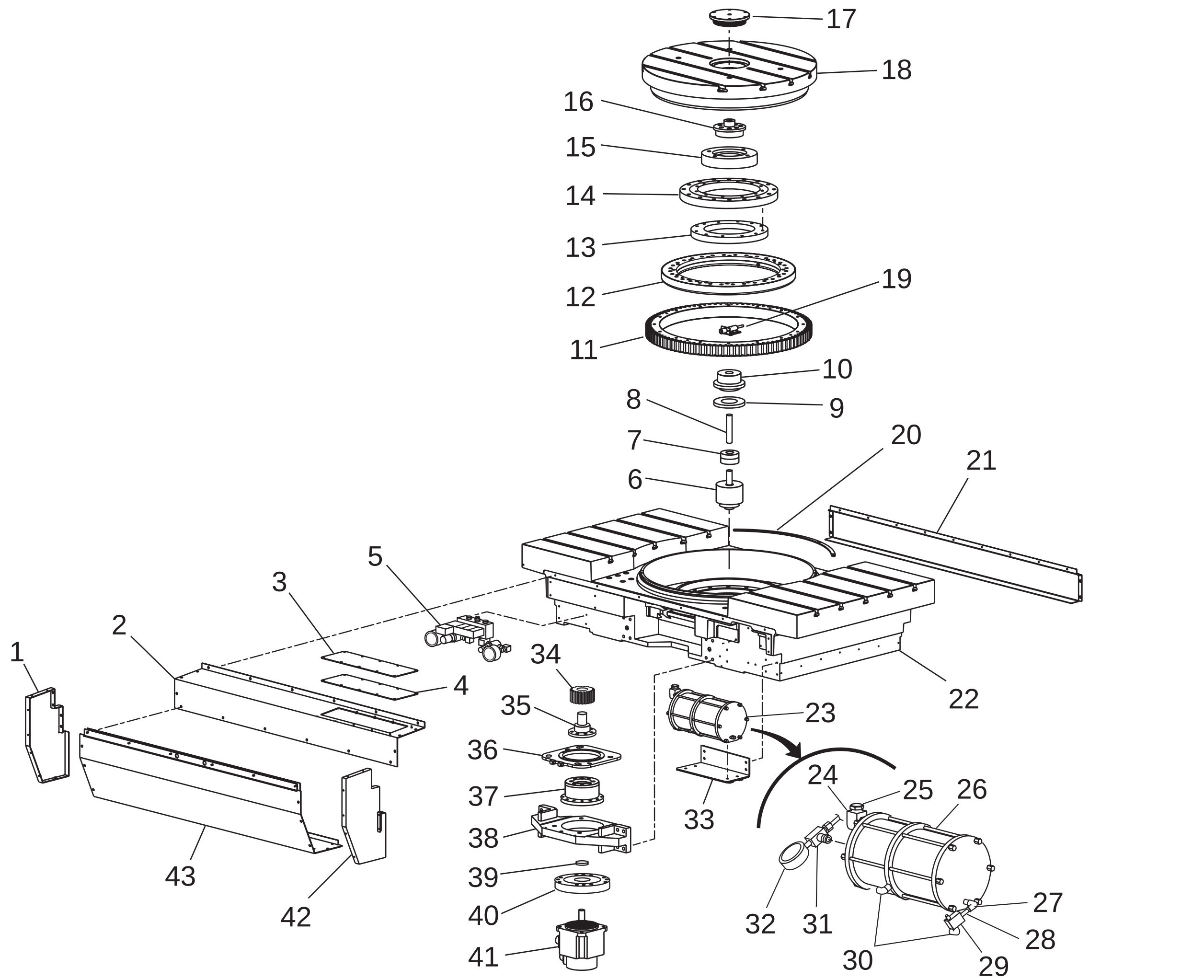
1. 20-0018 Air Cyl. Shaft
2. 57-0027 O Ring 2-121 (4X)
3. 57-0082 O Ring 2-448 (2X)
4. 20-0019 Air Cyl. Piston (2X)
5. 20-0020 Lower Air Cyl. Spacer
6. 57-0095 O Ring 2-327 (3X)
7. 48-1662 Dowel Pin (6X)
8. 20-0022 Air Cyl. Housing
9. 58-1695 90 Degree Elbow (3X)
10. 20-0021 Upper Air Cyl. Spacer
11. 25-0009 Switch Bracket (2X)
12. 32-2204 Clamp Prox Switch
13. 32-2203 Unclamp Prox Switch
14. 40-0006 SHCS ½-13x5 (8X)
15. 59-0049 Compression Spring
16. 20-1657 Spring Retainer
17. 52-0003 Shaft Clamp
18. 58-3631 Reducer
19. 58-3050 90 Elbow
20. 20-0015 Spindle Fork Lift
21. 20-0013 Spindle Fork Spacer (4X)
22. 20-0014 (22-0014) Spacer (4X)
23. 45-0014 Washer .010
24. 45-0015 Washer .018
25. 20-0017 Sub Plate (EC-1600)
26. 20-2988 Sub Plate
27. 20-7655 Bearing Holder
28. 20-7654 Extension Tube
29. 52-6200 Rotating Union

(5° Indexer)



1.	25-5541	Left Shroud
2.	25-5542	Top Shroud
3.	25-5544	Pump Cover Access
4.	57-0373	Pump Cover Gasket
5.	32-6929	Hydraulic Solenoid
6.	25-5546	Hydraulic Valve Bracket
7.	20-2528	Zero Ref. Sensor Mount
8.	20-6103	Ring Gear
9.	20-2523	Hydraulic Clamp Cylinder Housing
10.	51-0162	160mm Thrust Bearing
11.	20-2524	Hydraulic Clamp Piston
12.	20-2529	Face Gear
13.	20-0973	Table Cover Center
14.	20-2980	Indexing Platter
15.	20-2530	Piston Adapter
16.	51-0168	Thrust Washer 160200 (2)
17.	20-2522	Hydraulic Clamp Cylinder Cap
18.	69-1700	Prox. Sensor
19.	25-5538	Retainer Platter Seal
20.	25-9817	X-Axis Chip Guard
21.	20-2508	Table
22.	30-7410	Saddle Oil Line
23.	30-7510	Haskel Pump
24.	25-55545	Pump Sound Wall
25.	69-1700	Prox. Sensor
26.	20-2532	Sensor Bracket
27.	20-2527	Pinion 22T Indexer
28.	20-1400	Backlash Plate
29.	20-2526	Indexer Mount
30.	25-5539	Shroud Support
31.	20-2531	Platter Drive Mount
32.	59-0695	Alpha Ip 120
33.	62-0024	Servo Motor
34.	25-5540	Right Shroud
35.	25-5543	Bottom Shroud

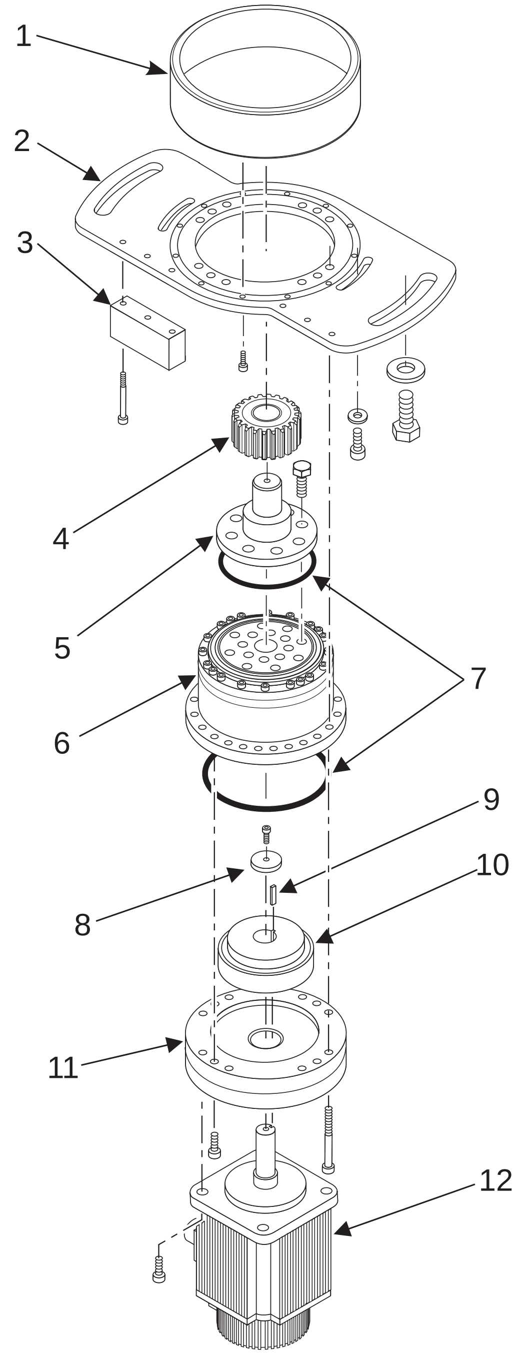
EC-1600 Table Assembly (Full-Fouth Indexer)



1.	25-5541	Left Shroud
2.	25-5542	Top Shroud
3.	25-5544	Pump Cover Access
4.	57-0373	Pump Cover Gasket
5.	30-7398A	Hydraulic Solenoid Assembly
6.	32-1459	Encoder Assembly
7.	52-4471	Coupling
8.	20-6115	Encoder Shaft
9.	20-6114B	Encoder Mounting Plate
10.	20-6027	Coupling Tube
11.	20-6103	Ring Gear
12.	30-7754	Hydraulic Brake Assembly
13.	20-6113	Bearing Retainer Ring
14.	51-2038	Cross Roller Bearing
15.	20-2534	Encoder Shaft Plate Adapter
16.	20-6116	Encoder Shaft Plate
17.	20-0973	Table Cover Center
18.	20-2510A	4^{th} Axis Platter Machined
19.	69-1700	Prox. Sensor
20.	25-5538	Retainer Platter Seal
21.	25-9817	X-Axis Chip Guard
22.	20-2508	Table
23.	30-7410	Saddle Oil Line
24.	30-7881	Brake Booster Assembly (with Sensor)
25.	58-2267	Muffler
26.	59-0216	Booster
27.	58-1696	Elbow
28.	58-0051	Connector
29.	59-0047	Quick Exhaust Valve
30.	58-3658	Elbow (2x)
	58-1671	Nipple
31.	58-0315	"T"
32.	52-0014	Pressure Guage
33.	25-5547	Booster Mounting Bracket
34.	20-6102	Pinion Gear
35.	20-6100	Cooling Jacket Inlet Plate
36.	20-1400	Backlash Plate
37.	59-2930	Harmonic Drive (50:1)
38.	20-2531	Platter Drive Mount
39.	20-6110	Motor Shaft Spacer
40.	20-6109	Motor Adapter
41.	62-0014	Motor

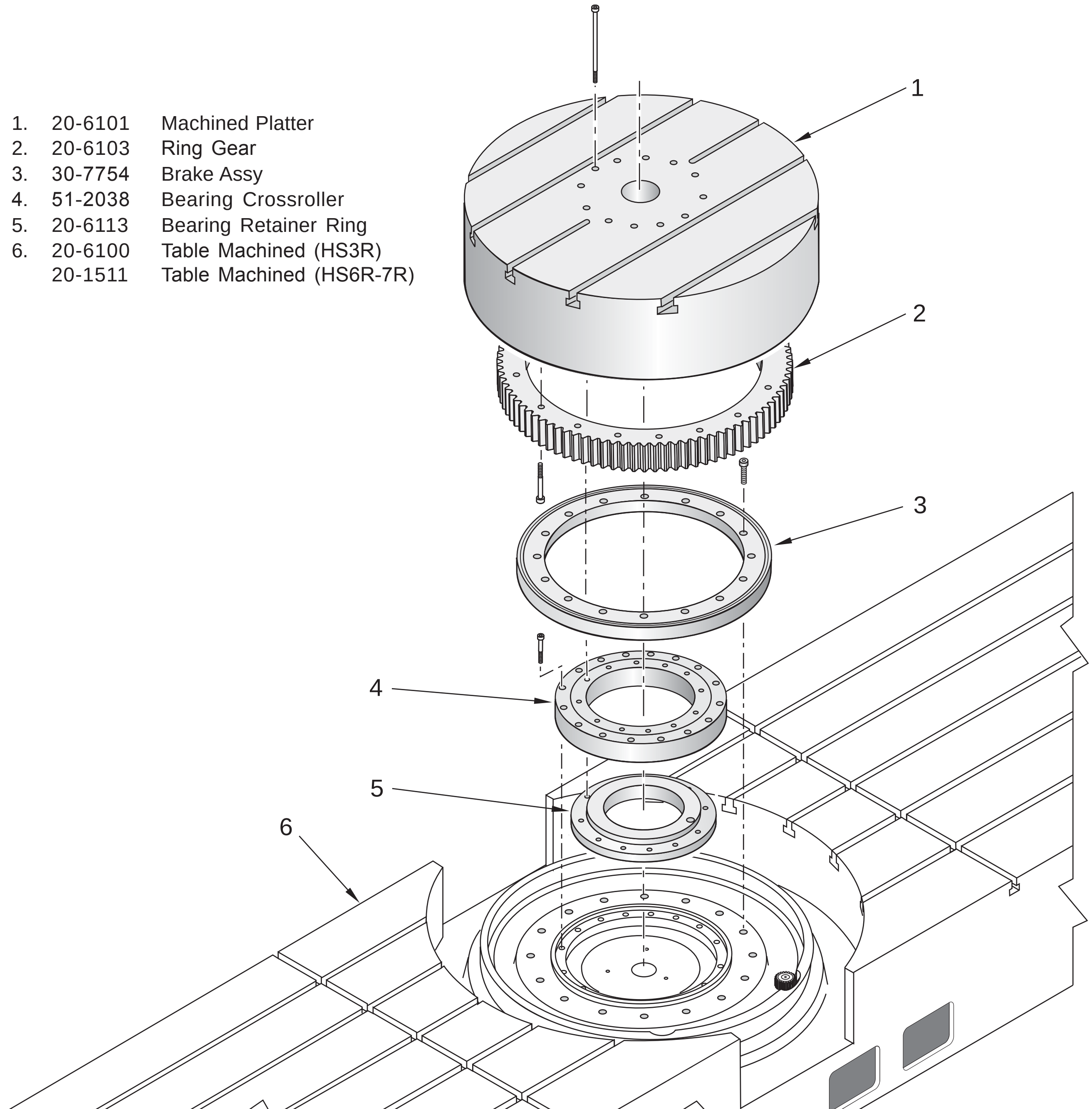
HS3-7R Harmonic Drive Assembly

1.	20-6047	Tube Backlash Adjuster (HS3R)
2.	20-6048	Cam Backlash Adjuster (HS3R)
3.	20-6005	Push Block (HS3R)
4.	20-6102	Pinion Gear (HS3R)
5.	20-6109	Sigma Adapter (HS3R)
6.	59-2930	Harmonic Drive
7.	20-6112	Shoulder Washer (HS3R)
8	22-2627	Yasakawa Motor Key
9.	59-2930	Harmonic Drive Assy
10.	20-6108	Gearbox Adapter (HS3R)
11.	62-0014	Yaskawa Sigma Motor

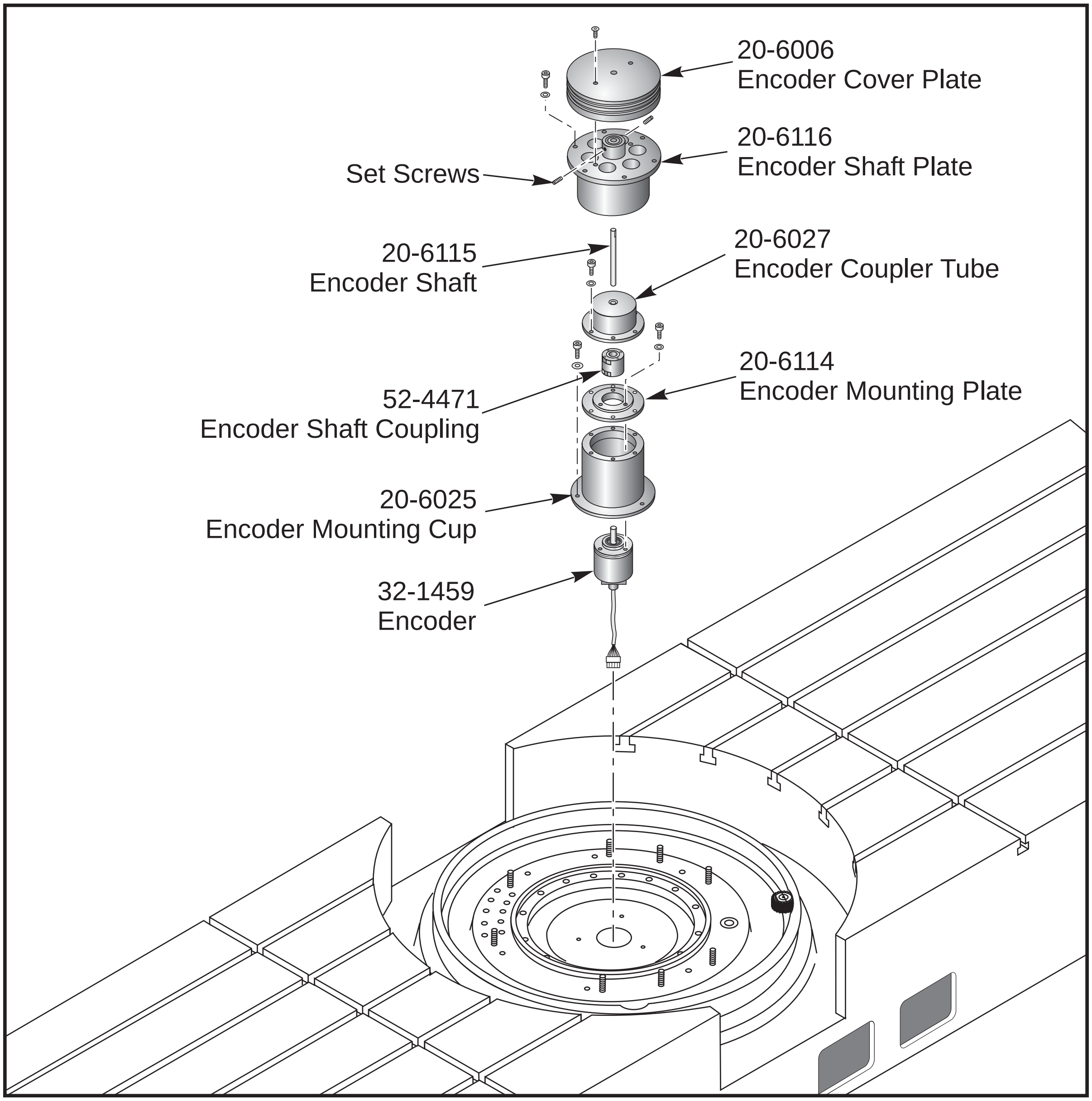


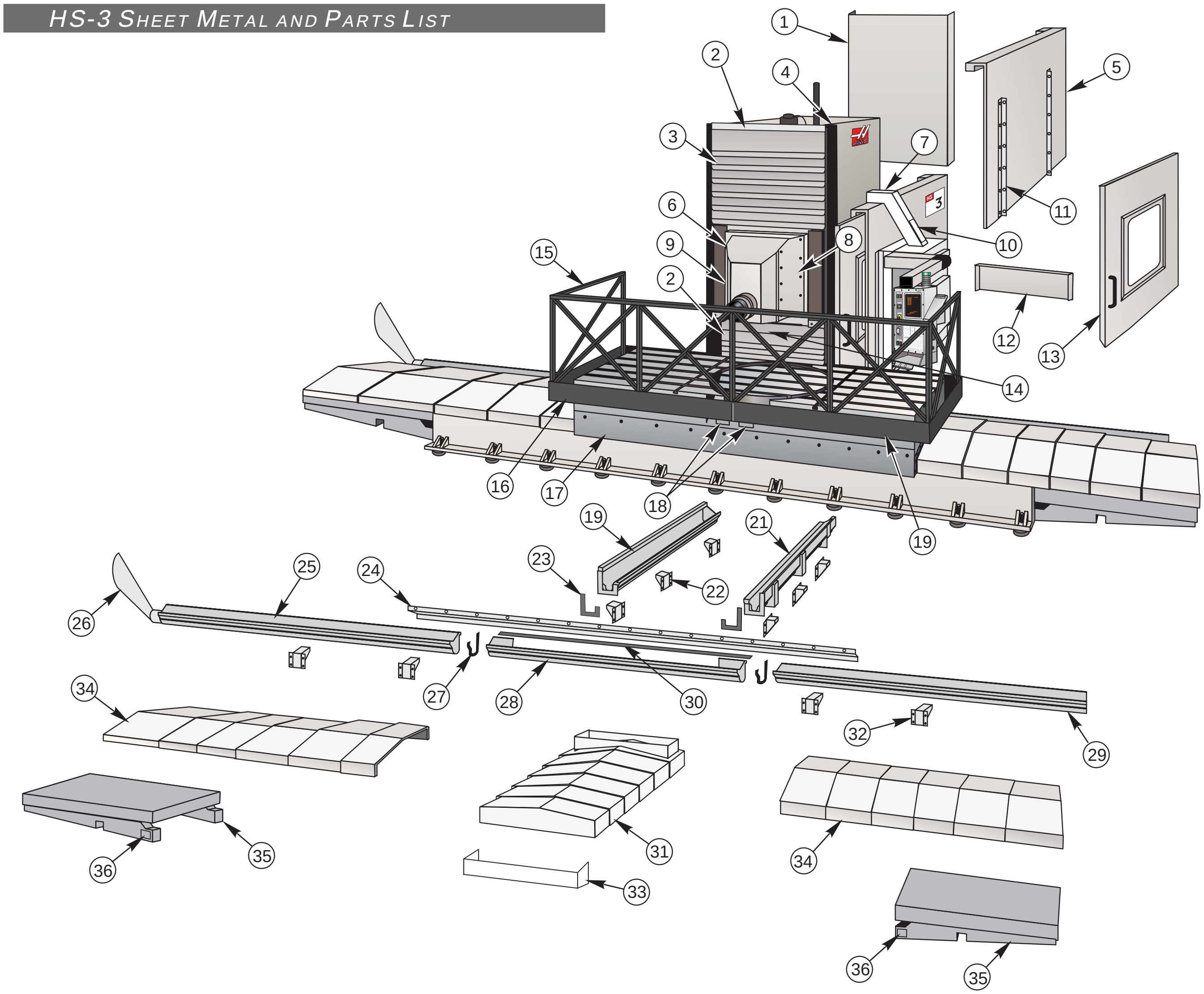
HS3-7R Table Assembly

1. 20-6101 Machined Platter
2. 20-6103 Ring Gear
3. 30-7754 Brake Assy
4. 51-2038 Bearing Crossroller
5. 20-6113 Bearing Retainer Ring
6. 20-6100 Table Machined (HS3R)
   20-1511 Table Machined (HS6R-7R)



HS3-7R Encoder Assembly

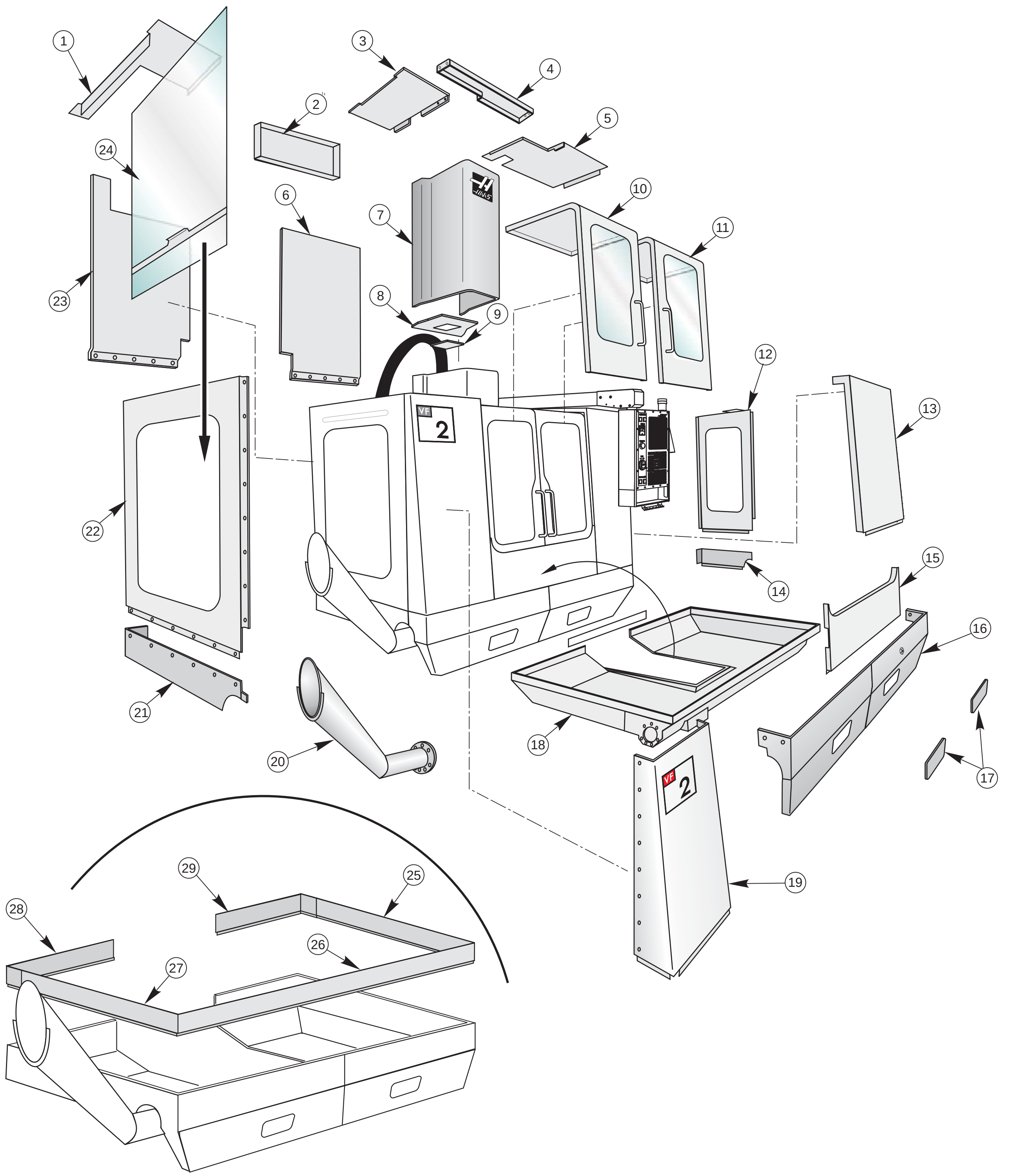




1. 25-0528 Back panel sheet metal
2. 25-0163 Y-Axis bellows top edge cover
3. 59-0268 Y-Axis upper bellows
4. 25-6017 Y-Axis splash cover
5. 25-6051 Door enclosure
6. 25-6017 Y-Axis chip guard
7. 25-6057 Conduit enclosure
8. 25-6026 Head cover, right
9. 25-6025 Head cover, left
10. 25-6057 Conduit enclosure access plate.
11. 25-6571 "L" bracket
12. 25-0446 Center bottom sheet metal
13. 25-6052 Door
14. 59-0267A Y-Axis lower bellows
15. 22-6056 Fence panel (6)
16. 25-0626 Left table gutter
17. 25-0630 Front table cover
18. 25-6003 Access cover (2)
19. 25-0627 Right table gutter
20. 25-0448 Z-Axis chip conveyor tray, left
21. 25-0449 Z-Axis chip conveyor tray, right
22. 25-6043 Z-Axis chip conveyor brace (6)
23. 57-0085 Z-Axis chip conveyor tray gasket (2)
24. 25-6054 X-Axis splash guard
25. 25-0450 X-Axis chip conveyor tray, left
26. 25-0548 Chip conveyor chute
27. 57-0086 X-Axis chip conveyor tray gasket
28. 25-0451 X-Axis chip conveyor tray, middle
29. 25-0452 X-Axis chip conveyor tray, right
30. 57-0087 Center Trough Gasket
31. 25-6008 Z-Axis way covers
32. 25-6063 X-Axis chip conveyor brace (4)
33. 25-0447 Z-Axis way cover end support
34. 25-6007 X-Axis way covers (2)
35. 25-0645 X-Axis extension
36. 25-0679 X-Axis extension access cover

VERTICAL MILL ASSEMBLY DRAWINGS AND PARTS LISTS

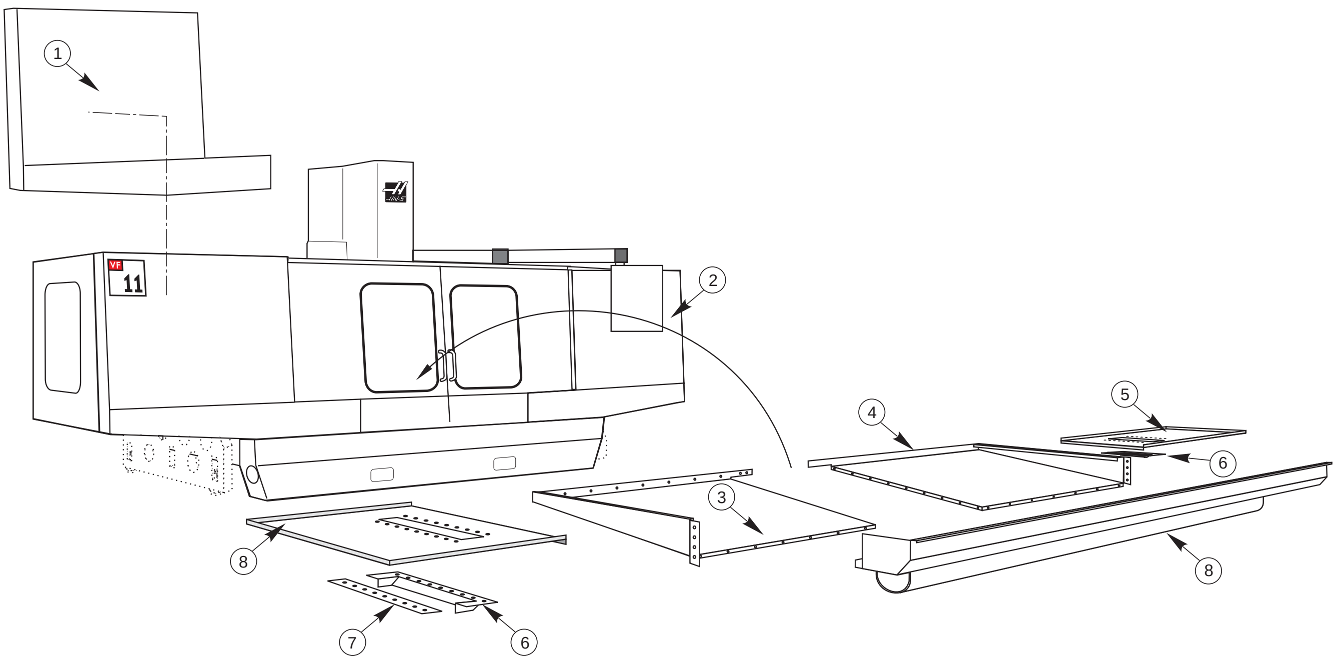
VF Exterior Sheet Metal



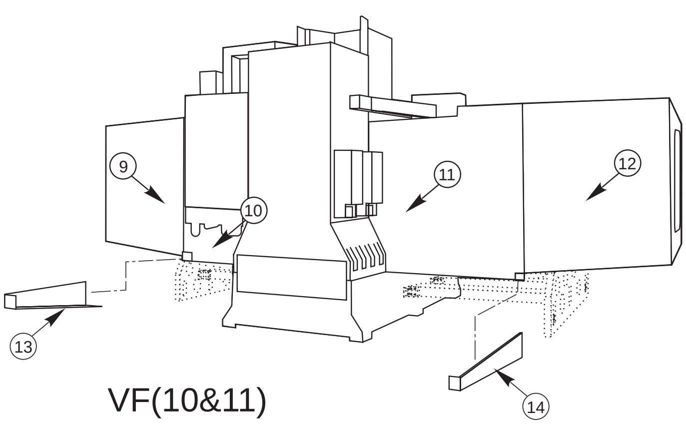
VF6 - 8 Extended Column - Riser Sheet Metal
(Optional)

1. Plate, Top Left
2. Back Panel Spacer
3. Top Left Panel
4. Upper Door Brace
5. Plate, Top Right
6. Back Right Panel
7. Spindle Head Cover
8. Spindle Head Cover, Bottom
9. Bottom Head Cover Inspection Panel
10. Left Door Assembly
11. Right Door Assembly
12. Panel, Right Side
13. Panel, Front Right
14. Apron Extension, Right
15. Middle Front Panel
16. Apron, Left and Right
17. Access Panel
18. Pan, Chip Enclosure
19. Front Left Panel
20. Chip Chute
21. Apron Extension, Left
22. Side Panel, Left
23. Back, Left Panel
24. Side Window (handle not included)
25. Right Side Riser
26. Front Riser
27. Left Side Riser
28. Left Rear Riser
29. Right Rear Riser

VF Exterior Sheet Metal

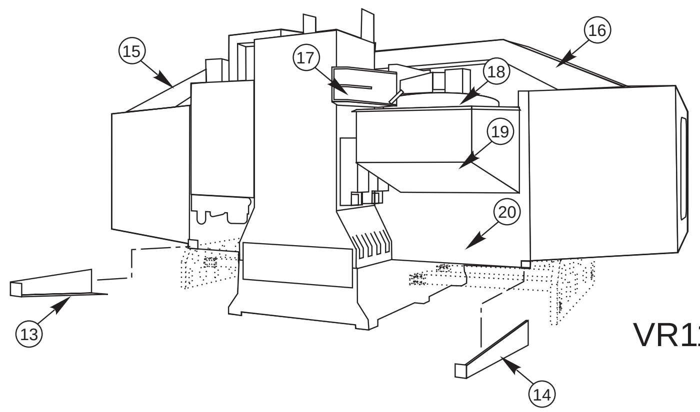


1. Front Left Panel
2. Front Right Panel
3. Floor Pan Left
4. Floor Pan Right
5. Pan Right, Outrigger
6. Pan Support
7. Pan Support
8. Pan Left, Outrigger



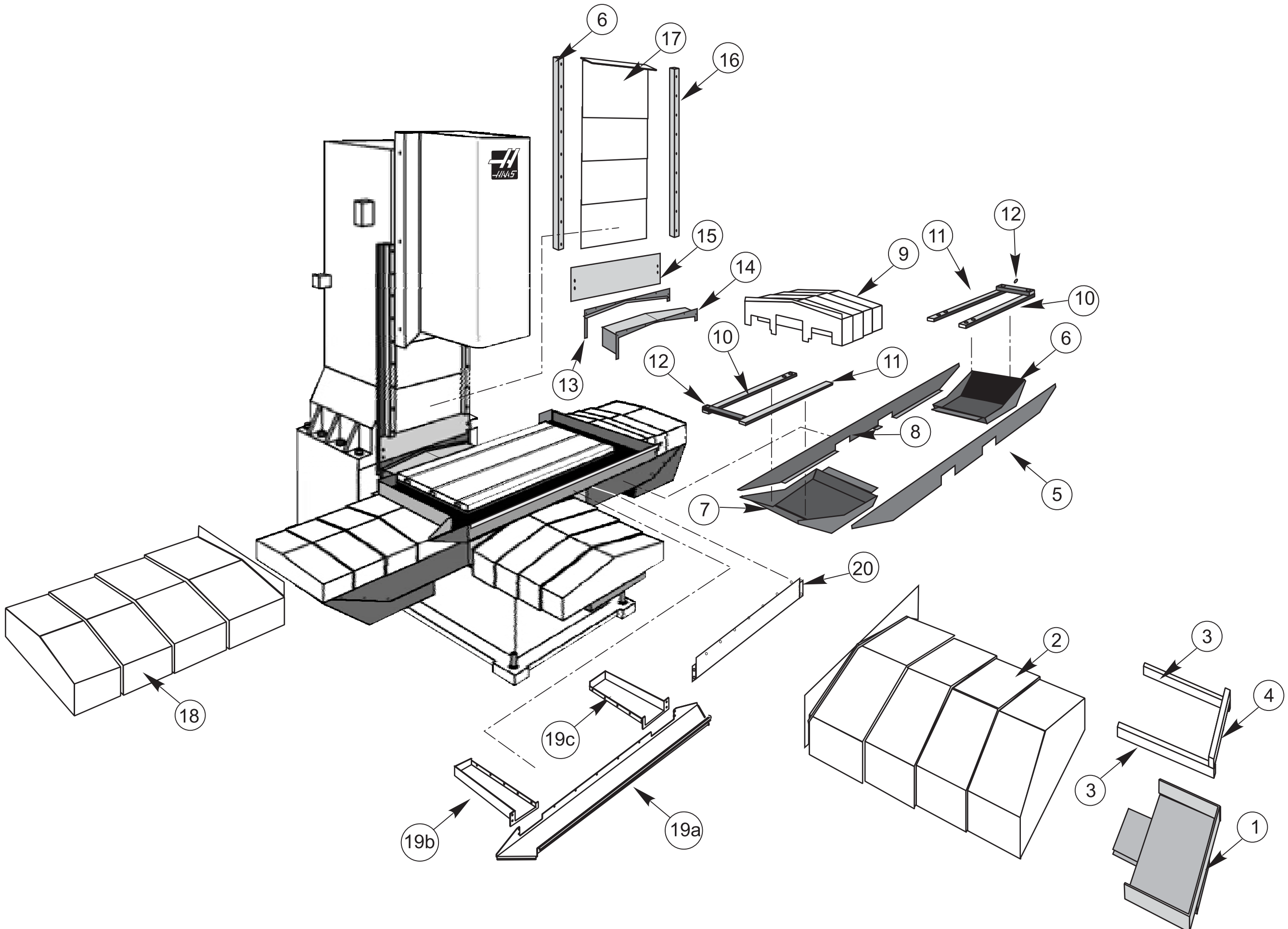
VF(10&11)

9. Back Right Panel Extension
10. Inner Back Panel, Right
11. Inner Back Panel, Left
12. Back Left Panel Extension
13. Apron Extension Right
14. Apron Extension Left
15. Support Beam
16. Support Beam
17. Tool Changer Bracket
18. Tool Changer Cover
19. Tool Changer Pan
20. Back Panel Left



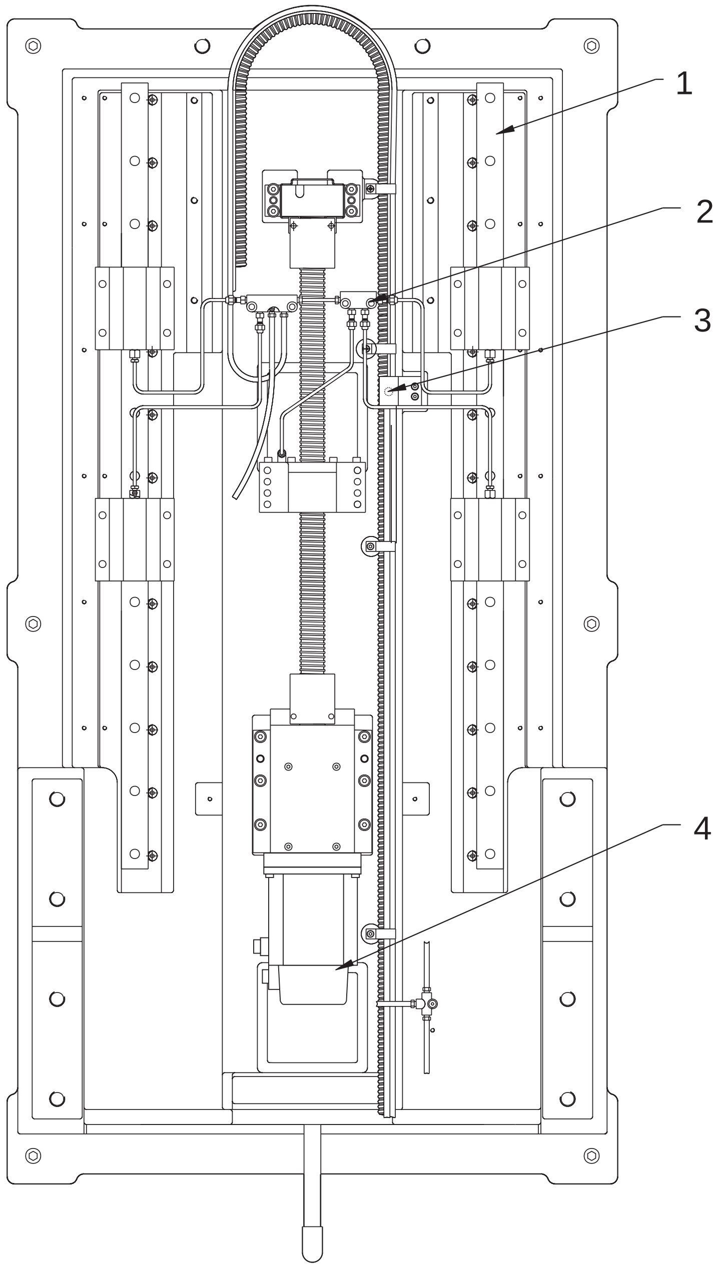
VR11

VF Interior Replaceable Parts



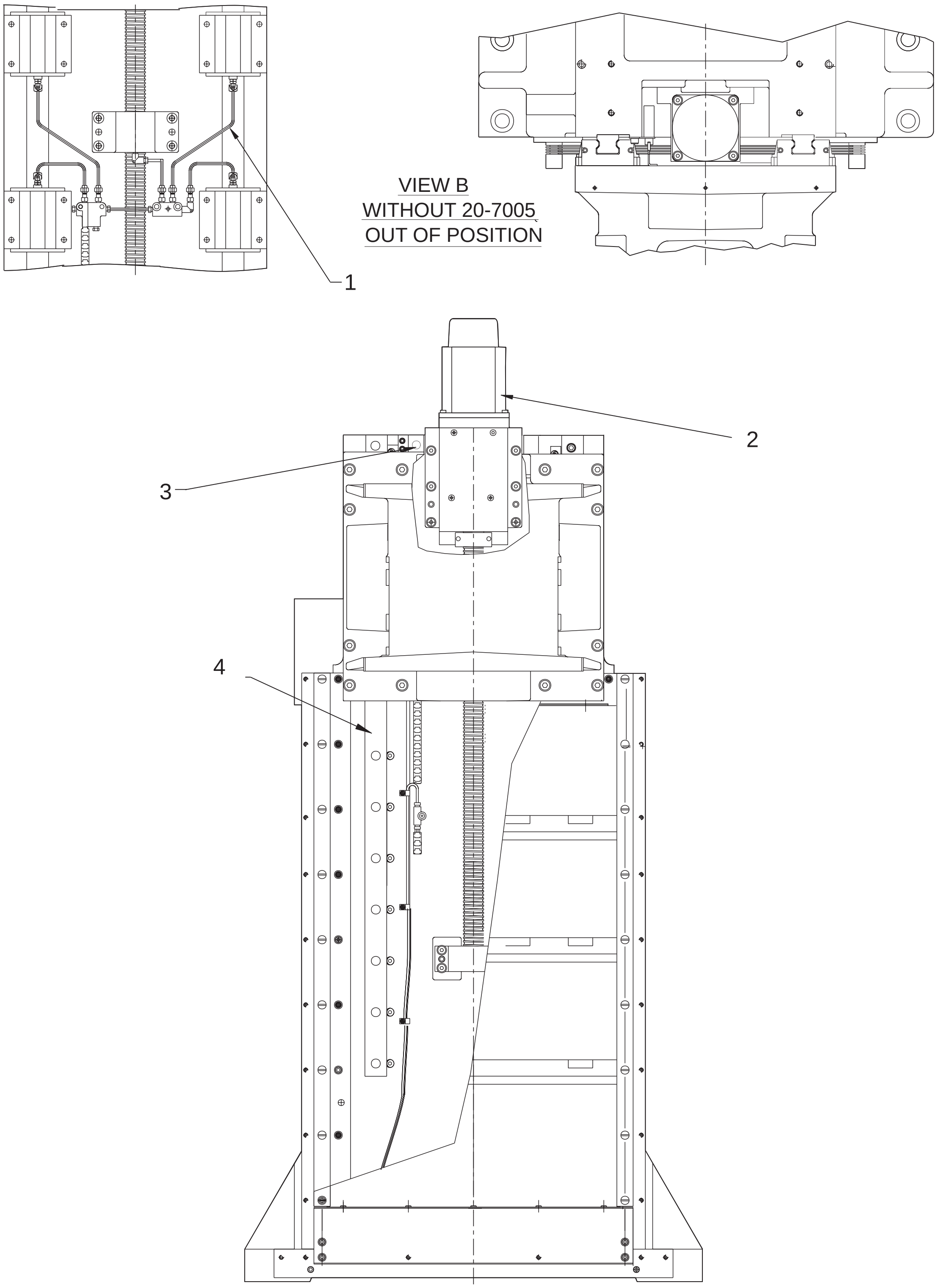
1. Y-axisGutter
2. Y-axis Waycover
3. Y-axis Guide Rails
4. Way Cover Bracket
5. Saddle Cover
6. X-axis Gutter
7. X-axis Gutter
8. Saddle Cover
9. X-axis Waycover
10. X-axis Guide Rails
11. X-axis Guide Rails
12. Way Cover Bracket
13. Y-axis Wiper
14. Y-axis Rear Waycover
15. Z-axis Waycover Support
16. Z-axis Chip Guard
17. Z-axis Waycover
18. X-axis Waycover
19. Table Gutter
20. Table Cover

VF-1 Base



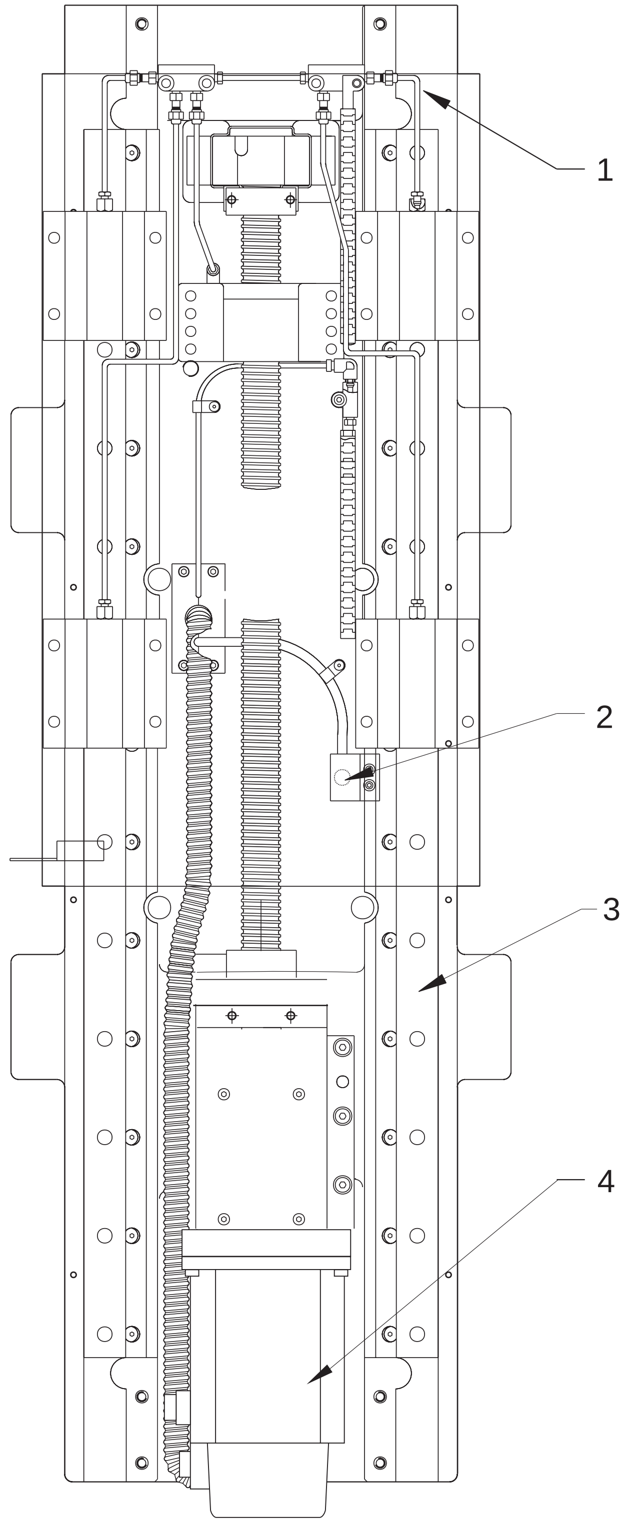
1. 50-3300 Linear guide
2. 30-0171 Oil line assembly
3. 32-2030 Switch assembly
4. 62-0014 Motor (except XRT)

VF-1 Column



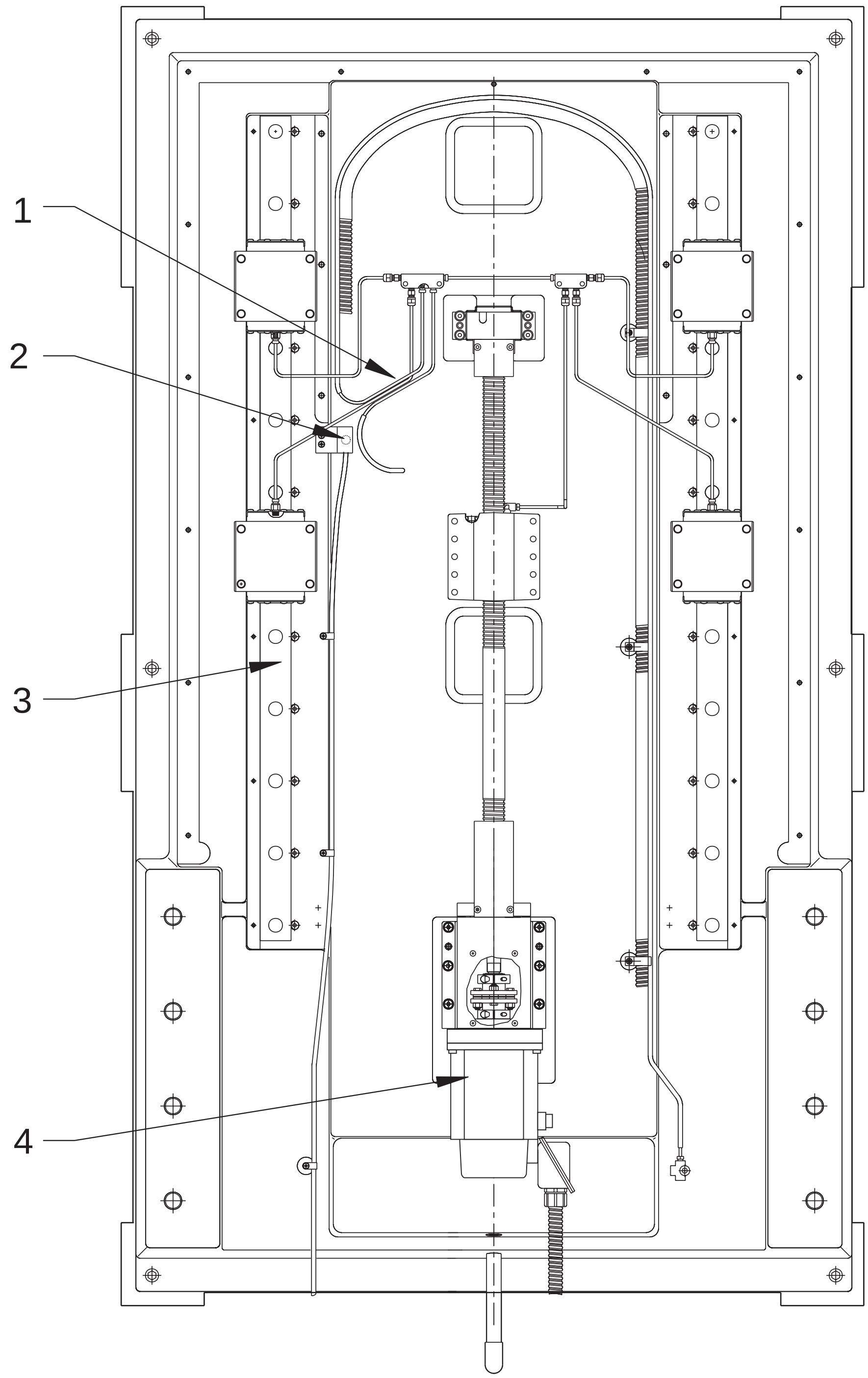
1. 30-0170 Oil line assembly
2. 62-0009 Motor (except XRT)
3. 32-2040 Switch assembly
4. 50-3300 Linear guide

VF-1 Saddle



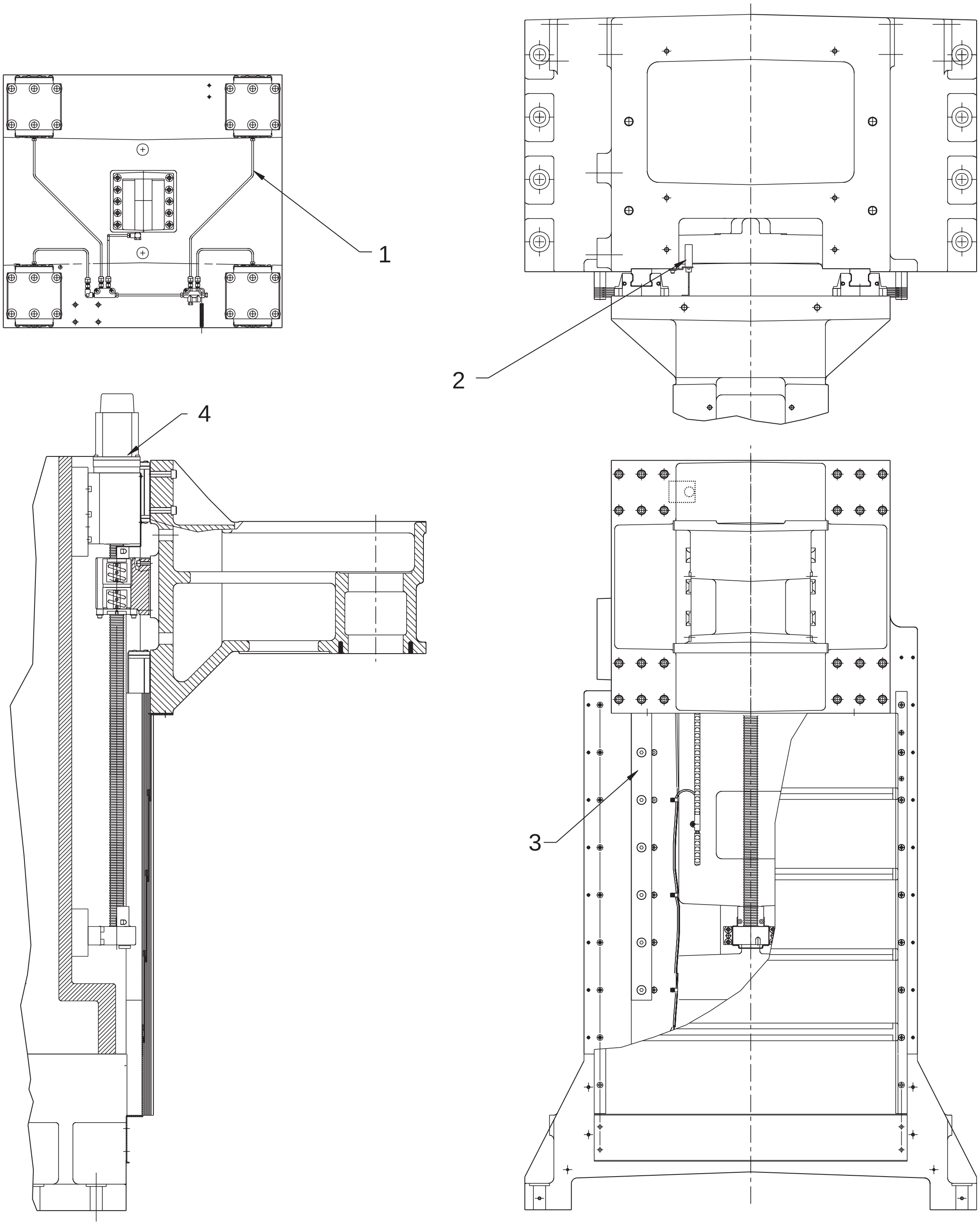
1. 30-0173 Oil line assembly
2. 32-2050 Switch
3. 50-3300 Linear guide
4. 62-0014 Motor (except XRT)

VF-3 Base



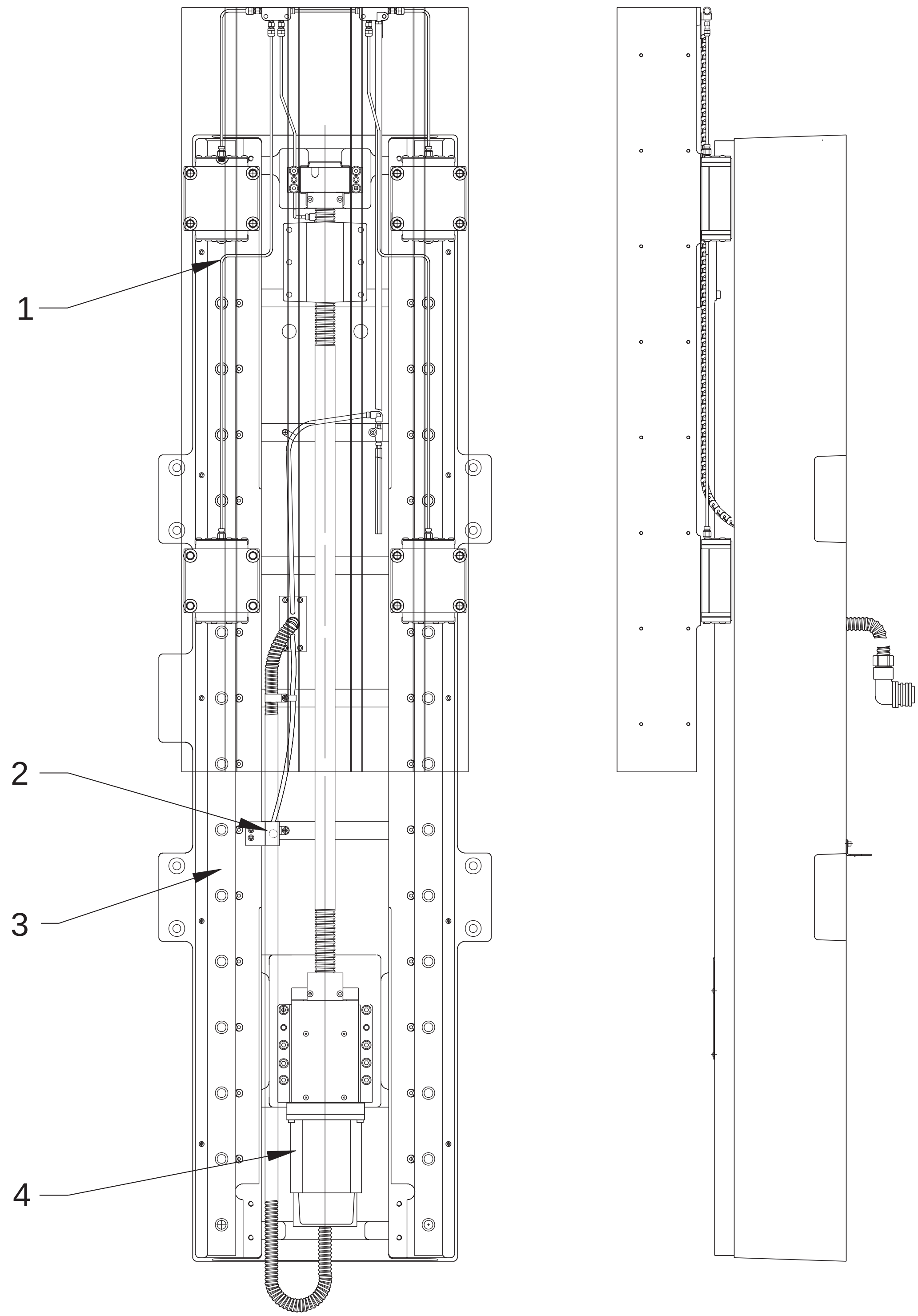
1. 30-0221 Oil line assembly
2. 32-2031 Switch assembly
3. 50-9011 Linear guide
4. 62-0014 Motor assembly (except XRT)

VF-3 Column



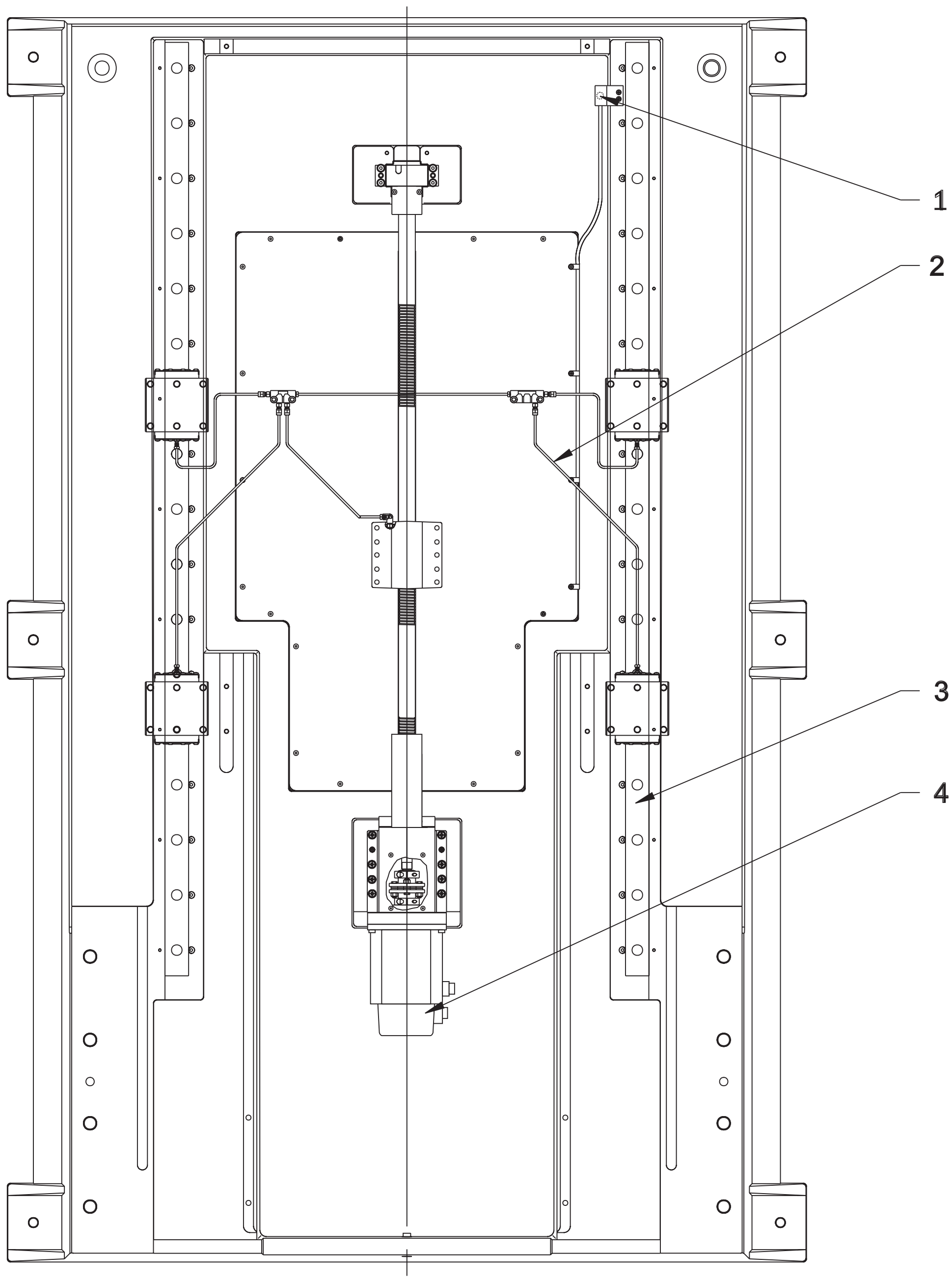
1. 30-0687 Oil line assembly
2. 32-2041 Switch assembly
3. 50-9011 Linear guide
4. 62-0014 Motor (except XRT)

VF-3 Saddle

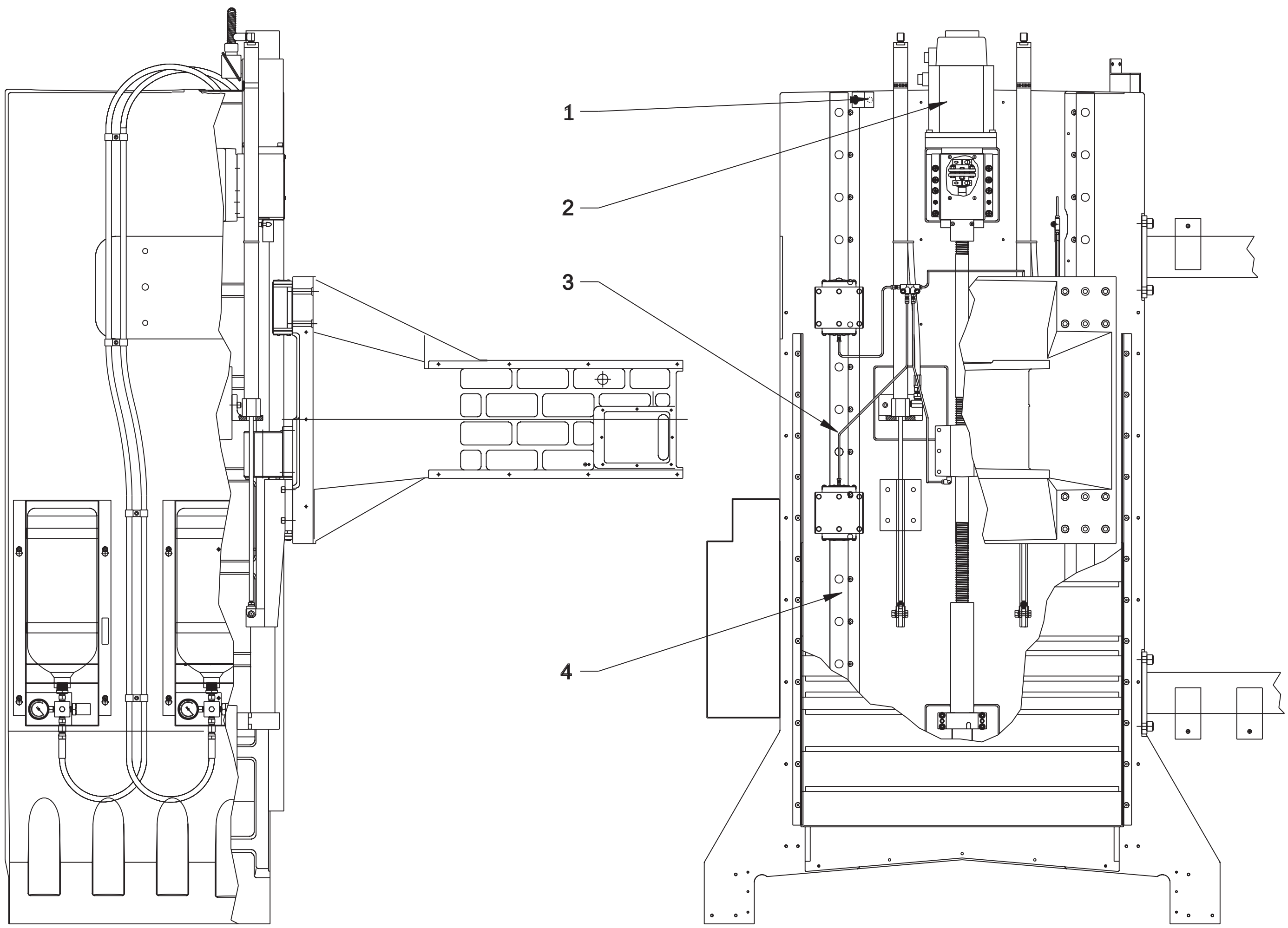


1. 30-0223 Oil line assembly
2. 32-2050 Switch assembly
3. 50-9010 Linear guide
4. 62-0014 Motor (except XRT)

VF-6 Base

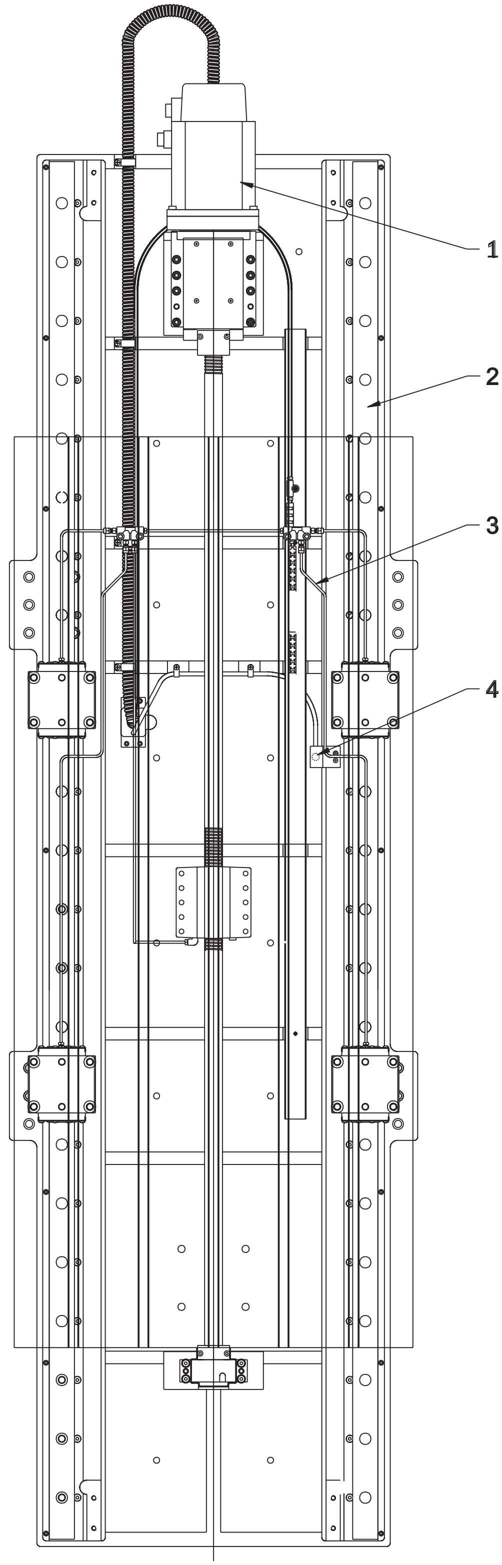


1. 32-5056 Limit switch assembly
2. 30-0221 Oil line assembly
3. 50-9010 Linear guide
4. 62-0014 Motor (except XRT)



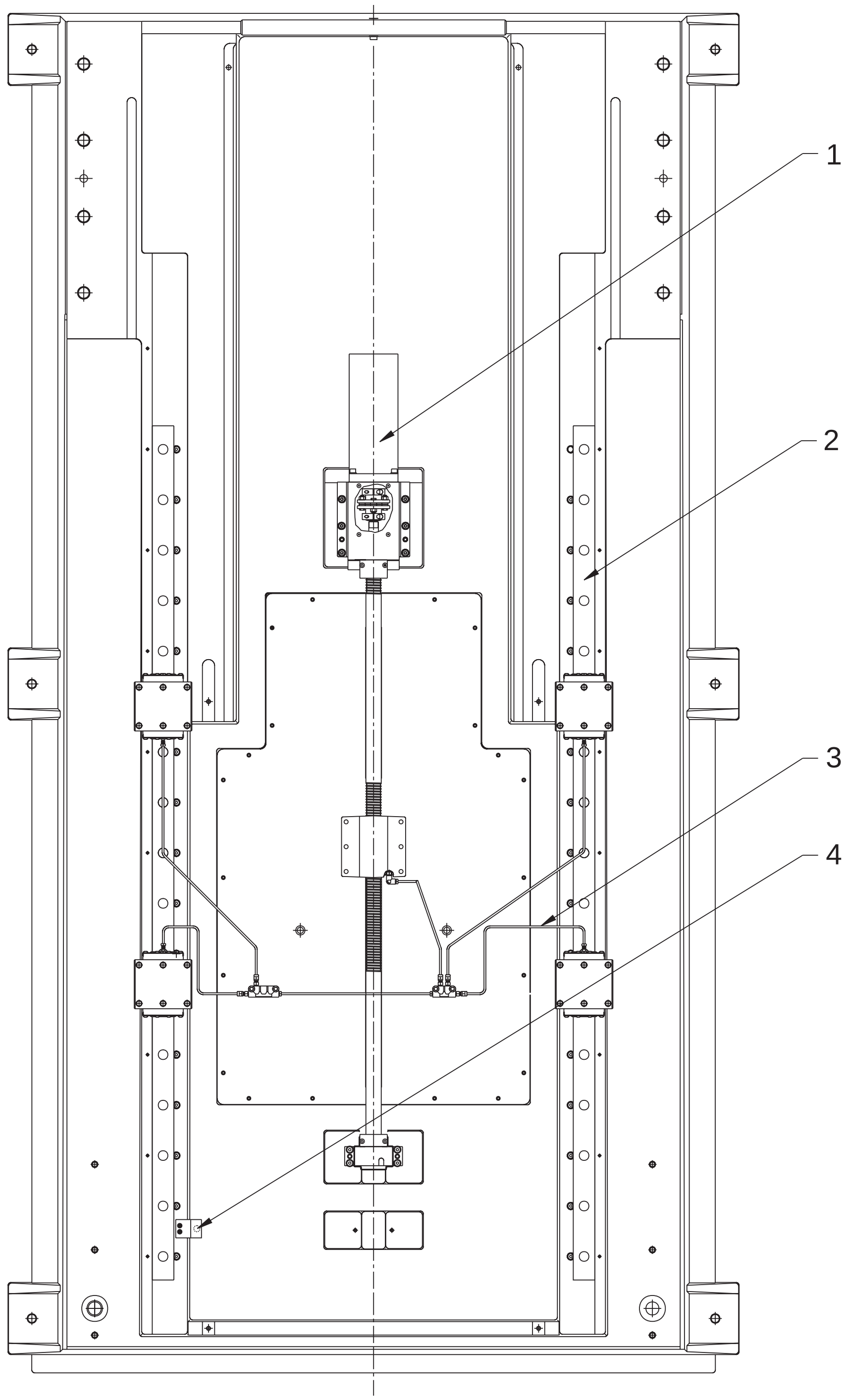
1. 32-2050 Limit switch assembly
2. 62-0014 Motor (except XRT)
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide

VF-6 Saddle

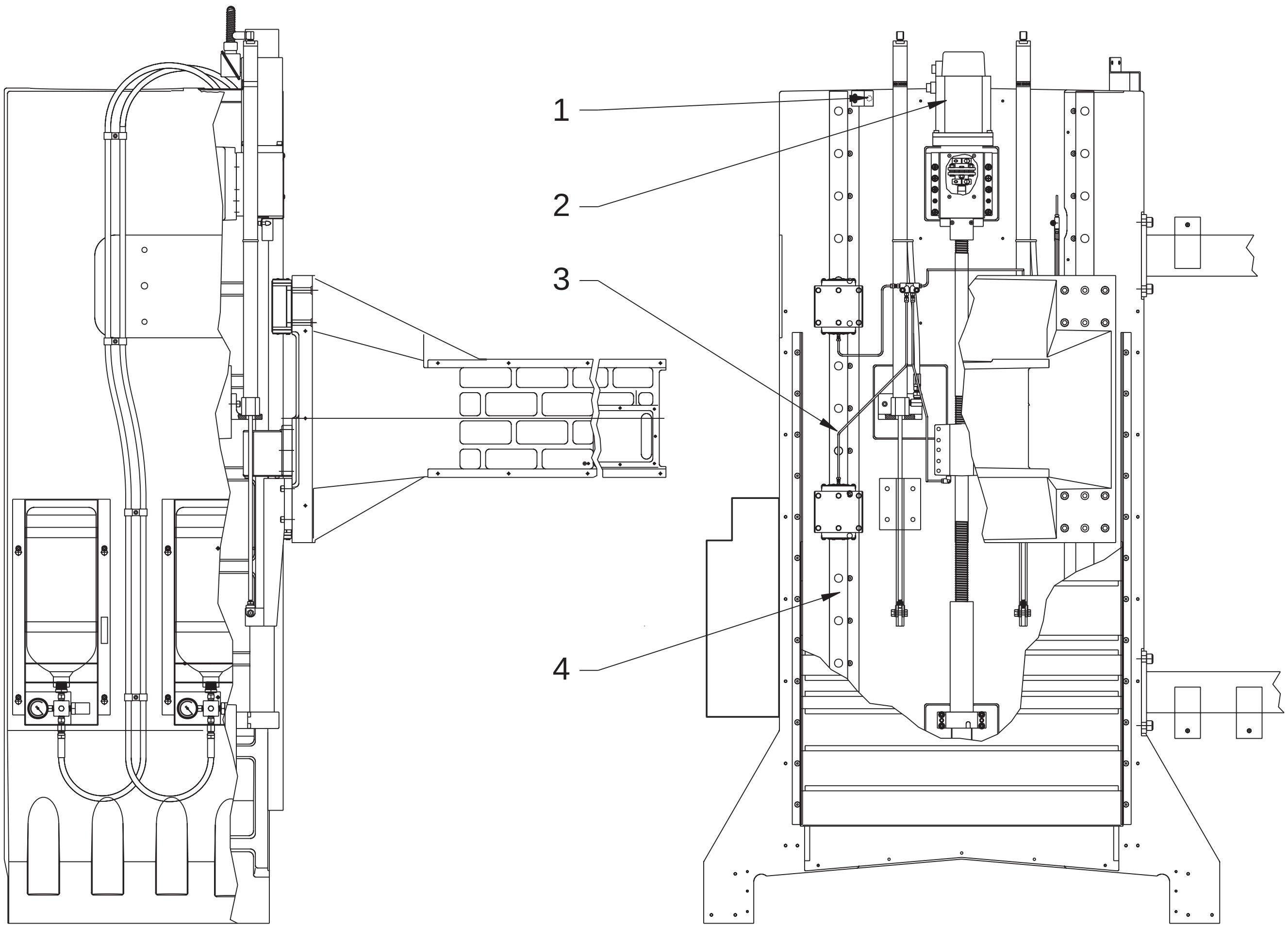


1. 62-0014 Motor (except XRT)
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2051 Limit switch assembly

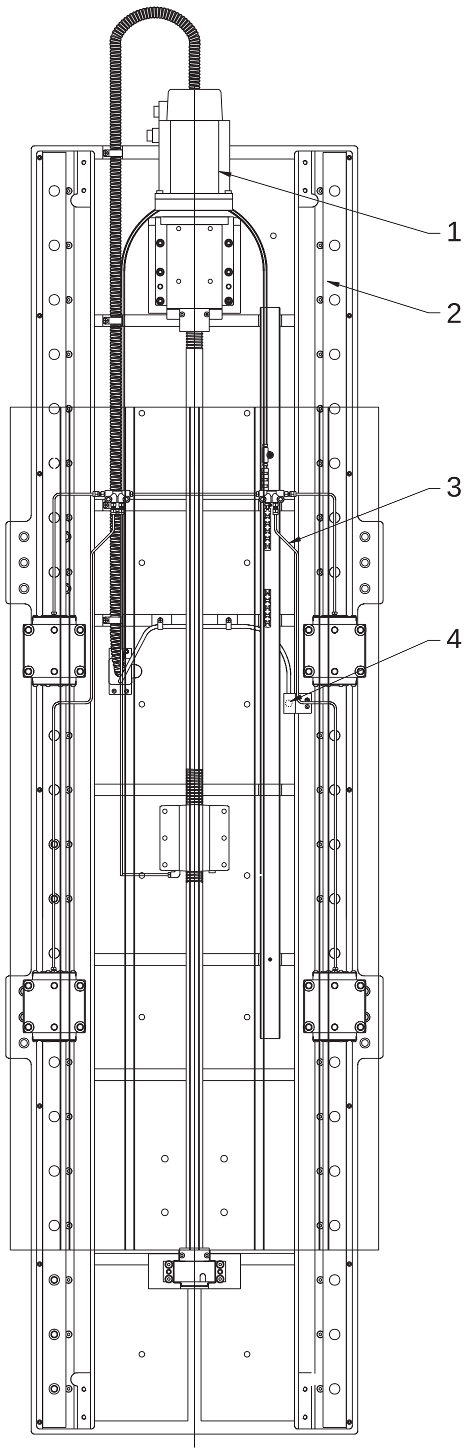
VF-8 Base



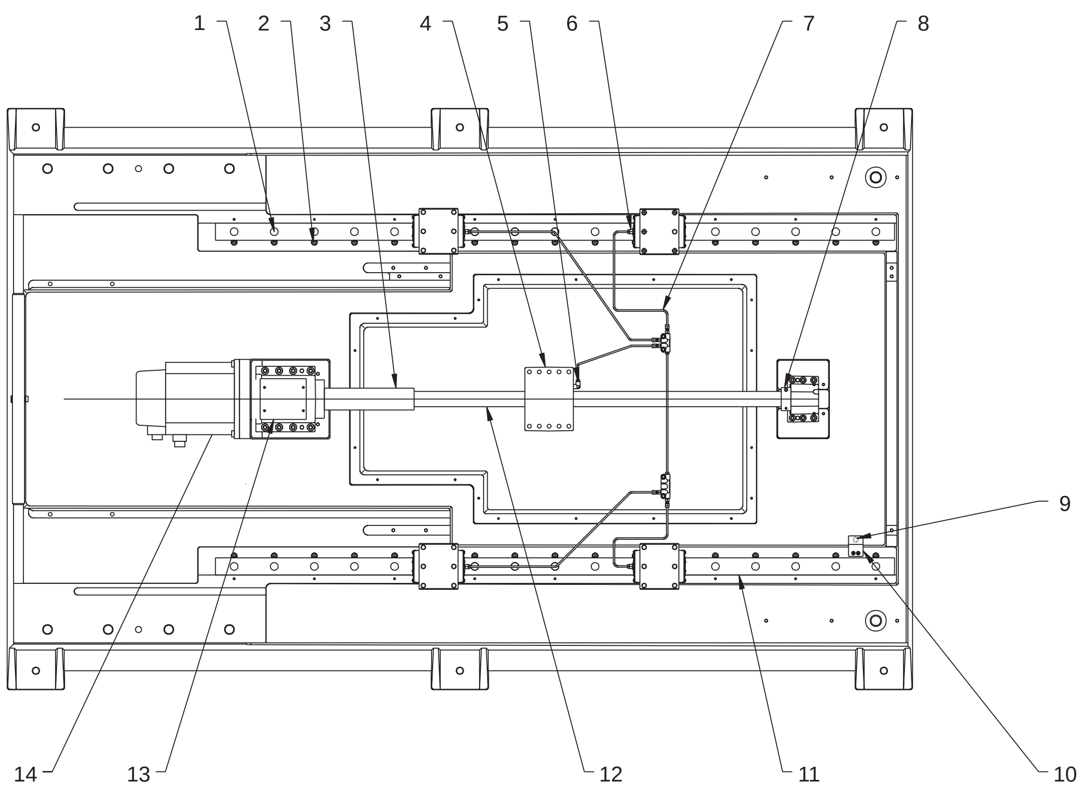
1. 62-0014 Motor (except XRT)
2. 50-9010 Linear guide
3. 30-0461 Oil line assembly
4. 32-5056 Limit switch assembly



1. 32-2050 Limit switch assembly
2. 62-0014 Motor (except XRT)
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide

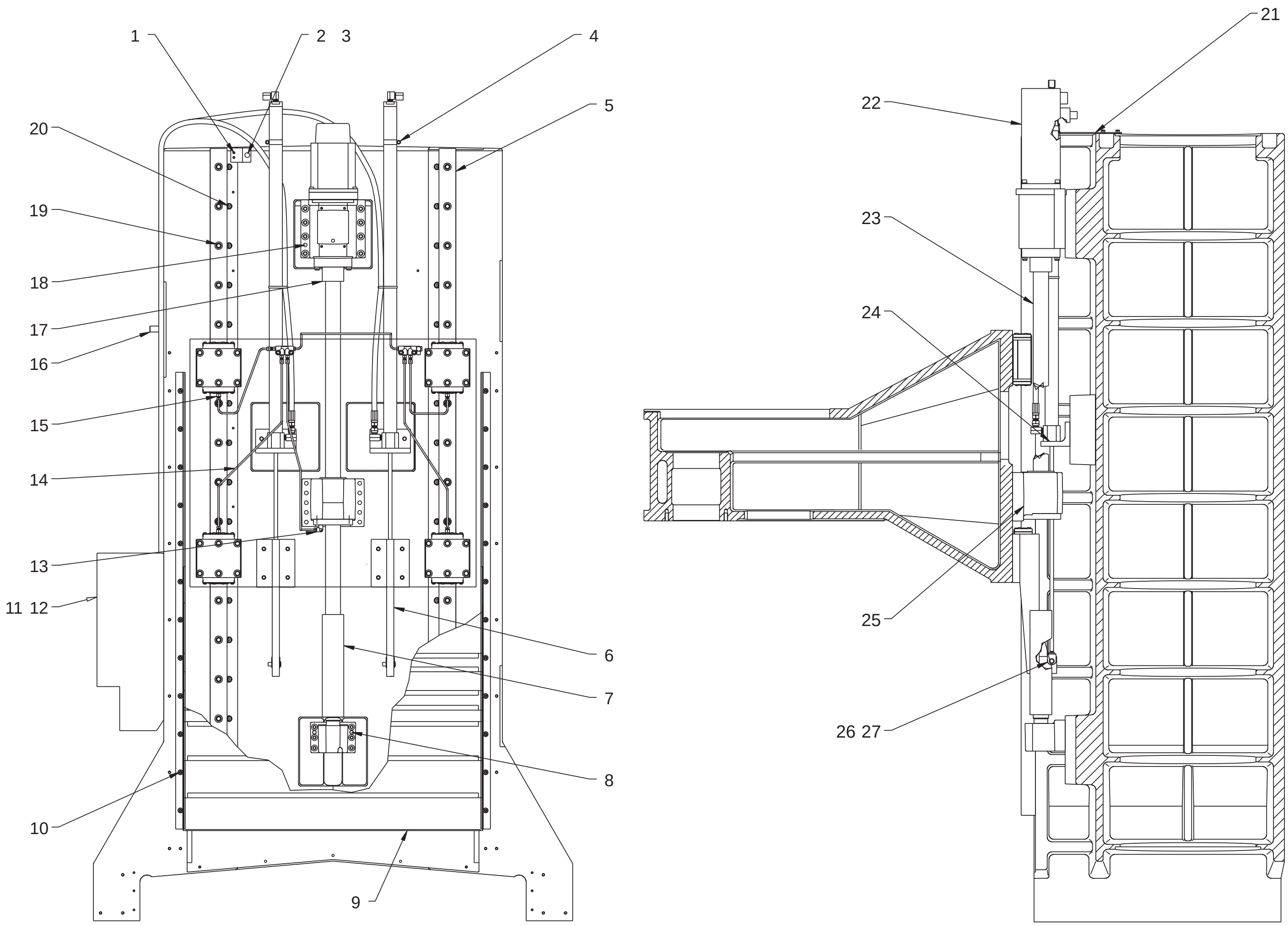


1. 62-0014 Motor (except XRT)
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2051 Limit switch assembly



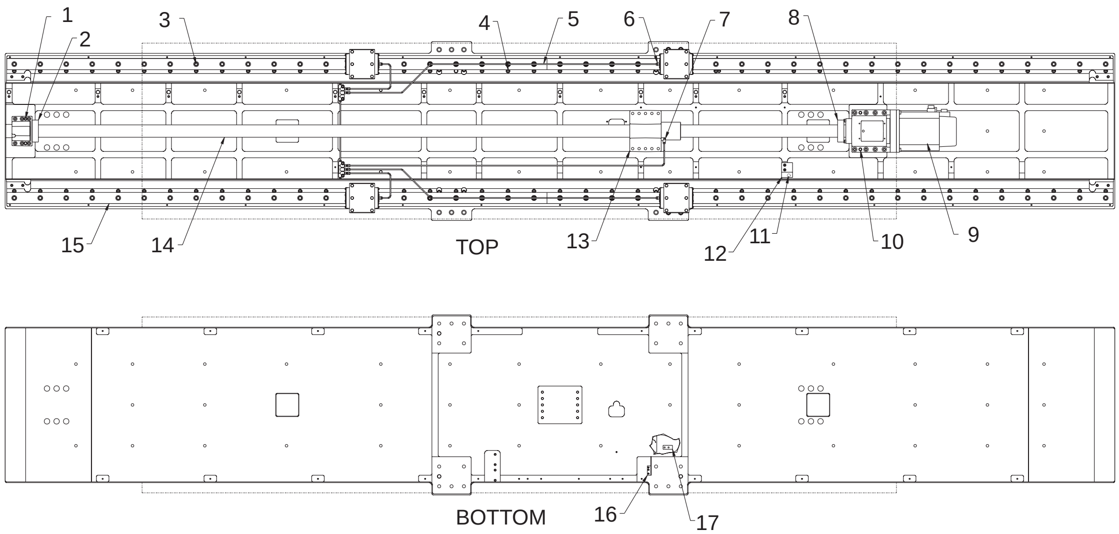
1. 59-6655 Rubber plug guide rail
2. 22-7458 Cam, linear guide
3. 20-9218 Y-axis bumper, motor end
4. 20-0150 Nut housing
5. 58-3031 Banjo elbow 5/16 female x M6 male
6. 58-1560 Adapter 1/8m (NSK and THK Linear guides) 59-0001 (Star linear guides)
7. 30-0461 Oil line assembly
8. 20-0156 Bumper for 40 and 50 mm ballscrews
9. 32-5056 Limit switch assembly
10. 25-7268 Bracket mounting Y-axis
11. 50-9010 Linear guide
12. 24-9960 40mm ballscrew (except XRT)
13. 25-9203 Cover plate motor mount
14. 62-0014 Servo motor (40 taper) 62-0016 servo motor (50 taper)*

*Except XRT



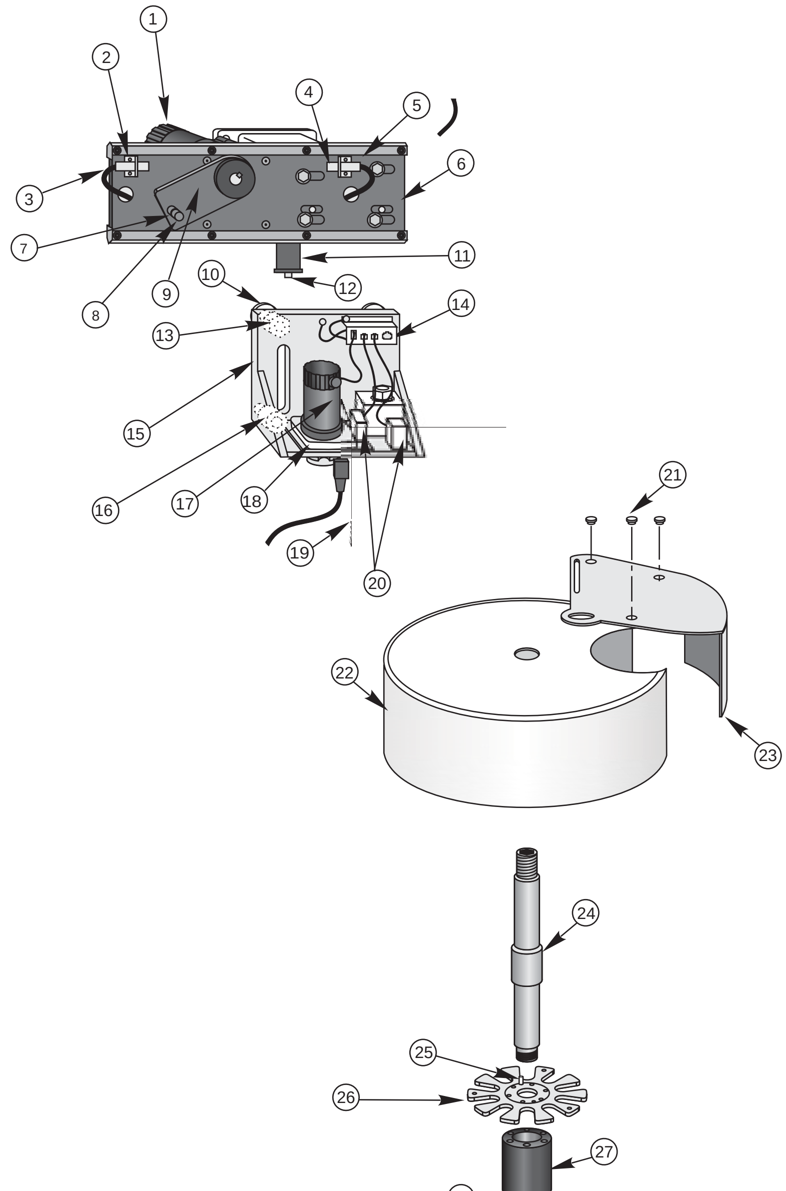
1.	25-7267	Bracket mounting Y-axis
2.	25-9929	Stabilizer bracket hyd. cyl.
3.	32-2050	Limit switch Z-axis
4.	59-4002	Hose clamp 13/16 x 1 3/4
5.	50-9010	Linear guide
6.	22-9826A	Counterweight head bracket
7.	20-9217	Z-axis bumper, support end
8.	48-0045	Dowel pin 3/8 x 1 1/2 pull
9.	25-9813	Z-axis waycover
10.	40-2021	FHCS 1/4-20 x 3
11.	25-7560B	Tank cover
12.	30-1420	(40 taper) 30-1421 (50 taper) Counterbalance tank assembly
13.	58-3031	Banjo elbow 5/16 F x M6 M
14.	30-0464	Oil line assembly
15.	58-1560	Linear guide adapter 1/8m (NSK and THK) 59-0001 (Star)
16.	48-1699	Dowel pin 5/8 x 2 1/4
17.	20-9216	Z-axis bumper, motor end
18.	48-10045	Dowel pin 3/8 x 1 1/2
19.	59-6655	Rubber plug
20.	22-7458	Cam
21.	25-9929	Stabilizer bracket
22.	20-0365	Clevis counterbalance
23.	48-0017 49-0026	Clevis pin 3/8 dia. x 1 1/4 and Cotter pin 1/8 x 1 1/4
24.	20-0150	Nut housing
25.	22-9927	Bracket cylinder counter
26.	24-9960	40mm ballscrew (except XRT)
27.	62-0014	Motor (except XRT)

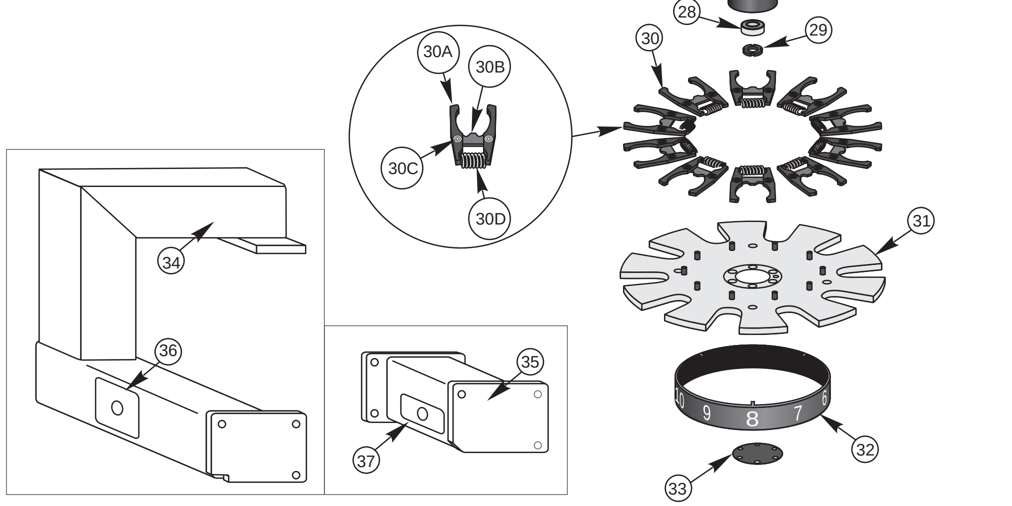
VF-10 Saddle

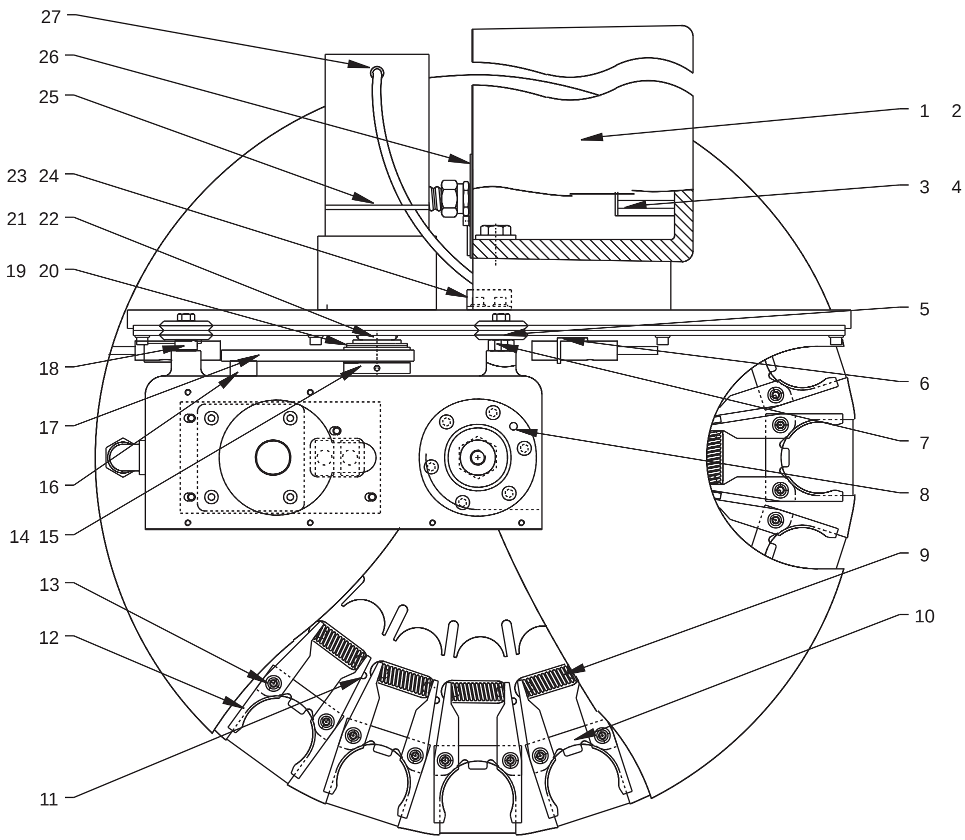


1. 20-0152 Bearing housing 40mm and 50mm ballscrew
2. 20-0156 Bumper
3. 59-6655 Rubber plug
4. 22-7458 Cam, linear guide
5. 30-0534 Oil line assembly
6. 58-1560 Linear guide adapter 1/8m (NSK and THK) 59-0001 (Star)
7. 58-3031 Banjo elbow 5/16 F x M6 M
8. 20-0156 Bumper 40 and 50mm ballscrews
9. 62-0016 Motor (except XRT)
10. 48-0045 Dowel pin 3/8 x 1 1/2 pull
11. 32-2055 X-axis limit switch
12. 25-9219 Bracket, limit switch
13. 20-0150 Nut housing
14. 24-0002C Ballscrew 50mm (except XRT)
15. 50-0001 Linear guide
16. 25-7459 Bracket trip table
17. 25-9220 Bracket, trip X-axis

1.	32-1875	Motor Assembly
2.	22-7263	Block Switch Mounting
3.	32-2010	Limit Switch
4.	32-2000	Limit Switch
5.	25-4146	Cover T/C Switch
6.	20-0682	Tool Holding Plate
7.	22-7034	Spacer Cam Follower
8.	54-0010	Cam Follower T/C
9.	30-7200A	Actuating Arm
10.	54-0030	Guide Wheel
11.	25-0466	Door Opener Bracket
12.	22-2065	Locating Pin
13.	54-0020	Bushing Guide Wheel
14.	25-7162	Connector Bracket
15.	20-1354A	T/C Carriage
16.	54-0040	Standard Bushing Gd Wheel
17.	30-1679	Turret Motor Assembly
18.	20-0680A	Plate Motor Mtg 10 pkt
19.	25-0634	T/C Cover
20.	32-1999	Limit Switch
21.	22-7163	Rider Trap Door
22.	25-0633	T/C Shroud
23.	25-0636A	Trap Door
24.	20-0681	Vertical Axle
25.	22-7255A	Tool #1 Standoff
26.	20-0678	Geneva Star
27.	20-0679	Bearing Housing
28.	51-2022	Bearing Radial
29.	51-2041	Bearing Locknut BH-05
30.	A 22-9574A	CT Extractor
	B 22-7067F	Extractor Key
	C 22-9256	Extractor Bushing
	D 24-9257	Extractor Spring
31.	93-0403	Carousel
32.	25-0638	Number Ring
33.	25-0635	Bearing Cover
34.	20-1118A	(TRM)
35.	20-1263	(MM)
36.	25-4030	(TRM)
37.	25-9912	(MM)



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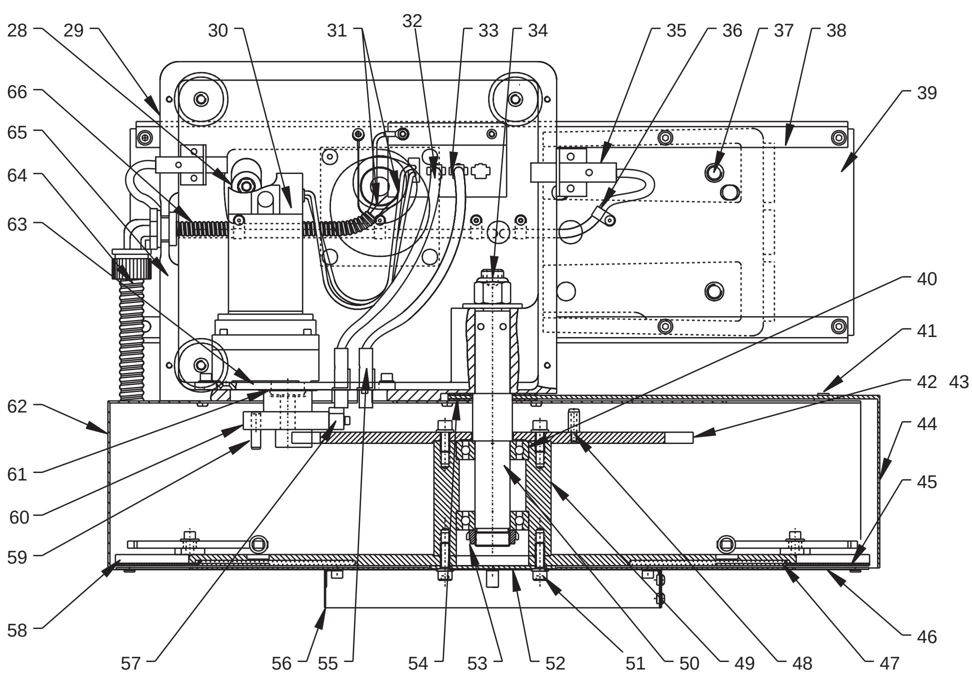
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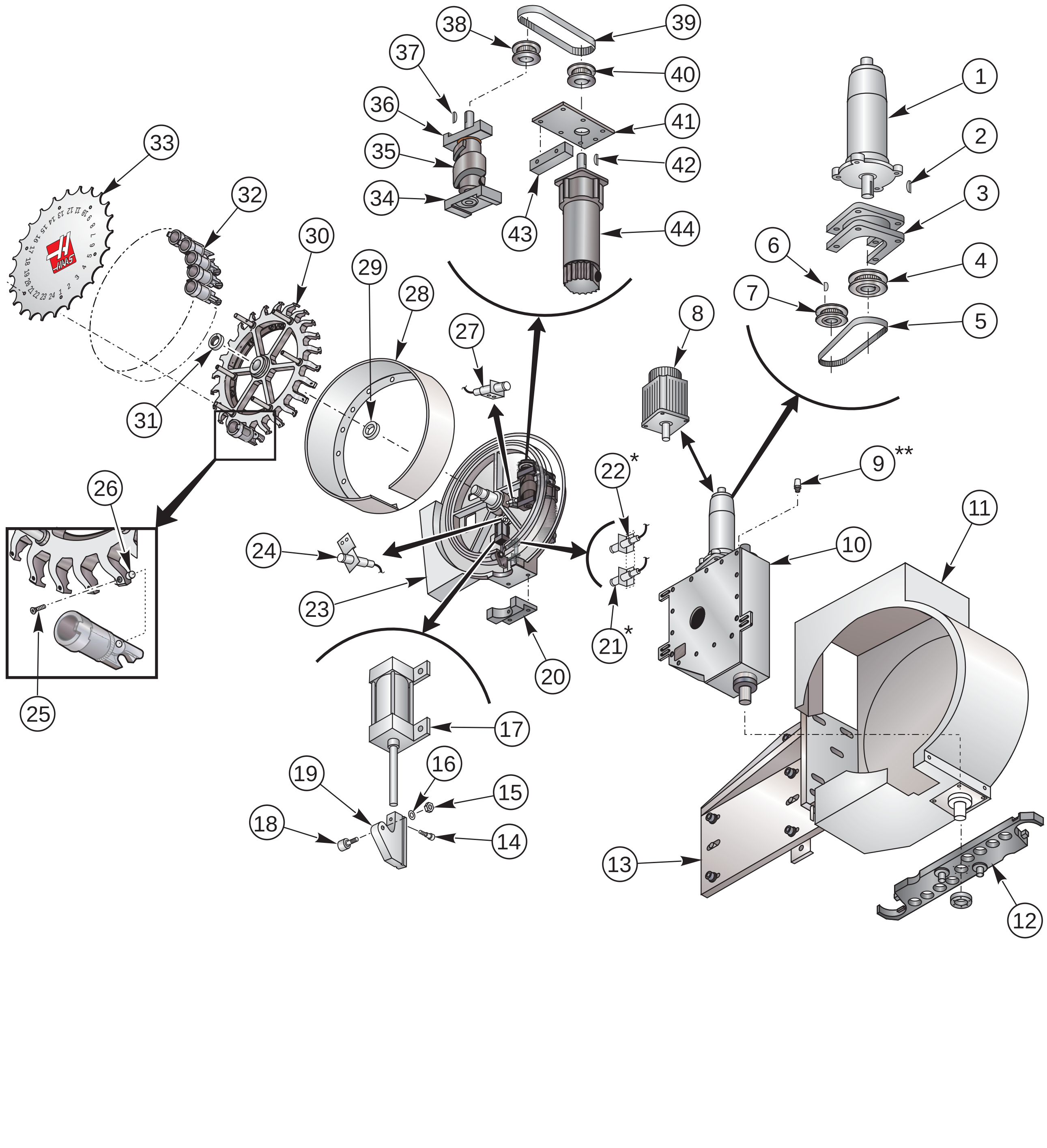
1. 20-7029B Holding arm
2. 57-7379 Tool holding arm gasket
3. 79-1000 Wire channel 1in. x 2in.
4. 79-1001 Cover wire channel 1"
5. 54-0030 Guide wheel
6. 22-7263 Block switch mounting
7. 54-0020 Bushing guide wheel
8. 48-0019 Dowel pin 1/4 x 5/8
9. 24-9257 Spring, extractor
10. 22-7067F Key extractor spring
11. 48-0002 Roll pin 7/32 x 7/8
12. 22-9574A CT extractor spring load
    22-7166A BT Extractor
13. 22-9256 Bushing extractor
14. 20-7476 Hub slip clutch
15. 48-0005 Dowel pin 3/16 x 3/8
16. 22-7034 Spacer, cam follower
17. 20-7475 Arm slip clutch
18. 54-0040 Standard bushing guide wheel
19. 22-9256 Bushing extractor
20. 45-2020 Washer 1 1/4 nylon
21. 51-6000 Bearing locknut NT-05
22. 55-0010 Spring washer B2500-080
23. 22-2065 Locating pin
24. 25-7168 Bracket, door opener
25. 70-0050 PLT4S-M cable ties
26. 25-9253 Conduit mounting plate
27. 32-1800 Shuttle motor assembly
28. 54-0010 Cam follower T/C
29. 20-7030E Tool carriage
30. 32-1900A Turret motor assembly
31. 32-7011A Molded T/C cable assembly (VF 0-5)
    32-7012B Molded T/C cable Assembly (VF 6-11)
32. 75-15721 MLX 2 pin M 7.11 LSW/Earmolex
33. 25-7162 Connector bracket
34. 46-1705 Nut 3/4-10 nylon lock
35. 32-2010 Limit switch shuttle In/Out 24"
36. 63-1031 Cable clamp 1/4
37. 48-1750 Dowel pin 1/2 x 1 1/2
38. 22-7106 V track
39. 20-7033 F hold plate
40. 51-0010 Bearing deep groove
41. 22-7163 Rider trap door
42. 20-9336 20 pocket geneva star
43. 48-0020 Dowel pin 1/4 x 1
44. 25-7238C Tool trap door
45. 25-7249 Sliding panel
46. 25-7250B Sliding panel cover
47. 24-2010A Compression Spring
48. 22-7255A Tool #1 standoff
49. 20-7038A Bearing housing
50. 20-7035G Vertical axle
51. 54-0040 Standard bushing guide wheel
52. 25-7036 Cap, tool changer
53. 51-0012 Bearing locknut BH-06
54. 26-7239 Spacer ring
55. 32-2000 Limit switch 4 wire 12"
56. 25-7570 Number ring
57. N/A
58. 20-7352B 20 tool carousel
    20-1524 20 Tool carousel BT
59. 51-0001 Bearing 3/4 cam follower
60. 20-9332 Driver geneva 2 pin
61. N/A
62. 25-7237C 20 pocket T/C cover
63. 20-7236A Motor mounting plate
64. 32-7618 TL Carriage cable 40T (VF 6-11)
65. 57-7378 Tool Carriage gasket (VF6-10)
66. 78-1996 Split flex tubing 1/2 I.D.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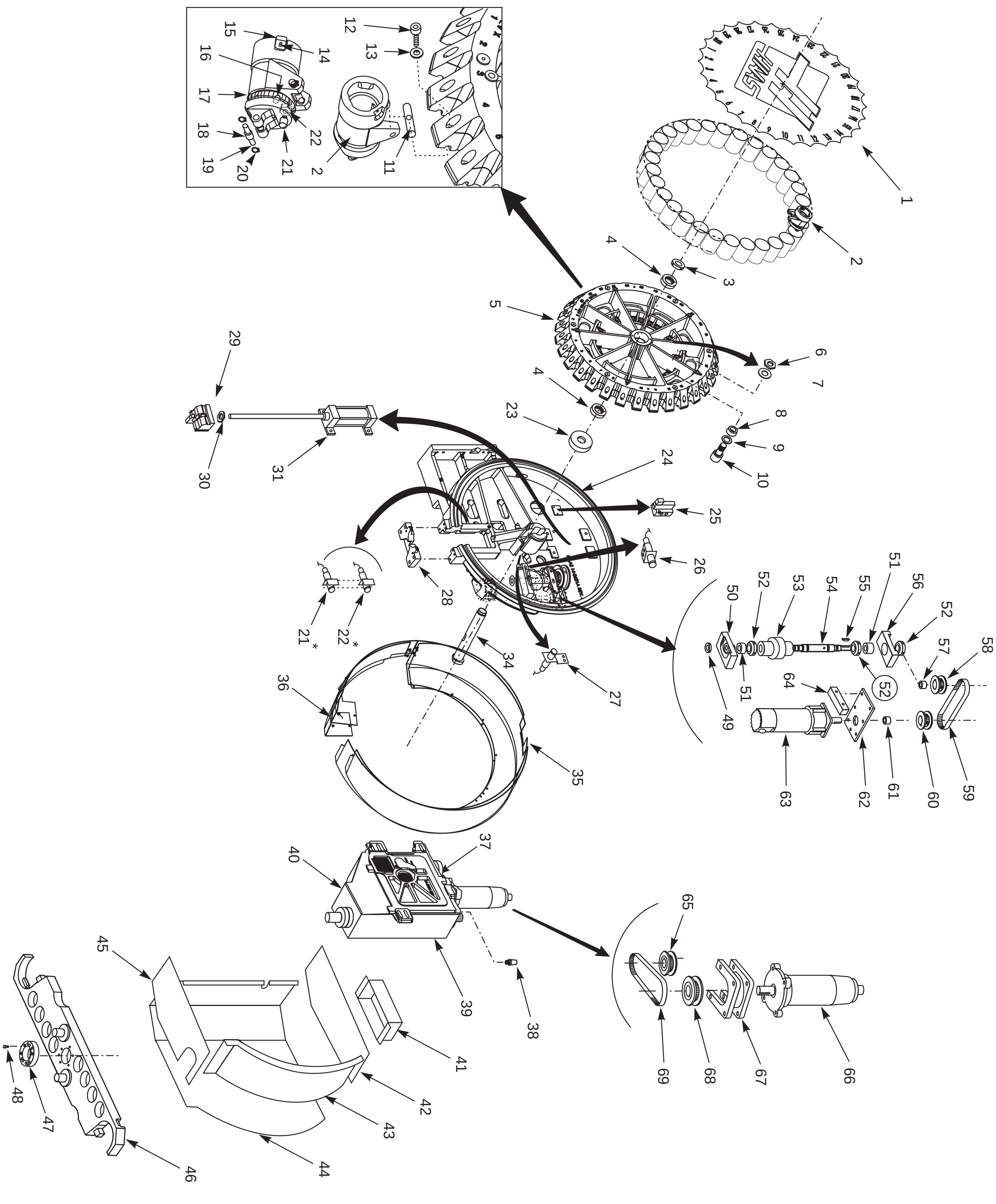
SIDE MOUNT TOOL CHANGER ASSEMBLY

* Back Side
** Hose, on Horizontal Applications

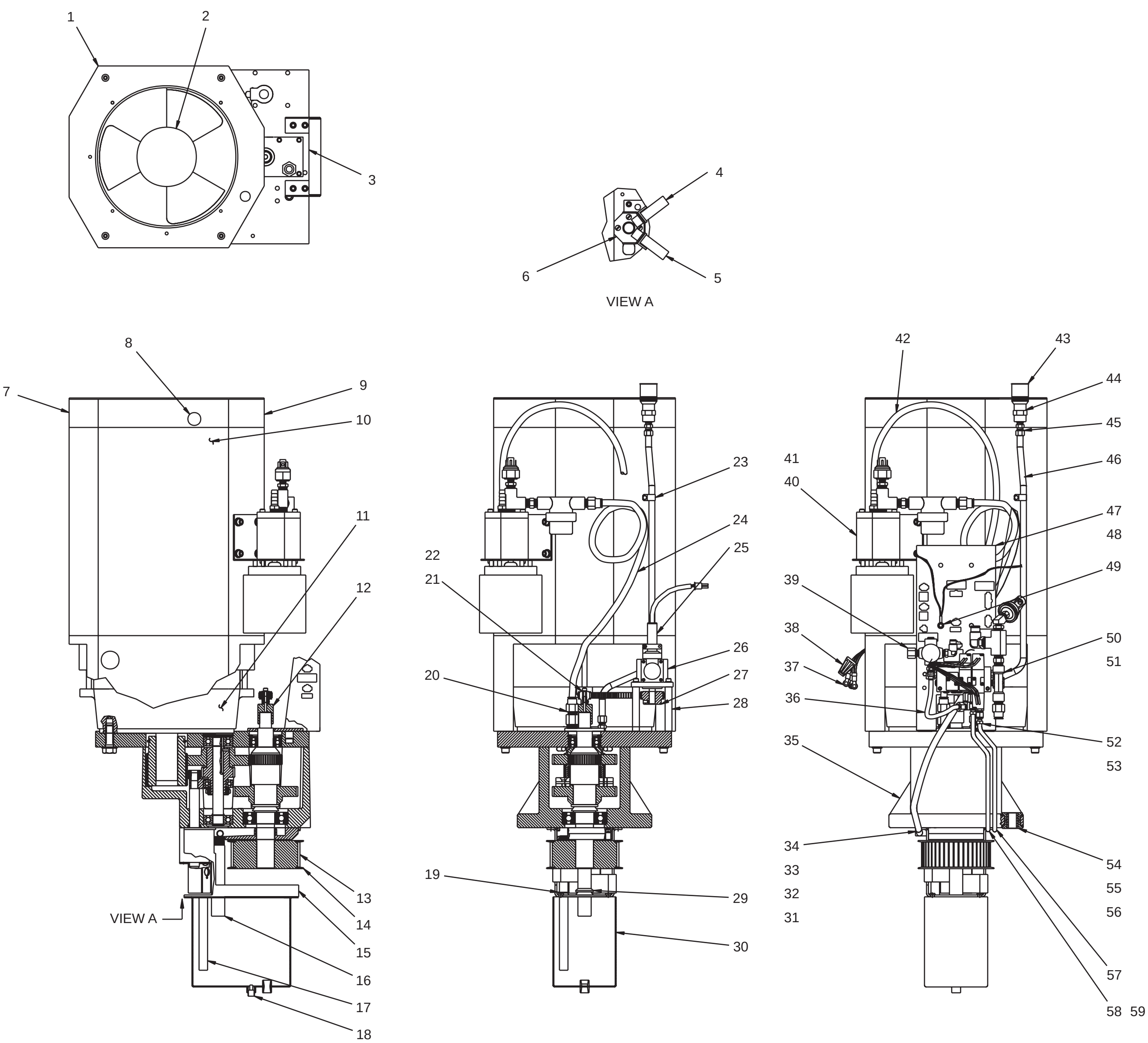
1. Cam Box Motor
2. Key
3. Cam Box Motor Mount
4. Cam Box Pulley
5. Drive Belt
6. Key
7. Pulley
8. Cam Box Motor (High Speed)
9. Oil Fill/Breather
10. Cam Box Assembly
11. ATC Enclosure
12. Double Arm Assembly
13. ATC Mount
14. Shoulder Bolt
15. Hex Nut
16. Lockwasher
17. Air Cylinder
18. Slide Roller
19. Tool Pocket Slide
20. Pocket Stop
21. Proximity Switch (Pocket Up)*
22. Proximity Switch (Pocket Down)*
23. Carousel Housing
24. Proximity Switch (Tool One)
25. Pocket Retaining Screw
26. Tool Pocket Shaft
27. Proximity Switch (Tool Mark)
28. Carousel Shroud
29. Bearing
30. Carousel
31. Bearing Nut
32. Tool Pockets
33. Carousel Number Disc
34. Bottom Cam Support
35. Carousel Cam
36. Top Cam Support
37. Key
38. Pulley
39. Timing Belt
40. Pulley
41. Motor Mounting Plate
42. Key
43. Motor Mounting Block
44. Carousel Motor

50 Taper Side Mount Tool Changer Assembly



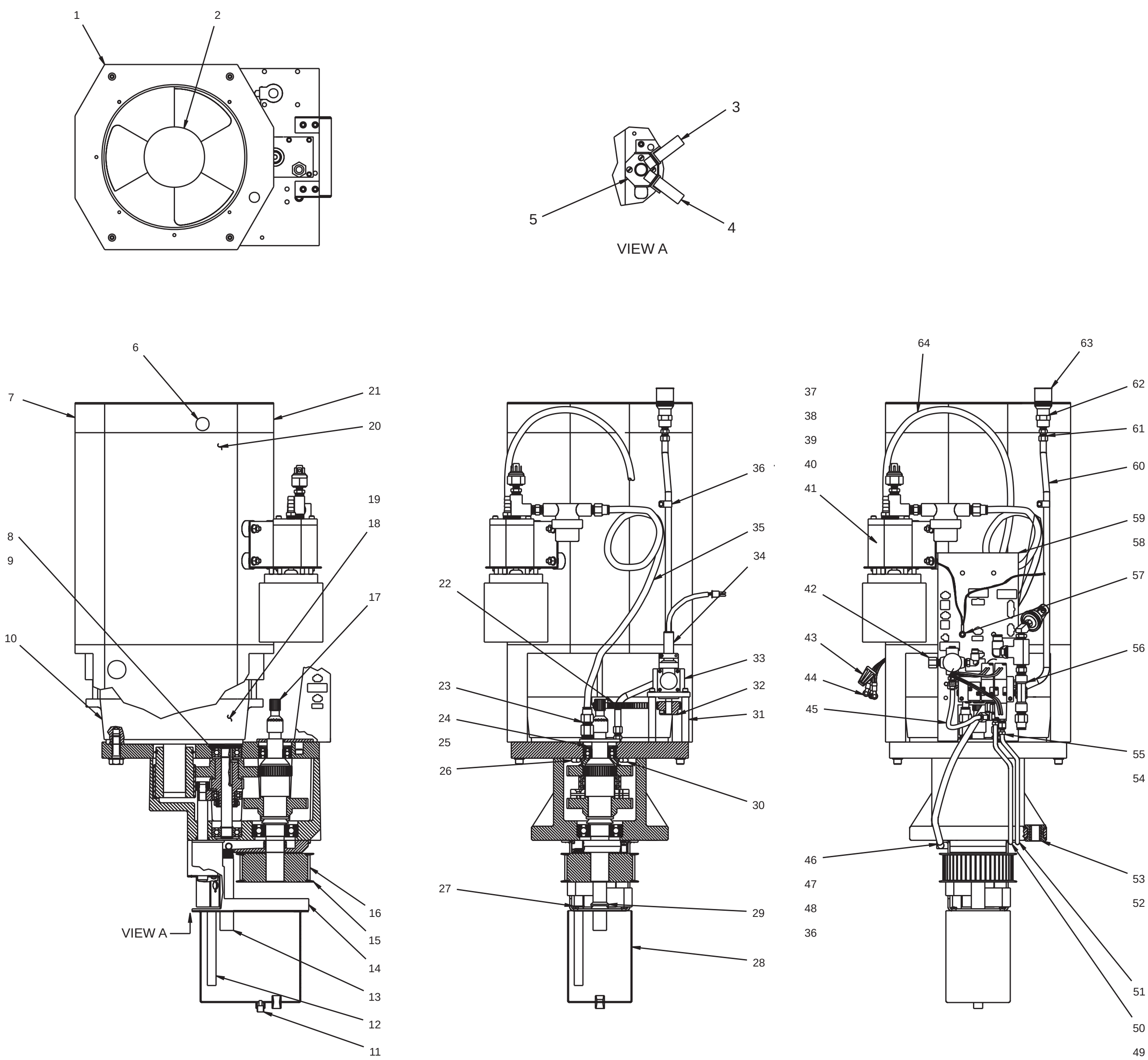
1.	25-0284A	Carousel Cover
2.	20-0490B	Tool Pocket 50T
3.	51-2043	Bearing Lock Nut
4.	51-0020	Bearing
5.	20-0438	Carousel 50T
6.	46-1663	Jam Nut
7.	45-0068	Flat Washer
8.	20-1239A	Tapered Bushing
9.	45-0070	Washer
10.	51-0045	Cam Follower
11.	20-0385	Pocket Roller Shaft
12.	56-0020	Retaining Clip
13.	40-1715	SHCS
14.	45-1739	Washer
15.	40-1919	Screw
16.	20-0384	Arm Key
17.	29-0382	Pocket Plunger
18.	59-0114	Spring
19.	20-0383	Tool Pocket Rollers
20.	20-0386	Tool Pocket Shaft
21.	51-0051	Cam Follower
22.	46-1810	Nut
23.	20-0392	Press Fit Washer
24.	20-0621A	ATC Housing
25.	32-0039	Solenoid Assy.
26.	32-2295	Prox. Switch
27.	32-2253	Prox. Switch
28.	20-0390	Pocket Slide
29.	20-0393	Pocket Stop
30.		¾ 16 Jam Nut
31.	59-0116	Air Cylinder
32.	32-2252	Prox. Switch
33.	32-2251	Prox. Switch
34.	20-0387A	T/C Shaft
35.	25-0286B	Shroud
36.	25-0291B	Corner Shroud
37.	20-0456A	Cam Box Cover
38.	58-3069	Muffler
39.	20-0455B	Cam Box Case
40.	30-1150	Cam Box Assy.
41.	25-0288A	Motor Cover
42.	25-0287A	Top Plate
43.	25-0290A	Front Cover
44.	25-0289A	Right Cover
45.	25-0292A	Bottom Cover
46.	20-0388A	Double Arm Assy.
47.	20-0240	Arm Hub
48.	40-1610	(8X) SHCS ¼-20-1"
49.	51-2012	Bearing Lock Nut
50.	20-0268	Carousel Cam Bottom Support
51.	51-2025	Bearing
52.	51-2041	Bearing Lock Nut
53.	20-0439	Carousel Cam
54.	20-0231	Carousel Shaft
55.	22-2629	Key Stub
56.	20-0268	20-7239 Carocam Support
57.	54-0039	Bushing
58.	54-0044	Pulley
59.	54-0045	Belt
60.	54-0043	Pulley
61.	54-0017	Bushing
62.	20-0272A	Motor Mount Plate
63.	32-1875	Motor Assy.
64.	20-0273	Motor Mount Block
65.	54-0043	Pulley
66.	32-1880B	Motor Assy.
67.	20-0772	Motor Mounting Base
68.	54-0037	Pulley
69.	54-0036	Belt

VF 1-11 Gearbox Assembly 15 HP



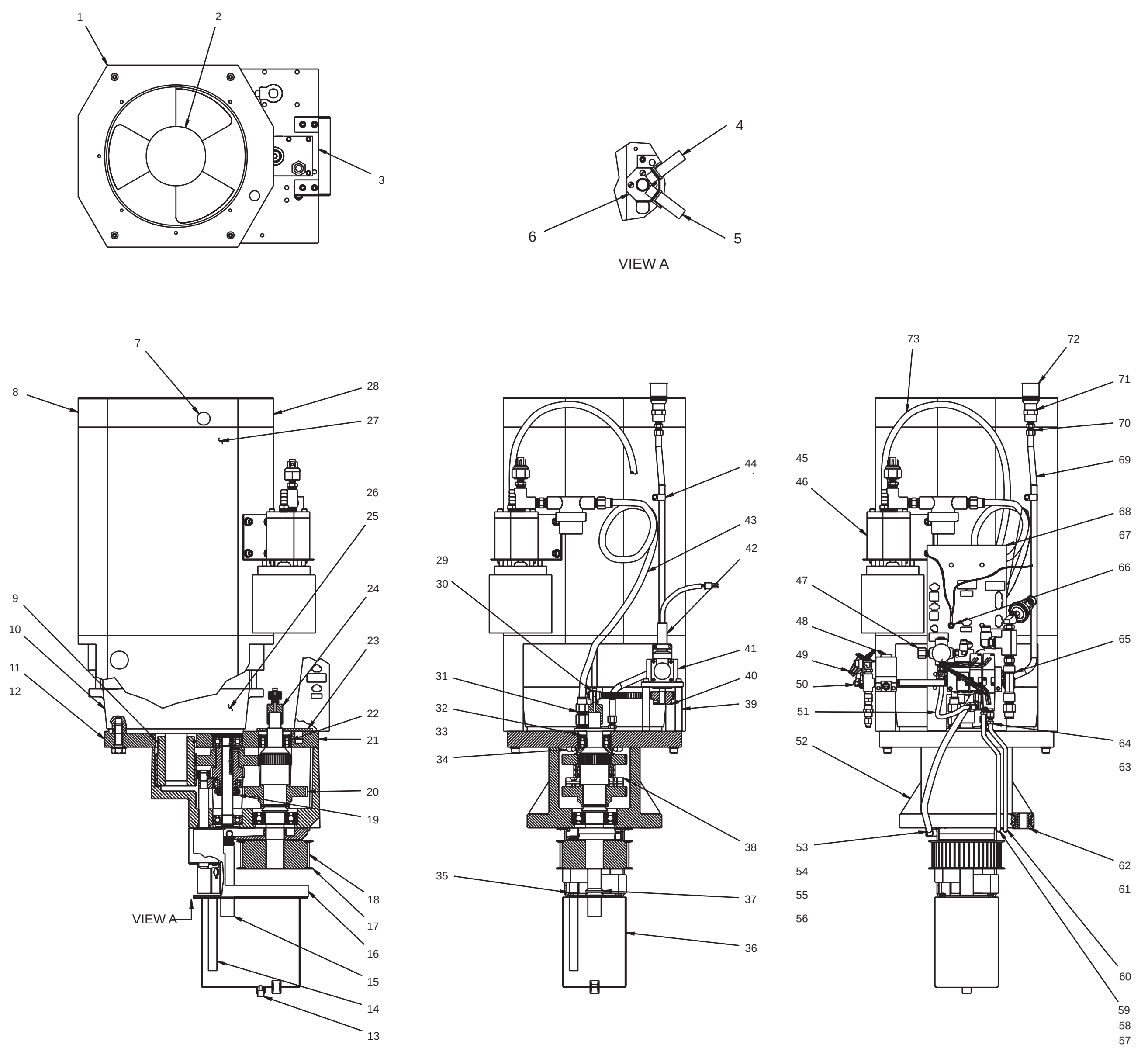
1. 25-0108 Fan bracket motor shroud
2. 36-3035 Spindle fan assembly
3. 59-7130 Protective strip
4. 32-2011 30" limit switch
5. 32-2010 24" limit switch
6. 25-7264 Switch mounting bracket
7. 29-0022 Shroud caution decal
8. 59-1482 Nylon finish plug, 13/16
9. 25-01074 Motor shroud
10. 20-0064 Adapter encoder pulley
11. 62-3010 Spindle motor, 10HP
12. 59-0046 Soundcoat shroud RT/LT
13. N/A
14. N/A
15. 25-7433 Sump bracket
16. 22-7445A Drain tube dry sump
17. 22-7446 Pick up tube dry sump
18. 58-2745 Magnetic oil plug
19. 57-0001 Oil seal
20. 58-3657 1/4 female 1/8 male adaptor
21. 54-2125 Drive belt HTD 300-3M-09
22. 54-1013 Drive sprocket .250 RTAP
23. 59-2040 Cable clamp 7/16
24. 58-2001 Polyu hose 1/2OD x 3/8ID
25. 32-1455D RTAP encoder cable
26. 60-1810 Shaft encoder 2000 line
27. 54-7127 Drive sprocket .375 RTAP
28. 22-7260 Encoder standoff
29. 57-0002 Oil seal
30. 25-7434 Sump tank
31. 63-1031 Cable clamp 1/4
32. 59-4006 Hose crimp, 35/64
33. 59-2040 Cable clamp, 7/16
34. 58-3616 3/8 90 deg. elbow 1/4 NPT
35. N/A
36. 58-7377 Air reg/solenoid tube
37. 76-2420 Crimp ring, 12-10 10 stud
38. 77-8011 Wire nut, ideal #30-076
39. 30-3270A Precharge regulator assy
40. 30-3260B Oil gear pump assy
41. 59-0027 Hose clamp 1/2 hose
42. 58-2020 3/8OD natural tubing
43. 22-7487 Oil fill cap modified
44. 58-2065 Coupling, 1/4NPT
45. 58-2070 1/4NPT male to 3/8 comp
46. 58-9114B Trans fill tube
47. 25-7336 Solenoid mounting bracket
48. 33-3200 Solenoid bracket cable assembly
49. 33-5088 Ground strap spindle motor shroud
50. 30-3146 Air solenoid assy mac TP
51. N/A
52. 58-2100 Sleeve lube assembly
53. 58-2110 Sleeve nuts lube assembly
54. 22-7520A Isolater trans
55. 22-7521A Spacer trans
56. N/A
57. 58-7636 High gear tube VF-3
58. 58-7635 Low gear tube VF-3
59. 63-0001 Nylon cable clamp 1/2

VF 1-11 Gearbox Assembly HT10K

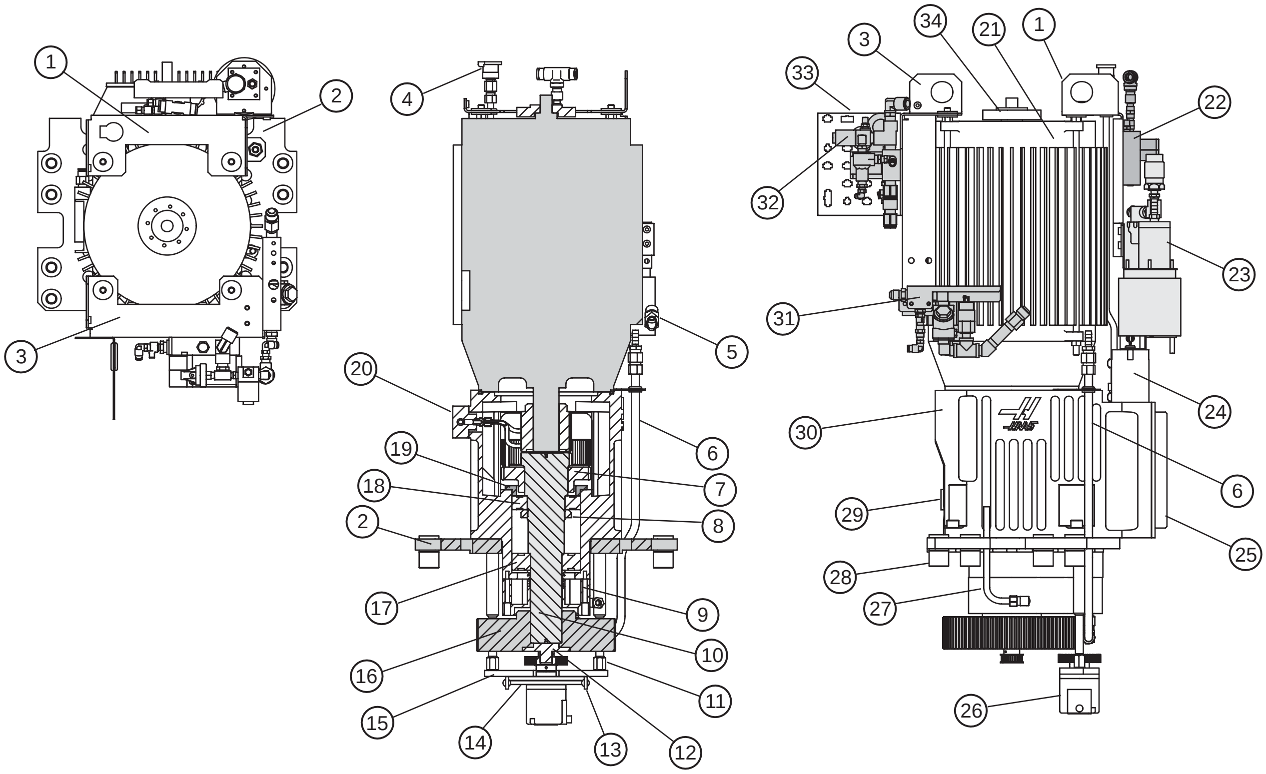


1. 25-0108 Fan bracket motor shroud
2. 36-3035 Spindle fan assembly
3. 32-2011 Switch assembly (30" cable length)
4. 32-2010 24" limit switch
5. 25-7264 Switch mounting bracket
6. 59-1482 Nylon finish plug, 13/16
7. 29-0022 Shroud caution decal
8. 55-0035 Spring washer, BS-204
9. 56-2087 Snap ring, N5000-206
10. 29-7399 Transmission motor label
11. 58-2745 Magnetic oil plug
12. 22-7446 Pick up tube dry sump
13. 22-7445A Drain tube dry sump
14. 25-7433 Sump bracket
15. 22-7376 Sprocket flange
16. 20-7374 1 1/8 sprocket
17. 20-0125 Drive sprocket encoder
18. 57-7573A Trans motor gasket
19. 36-3078 10K 10HP motor kit
20. 59-0046 Sound coat shroud RT/LT
21. 25-0107 Motor shroud
22. 54-2125 Drive belt HTD 300-3M-09
23. 58-3657 1/4 female 1/8 male adapter
24. 55-0036 Spring washer, BS-205
25. 56-0070 Snap ring, N5000-187
26. 58-7357 Top plate tube-A
27. 57-0001 Oil seal
28. 25-7434 Sump tank
29. 57-0002 Oil seal
30. 58-7358A Top plate tube-B
31. 22-7260 Encoder standoff
32. 54-7127 Drive sprocket .375 RTAP
33. 60-1810 Shaft encoder 2000 line
34. 32-1455D RTAP encoder cable
35. 58-2001 Polyu hose 1/2OD x 3/8ID
36. 59-2040 Cablt clamp, 7/16
37. 59-0027 Hose clamp 1/2 hose
38. 57-0049 Rubber stud bumper
39. 46-1625 Nut hex blk ox 1/4-20
40. 45-1800 Washer split lock 1/4 med
41. 30-3260B Oil gear pump assembly
42. 30-3270A Precharge regulator assembly
43. 77-8011 Wire nut, ideal #30-076
44. 76-2420 Crimp ring, 12-10 10 stud
45. 58-7377 Air reg/solenoid tube
46. 58-3616 3/8 90 deg elbow 1/4 NPT
47. 59-4006 Hose crimp, 35/64
48. 63-1031 Cable clamp 1/4

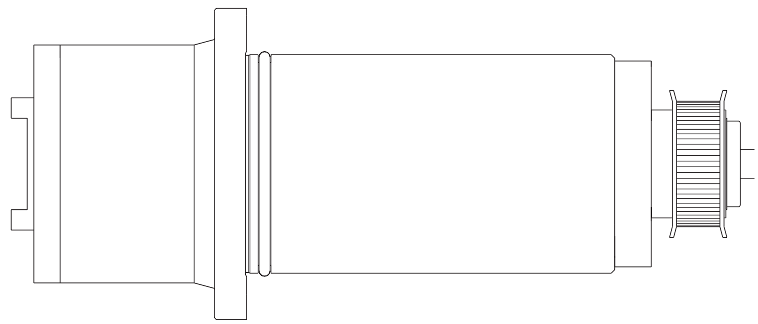
VF 1-11 GEARBOX ASSEMBLY HT10K TSC



1. 25-0108 Fan bracket motor shroud
2. 36-3035 Spindle fan assembly
3. 59-7130 Protective strip
4. 32-2011 Switch (30" cable lenght)
5. 32-2010 24" limit switch
6. 25-7264 Switch mounting bracket
7. 59-1482 Nylon finish plug 13/16
8. 29-0022 Shroud caution decal
9. 57-0006 O-ring 2-328 buna
10. 29-7399 Transmission motor label
11. 29-9128 Label, transmission
12. 48-0020 Pin, dowel 1/4 x 1
13. 58-2745 Magnetic oil plug
14. 22-7446 Pick up tube dry sump
15. 22-7445A Drain tube dry sump
16. 25-7433 Sump bracket
17. 22-7376 Sprocket flange
18. 20-7374 1 1/8 Sprocket
19. N/A
20. N/A
21. N/A
22. N/A
23. 20-7435 Oil plate
24. 20-0064 Adapter encoder pulley
25. 57-7573A Trans motor gasket
26. 36-3078 10K 10HP motor kit
27. 59-0046 Soundcoat shroud RT/LT
28. 25-0107 Motor shroud
29. 54-1013 Drive sprocket .250 RTAP
30. 54-2125 Drive belt HTD 300-3M-09
31. 58-3657 1/4 female 1/8 male adapter
32. 55-0036 Spring washer, BS-205
33. 56-0070 Snap ring N5000-187
34. 58-7357 Top plate tube-A
35. 57-0001 Oil seal
36. 25-7434 Sump tank
37. 57-0002 Oil seal
38. N/A
39. 22-7260 Encoder standoff
40. 54-7127 Drive sprocket .375 RTAP
41. 60-1810 Shaft encoder 2000 line
42. 32-1455D RTAP encoder cable
43. 58-2001 Polyu hose 1/2OD x 3/8 ID
44. 59-2040 Cable clamp 7/16
45. 59-0027 Hose clamp 1/2 hose
46. 30-3260B Oil gear pump asssembly
47. 30-3270A Precharge regulator assembly
48. 30-3276 Purge solenoid valve assembly
49. 77-8001 Wire nut, ideal #30-076
50. 76-2420 Crimp ring, 12-10 10 stud
51. 58-7377 Air reg solenoid tube
52. N/A
53. 58-3616 3/8 90 deg. elbow 1/4NPT
54. 59-4006 Hose crimp, 35/64
55. 59-2040 Cable clamp 7/16
56. 63-1031 Cable clamp 1/4
57. 63-0001 Nylon cable clamp 1/2
58. 58-7635 Low gear tube VF-3
59. N/A
60. 58-7636 High gear tube vf-3
61. 22-7521A Spacer trans
62. 22-7520A Isolater trans
63. 58-2110 Sleeve nuts lube assembly
64. 58-2100 Sleeve lube assembly
65. 30-3146 Air solenoid assy mac tp
66. 33-5008 Ground strap spindle motor shroud
67. 33-3200 Solenoid bracket cable assembly
68. 25-7336 Solenoid mounting bracket
69. 58-9114B Trans fill tube
70. 58-2070 1/4NPT male to 3/8 comp
71. 58-2065 Coupling, 1/4NPT
72. 22-7487 Oil fill cap modified
73. 58-2020 3/8OD natural tubing



1. 25-4420 Oil Pump Bracket
2. 20-1452 Transmission Plate
3. 25-4419 Solenoid Bracket
4. 22-7487 Oil Fill Cap
5. 30-3275 TSC Check Valve
6. 58-0609 Oil Pickup Tube
7. 20-1440 Out put Gear
8. 51-0089 Bearing Locknut
9. 20-1459 Oil Pan
10. 35-0017 Output Shaft
11. 20-2965 Encoder Stand Off
12. 20-1454 Encoder Pulley
13. 25-6298 Encoder Spring Clamp
14. 25-6299 Encoder Spring Plate
15. 20-2964 Encoder Spring Mounting Plate
16. 20-1455 Pulley
17. 51-0088 Deep groove Bearing
18. 51-0087 Bearing
19. 20-2393 Bearing Ring
20. 20-1458 Oil Manifold
21. 62-4010 Spindle Motor
22. 30-3644 Shift Valve
23. 30-3260 Oil Pump Assembly
24. 20-1448 Cylinder Shifter
25. 20-1782 Housing Cover Plate
26. 32-1457 Rtap Encoder
27. Dipstick
28. 20-1396 Transmission Spacer Plug
29. Oil Sight Level
30. 20-1526 Housing Gearbox
31. 30-3275 Check Valve Assembly
32. 30-3642 TRP TSC Solenoid Assembly
33. 25-4421 Spindle Connector Bracket
34. 20-1147 X-Axis Support Bumper

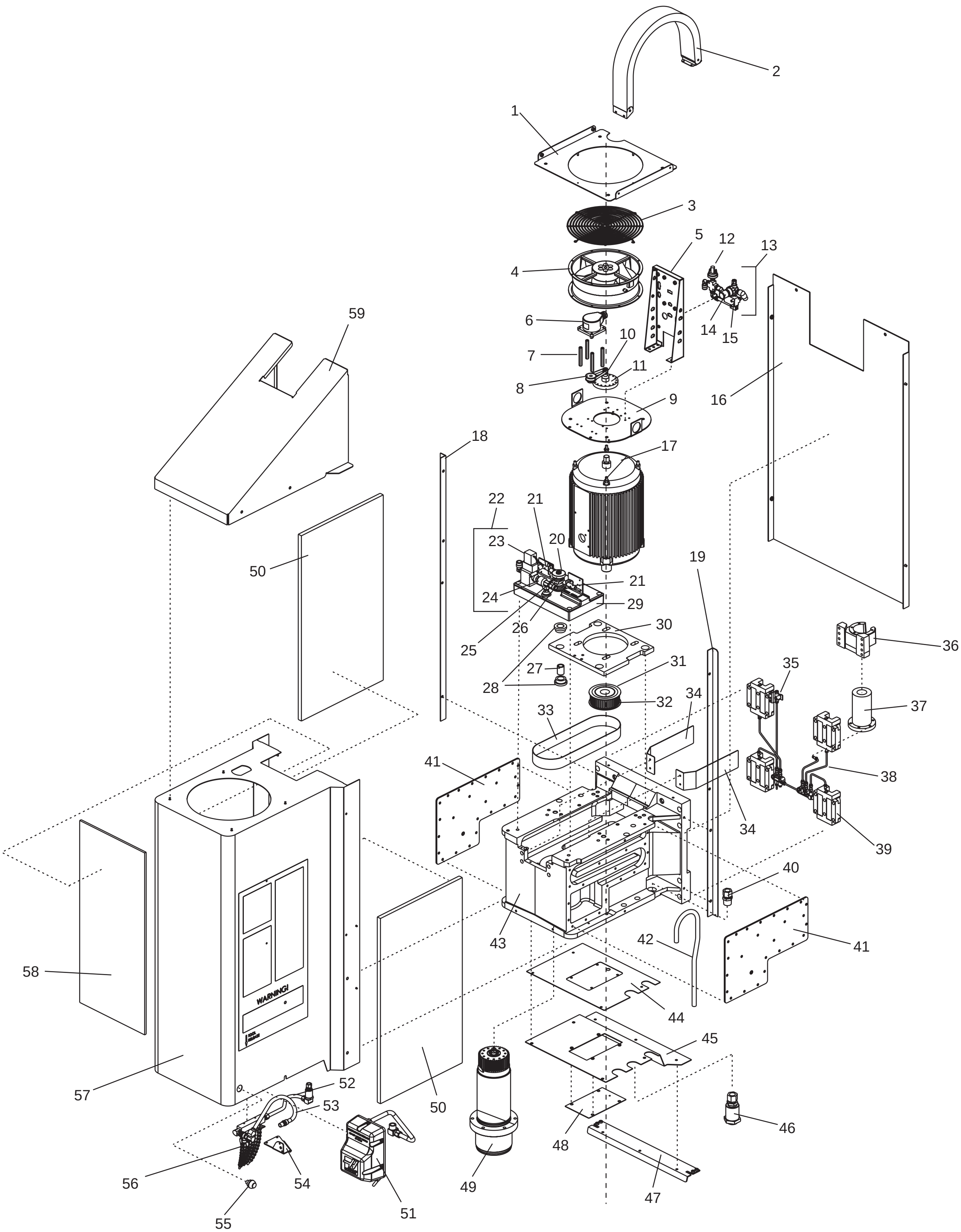


SPINDLES

30-0319A	7.5 Spindle Assembly
30-2132	10K Spindle Assembly
30-1360	15K Spindle Assembly
30-1468	15K spindle Assembly VF5-11
30-0449	50 Taper Spindle Assembly

DRAWBAR

30-3410E	7.5k spindle with or without TSC
30-0067	50 Taper



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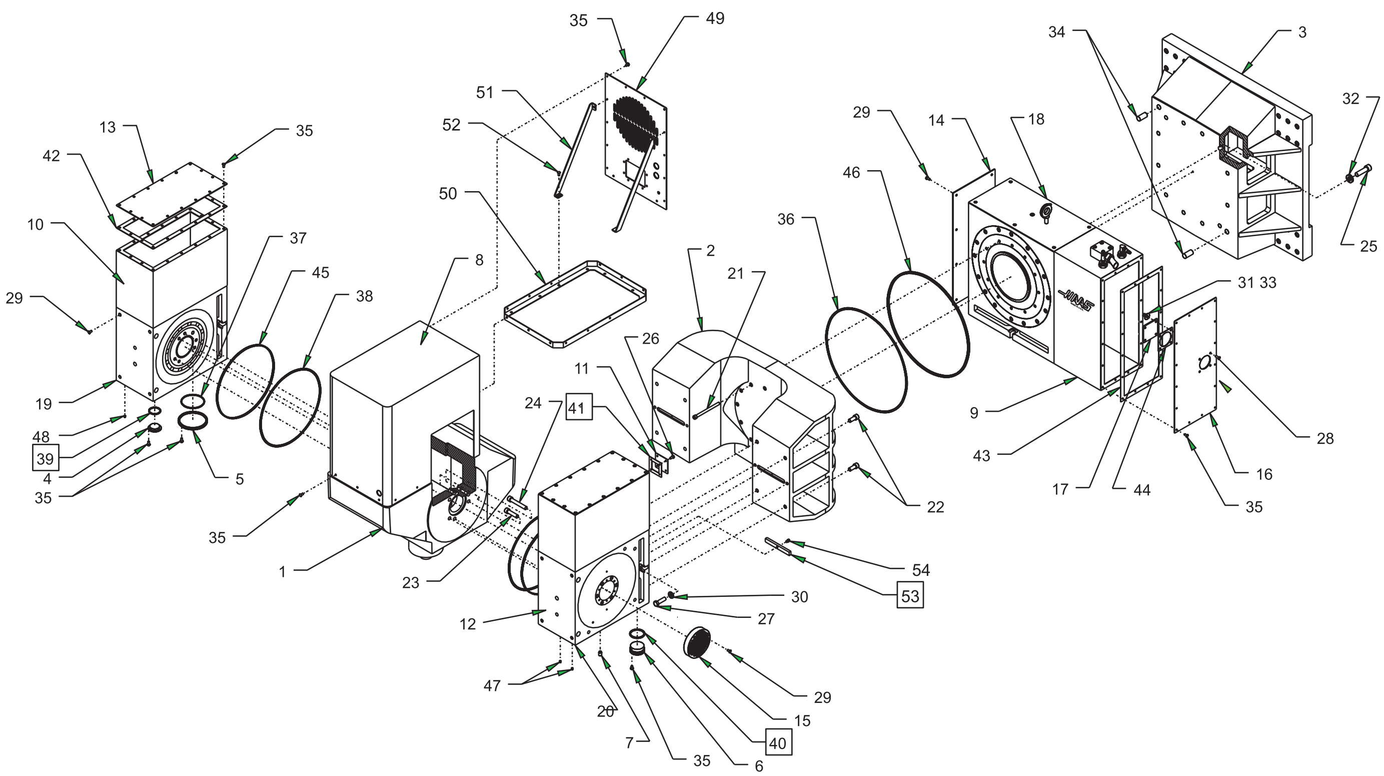
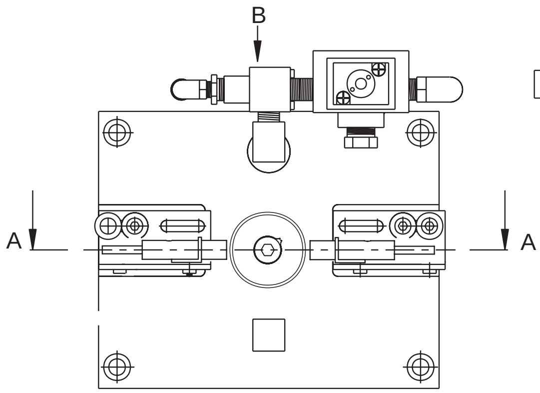
1. 25-6804 Fan racket
2. 59-0091 Cable carrier
3. 59-0144 Fan guard
4. 36-3035 Fan Assembly
5. 25-7336 Solenoid bracket
6. 60-1815 Encoder
7. 22-7260 Encoder stand-off
8. 54-7127 Drive sprocket
9. 25-9667 Encoder mounting plate
10. 54-2121 Drive belt
11. 20-0276 Drive sprocket
12. 53-3001 Pressure switch
13. 30-3156 Air solenoid
14. 58-2736 Air regulator
15. 59-2780 Solenoid
16. 25-7440 Rear sound shield
17. 62-3016 Spindle motor
18. 25-5748 Left chip shield
19. 25-5747 Right chip shield
20. 20-1656 Spring retainer
21. 32-2010 Limit switch
22. 32-5620 Solenoid valve assembly
23. 30-3201 TRP assembly
24. 59-2832 Quick exhaust
25. 59-2760 Compression spring
26. 20-7626 TRP shaft
27. 22-7520 Isolator
28. 22-7521 Spacer
29. 20-1514 Cylinder housing
30. 20-7429 Motor sub plate
31. 20-7376 Sprocket flange
32. 20-9672 Sprocket
33. 54-2660 Drive belt
34. 25-0982 Retaining bracket
35. 30-7494 Upper oil line assembly
36. 20-7008 Nut housing
37. 24-0041 Ball screw assembly
38. 30-7525 Oil line assembly
39. 50-0017 Linear guide assembly
40. 58-2071 ½ x ½ weatherhead
41. 25-0957 Coolant jacket
42. 58-0204 Coolant jacket tube
43. 20-7005 Spindle head
44. 59-9134 Bottom sound cover
45. 25-7096 Bottom spindle head cover
46. 58-1680 Anchor connector
47. 25-5737 Gordillo adapter plate
48. 25-7284 Inspection plate
49. 30-6656 Spindle
50. 59-9132 Side sound foam
51. 30-7365 P-cool assembly
52. 58-5173 Conduit
53. 52-0026 P-cool hose assembly
54. 25-5820 P-cool mounting bracket
55. 61-1040 Switch
56. 30-7459 Manifold assembly
57. 25-7600 Spindle head cover
58. 59-9131 Front sound foam
59. 25-6805 Top chip cover

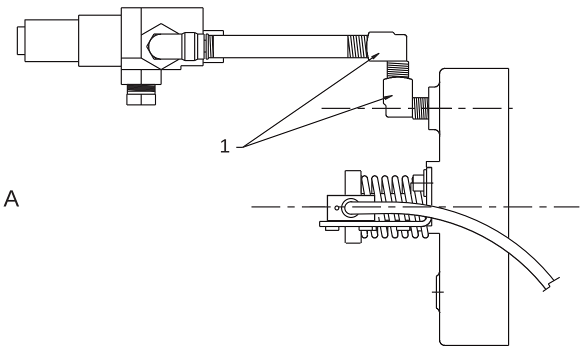


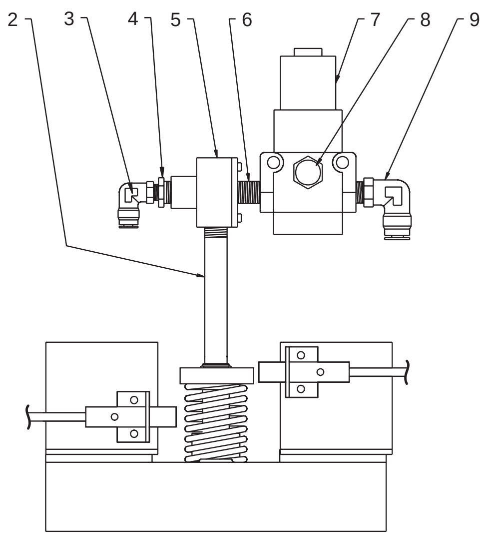
TORQUE SETTINGS	
ITEM	VALUE
21	45 FT LBS
22	88 FT LBS
23	100 FT LBS
24	100 FT LBS
25	160 FT LBS

ITEM	QTY	DWG #	DESCRIPTON
1	1	20-4360	5AX SPINDLE HEAD (MACHINED)
2	1	20-4361	5AX YOKE, (MACHINED)
3	1	20-4367	5AX HEAD SPACER (MACHINED)
4	1	20-4381	SIGHT GLASS PLUG
5	1	20-4382	WORM HOUSING COVER, 5AX
6	1	20-4388	WORM PLUG 310 PULLEY SIDE
7	1	22-4040	MICRO SWITCH, PLUG
8	1	25-4363	5AX HEAD COVER
9	1	25-4366	MOTOR ENCLOSURE 450
10	2	25-4371	MOTOR ENCLOSURE 310/5AX
11	1	25-4372	BLOCK OFF PLATE 310/5AX
12	2	25-4373	TOP COVER 310/5AX
13	2	25-4375	ENCLOSURE COVER 310/5AX
14	1	25-4377	SIDE COVER 450/5AX
15	2	25-4380	PORT CHIP GUARD 5AX
16	1	25-4386	ENCLOSURE COVER 450/5AX
17	1	28-4278	SIGHT GLASS, PRESS GAGE
18	1	30-1070	HRT450 ASSY W/ 5AX MODS
19	1	30-1071	HRT310 DRIVE ASSY 5AX
20	1	30-1072	HRT310 DRIVEN ASSY 5AX
21	12	40-164391	SHCS, 3/8-16 X 5 1/4
22	8	40-16575	SHCS, 1/2-13 X 1 1/4
23	8	40-1661	SHCS, 1/2-13 X 2
24	4	40-16626	SHCS, 1/2-13 X 3 1/4.
25	12	40-16643	SHCS, 5/8-11 X 2 1/4
26	4	40-1669	BHCS, 8-32 X 3/8
27	4	40-1830	HHB, 1/2-13 X 1 3/4
28	4	40-1976	BHCS, 1/4-20 X 3/4
29	22	40-1980	BHCS, 1/4-20 X 1/2
30	4	45-1740	WASHER, BLACK HARD 1/2
31	4	45-1850	WASHER, FENDER 1/4 IDX1 OD
32	12	45-2011	HARD WASHER 5/8
33	4	46-1625	NUT HEX BLK OX 1/4-20
34	2	48-1757	DOWEL PIN 3/4 X 1 1/2.
35	85	49-1750	BHCS, 10-32 X 3/8
36	1	57-0093	O RING, 2-385 BUNA
37	1	57-2250	O-RING, 2-156 VITON
38	2	57-2252	O RING, 2-381 VITON
39	1	57-2831	0-RING, 2-130 BUVA
40	1	57-4120	O-RING, 2-226 VITON
41	1	57-4133	J-BOX GASKET
42	2	57-4223	GASKET MOTOR ENCLOSURE
43	1	57-4261	ENCLOSURE COVER GASKET 450
44	1	57-4279	GASKET, SIGHT GLASS
45	2	57-4384	HRT310 TEFLON SEAL
46	1	57-4385	HRT450 TEFLON SEAL
47	3	58-1627	1/8-27 PIPE PLUG
48	1	58-3105	1/4 NPT PIPE PLUG
49	1	25-4362	5AX HEAD COVER, BACK PLATE
50	1	25-4364	HEAD COVER MOUNTING ANGLE
51	2	25-4383	HEAD COVER BRACE, 5AX
52	10	40-1975	BHCS 1/4-20 X 5/19
53	2	20-4230	KEY, BODY
54	20	40-1630	SHCS 1/4-20 X 5/16

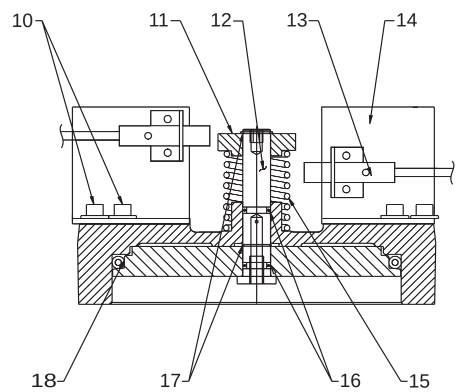
Tool Release Piston Assembly







VIEW B
OUT OF POSITION

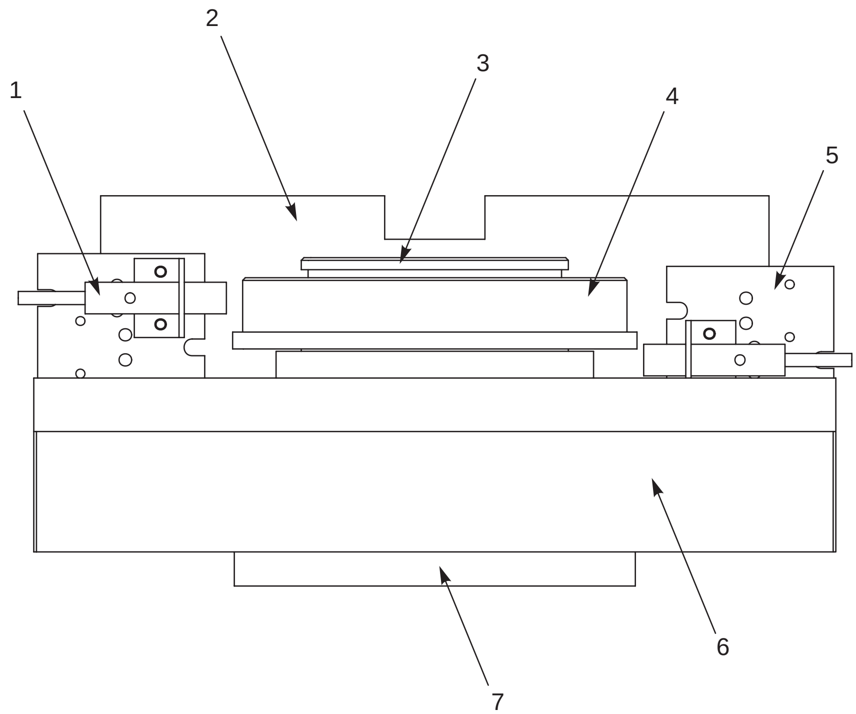


SECTION A-A
OUT OF POSITION

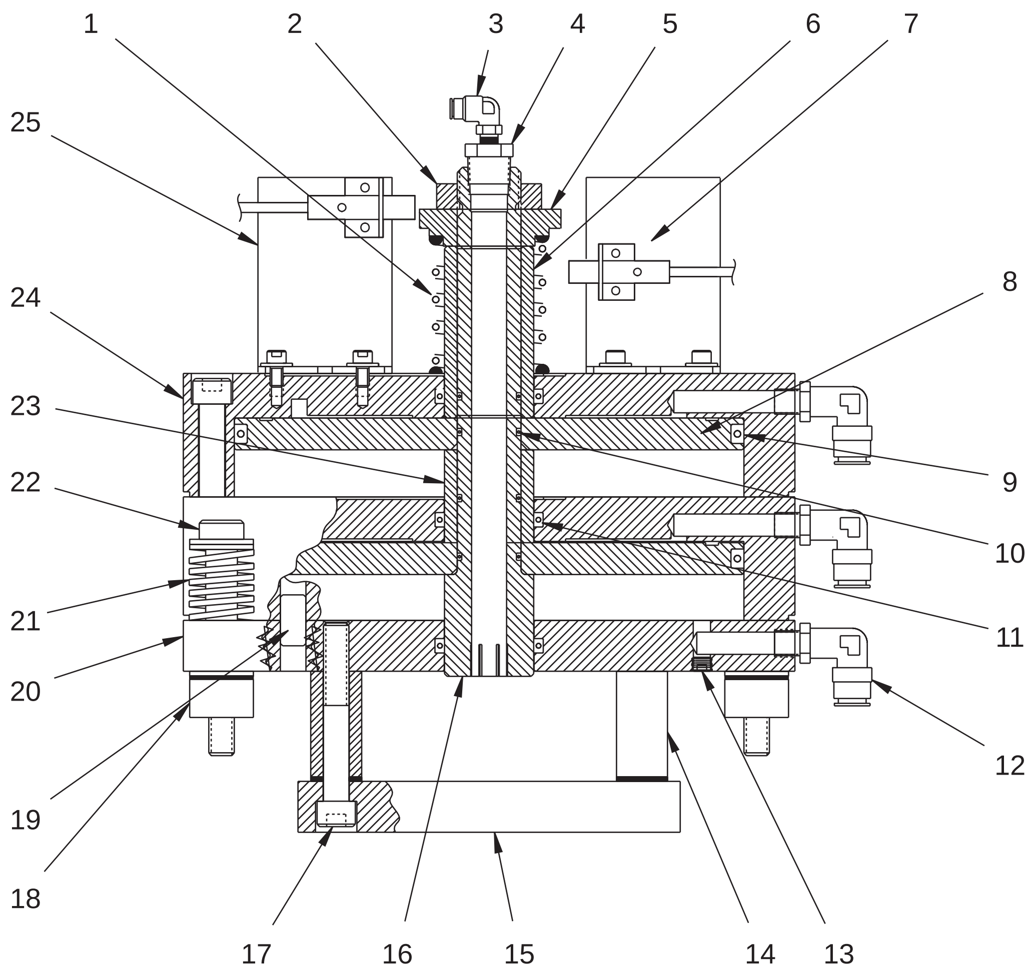
1.	58-3613	1/4 Street elbow
2.	58-3050	Elbow 1/4 bylon tubing
3.	58-3670	1/4NPT M 1/8F reducer
4.	58-3727A	1/4NPT x 4 nipple brass
5.	59-2832B	Quick exhaust 1/4
6.	58-2165	Fitting close nipple 1/4
7.	32-5620	TRP solenoid valve assembly
8.	58-2265	Air muffler 3/8 flat
9.	58-3685	1/4NPT M 3/8 tube swivel elbow
10.	N/A	
11.	22-4045	Spring retainer TRP 30 degree
12.	N/A	
13.	32-2010	Limit sw shuttle in/out 24"
14.	25-4050C	Switch mounting bracket
15.	59-2760	Comp spring/large wire
16.	57-0040	O-ring 2-111 Buna
17.	56-0040	Retaining ring N5100-62
18.	57-0018	O-ring 2-446 buna

40 Taper Complete Assembly Non-TSC 30-3201A
Mini Mill TRP Assembly 30-1668

TRP base XHC 30-3207
TRP base 30-3205



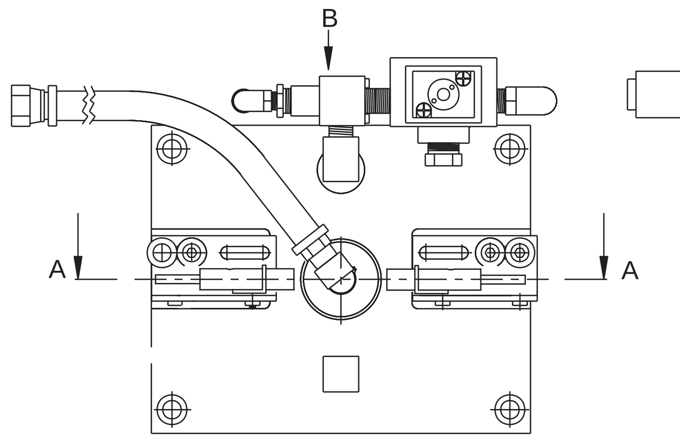
1. 32-2201 Proximity Switch
2. 20-1692A TRP Piston, In-line
3. 20-1691 TRP Shaft
4. 20-1696A TRP Spring Retain, In-line
5. 25-4648A Bracket Switch Mounting
6. 20-1693A TRP Cylinder In-line
7. 20-1690C Striker Plate

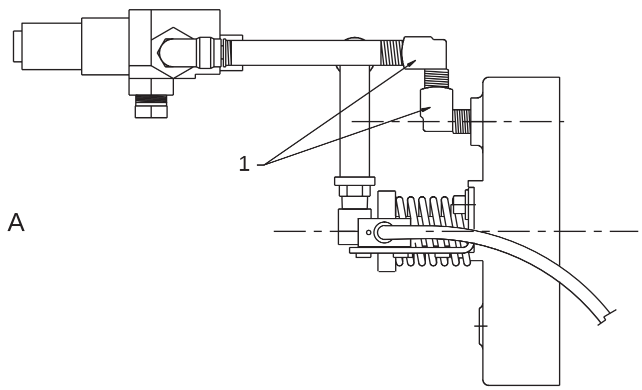


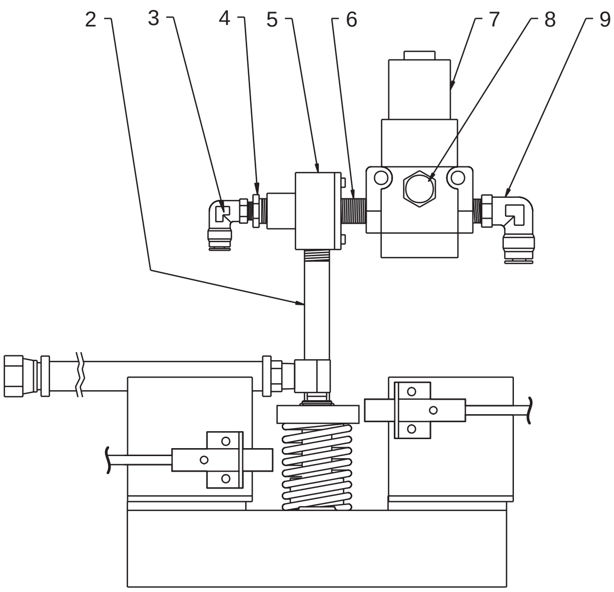
1. 59-0049 Spring compression
2. 52-0003 Shaft clamp
3. 58-3050 Elbow 1/4 nylon tubing
4. 58-3631 Reducer bushing 1/2M-1.8F
5. 20-0016B Switch plate
6. 20-0021 Spacer upper TRP 50T
7. 32-2013 Limit switch shuttle assembly
8. 20-0019A Piston TRP 50T
9. 57-0092 O-ring 2-448 Viton
10. 57-0027 O-ring 2-121 Buna
11. 57-0095 O-ring 2-327 Viton
12. 58-1695 Elbow 1/4MPT
13. 58-1627 1/8-27 pipe plug
14. 20-0013 Spacer fork spindle
15. 20-0015 Fork lift Spindle
16. 20-0018A Shaft TRP 50T
17. N/A
18. 22-0014 Spacer .62ID x 1.25OD.857
19. 48-1662 Dowel pin 1/2 x 1
20. 20-0017A Sub plate TRP 50T
21. 59-0016 Spring compression
22. 49-0003 Shoulder bolt 5/8 x 3 1/2
23. 20-0020A Spacer lower TRP 50T
24. 20-0022A Housing air cylinder
25. 25-0009 Switch mounting bracket

50 Taper complete assembly 30-3202A

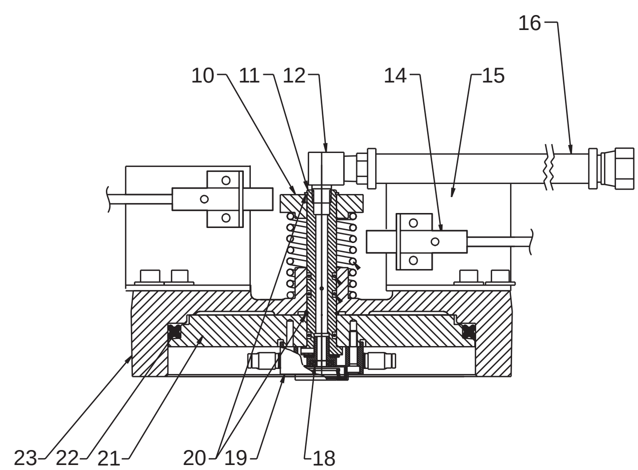
TSCHP Tool Release Piston Assembly







VIEW B
OUT OF POSITION

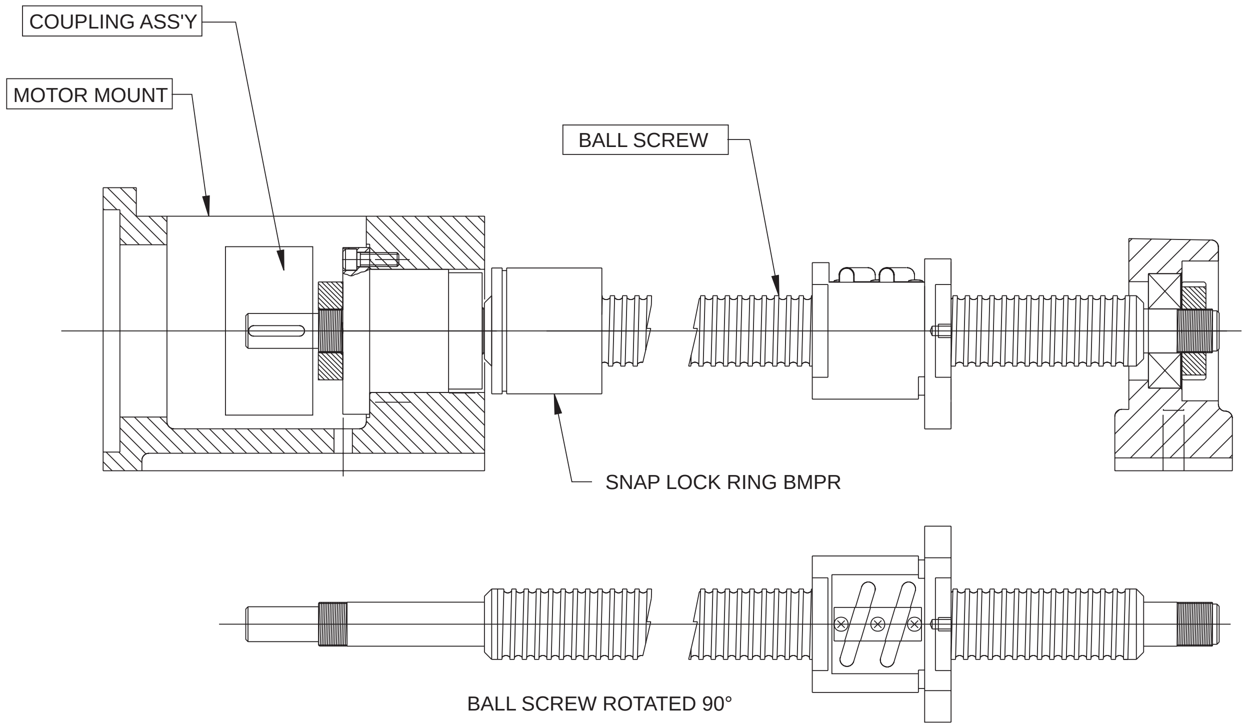


SECTION A-A
OUT OF POSITION

93-30-3206 Complete assembly

1.	58-3618	1/4 Street elbow 90 deg.
2.	58-3727A	1/4NPT x 4 nipple brass
3.	58-3050	Elbow 1/4 nylon tubing
4.	58-3670	1/4NPT M 1/8 F reducer
5.	59-2760	Compr spring/large wire
6.	58-2165	Fitting close nipple 1/4
7.	32-5620	TRP solenoid valve assembly
8.	58-2265	Air muffler 3/8 flat
9.	58-3685	1/4NPT M 3/8 tube swivel elbow
10.	22-7045A	Spring retainer TRP 30 degree
11.	20-7626A	Shaft TRP hex
12.	58-3614	1/4F 1/8M street elbow
14.	32-2010	Limit switch shuttle in/out 24"
15.	25-7050C	Switch mount tool release
16.	30-6733	Hose Assy Ck Vlv/TRP VF1-11/40T QAPC
	30-6734	Hose Assy Ck Vlv/TRP VF5-11/50T , VF-SS, VS-3
	30-6733	Hose Assy Ck Vlv/TRP VR-8, VR-9, VR-11
18.	20-7640	Tool Release Bolt, 3/8-LH
19.	30-3298	Seal Housing Assembly
20.	56-0040	Retaining ring N5100-62
21.	20-7630A	TRP rectangle TSC
22.	57-2156	Quad-ring Q4-440 buna
23.	20-7007A	Cylinder housing

Ball Screw Assembly



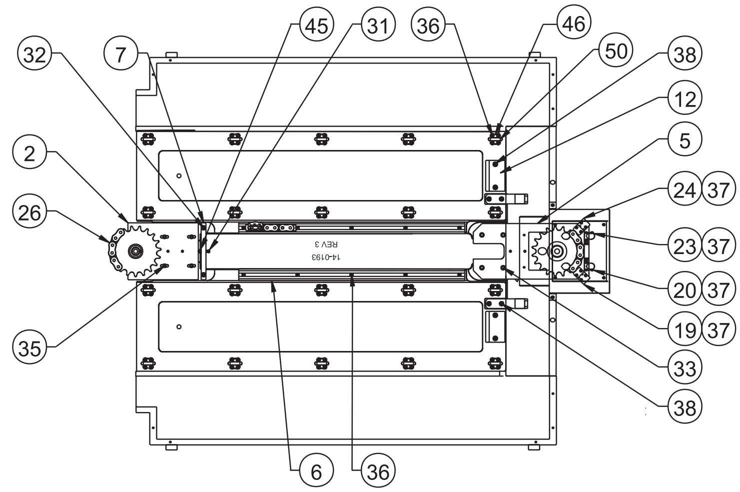
	Mini-mill	VF 0-1	VF 2	VF 3	VF 4-5	VF-5XT
Base	24-3006	30-0157	30-0157	30-0196	30-0196	30-0196
Saddle	24-3006	30-0157	30-0194	30-0195	30-0197	30-2152
Column	24-3006	30-0157	30-0157	30-0196	30-0196	30-0196

	VF-6/8	VF-7/9	VF-10/11
Base	30-0474	30-0474	30-0474
Saddle	30-0470	30-0473	30-0516
Column	30-0474	30-0474	30-0474

50 Taper

	VF5	VF-5XT	VF-6/8	VF-7/9	VF-10/11
Base	30-0202	30-0202	30-0895	30-0895	30-0895
Saddle	30-0198	30-2152	30-0896	30-0897	30-0516
Column	30-0202	30-0202	30-0895	30-0895	30-0895

*Except XRT



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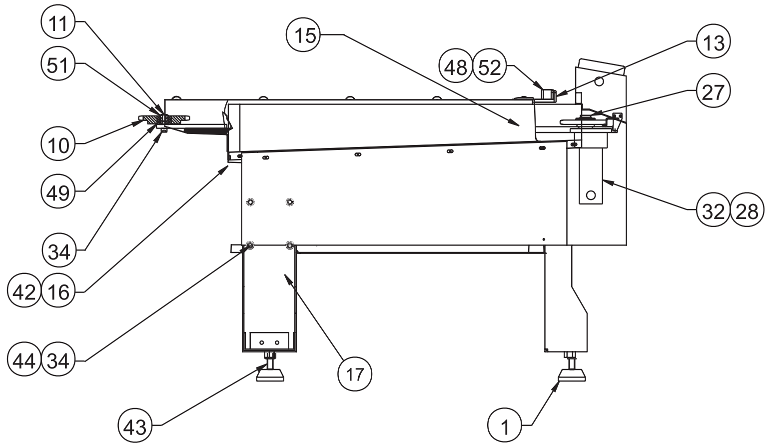

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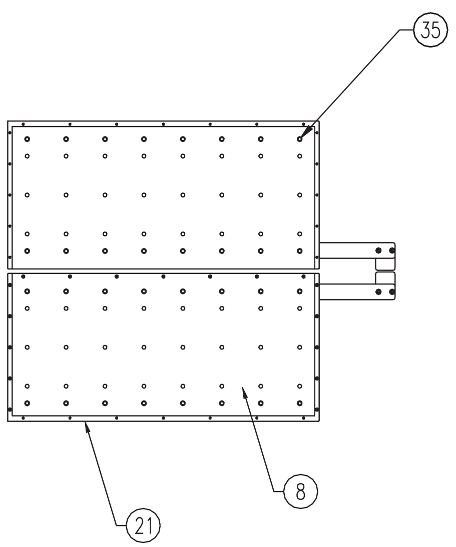

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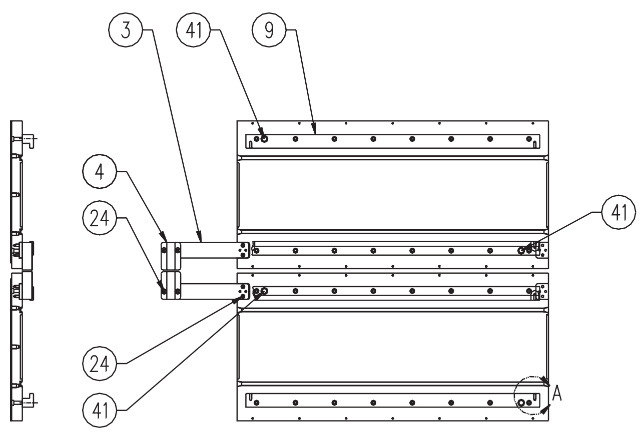

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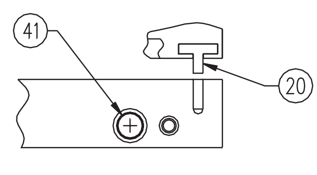

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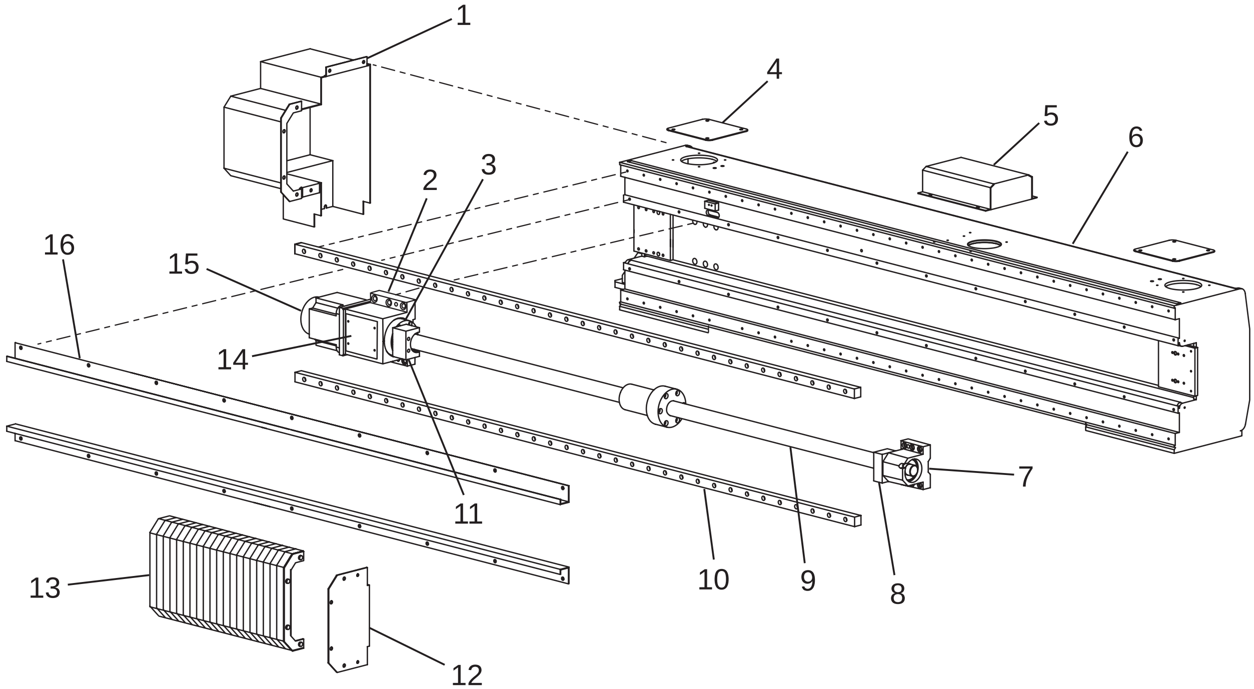
DETAIL A
SCALE 1:2

APC Assembly

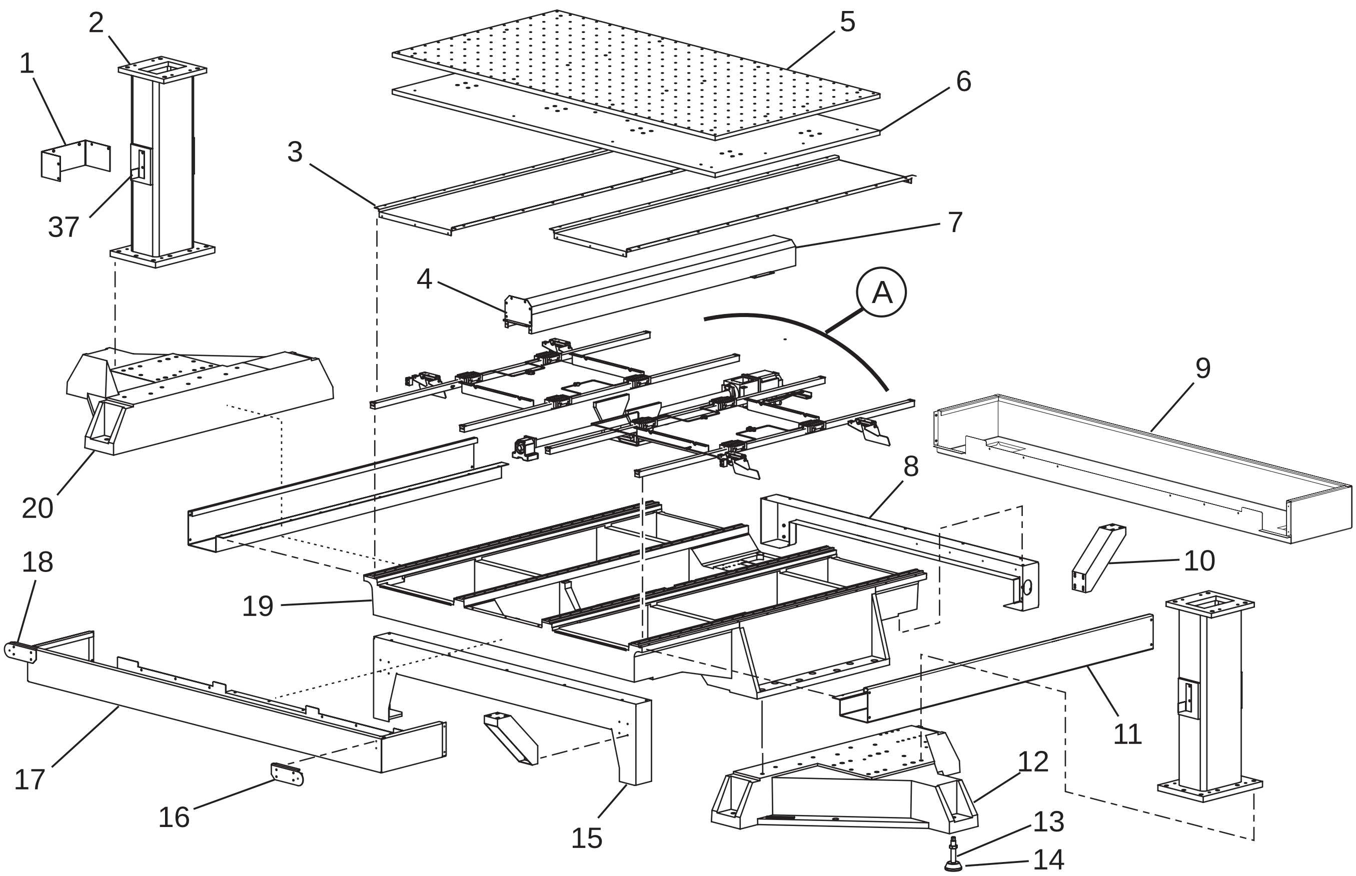
ITEM	QTY.	PART NO.	TITLE
1.	3	14-7068	CASTING, LEVEL PAD
2.	1	20-0046	SUPPORT, IDLER SPROCKET
3.	2	20-0048	DRIVE LEG, APC
4.	2	20-0049	DETENT, APC
5.	1	20-0050	SUPPORT, MOTOR, APC
6.	2	20-0051	GUIDE, CHAIN, APC
7.	1	20-0052	TENSIONER BLOCK
8.	2	20-0053	PALLET
9.	4	20-0054	CLAMPING RAIL
10.	1	20-0057	IDLER SPROCKET
11.	1	20-0060	JOURNAL, IDLER SPROCKET
12	2	20-0065	FRICTION BLOCK
13.	2	20-0066	PALLET STOP, APC
14.	N/A		
15.	1	20-0193	BASE, MACHINED
16.	1	25-0066	SHIELD, SPLASH, LOW PROFILE
17.	3	25-0072	LEG, APC
18.	2	25-0077	PALLET, SKIRT, REAR
19.	1	25-0082	SWITCH BRACKET, CHAIN, LOW
20.	4	26-8964	WIPER APC
21.	2	25-0095	PALLET DRIP PAN
22.	4	25-0100	BRACKET, WIPER
23.	1	25-0101	SWITCH BRACKET ARM #2
24.	1	25-0102	SWITCH BRACKET, CHAIN, HIGH
25.	2	25-0105	PALLET SKIRT, FRONT
26.	1	30-0054	CHAIN ASSEMBLY, APC
27.	1	30-0055	SLIP CLUTCH ASSEMBLY
28.	1	32-1800	SHUTTLE MOTOR, 507-01-110AH
29.	8	40-0017	FHCS, 5/16-18 X 3/4”
30.	8	40-16081	BHCS, 6-32 X 5/16”
31.	1	40-1614	SHCS, 1/4-20 X 1 1/4
32.	2	40-1617	FHCS, 1/4-20 X 1”
33.	4	40-1636	SHCS, 3/8-16 X 1 1/4
34.	13	40-1654	SHCS, 1/2-13 X 1”
35.	4	40-1667	SHCS, 5/16-18 X 1 1/4
36.	124	40-1703	FHCS, 10-32 X 1/2
37.	8	40-1850	SHCS, 10-32 X 3/8”
38.	8	40-1920	FHCS, 1/4-20 X 5/8
39.	2	40-1950	SHCS, 10-32 X 3/4
40.	32	40-1961	SHCS, 3/8-16 X 2”
41.	4	40-1970	FHCS, 1/4-28 X 1”
42.	3	40-1981	FBHCS, 1/4-20 X 1/2
43.	3	44-1700	SSS, CUP PT. 3/4-10 X 4:”
44.	12	45-1666	WASHER, FLAT 1/2 I.D.
45.	1	46-1625	NUT, HEX, BLACK OX, 1/4-20
46.	20	48-0012	DOWEL PIN, 12mm X 30 mm LG.
47.	32	49-16201	BHCS, 10-32 X .38
48.	4	51-0030	BUSHING, DRILL .6260 I.D.
49.	2	51-2836	BEARING, RADIAL, #60052RS
50.	20	51-4000	BEARING, RADIAL 12 X 32 X 10MM
51.	1	56-0085	RETAINING RING 5100-100
52.	2	59-1057	BUMPER, PALLET

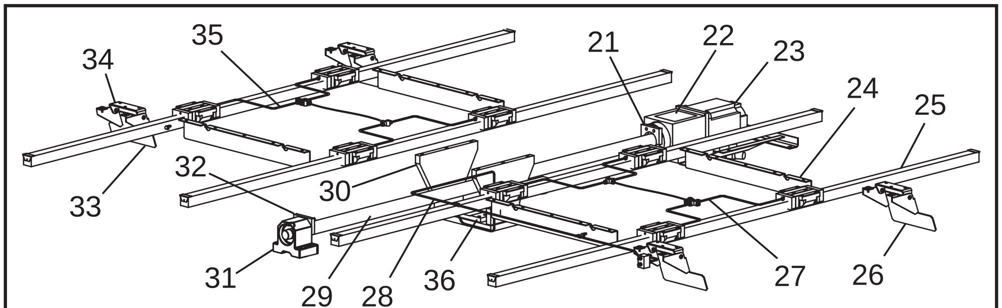
GANTRY ROUTER BRIDGE ASSEMBLY PARTS LIST



1.	25-1147	Y-axis Servo Motor Cover
2.	20-0151	Ballscrew Motor Mount
3.	29-9211	Ballnut Housing (40mm)
	20-9212	Bearing Housing (40mm)
4.	25-1304	Cable Hole Covers (2x)
5.	25-1360	Y-axis Cable Carrier Cover
6.	20-3256A	Bridge (GR 408 only)
	20-3238	Bridge (GR 510-512)
	20-2829	Bridge (GR 710-712)
7.	20-0152	Bearing Housing (40-50mm)
8.	28-0195	Bumper 1.25 40-50mm
		Bumper .500 (GR-408)
9.	24-0118	Y-axis Ballscrew (GR 408 only)
	24-0030B	Y-axis Ballscrew (GR 510-512)
	24-0111B	Y axis ballscrew (GR710-712)
10.	50-0110	Linear Guide 2x (GR 408)
	50-0024A	Linear Guide 2x (GR 510-512)
	50-0107A	Linear Guide 2x (GR710-712)
11.	28-0215	Bumper .500 40-50mm
12.	25-1164	Y-axis right bellow mount (GR 510-712)
	25-7436	Y-axis right bellow mount (GR-408)
13.	59-0817	2x Y-axis bellows (GR-408)
	59-0360	2x Y-axis bellows (GR 510-512)
	59-0718	2x Y-axis bellows (GR 710-712)
14.	25-9203	Motor mount cover plate
15.		Servo motor
16.	25-7435	2x Y-axis bellows guide (GR408)
	25-1163	2x Y-axis bellows guide (GR 510-512)
	25-5960	2x Y-axis bellows guide (GR 710-712)

GR-408 Base & Table Assembly Parts List



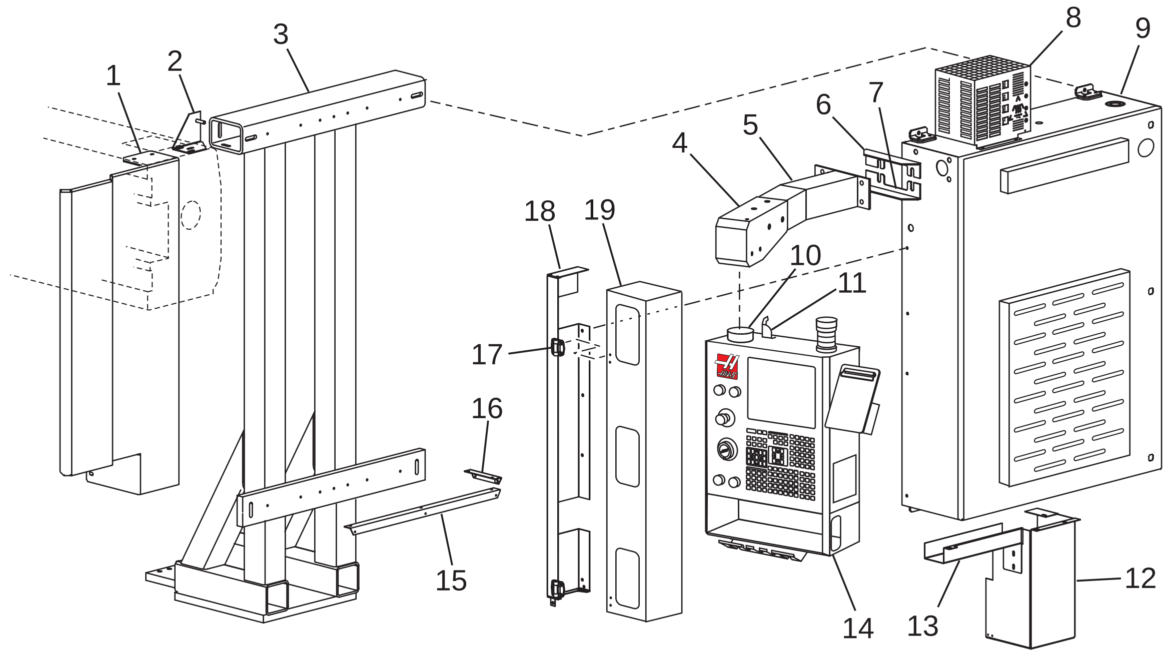


Detail A

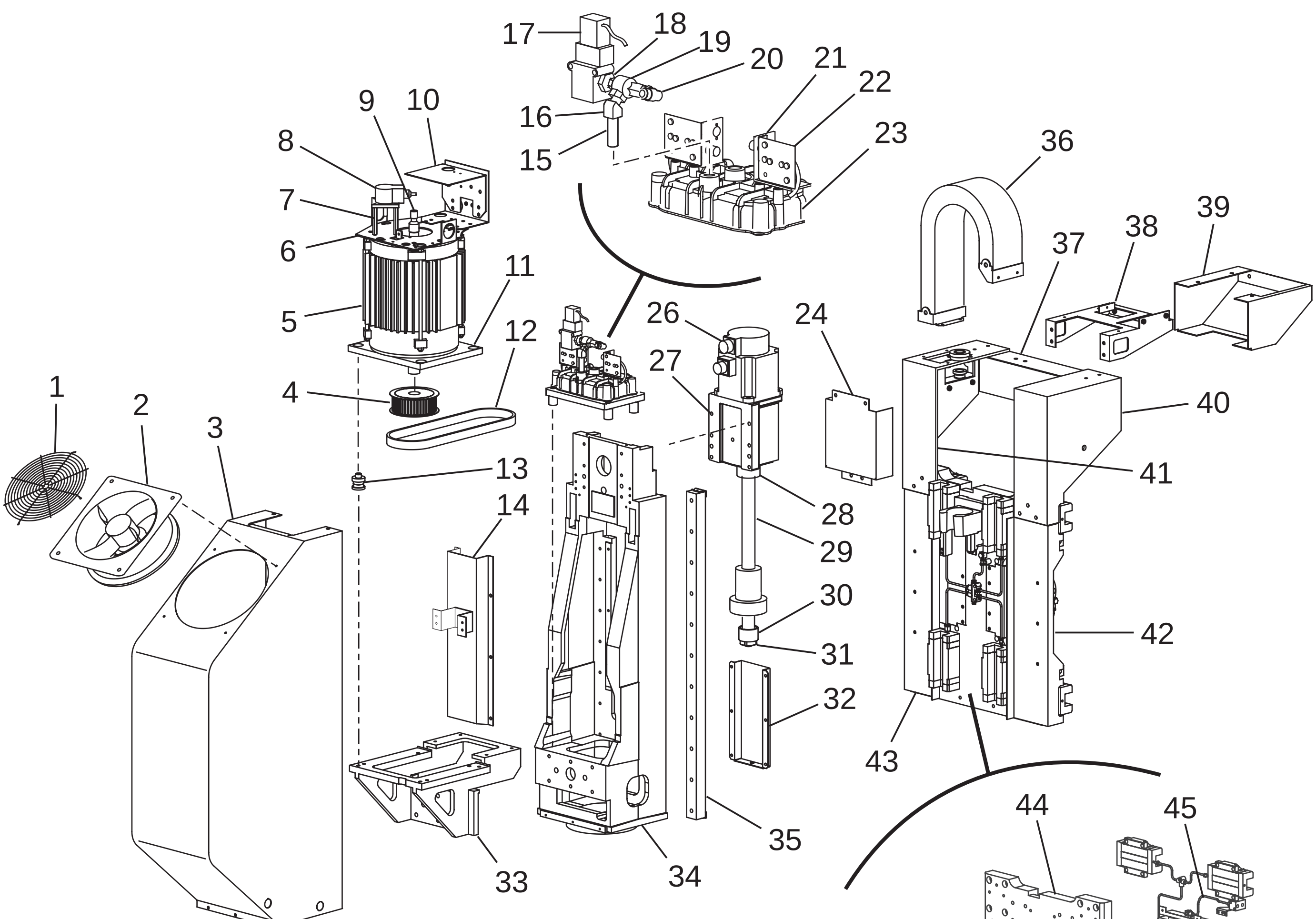
GR-408 Base & Table Assembly Parts List

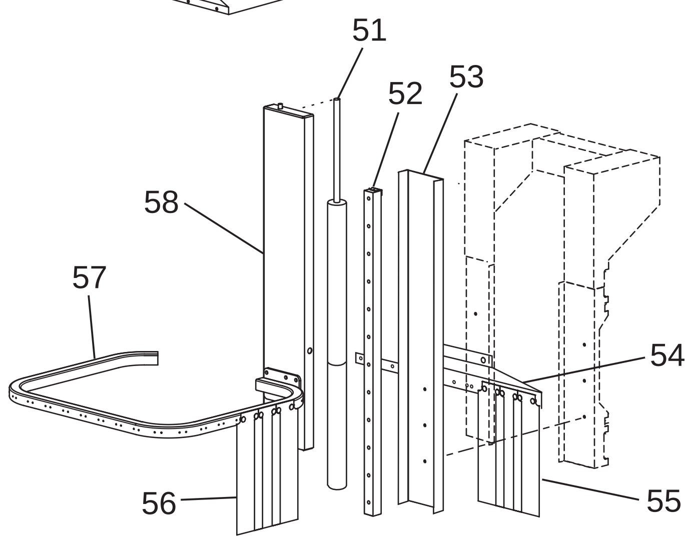
1. 25-7720A MOM-408 Bracket
2. 20-3254 2X Bridge Support
3. 25-7427A 2X Chip Tray
4. 25-7429 X-Axis Ballscrew End Cover
5. 20-3268 Table
6. 20-3267A Sub-Table
   25-7552 Proximity Switch Trip Bracket
7. 25-7428 X-Axis Ballscrew Cover
   25-7801 Cable Cover
8. 25-7417 Rear Chip Pan Support
9. 25-7416A Rear Chip Pan
10. 25-7413 4X Front Chip Pan Support
11. 25-7415A 2X Left and Right Side Chip Pan Drain
12. 20-3261 Control Side Foot
13. 46-1027 8x Adjusting Screw
14. 14-7068 8x Leveling Pad
15. 25-7441 Bed Support Panel
16. 25-7721 Right Side Reflector Bracket
17. 25-7418A Front Chop Pan Drain
18. 25-7722 Left Side Reflector Bracket
19. 20-3259A Base
20. 20-3262 TC Side Door
21. 30-1222 Ballscrew Support Bearing Assembly
22. 20-0151 Ballscrew Motor Mount
23. 62-0016 Servo Motor
24. 25-7571A 4x Chip scraper
25. 50-0024A 4X Linear Guide
26. 25-7567 2X Right Chip Scraper
27. 30-8356A X-Axis Right Lube Line Assembly
28. 30-8412 X-Axis Ballnut Lube Assembly
29. 24-0116 X-Axis Ballscrew
30. 20-3269 X-Axis Ballnut Support
31. 30-0472 2x Ballscrew Bearing Housing
32. 28-0215 3x Bumper (.500")
33. 25-7568 2x Left Chip Scraper
34. 25-7569 4x Chip Scraper Mount
35. 30-8357A X-Axis Left Lube Line Assembly
36. 20-0150 X-Axis Ballscrew Nut Housing
37. 25-7705 2x Sensor Mount

GR-408 Control Assembly Parts List



1. 25-7580A Operator Shield Bracket
2. 25-7574A Control Support Bracket
3. 20-3679 Control Box Mount
4. 25-6661A Arm End Cap
   25-6659A Swivel Mounting Plate
5. 14-2135 Pendant Arm
6. 25-6380 Control Arm Top Stiffener
7. 25-6381 Control Arm Bottom Stiffener
8. 25-4311A Front Regen Cover
   25-0462A Back Regen Cover
9. 32-9654B Control Box Assembly
10. 93-0282 Swivel Control Assembly
11. 25-1129 Pendant Hard Stop
12. 25-7442A Control Junction Box
13. 25-7443A Wire Cover Junction Box
14. 32-6006C Control Pendant Assembly
15. 25-1136 Control Skirt Bracket
16. 25-1137 Control Skirt Bracket
17. 59-0023 2X Door Positioning Hinge
18. 25-1132A Control Box Cover Bracket
19. 25-1133A Control Box Cover Door

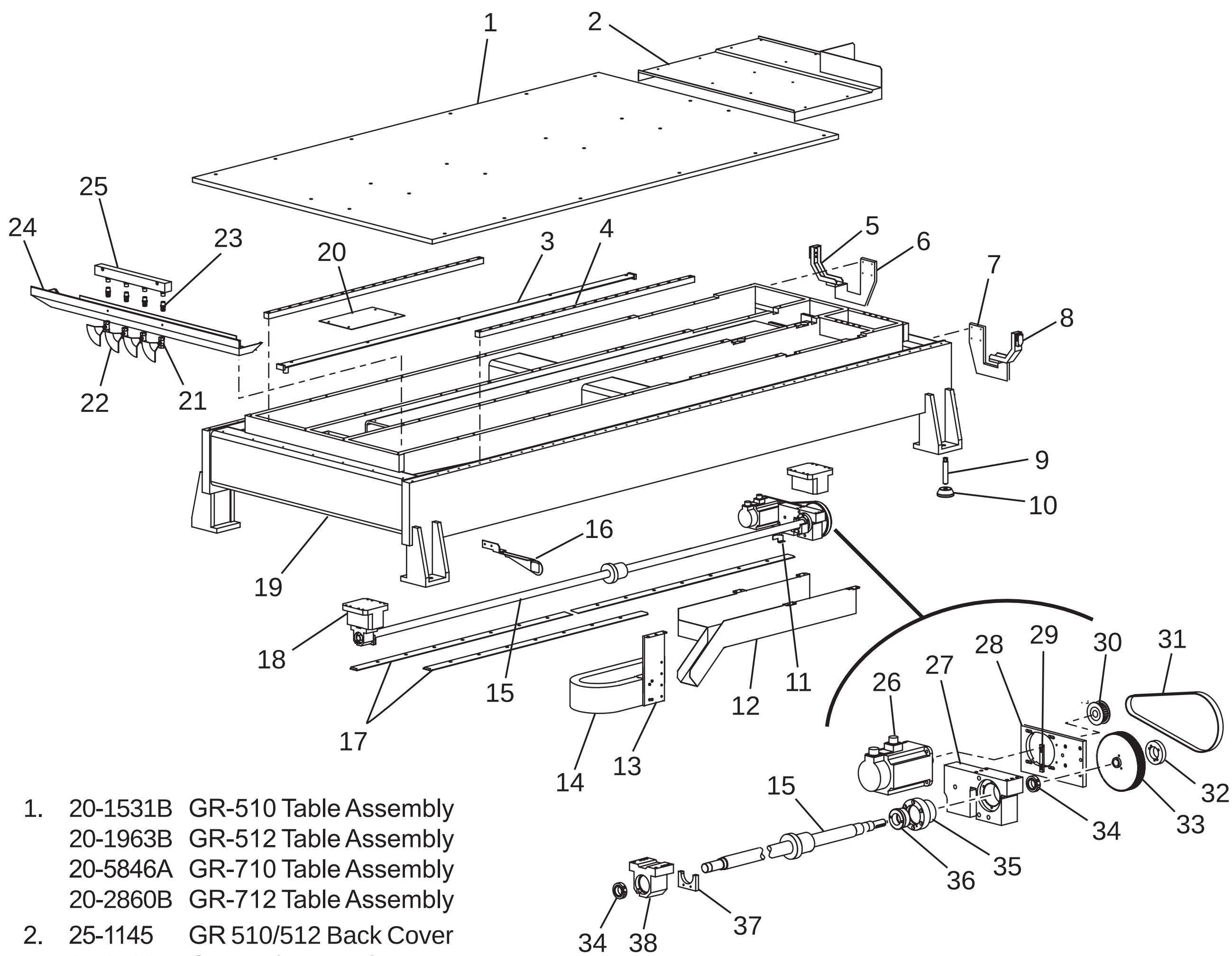




Runner Block Assembly (Optional)

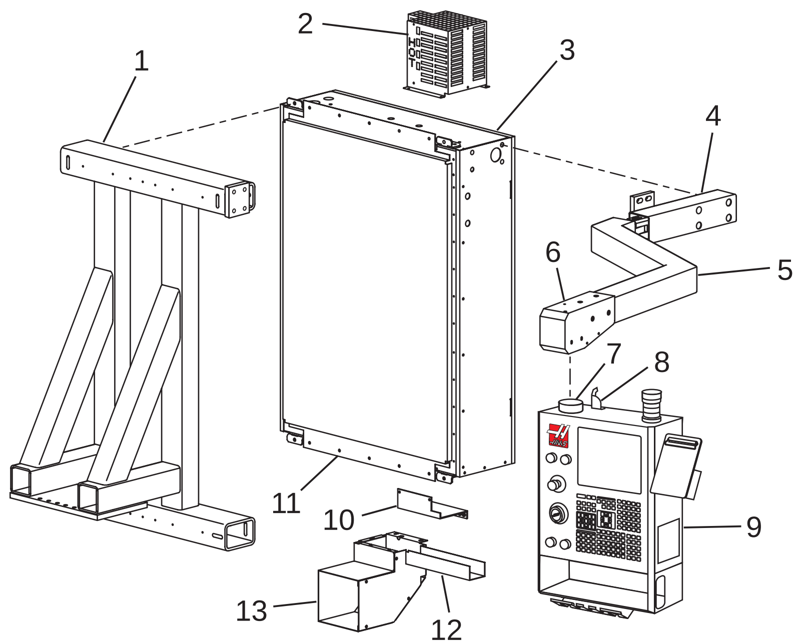
GR-408 Ram Assembly Parts List

1. 59-0144 Fan Guard
2. 25-1157 Spindle Fan Cover
3. 25-1162 Head Cover
4. 22-7376 2x Sprocket Flange
   20-0997 Pulley
5. 62-1015 Spindle Motor
6. 25-6181 Encoder Mounting Plate
7. Encoder Bracket
8. 30-9569 Encoder Assembly
9. 22-0125 Encoder Drive Sprocket
10. 25-6180A Solenoid Motor Plate
11. 20-2415 Spindle Motor Plate
12. 54-2121 Belt
13. 22-7520A 8x Isolator
14. 25-1153 Z-Axis Ballscrew Cover
15. 58-0004 Nipple ¼ NPT x2
16. 58-3613 Street Elbow 1/4F x NPT 1/4M
17. 32-5620 TRP Solenoid Valve Assembly
18. 58-3691 Nipple ¼ NPT Hex
19. 59-2832 Quick Exhaust
20. 58-3685 90° Elbow 3/8 x NPT ¼-M
21. 25-5516 2x Clamp/Unclamp Bracket
22. 25-7050 2x Switch Mounting Bracket
    69-1700 2x Proximity Switch
23. 20-1491A Cylinder Housing Casting Machined
24. 25-6777 Z-axis Ballscrew Shield
26. 62-0036 Servo Motor
27. 20-7010A Motor Mount
28. 20-1114 Ballscrew Cover Spacer
    20-7416 Bearing Cartridge Housing
    22-7417 Bearing Cartridge Spacer
    20-7418 Bearing Cartridge Lock
29. 24-0031 Ballscrew (32mm)
30. 28-0242 Z-Axis Bumper
31. 51-2012 Bearing Locknut
32. 25-1154A Head Vent Cover
33. 20-1548 Ram Motor Base
34. 20-1549B Ram Casting
35. 50-0025 2x Linear Guide
36. Cable Carrier Assembly
37. 25-1150A Z-Axis Cable Carrier
38. 25-1151 Z-Axis Cable Carrier Mount
39. 25-1152 Z-Axis Cable Carrier Mount Cover
40. 25-1148A Y-Axis Right Cable Carrier Bracket
41. 25-1149A Y-Axis Left Cable Carrier Bracket
42. 25-1156 Right Sub Plate Cover
43. 25-1155 Left Sub Plate Cover
44. 20-1525B Router Sub Plate
    25-5937 Sub Plate Cover
45. 30-3778 Y-Axis Lube Line Assembly
46. 20-0150 Ballnut Housing (40-50mm)
47. 30-3786B Y-Axis Lube Line Assembly
48. 25-1165A Y-Axis Bellows Moving Mount
49. 30-3788 Z-Axis Lube Line Assembly
50. 20-1532 Ballnut Housing (32mm)
51. 59-0058 Air Cylinder (1.25x26)
52. 50-30007 Linear Guide
53. 25-7659 Curtain Lift Inside Mount
54. 25-7662 Rear Curtain Lift Mount
55. 59-0845 Rear Curtains
56. 59-0844 Front Curtains
57. 20-3463 Curtain Lift Rod
58. 25-7660 Curtain Lift Cover

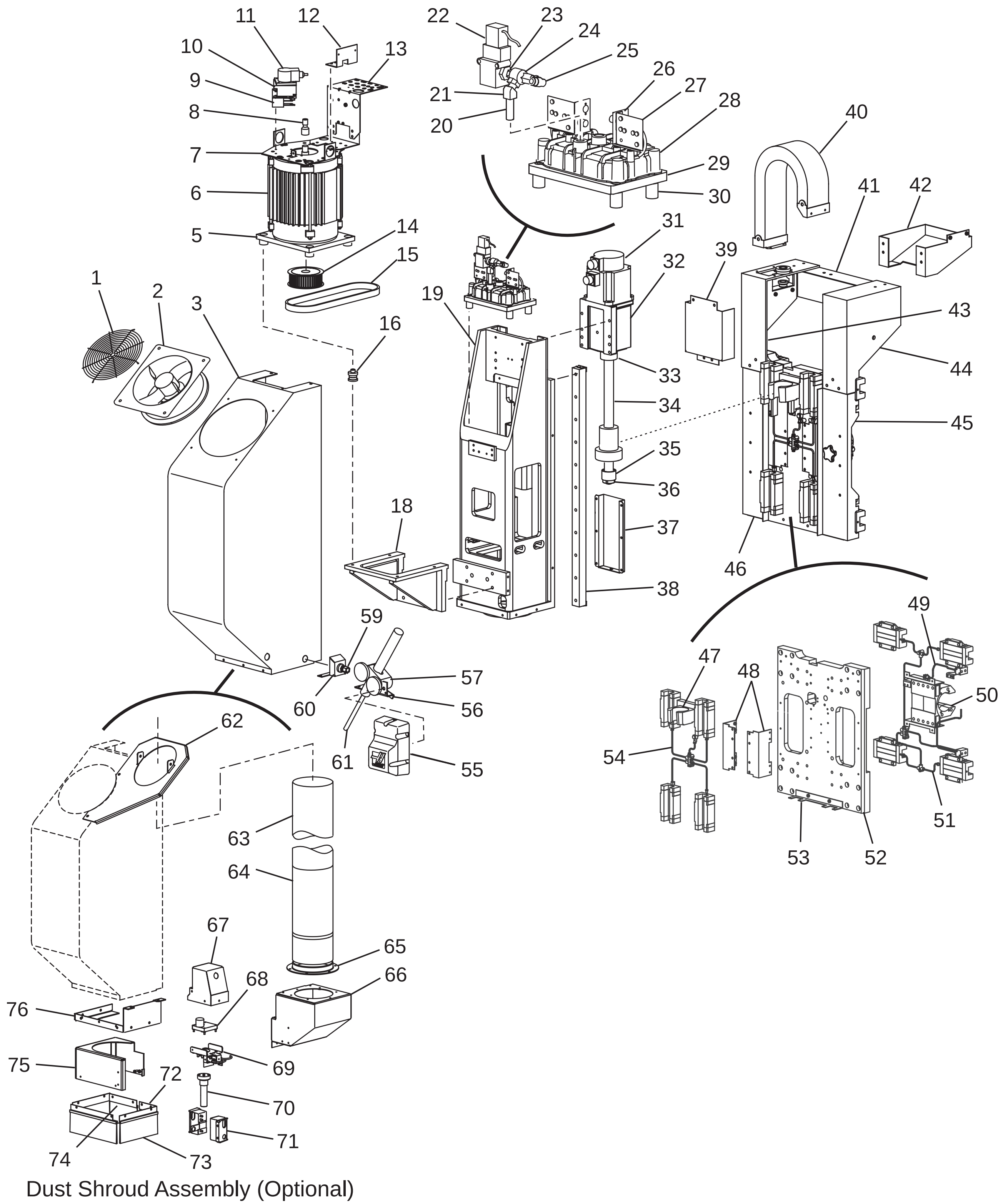


No.	Part No.	Description
1.	20-1531B	GR-510 Table Assembly
	20-1963B	GR-512 Table Assembly
	20-5846A	GR-710 Table Assembly
	20-2860B	GR-712 Table Assembly
2.	25-1145	GR 510/512 Back Cover
	25-6763	GR 710/712 Back Cover
3.	20-1828A	Vacuum Table Pipe
4.	50-0023C	2x GR 510, 710 Linear Guide
	50-0029C	2x GR 512, 712 Linear Guide
5.	25-4796D	2x Light Sensor Bracket
6.	25-4798B	Left Safety Arm Mount
7.	25-4797B	Right Safety Arm Mount
8.	32-7455	2x Light Sensor
9.	46-1027	4x Adjusting Screw
10.	14-7068	4x Leveling Screw
11.	25-5187	Table Trip Bracket
	25-7267	Y-Axis Mounting Bracket
	69-1700	Proximity Switch
12.	25-1348	GR 510, 512 Base Cable Trough
	25-6767	GR 710, 712 Base Cable Trough
13.	25-1159	Cable Carrier Fixed End Bracket
14.	59-0395	Cable Carrier X-Axis (GR-510/710)
	59-0603	Cable Carrier X-Axis (GR-512/712)
15.	24-0029	Ballscrew 40mm (GR510, 710)
	24-0037	Ballscrew 50mm (GR512, 712)
16.	25-4795A	2x Reflector Mount
17.	20-1556A	3x Cable Carrier Track
18.	20-1530	2x Ballscrew Mount Extension
19.	20-1552A	GR510 Base
	20-1860	GR512 Base
	20-2993	GR710 Base
	20-2998	GR712 Base
20.	25-1373	Front Ballscrew Shield
21.	58-2066	4x Hose Barb Fitting
22.	58-0511	Valve
23.	58-0287	4x Hex Nipple
24.	25-1144	GR510, 512 Front Gutter
	25-5965B	GR710, 712 Front Gutter
25.	20-1814	Vacuum Table Manifold

GR-510/512/710/712 Control Assembly Parts List



1. 14-1550A Control Box Mount
2. 25-4311A Front Regen Cover
   25-0462A Back Regen Cover
3. 32-9654B Control Box Assembly
4. 20-1593A Fixed End Control Arm
5. 20-1560A Control Arm
6. 25-6661A Arm End Cap
   25-6659A Swivel Mounting Plate
7. 93-0282 Swivel Control Assembly
8. 25-1129 Pendant Hard Stop
9. 32-6006C Control Pendant Assembly
10. 25-1245A Regulator Mounting Bracket
11. 25-1246 Control Cabinet Back Cover
12. 25-1228 Control Cover Junction Box
13. 25-1227A Control Junction Box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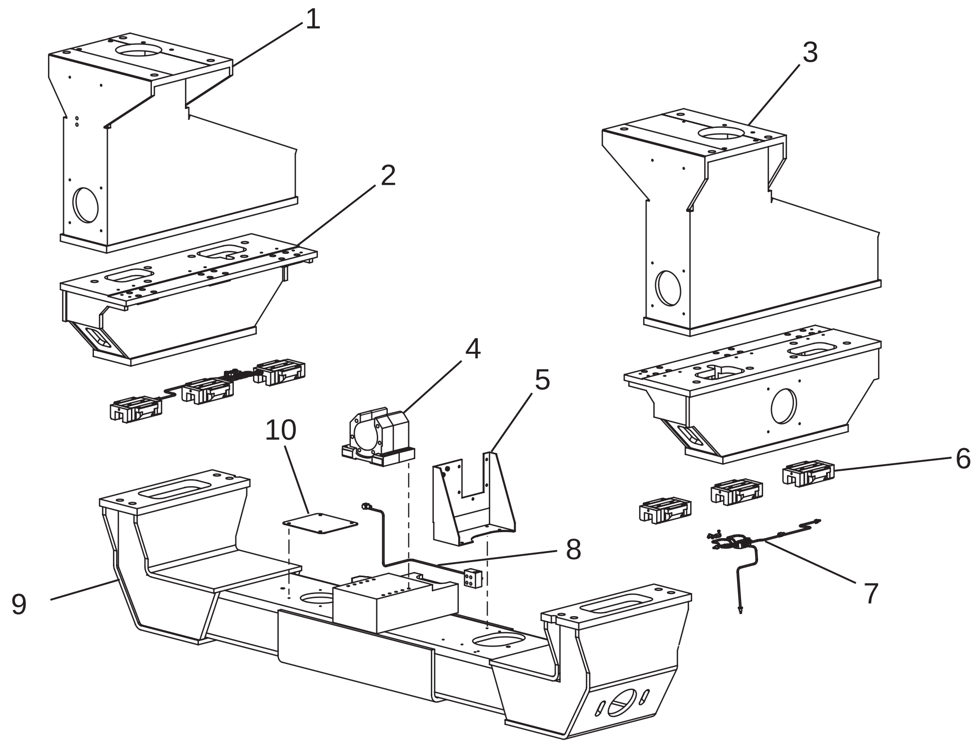
Dust Shroud Assembly (Optional)

GR-510/512/710/712 Ram Assembly Parts List

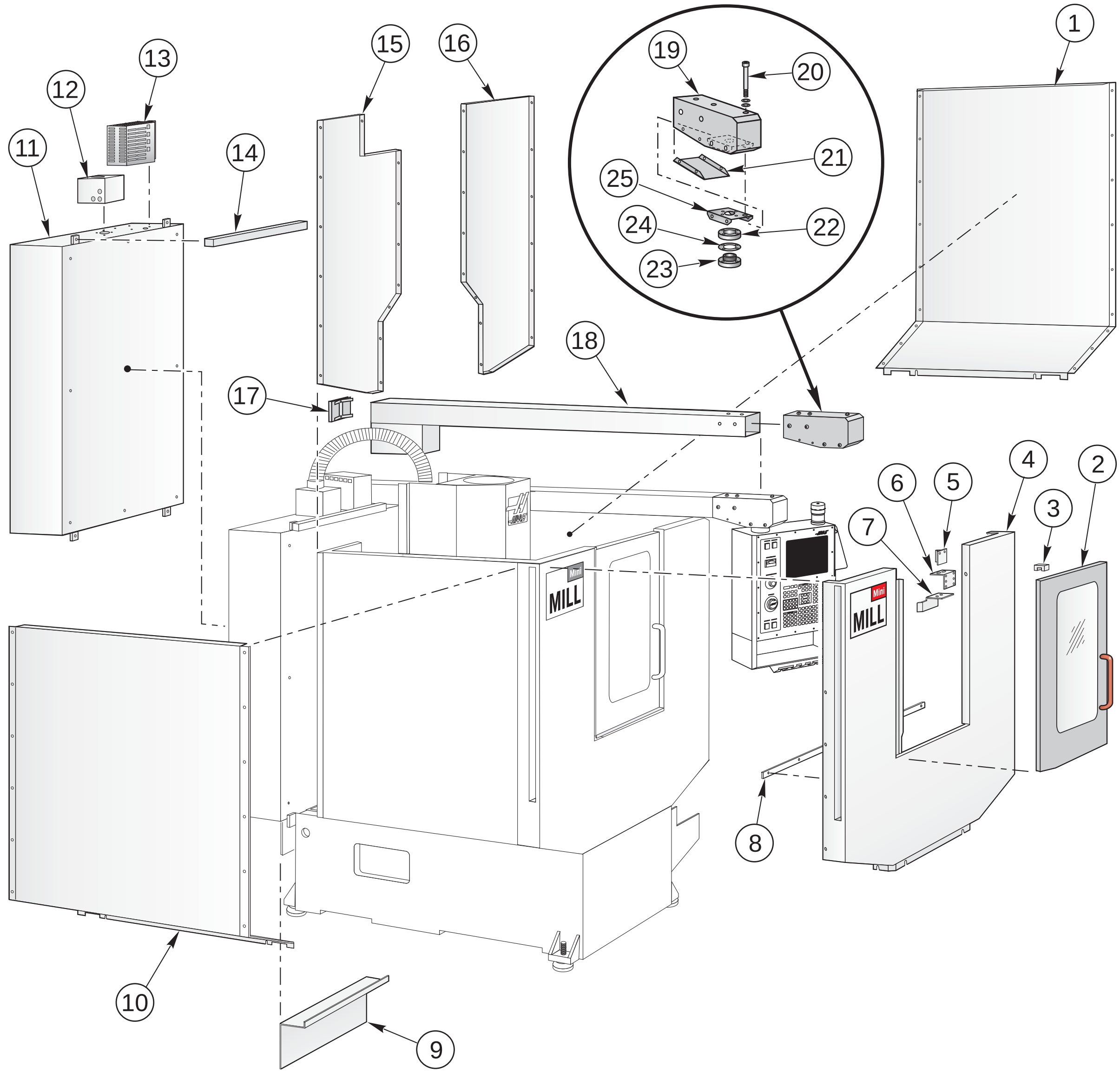
1. 59-01544 Fan Guard
2. 25-1157 Spindle Fan Cover
3. 25-7910 Head Cover
4. Not Used
5. 20-2415 Spindle Motor Plate
6. 62-1015 Spindle Motor 5HP
7. 25-6181 Encoder Mounting Plate
8. 20-0276A Encoder Drive Sprocket
9. 25-6297 Encoder Spring Spacer
10. 25-6293A Encoder Spring Mounting Box
11. 30-9569 Encoder Assembly
12. 25-6761 Terminal Block Bracket
13. 25-6180C Solenoid Mounting Bracket GR-510 (10 HP)
    25-7913 Solenoid Mounting Bracket GR-510 (5 HP)/512/710/712
14. 20-0997 Pulley
15. 54-0221 Belt
16. 22-7520A 8X Isolator
17. Not Used
18. 20-3037A Motor Mount
19. 20-3477A RAM
20. 58-0004 Nipple ¼ NPT x 2
21. 58-3613 Street Elbow 1/4F x NPT 1/4M
22. 32-5620 TRP Solenoid Valve Assembly
23. 58-3691 Nipple ¼ NPT HEX x 1
24. 59-2832 Tool Changer Quick Exhaust
25. 58-3685 90 Degree Elbow 3/8 x NPT 1/4M
26. 25-5516 2X Clamp Unclamp Bracket
27. 25-7050C 2X Switch Mounting Bracket
    69-1700 2X Proximity Switch
28. 20-1491A Cylinder Housing Casting
29. 20-3724A TRP Mounting Plate
30. 20-3787 4X TRP Plate Spacer
31. 62-0036C Yaskawa Servo Motor
32. 20-7010A Motor Mount
33. 20-3531 Ballscrew Cover Spacer
    51-1011 Bearing
    20-7416 Bearing Cartridge Housing
    22-7417 Bearing Cartridge Spacer
    20-7418 Bearing Cartridge Lock
34. 24-0031 Ballscrew 32mm
35. 28-0242 Z-Axis Bumper
36. 51-2012 Bearing Locknut
37. 25-1154A Head Vent Cover
38. 50-0025 2X Linear Guide
39. 25-6777 Z-Axis Ballscrew Shield
40. 59-0393 Cable Carrier Assembly Z-Axis
41. 25-1150A Z-Axis Cable Cover
42. 25-6774 Z-Axis Cable Carrier Bracket
43. 25-1149A Y-Axis Left Cable Carrier Bracket
44. 25-1148A Y-Axis Right Cable Carrier Bracket
45. 25-1156 Right Sub-Plate Cover
46. 25-1155 Left Sub-Plate Cover
47. 20-1532 Ballnut Housing 32mm
48. 25-1165A 2X Y-Axis Bellows Moving Mount
49. 30-3778 Y-Axis Lube Line Assembly
50. 20-0150 Ballnut Housing 40-50mm
51. 30-3786B Y-Axis Lube Line Assembly
52. 20-1525B Router Sub-Plate
53. 25-5967 Sub-Plate Bottom Cover
54. 30-3788 Z-Axis Lube Line Assembly
55. 14-2149 P-Cool Cover Casting
56. 25-7850 Programmable Coolant Bracket
57. 20-0714A Air Cylinder Bracket
58. Not Used
59. 58-2071 Fitting ½ x NPT - 1/2M
60. 25-5654 Pipe Fitting Bracket
61. 30-2738 Air Cylinder Assembly
62. 25-7707A Dust Shroud Bracket
63. 59-0929 Duct to Hose Adapter
64. Pipe
65. 59-0359 Flange Adapter 6 inch
66. 25-7642C Dust Shroud Plenum
67. 25-7666B MTR DEP Top Cover
68. 32-0280B Turret Motor Assembly
69. 25-7638B Dust Shroud Hinge
    20-3372 Motor to Shaft Coupling
    69-1700 2X Proximity Switch
70. 20-3371A Shroud Door Shaft
    20-0356 Flange Bushing 1 inch
71. 25-7639 2X Shroud Door Hinge Bracket
72. 26-0196A Left Rear Brush
73. 26-0195A 3X Dust Shroud Front Brush
74. 26-0197 X-Axis Rear Chip Guard
75. 25-7640C Dust Shroud Door
76. 25-7641C Dust Shroud Hood

GR-510/512/710/712 Saddle Assembly Parts List



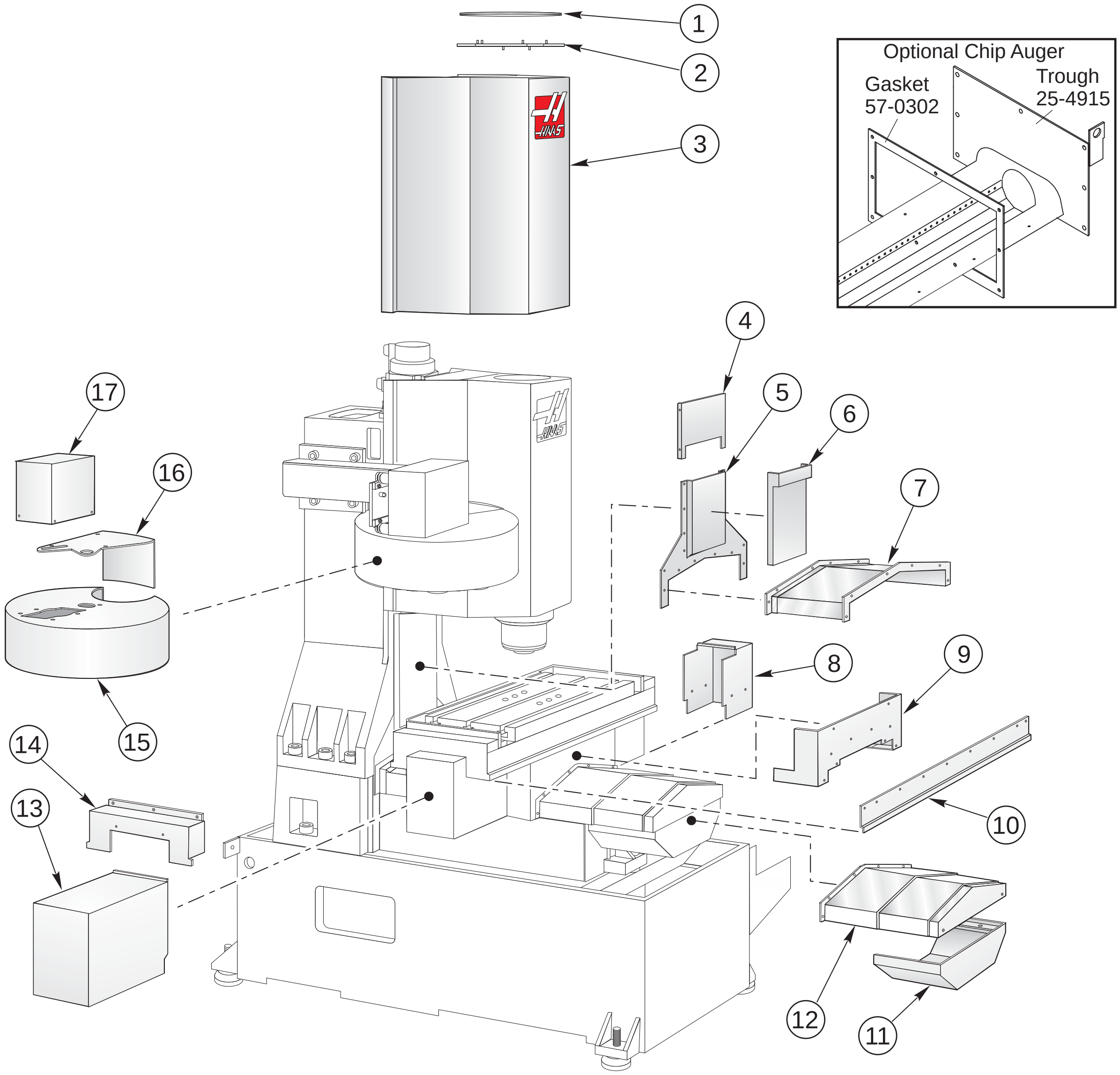
1. 20-2830A Left Column
2. 20-1544B 2x Saddle Spacer
3. 20-2831A Right Column
4. 20-0150 Ballnut Housing (40-50mm)
   20-1964 Ballnut Housing (50x50mm)
5. 25-1158 X-Axis Moving Cable Carrier Bracket
6. 50-0029C 6x Linear Guide Trucks
7. 30-3789B 2x X-Axis Lube Line Assembly
8. 30-3957A X-Axis Lube Line Assembly
9. 20-3070 Saddle (GR510, 512)
   20-3062 Saddle (GR710, 712)
10. 25-1304 Cable Hole Cover

Mini Mill Exterior Sheet Metal

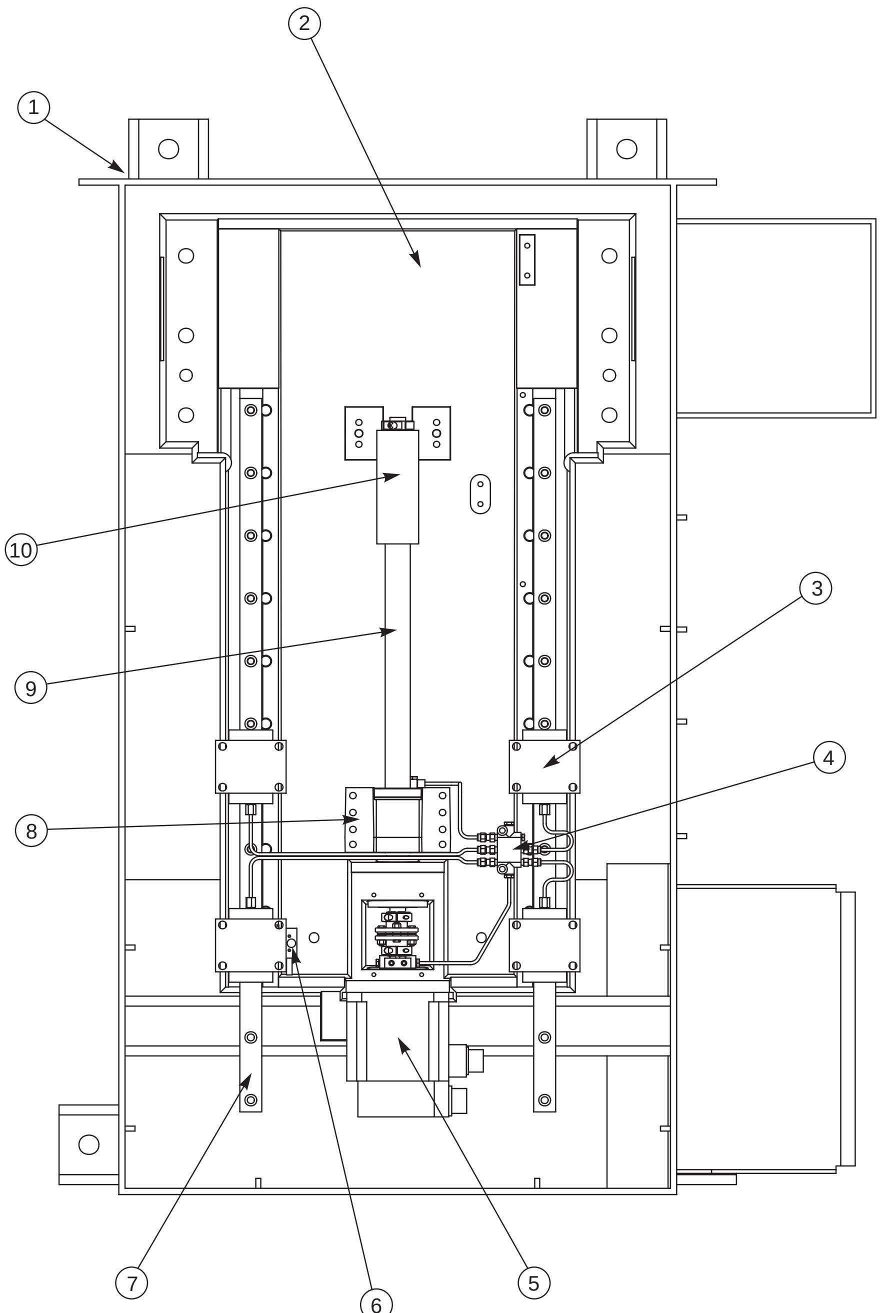


1. 25-0754 Enclosure Side
2. 25-0386 Door Assembly
   28-0011 Window
3. 20-0712 Guide Block
4. 25-0753 Panel Front Enclosure
5. 25-0958 Keybracket
6. 25-7050C Switch Mounting Bracket
7. 25-0757 Door Keeper
8. 22-7616 Lower Door Rail
9. 25-7195K Lube Panel Mounting
10. 25-0754 Enclosure Side Mirror
11. 25-0025D Main Electric Control Box
12. 25-7198B Junction Box
13. 25-0461 Regen Cover (Front)
    25-0462 Regen Cover (Back)
14. 20-3009 Box Bar
15. 25-0384A Back Panel Left
16. 25-0385A Back Panel Right
17. 14-1962 End Cap
    25-5394 End Cap Mounting Clip
18. 20-3008 Pendant Arm
19. 25-6661 Pendant Arm Knuckle
20. 44-0018 Leveling SHCS
21. 25-6660 Knuckle Cover
22. 20-7109A Pendant Arm Mount
23. 20-7110A Pendant Mount
24. 55-0020 Wavy Washer
25. 25-6659 Knuckle Swivel Plate

MINI MILL INTERIOR SHEET METAL

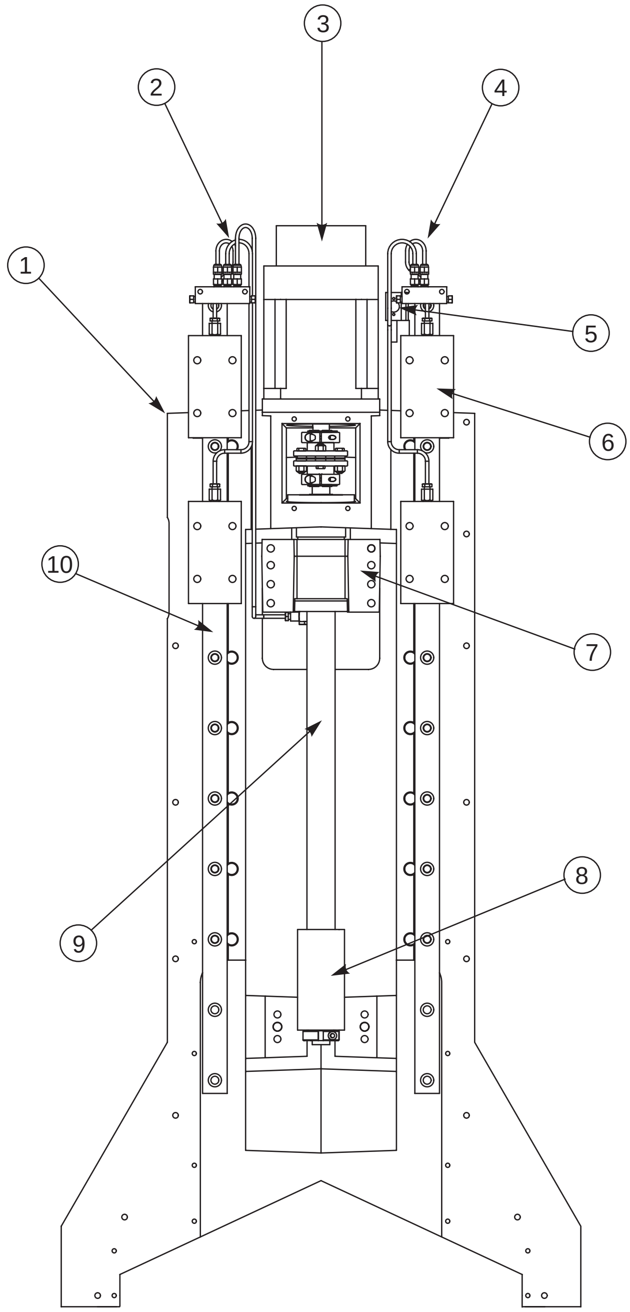


1.	59-0144	Fan guard	10.	25-0378	Tab side cover (2)
2.	25-0389	Fan bracket top	11.	25-0374	Front Y-axis motor cover
3.	25-0382A	Head Cover	12.	25-0372	Y-axis Waycover, Front
4.	25-0388	Back Head Cover	13.	25-0376	Motor Cover, X-axis
5.	25-0381	Z lower cover	14.	25-0379	Table End Cover (2)
6.	25-0380	Z upper cover	15.	25-0633	Tool Changer Shroud
7.	25-0373	Y-axis way cover, rear	16.	25-0636A	Trap Door
8.	25-0377	Support Cover	17.	25-0634	Tool Changer Cover
9.	25-0375	Saddle cover (2)			



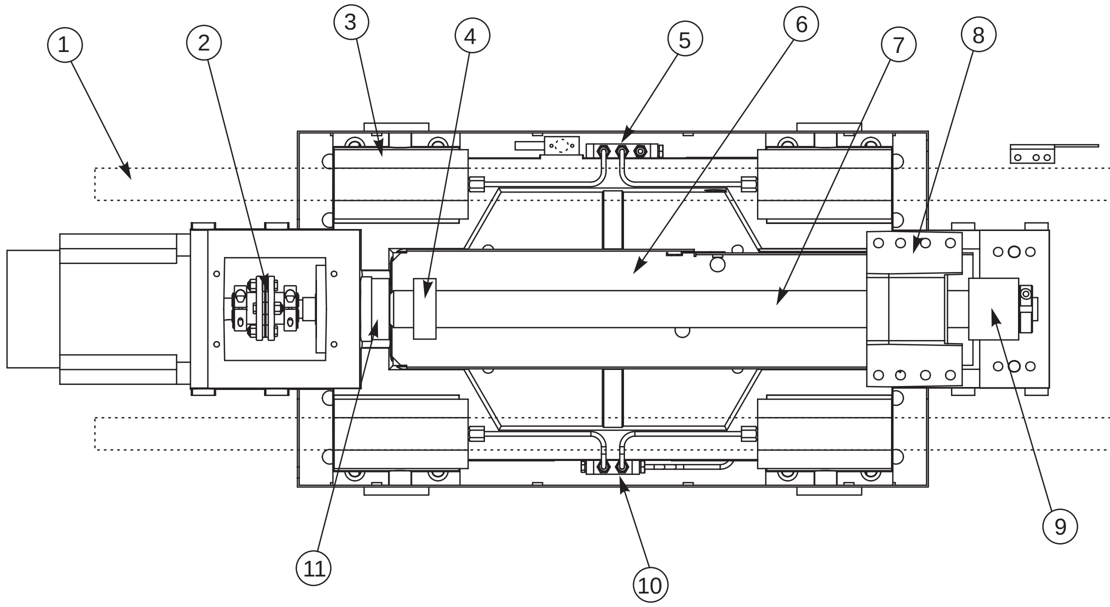
1. 20-3005 C Base
2. 20-3000 Casting
3. 50-0011 Y-axis runner block
4. 30-1752 Lube line assy
5. 62-0014 Y-axis motor
6. 32-2131 Limit switch
7. 50-3007 Linear Guide
8. 20-7008F Nut housing
9. 24-3006 Ballscrew
10. 20-3018 Bumper Y-axis

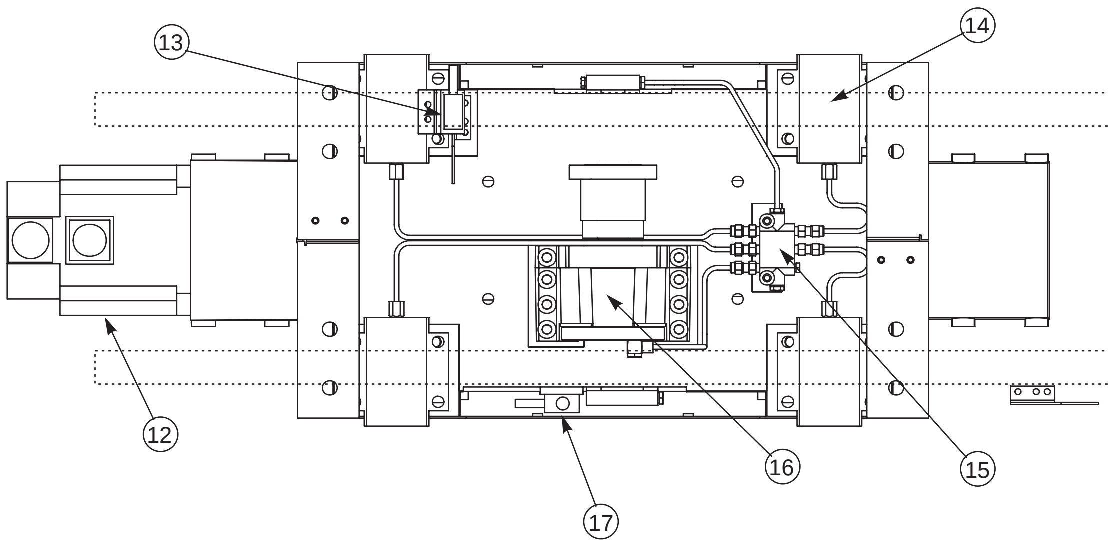
Mini-Mill Column



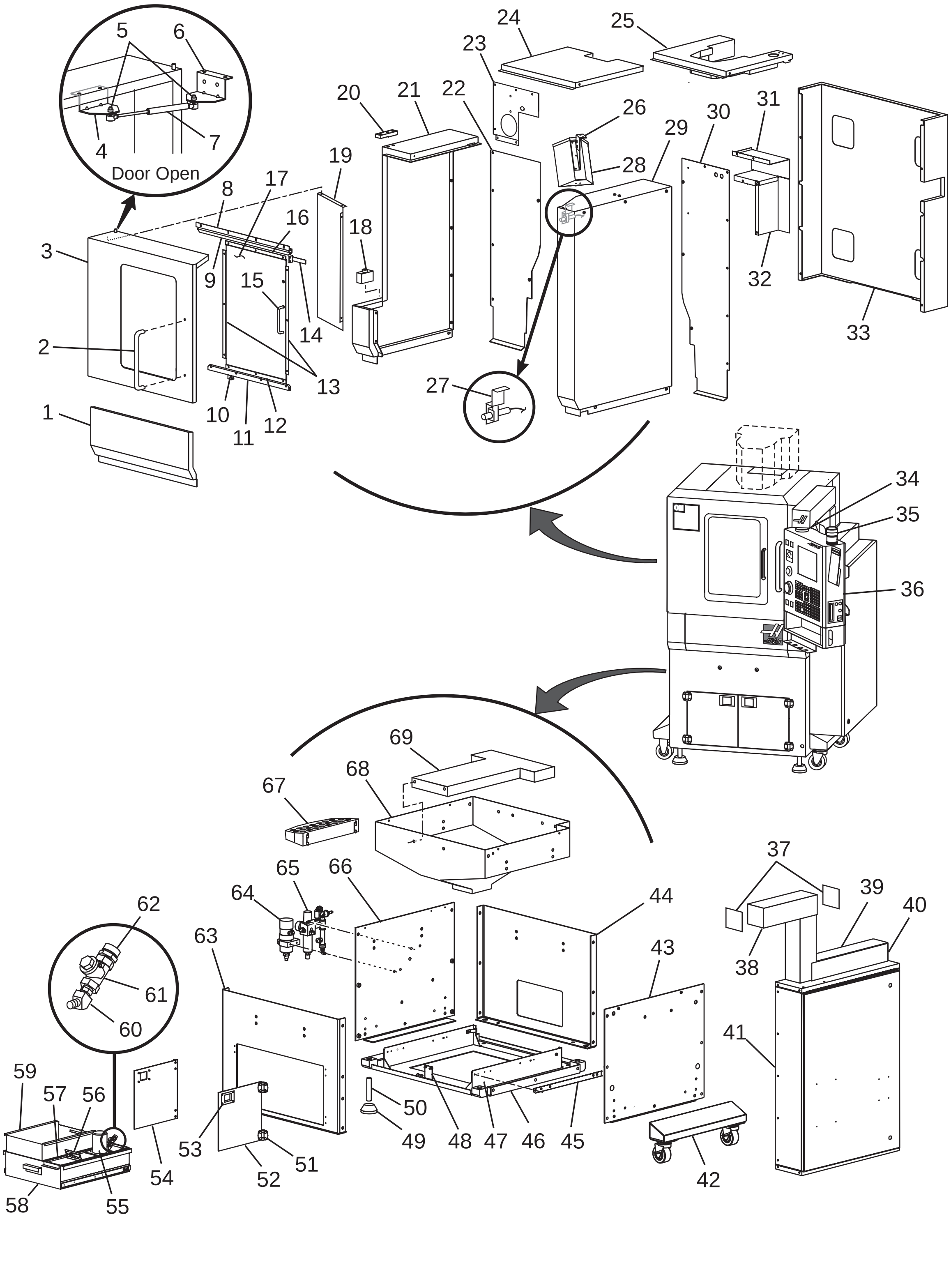
1. 20-3001 Column casting
2. 30-3048 Oil line assembly
3. 62-0009 Z-axis motor
4. 30-3049 Oil line assembly
5. 32-2130 Limit Switch
6. 50-0010 Runner block
7. 20-7008F Nut housing
8. 20-3019 Bumper Z-axis
9. 25-7273 Ballscrew assembly
10. 50-3007 Linear guide

Mini-Mill Saddle





1. 50-3007 Linear guide
2. 30-1220 Coupling assembly
3. 50-0010 Runner block
4. 20-0505 Floating bumper
5. 30-1751 Lube line assembly
6. 25-0659 Carrier tray
7. 24-3006A Ballscrew
8. 20-7008F Nut Housing
9. 20-3017 Bumper, X-axis
10. 30-1750 Lube line assembly
11. 30-0154 Motor bearing assembly
12. 62-0014A X-axis motor
13. 32-2131 Limit switch
14. 50-0011 Runner block
15. 30-1752 Lube line assembly
16. 20-7008F Nut housing
17. 32-2130 Limit switch



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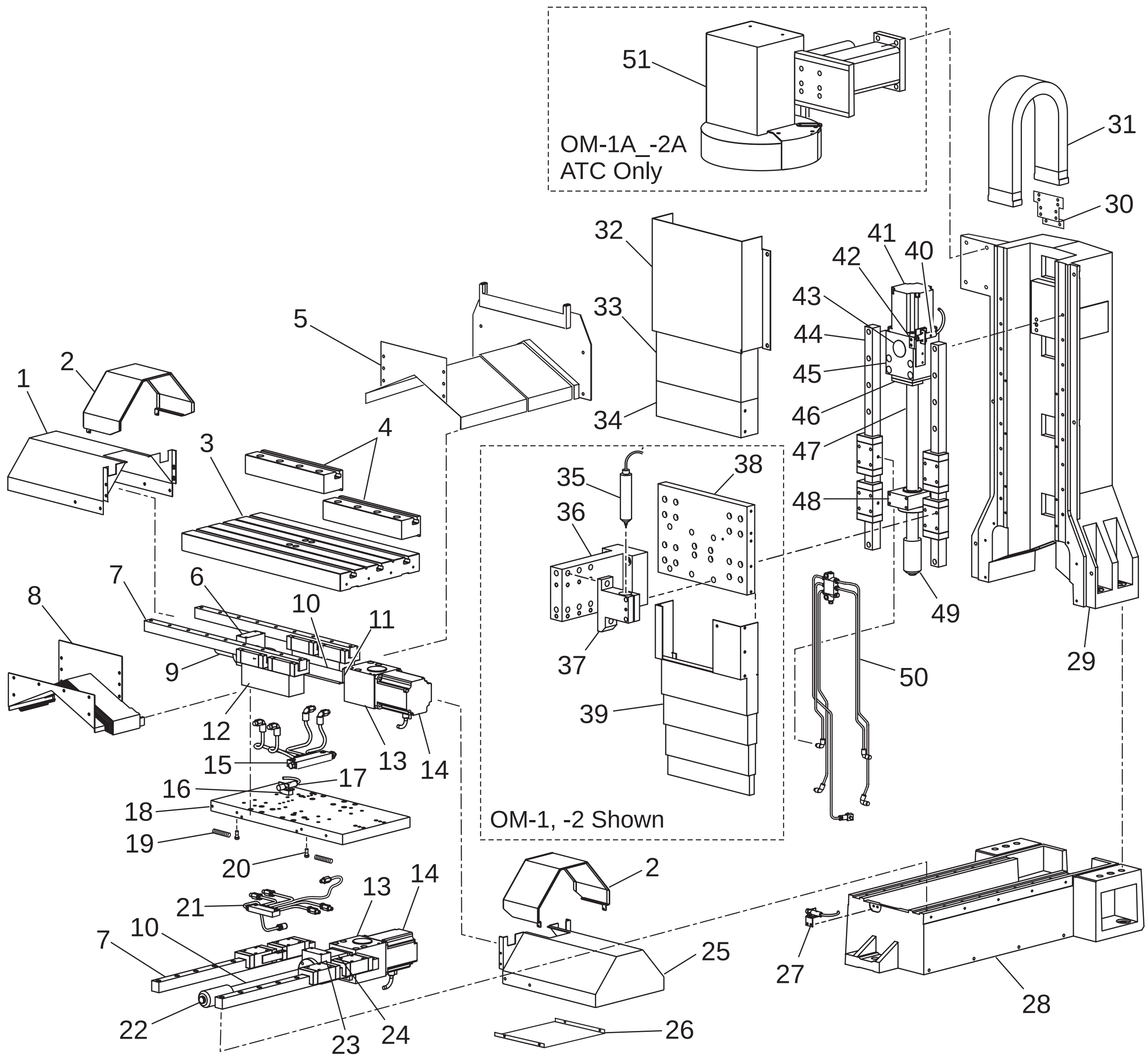
OM-1/OM-2 Exterior Sheet Metal

1.	25-7231	Bottom Front Panel
2.	59-8210	Door Handle
3.	25-7317	Enclosure Door
4.	25-7393	Gas Spring Door Bracket
5.	59-0008	2X Gas Spring Ball Stud
6.	25-7394	Gas Spring Enclosure Bracket
7.	59-0839	Gas Spring Assy
8.	25-7331	Op Door Guide Bracket
9.	28-0174	Window Top Guide
10.	25-7673	Shield Support Bracket
11.	20-3241	Op Door Bottom Guide
12.	25-7341	Bottom Window Frame
13.	25-7337	2X Window Frame Sides
14.	25-7333	Door Switch Trip Flag Bracket
15.	59-0162	Chip Basket Handle
16.	25-7338	Top Window Frame
17.	28-0182	Window
18.	20-3239	Door Hinge Stud
	20-3240	Door Hinge Bushing
	20-3242	Hinge Bottom
19.	25-7392	Operator Door Shield
20.	20-3244	Top Hinge
	20-3243	Top Hinge Bracket
21.	25-7319	Left Panel
22.	25-7325	Left Back Panel
23.	25-7326	Left Top Back Panel
24.	25-7322A	Top Panel (OM-2)
25.	25-6914	Top Panel (OM-1)
26.	25-4789A	Work Light Bracket Adjust
27.	25-7330	Door Switch Bracket
	69-1700	Proximity Switch
28.	25-4788	Work Light Housing
29.	25-7320	Right Panel
30.	25-7323	Right Back Panel
31.	25-7353	Horiz. Cables Back Cover
32.	25-7352	Vert. Cables Back Cover
33.	25-7329	Back Cover Panel
34.	20-7109	Swivel Arm Mount
	20-7110	Swivel Mount
35.	28-0024	Beacon
36.		Control Pendant Assy
37.	14-1962	2X End Cap
38.	20-3263	Pendant Arm
39.	25-6946A	Pendant Arm Support
40.	25-6948	Control Cable Box Cover
41.	30-7286	Control Box Assy
42.	30-7741	Swivel Caster Assy (Left Side) (Optional)
	30-7742	Swivel Caster Assy (Right Side) (Optional)
43.	25-7348A	Base Right
44.	25-7351A	Base Rear
45.	59-0837	2X Drawer Slide
46.	25-7350	Base Bottom
47.	25-7072	Coolant Tank Support
48.	25-7672	Tank Shipping Bracket
49.	14-7068	4X Casting Level Pad
50.	44-0018	4X Casting Level Bolt
51.	59-0023	4X Door Hinge
52.	25-5856A	Right Front Lower Door
53.	58-0227	2X Door Latch Assy
54.	25-5855A	Left Front Lower Door
55.	32-0189A	Coolant Pump Assy
56.	25-6838	Coolant Tank Filter
57.	25-7070	Pump Assy Bracket
58.	25-7069	Coolant Tank
59.	25-7071	Chip Tray
60.	58-1721	45 Degree Elbow 3-8npt
	58-3600	Nipple 3-8 Hex
61.	59-2228	Swing Check Valve
62.	58-3662	Garden Hose Conn. .372" to .75"
63.	25-7346A	Base Front
64.	59-0814	Auto Lube Pump
65.	30-8572	Air Regulator Assy
66.	25-7347	Base Left
67.	25-7390	Tool Tray
68.	25-7490A	Base Basin
69.	25-7354A	Short Machine Support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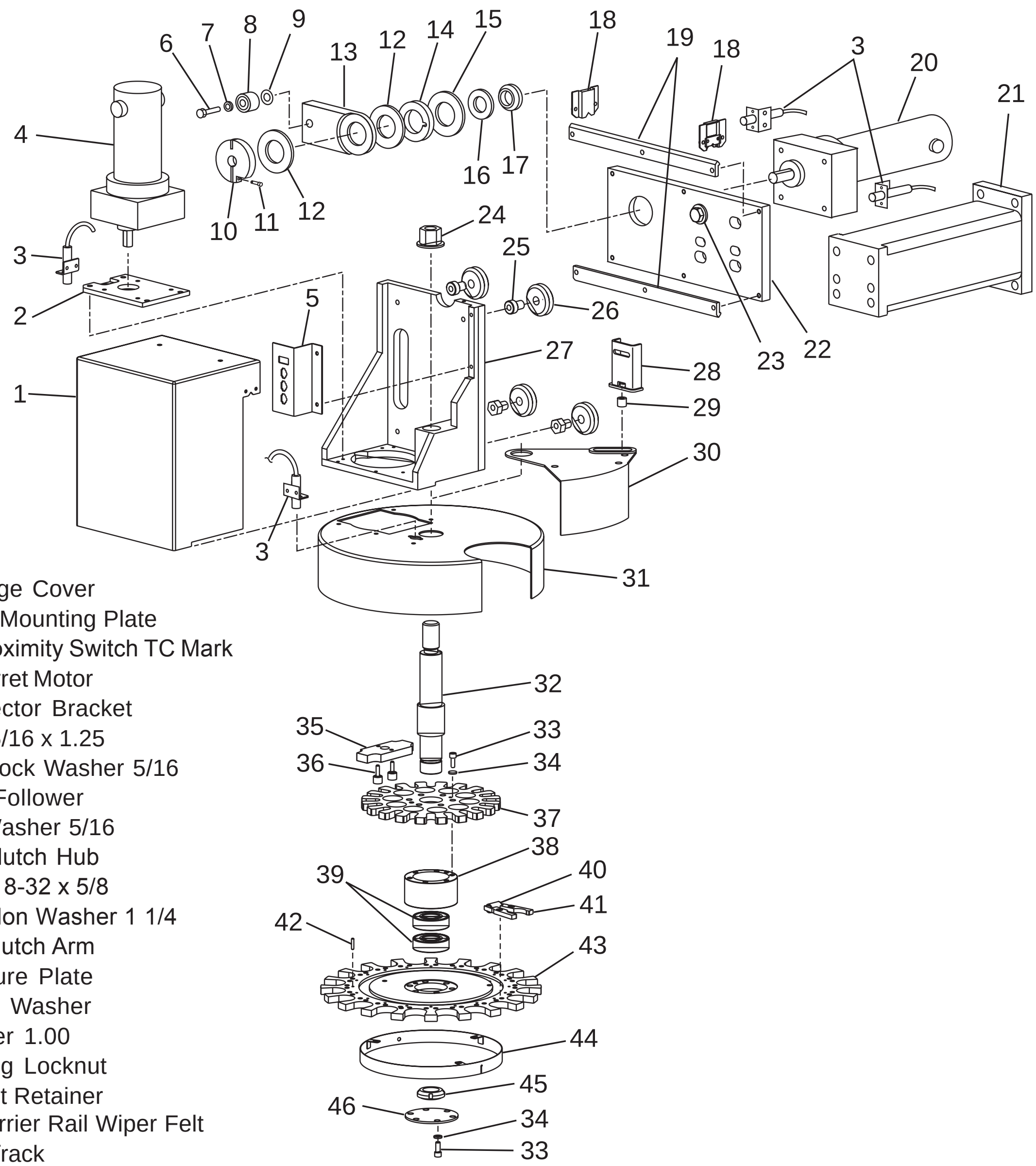
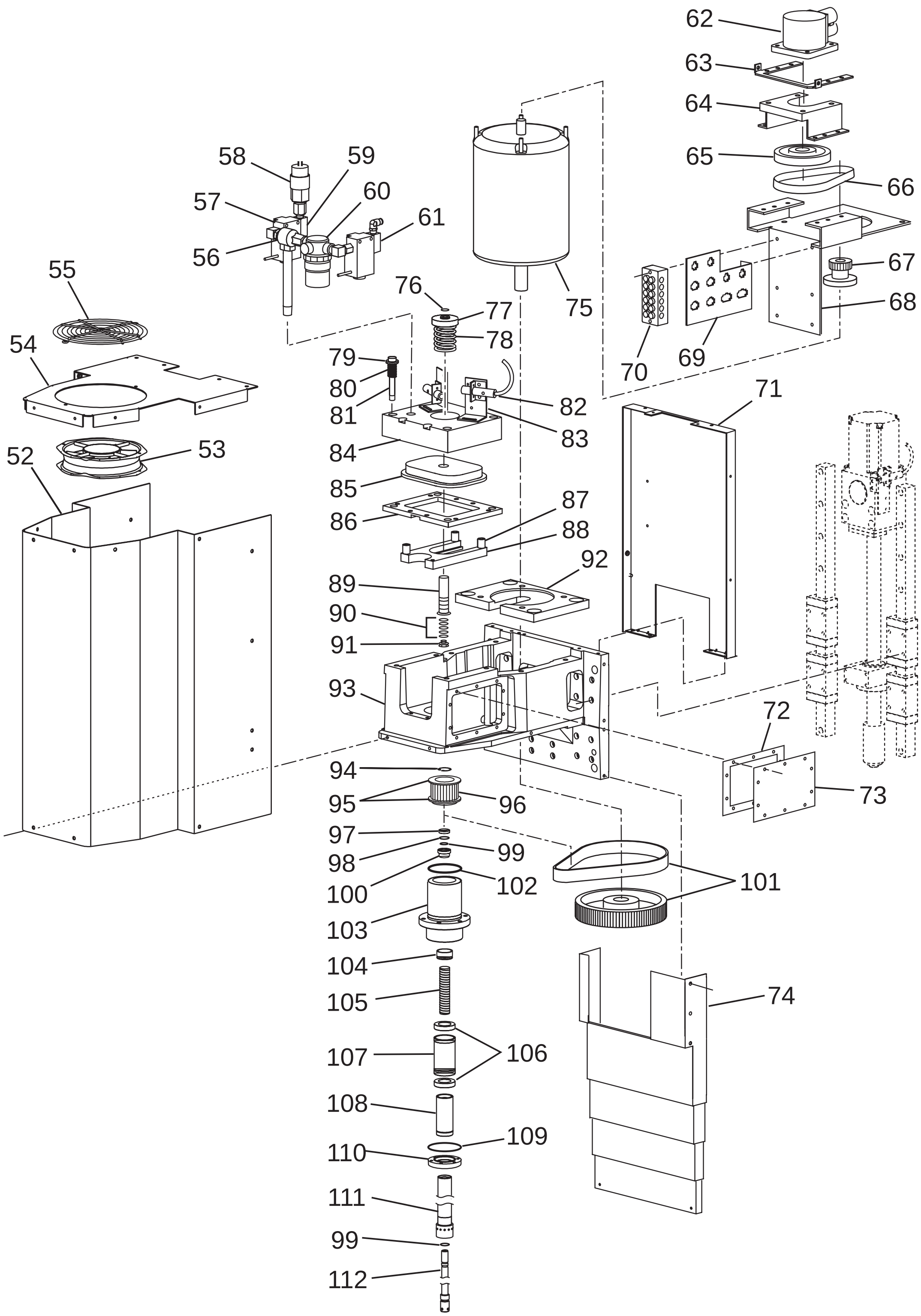
OM-1/OM-2 Internal Sheet Metal

1. 25-6831 X-Axis Short Waycover
2. 25-6848 X-Axis Floater Waycover
3. 20-2743 Table
4. 20-2775 2X Riser Rail
5. 25-5841 Y-Axis Rear Waycover
6. 20-3082 Nut Housing
7. 50-0106 2X Linear Guide
8. 25-5840 Y-Axis Front Waycover
9. 20-2749 Ball Screw Bumper
10. 24-0110 Ball Screw
11. 20-2748 Bumper (Motor End)
12. 20-2741 Saddle Spacer
13. 20-2747 Motor Mount
14. 62-2495 Servo Motor
15. 30-7541 X-Axis Lube Line Assy
16. 20-2834 Switch Spacer
17. 69-1700 Proximity Switch
18. 20-2742 Saddle
19. 59-0672 Spring
20. 49-1015 Shoulder Bolt
21. 30-7542 Y-Axis Lube Line Assy
22. 20-2751 Ball Screw Bumper
23. 20-2746 Nut Housing
24. 20-2750 Pocket Stop
25. 25-5842 X-Axis Side Waycover
26. Not Used
27. 25-5846 Home Switch Bracket
    69-1700 Proximity Switch
28. 20-2739 Base (Bed)
29. 20-2740 Column
30. Cable Carrier Bracket
31. 59-0882 Z-Axis Cable Carrier (OM-1, -2 only)
    59-0821 Z-Axis Cable Carrier (OM-1A, -2A only)
32. 25-5989A Z-Axis Top Waycover
33. 25-5990 Z-Axis Upper Mid Waycover
34. 25-5844 Z-Axis Upper Bottom Waycover
35. NR-402E Spindle
36. 20-2745 Spindle Head Adapter
37. 20-1580 30mm Toolholder
38. 20-2744 Spindle Head
39. 25-6874 Z-Axis Lower Waycover (40K Spindle Option)
    25-5845 Z-Axis Lower Waycover
40. 69-1700 Proximity Switch
41. 62-0048 Servo Motor
42. 25-5848 Switch Bracket
43. 59-0210 Plug
44. 50-0106 2X Linear Guide
45. 20-2747 Motor Mount
46. 20-2748 Bumper (Motor End)
47. 24-0110 Ball Screw
48. 20-2746 Nut Housing
49. 20-2749 Ball Screw Bumper
50. 30-7540 Z-Axis Lube Line Assy
51. 30-7868 ATC

OM-1/OM-2 Tool Changer



1.	25-6953	Carriage Cover
2.	20-0680A	Motor Mounting Plate
3.	32-2205	4X Proximity Switch TC Mark
4.	32-1911	2X Turret Motor
5.	25-7162	Connector Bracket
6.	43-0109	HHB 5/16 x 1.25
7.	45-1600	Split Lock Washer 5/16
8.	54-0010	Cam Follower
9.	45-1739	Flat Washer 5/16
10.	20-3124	Slip Clutch Hub
11.	40-1805	SHCS 8-32 x 5/8
12.	45-2020	2X Nylon Washer 1 1/4
13.	20-3123	Slip Clutch Arm
14.	20-7477	Pressure Plate
15.	55-0010	Spring Washer
16.	45-0050	Washer 1.00
17.	51-6000	Bearing Locknut
18.	25-1392	2X Felt Retainer
	26-0083	2X Carrier Rail Wiper Felt
19.	20-3120A	2X V-Track
20.	32-1911	Turret Motor
21.	20-3122	TC Mount
22.	20-3119A	V-Track Mount
23.	43-16011	HHB 1/2-13 x 1
	45-1740	Hard Washer 1/2
24.	46-1705	Nylon Lock Nut 3/4-10
	45-1725	Washer 3/4
25.	54-0040	4X Guide Wheel Std Bushing
26.	54-0030	4X Guide Wheel
27.	20-3114	Carriage Machined
28.	25-0466	Door Opener Bracket
29.	20-2065	Locating Pin
30.	25-6952	Trap Door
31.	25-6951	Shroud
32.	20-3115	Vertical Axle
33.	40-16385	12X SHCS 5/16-18 x 3/4
34.	45-1600	12X Split Lock Washer 5/16
35.	20-3118	Geneva Driver
36.	54-0222	2X Track Roller
37.	20-3117	Geneva Star
38.	20-3116	Bearing Housing
39.	51-2022	2X Radial Bearing
40.	24-0113	20X Compression Spring
41.	20-3113	20X Extractor
42.	48-0025	19X Roll Pin 1/8 x 5/8
43.	20-3112	Carousel
44.	25-6949	Number Ring
45.	51-2041	Bearing Locknut
46.	25-0635	Bearing Cover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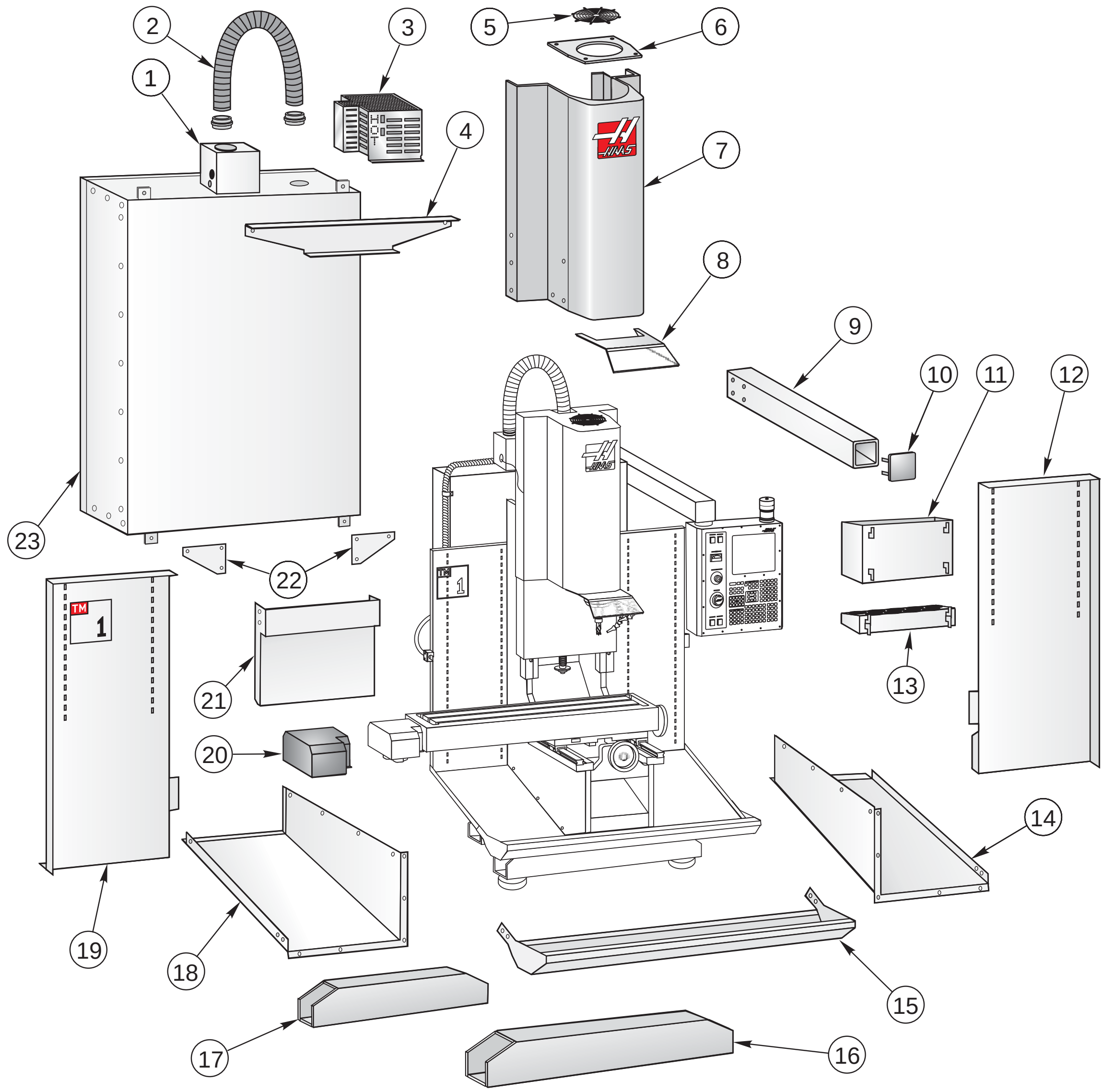
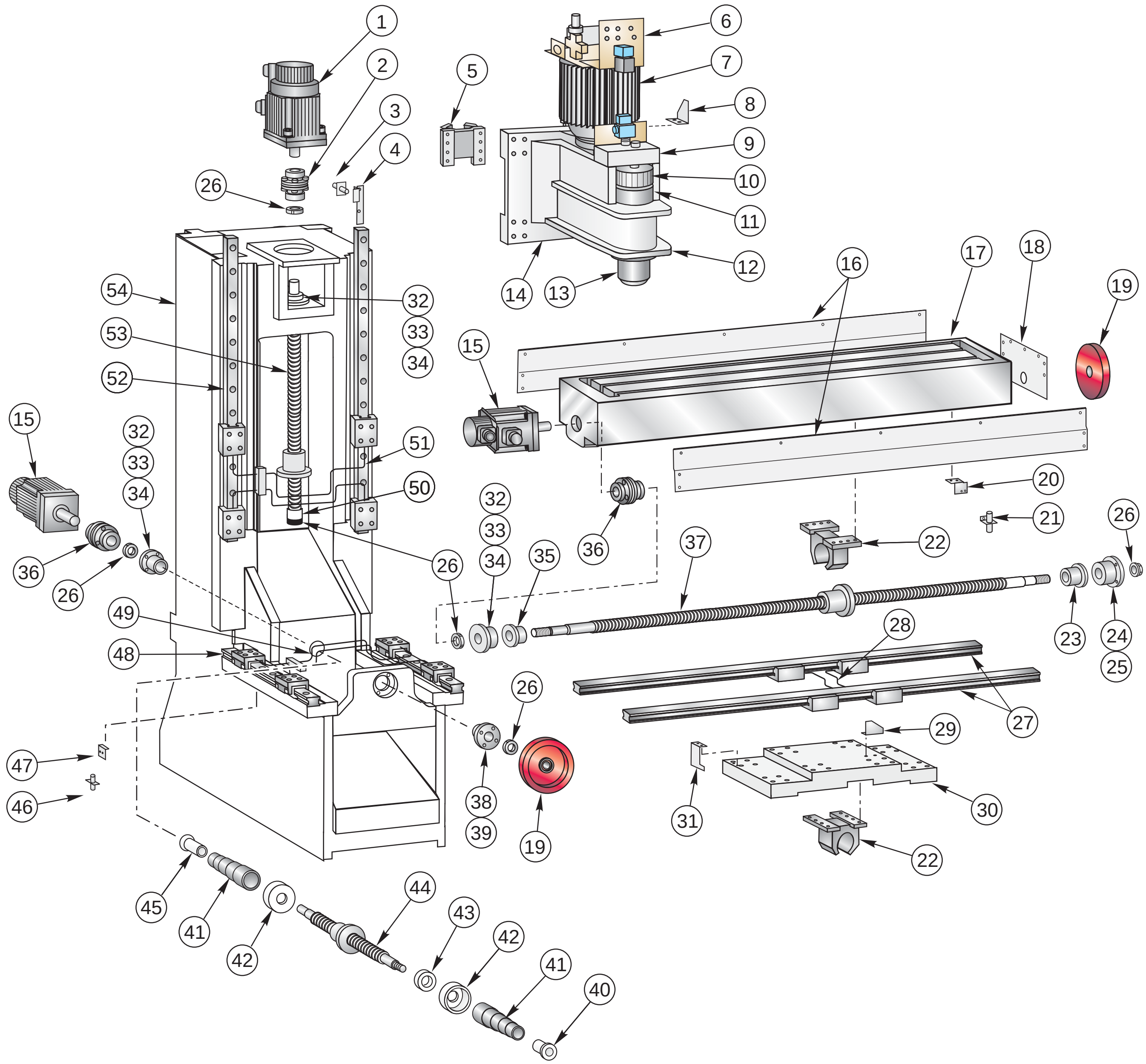
52. 25-7461A Spindle Head Cover
53. 66-1480 Fan
54. 25-7462A Top Head Cover
55. 59-0144 Fan Guard
56. 59-2832B Quick Exhaust
    58-3729 Nipple
57. 36-30675 Solenoid
58. 53-3012 Pressure Switch
59. 58-2743 Branch Tee
60. 58-2736 Air Regulator 0-10 B-1
61. 36-30670 Solenoid
62. 60-1813 Encoder
63. 25-6298 Encoder Spring Clamp
64. 25-6293 Encoder Spring Box
65. 20-3323 Encoder Drive Sprocket
66. HDT_Wb1 Encoder Drive Belt
67. 20-0276A Drive Sprocket
68. 25-7463 Terminal Block Mount
69. 25-7469 Spindle Connector Bracket
70. 73-3054 Terminal Block
71. 25-7460A Head Back Cover
72. 57-0401 2X Coolant Gasket Jacket
73. 25-7432 2X Coolant Gasket Cover
74. 25-6874 Z-Axis Lower Waycover
75. 62-0300 Spindle Motor 1.5 HP
76. Not Used
77. 20-1656 TRP Spring Retainer
78. 59-2760 TRP Spring
79. 45-1730 Hard Washer 3_8
80. Spring C0850_092_0880_M
81. 49-0130 Shoulder Screw 3/8 x 2 3/4
82. 69-1700 2X Proximity Switch
83. 25-7227 2X Switch Mounting Bracket
84. 20-3204 TRP Cylinder
85. 20-3205 TRP Piston
86. 20-3216 TRP Sub-Plate
87. 20-3207 4X TRP Support Spacer
88. 20-3206 TRP Support Finger
89. 20-7626C TRP TSC Shaft
90. 45-0063 5X
91. 20-7640 Tool Release Bolt
92. 20-3260 Washer 3/8 Steel
93. 20-3121 Head Machined
94. WHM75 Spiral Retaining Ring
95. 20-3199 2X Sprocket Flange
96. 20-3198 Sprocket GT2 5M-30S-15
97. 54-0101A Shaft Collar 5/16
98. 57-0070 O-Ring 2-114
99. O-Ring 2-012
100. 20-3202 Draw Bar Retainer
101. 3MR-635-15 Polychain GT2 Belt
102. 20-3226 Pulley 90T
103. 57-4120 O-Ring 2-226
104. 20-3192A Spindle Housing
105. 20-3197 Spindle Lock Ring
106. Spring 4.51g_Comp. 1_15
107. 2X Bearing 25_42_9mm
108. 20-3196 Spindle Outer Spacer
109. 20-3195 Spindle Inner Spacer
110. O-Ring 2-033
111. 20-3193A Spindle Cap
112. 20-3194A Spindle Shaft
113. 20-3201 Spindle Draw Bar

TOOLROOM MILL EXTERIOR SHEET METAL



1.	25-7198	Junction Box	12.	25-6596	Right Chip Pan
2.	59-0385	Corrugated Tubing Assembly	13.	25-0440A	Tool Crib
3.	32-0043	Regen Cover	14.	25-4006	Right Side Pan
4.	25-4044A	Control Box Top Mounting Bracket	15.	25-6656	Trough
5.	59-0144	Fan Guard	16.	20-1117A	Front Leg
6.	25-0389	Top Fan Bracket	17.	20-1116A	Rear Leg
7.	25-4003C	Spindle Head Cover	18.	25-4007	Left Side Pan
8.	25-4008	Safety Shield	19.	25-6597	Left Chip Pan
9.	25-1097	Pendant Arm	20.	25-4000A	Table Motor Cover
10.	14-1962	End Cap (2)	21.	25-4010	Spindle Waycover
	25-5394	End Cap Mounting Clip	22.	25-1091	Control Box Bottom Mount (2)
11.	25-0563	Storage Box	23.	25-0025	Control Box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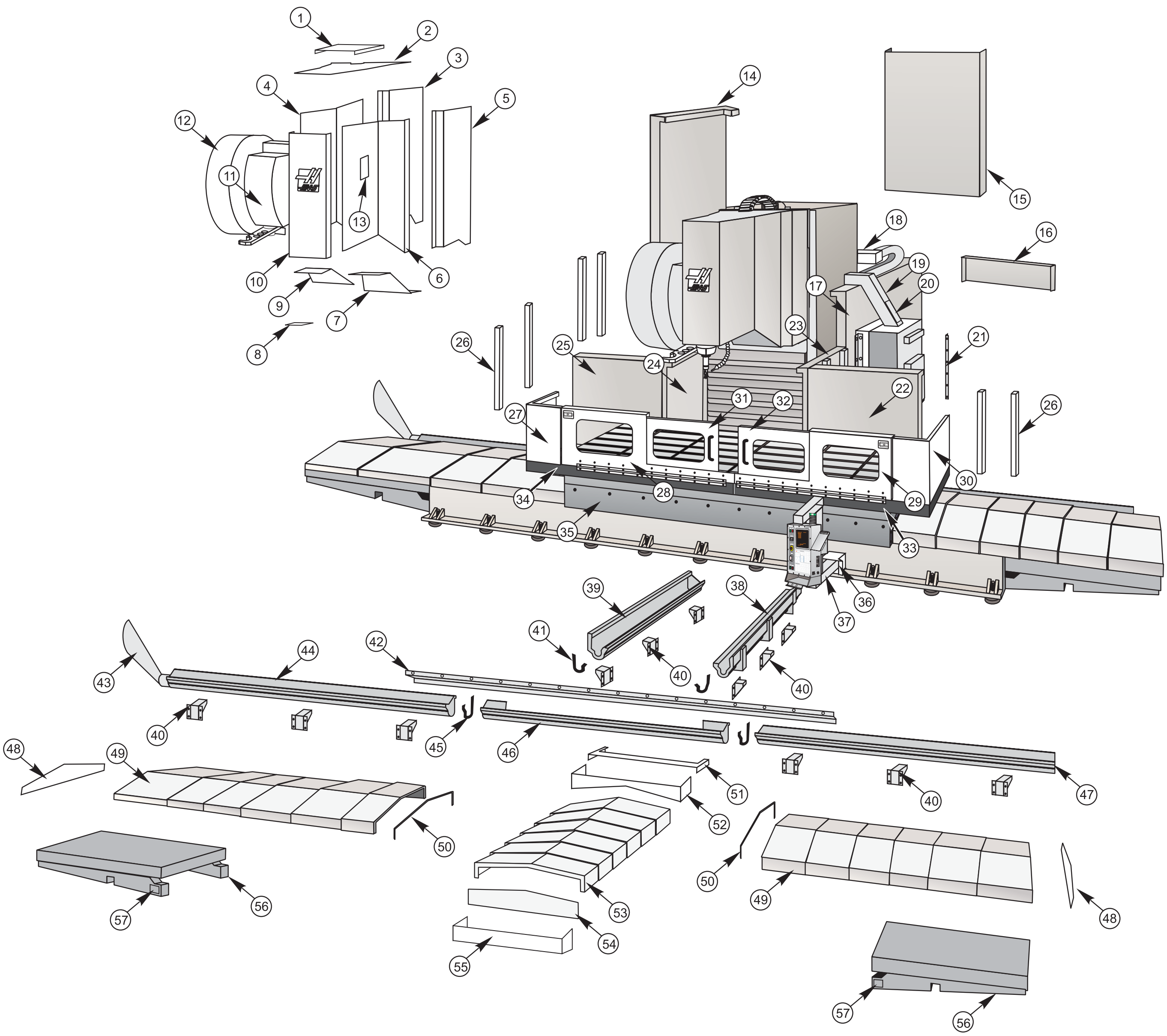
Toolroom Mill Interior Parts List

1. 62-0024 Motor
2. 30-1220A Coupling Assembly
3. 32-5060 Z-Axis Limit Switch
4. 25-4024 Z-Axis Limit Switch Mounting Bracket
5. 20-7008F Z-Axis Ball Screw Nut Housing
6. 30-2465A Air Solenoid Assembly
7. 30-1674 Linear Motor 5HP
8. 25-6578 Z-Axis Limit Switch Trip Bracket
9. 30-1668A TRP Assembly
10. 20-7373 Pulley 1_7_8
11. 20-7442 Oil Injection Cover
12. 20-1330 Spindle Head Housing Machined
13. 30-1337 Spindle Assembly CT30
14. 20-3003A Spindle Mounting Plate
15. 62-0014 Motor
16. 25-4001A Table Side Covers (2)
17. 20-1302A Table
18. 25-4002A Table End Cover
19. 20-1256 Handwheel (2)
20. 25-4014 X-Axis Proximity Switch Bracket
21. 32-2133 X-Axis Proximity Switch
22. 20-1093 X and Y Axis Ball Screw Nut Housing (2)
23. 20-1147 X-Axis Support Bumper
24. 30-2780 Bearing Housing Assembly
25. 51-2025 Ball Bearing
26. 51-2012 Bearing Locknut (6)
27. 50-0012A X-Axis Linear Guides (2)
28. 30-2767 X-Axis Oil Line Assembly
29. 25-4013 X-Axis Proximity Switch Trip Bracket
30. 20-1304B Saddle
31. 25-5191 Y-Axis Proximity Switch Trip Bracket
32. 20-7416 Bearing Cartridge Housing (3)
33. 51-1011U Ball Bearing (3)
34. 20-7418 Bearing Cartridge Lock (3)
35. 20-1146 Bumper (Motor Side)
36. 30-1220 Coupling Assembly (2)
37. 24-0019 X-Axis Ball screw
38. 30-2780 Bearing Housing Assembly
39. 51-2025 Ball Bearing
40. 20-1158 Y-Axis Support Bumper
41. 59-0264 Ball Screw Cover (2)
42. 20-1113 Ball Screw Cover Retainer (2)
43. 20-1114 Ball Screw Spacer
44. 24-0020 Y-Axis Ball Screw
45. 20-1148 Y-Axis Motor Bumper
46. 32-2133 Y-Axis Proximity Switch
47. 25-4012 Y-Axis Limit Switch Bracket
48. 50-0013A Y-Axis Linear Guides (2)
49. 30-2794 Y-Axis Oil Line Assembly
50. 20-3017 Bumper
51. 30-2042 Z-Axis Oil Line Assembly
52. 50-0014A Z-Axis Linear Guides (2)
53. 24-0021 Z-Axis Ball Screw
54. 20-1303A Base Machined

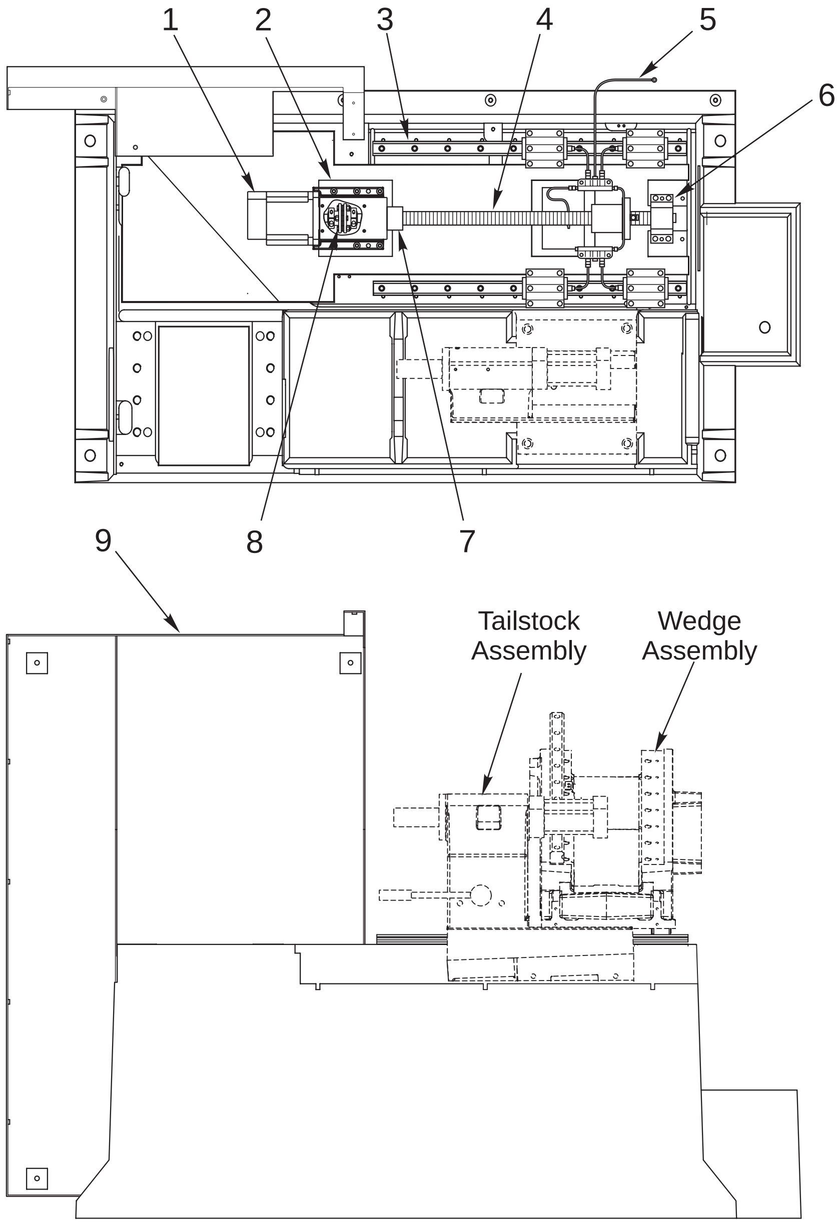
VS-3 Sheet Metal Assembly



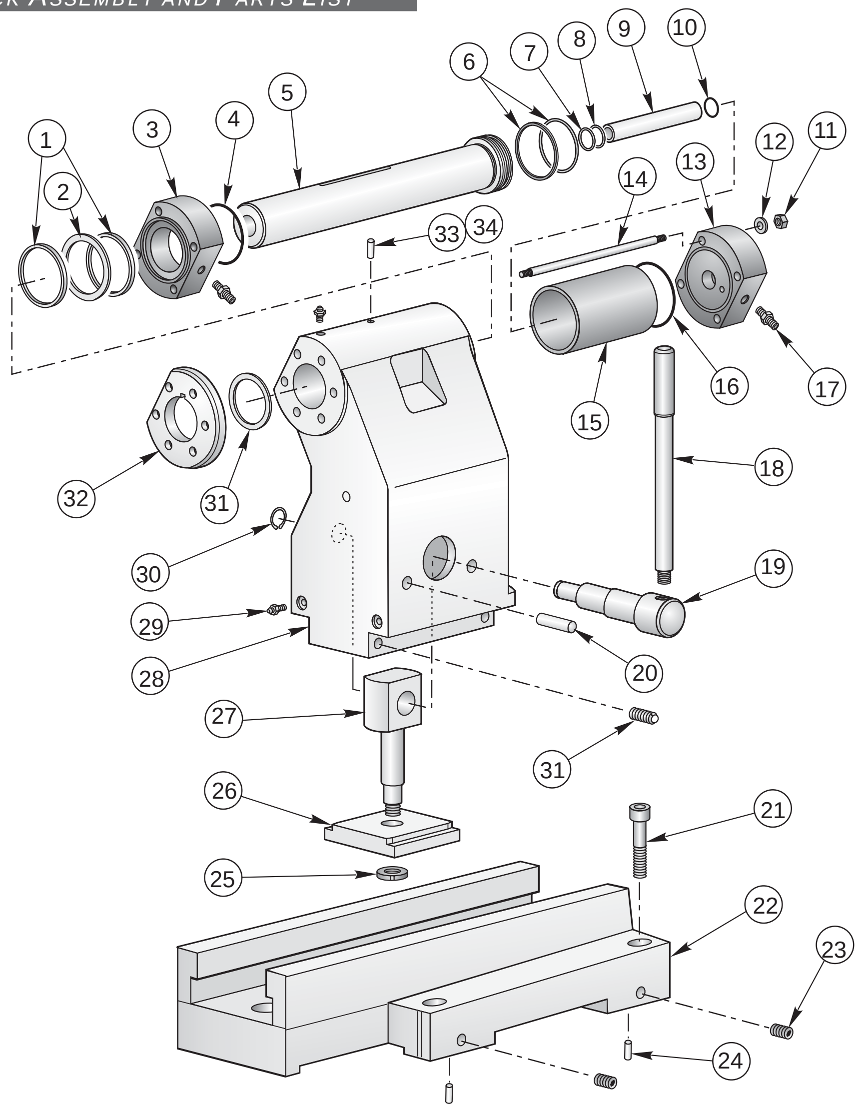
VS-3 Sheet Metal Assembly Parts List

1. Fan guard
2. Head cover, top plate
3. Head cover, left rear cover
4. Head cover, left front cover
5. Head cover, right rear cover
6. Head cover, right front cover
7. Head cover, rear bottom
8. Bottom head access plate
9. Head cover, front bottom cover
10. Head cover, front
11. Tool changer housing
12. Tool changer shroud
13. Head cover access plate
14. Left rear enclosure panel
15. Rear enclosure panel
16. Center bottom sheet metal panel.
17. Right rear enclosure panel
18. Conduit box
19. Conduit enclosure
20. Conduit access plate
21. “L” bracket
22. Right front sheet metal
23. Right forward sheet metal
24. Left forward sheet metal
25. Left front sheet metal
26. Support brace
27. Left corner, door assembly
28. Left door
29. Right door
30. Right corner, door assembly
31. Center, left door
32. Center, right door
33. Right splash tray
34. Left, splash tray
35. Table splash guard
36. Pedant arm shroud
37. Pendant arm
38. Z-Axis, right chip conveyor tray
39. Z-Axis, left chip conveyor tray
40. Brace
41. Z-Axis chip conveyor gasket
42. X-Axis splash guard
43. Chip conveyor chute
44. X-Axis chip conveyor tray, left
45. X-Axis chip conveyor tray gasket
46. X-Axis chip conveyor tray, middle
47. X-Axis chip conveyor tray, right
48. X-Axis way cover end plate
49. X-Axis way covers
50. X-Axis wiper
51. Z-Axis way cover wiper cover
52. Z-Axis way cover wiper
53. Z-Axis way covers
54. Z-Axis way cover end plate
55. Z-Axis way cover end support
56. X-Axis extension
57. X-Axis extension access cover

SL-10 Casting Assembly and Parts List

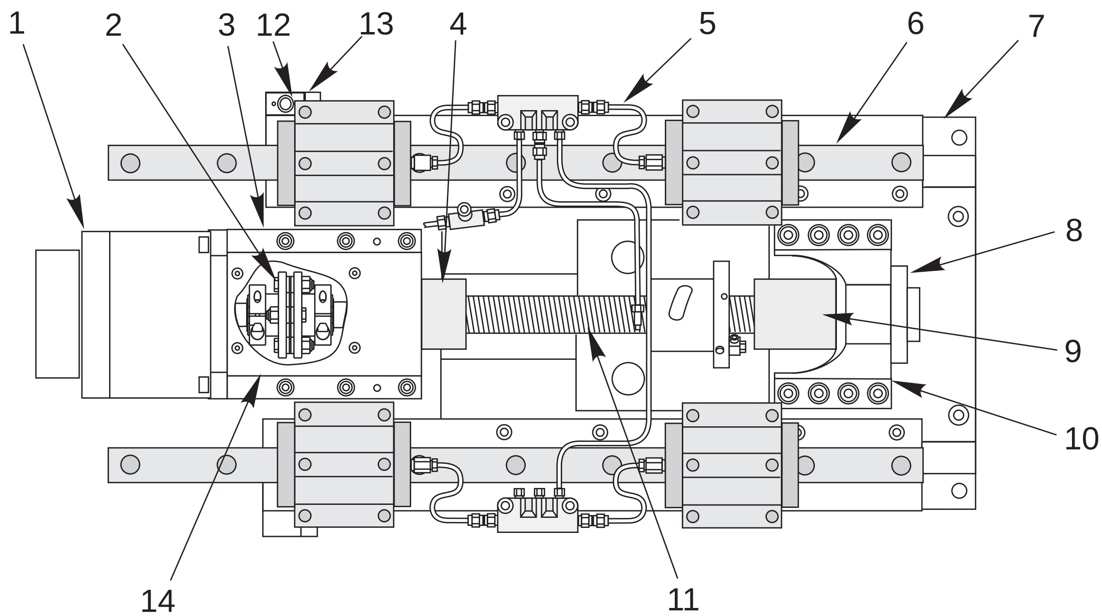


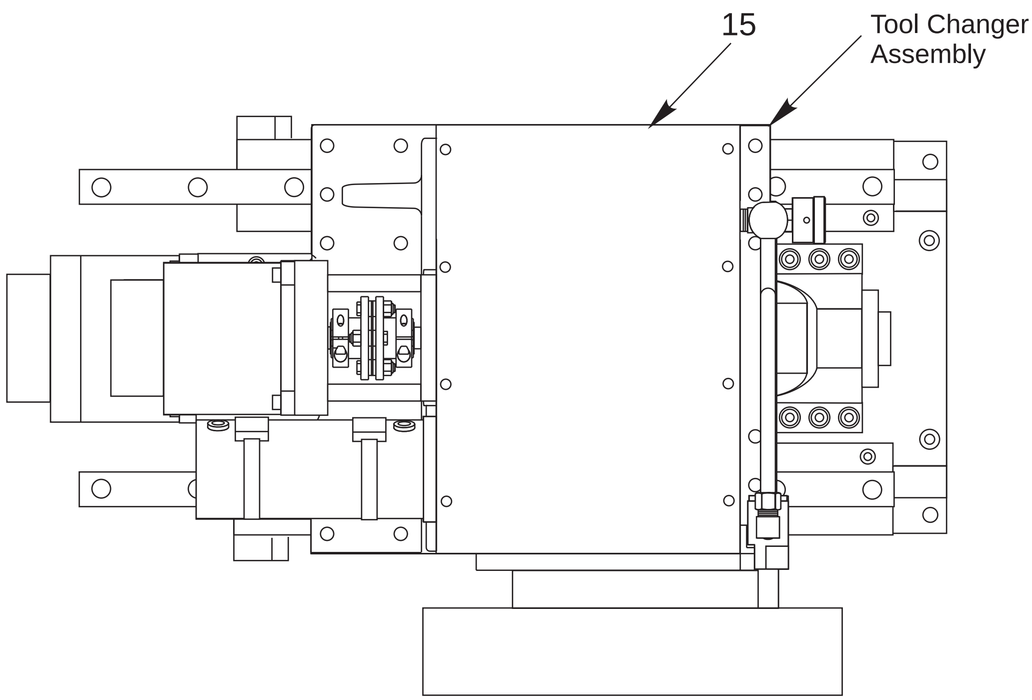
1.	62-0014	Motor	6.	30-0153	Support Bearing Assembly
2.	20-7010A	Motor Mount Machined	7.	20-0735	Snap Lock Ring Bumper
3.	50-8766	X-axis Linear Guide Assembly	8.	30-1220A	Coupling Assembly
4.	30-2290	Ball Screw Assembly	9.	25-0857B	Control Box Bracket
5.	30-2388A	Oil Line Assembly			



1.	57-0142	Seal Kit
2.	20-1070	Gland Retainer
3.	20-1017	Cylinder Head
4.	57-0140	O-Ring
5.	20-1012A	Shaft
6.	57-0136	Hydraulic Piston Seal
7.	57-0141	Quad Ring
8.	57-0143	Rod Seal
9.	20-1020	Knock-Out Tube
10.	57-0020	O-Ring
11.	46-1653	Hex Nut 5/16-18 (4)
12.	45-1600	Split Lock Washer (4)
13.	20-1014	End Cap
14.	20-1016	Tie Rod (4)
15.	20-1013	Cylinder Tube
16.	57-0140	O-Ring
17.	58-0045	Str Adapter (2)
18.	20-0858	Handle
19.	20-0859	Eccentric Clamp
20.	48-1755	Dowel Pin 1/2 x 2 (2)
21.	40-16643	SHCS 5/8-11 x 2-1/4 (4)
22.	20-1052	TS Base Machined
23.	44-1699	SSS 1/2-13 Flat PT (2)
24.	48-1750	Dowel Pin 1/2 x 1 1/2 (2)
25.	51-2012	Bearing Locknut
26.	20-0861	Clamp Plate
27.	20-0860	Clamp Rod
28.	20-0988F	TS Head Machined
29.	59-2016	Grease Fitting (6)
30.	56-2086	Retaining Ring
31.	57-0135	Wiper
32.	20-0857	Shaft Cap
33.	44-16395	SSS 3/8-16 x 1/2 Full Dog
34.	44-0052	SSS 3/8-16 x 1/2 Flat pt

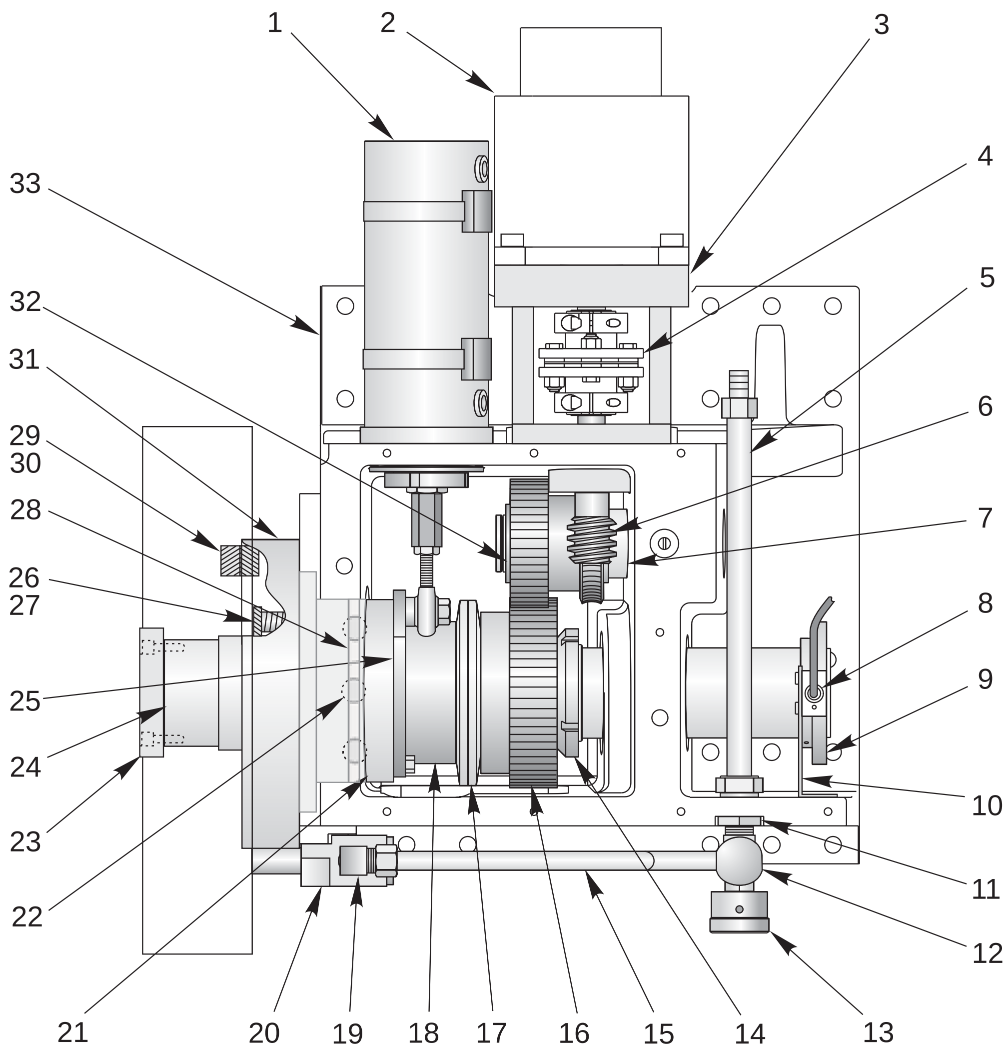
SL-10 Wedge Assembly and Parts List





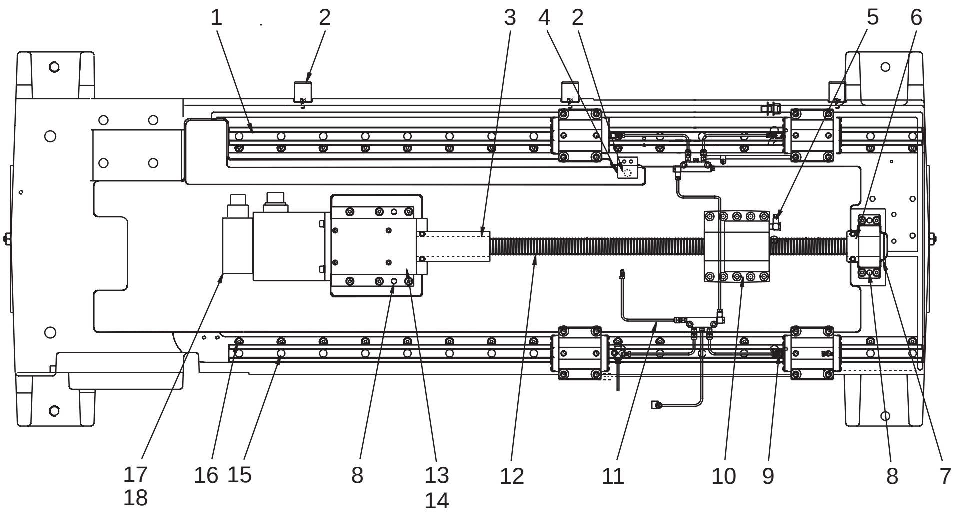
1.	62-0009	Motor	9.	20-0928	Ring Bumper
2.	30-1219	Coupling Assembly	10.	20-0773	Bearing Support Housing Machined
3.	20-7010A	Motor Mount Machined	11.	30-2244	Ball Screw Assembly
4.	20-1126	Snap Lock Ring Bumper	12.	32-2051	X-axis Home Limit Switch
5.	30-2387	Lube Line Assembly	13.	25-7266	Switch Mounting Bracket
6.	50-8766	X-axis Linear Guide Assembly	14.	25-7042A	Motor Mount Cover
7.	20-0986B	Wedge Machined	15.	20-0848	TC Housing Cover
8.	30-0154	Bearing Motor Housing			

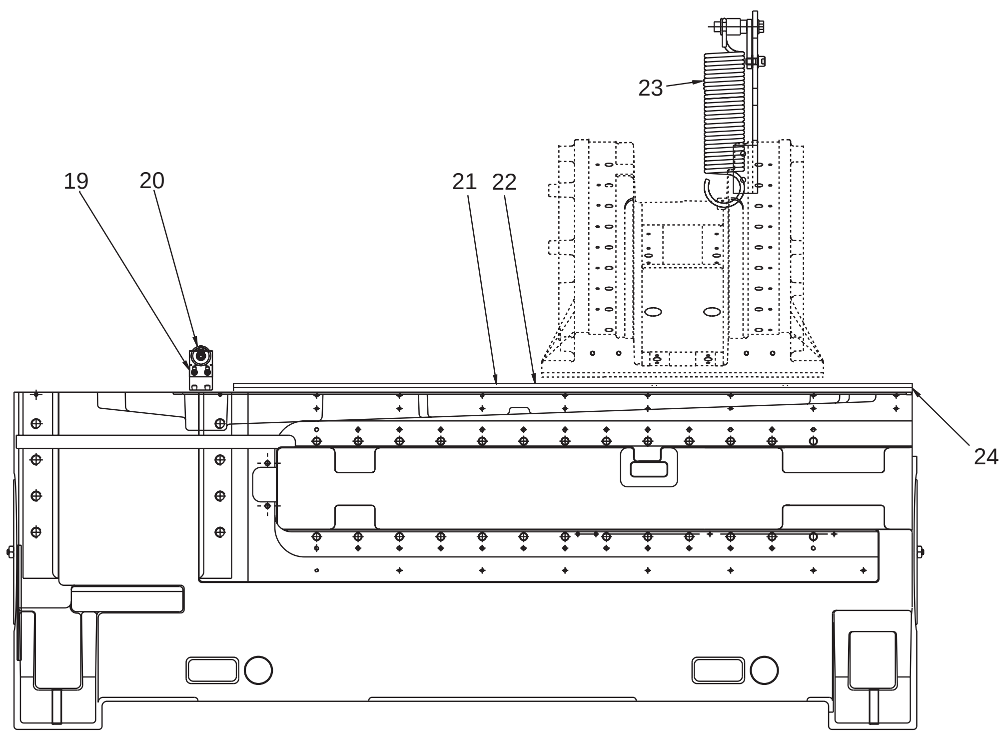
SL-10 Tool Changer Assembly and Parts List



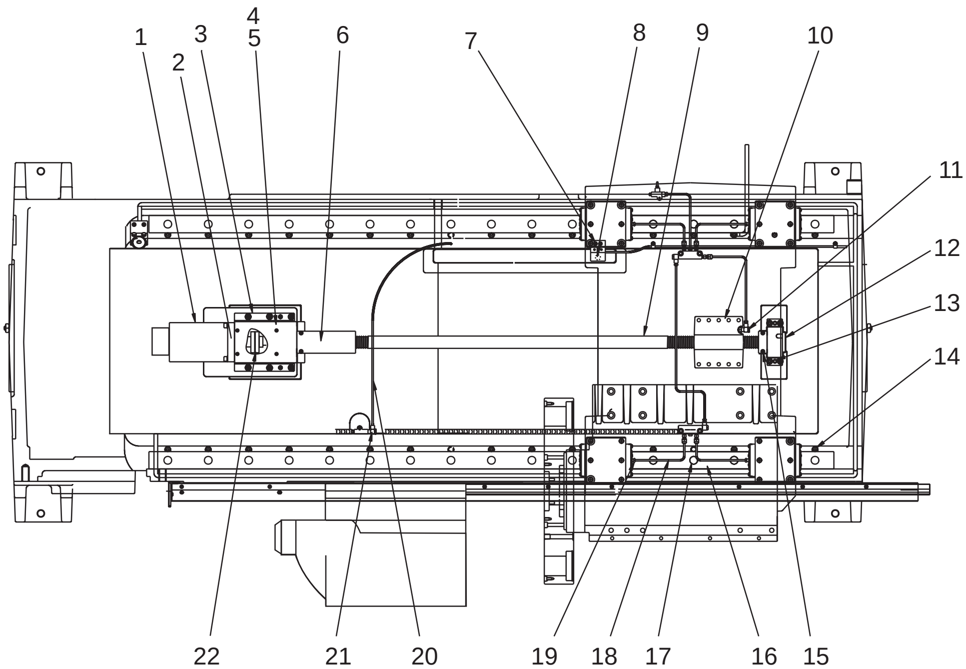
1.	30-3076	Air Cylinder Assembly
2.	62-0014	Motor
3.	20-8512A	Worm Housing
4.	30-1220A	Coupling Assembly
5.	30-3655	Coolant Line Assembly
6.	20-8509	Worm Shaft
7.	20-8510A	TC Transfer Shaft
8.	32-2011	Switch
9.	20-8533	TC Switch Ring
10.	25-0981	Turret Switch Bracket
11.	58-1679	Bulkhead Fitting
12.	58-0203	Coolant Valve
13.	20-0929	Coolant Knob
14.	46-7016	Bearing Nut N-13
15.	58-0202	Coolant Line
16.	20-8522A	TC Spur Gear
	22-8544	Spur Gear Key
17.	24-4010	Belleville Washers (2)
18.	22-8550A	TC Belleville Spacer
19.	58-3052	Coolant Elbow
20.	30-3660A	Coolant Transfer Assembly
21.	20-8517A	TC Turret Cams (2)
22.	59-2059	15/16 Steel Balls (3)
23.	20-8532	Turret Retainer
24.	20-8530	TC Turret Sfaft
25.	20-8516	TC Cam Lever
26.	20-8518	Spring Retainer
27.	59-0035	Spring
28.	20-8576	Cam Cage
29.	20-8505A	Male Turret Coupling
30.	20-8506A	Female Turret Coupling
31.	20-0675	Turret Mount Coupling
32.	20-8511A	TC Cluster Gear
33.	20-0985A	TC Turret Housing

SL-20 Casting Assembly and Parts List





1. 50-3400 Linear Guide
2. 25-9746 Cable Clamp Base
3. 20-9058 Ballscrew Bumper
4. 25-7266 X-Axis Mounting Bracket
5. 58-3030 Banjo Elbow 5/16 x M6
6. 25-7080 Bumper Bracket
7. 30-0153 Support Bearing Assembly
8. 48-0045 Dowel Pin
9. 24-7325 Str Fit Metric Linear Guide
10. 20-9007 Nut Housing
11. 30-8717A Oil Line Assembly
12. 24-9013 Ballscrew
13. 20-7010A Motor Mount
14. 30-0156 Motor Housing Bearing Assy
15. 59-6600 Guide Rail Plug
16. 22-7458 Linear Guide Cam
17. 22-2629 Stub Shaft/Worm Key
18. 62-0014 Yaskawa Sigma 09 Motor
19. 25-8653A Roller Bracket
20. 54-0030 Guide Wheel
21. 26-8623 Seal Rail Wiper
22. 22-8624 Seal Rail Backing Bar
23. 93-0209 Slide Spring Service Kit
24. 36-8980B Rail Interface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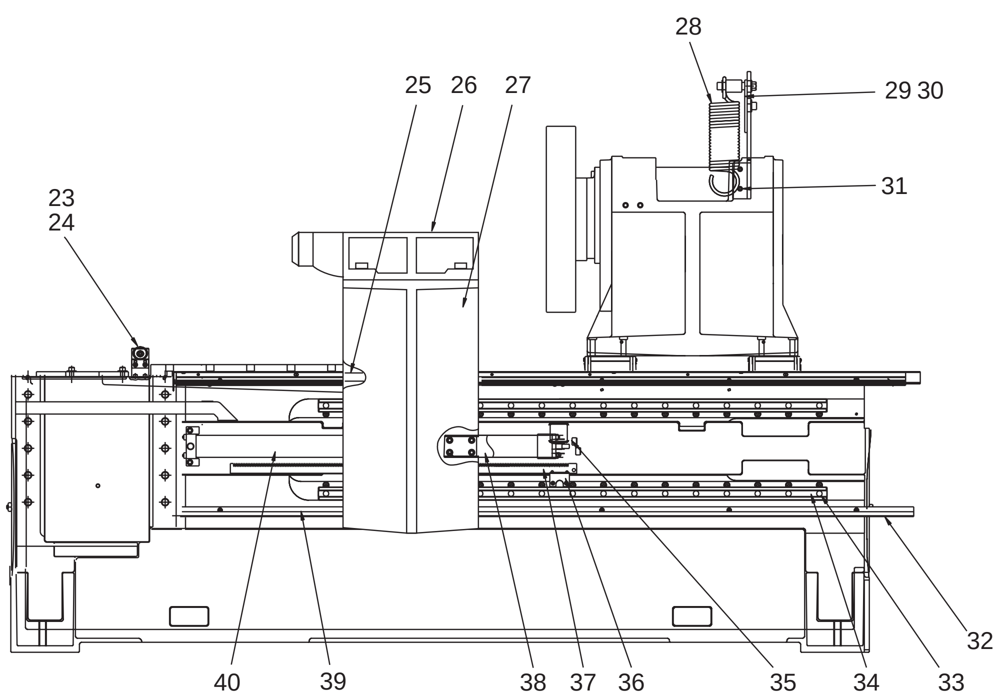
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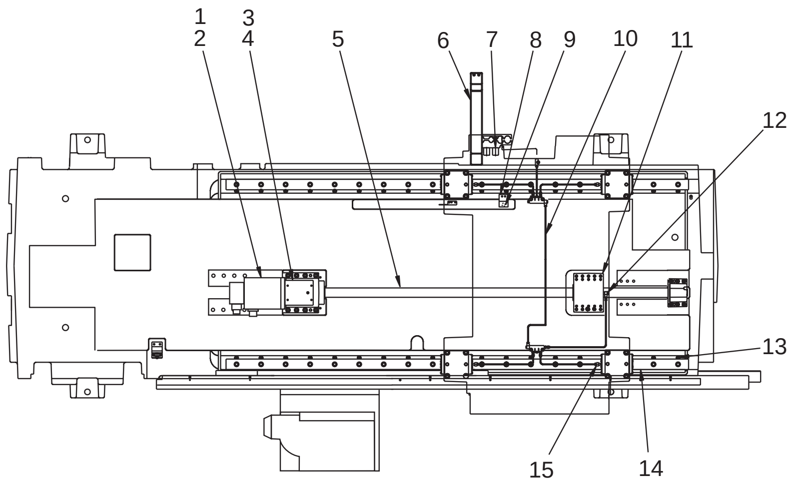
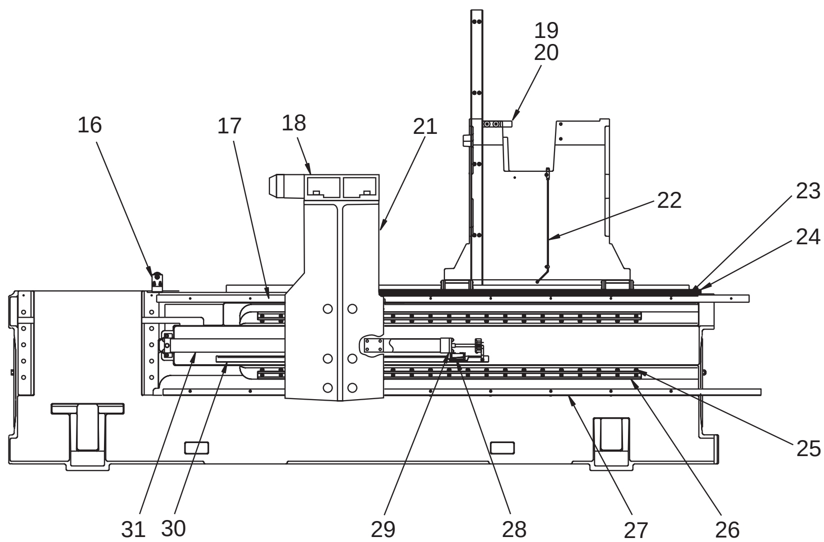
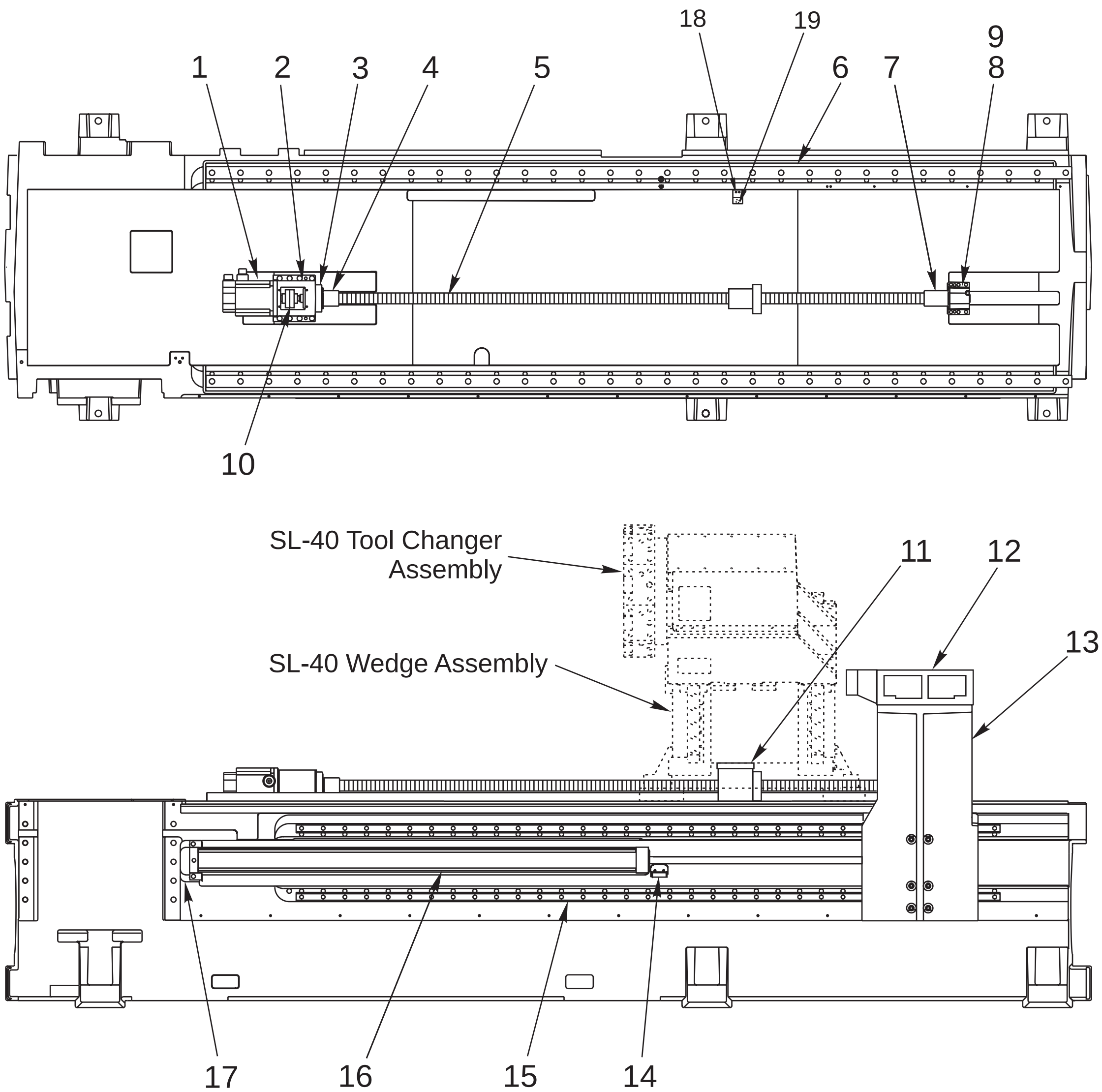
1. 22-2629 Key stub shaft
2. 62-0014 Motor
3. 20-7010A Motor mount
4. 25-7042A Snap lock motor mount cover plate
5. 26-7233A Gasket, deflector shield
6. 20-0143 Snap lock ring bumper
7. 25-7267 Brack mounting y-axis
8. 32-2040 Z-axis limit switch cable
9. 30-1962 Z-axis Ballscrew Assembly
10. 20-9007 Nut housing machined
11. 58-3031 Banjo Elbow 5/16F X M6 M
12. 25-7080 Bumper bracket
13. 48-0045 Dowel pin 3/8 x 1 1/2
14. 22-7458 Cam linear guide
15. 20-9058 Bumper
16. 50-9010 Linear guide X-axis
17. 59-6600 Guide rail plug
18. 30-8863 Oil line assembly
19. 58-1560 Adpt 1/8 M BSPT - 5/16 F
20. 58-2010 Nylon tubing 5/32
21. 58-3031 Banjo Elbow 5/16F X M6 M
22. 30-1220A Coupling assembly
23. 54-0030 Guide wheel
24. 25-8653A Roller Bracket
25. 25-8841 Seal strip
26. 20-8807 Tailstock head
27. 20-8808 Tailstock body
28. 93-0210 Spring cross slide
29. 20-8720 Swing arm spring
30. 20-8721A Bushing swing arm spring
31. 20-0534 Bracket spring T/C
32. 22-8064 Waycover bottom guide bs strip
33. 59-6655 Rubber plug guide rail
34. 50-3400 Linear guide
35. 20-8988A Tailstock cylinder attach bracket
36. 32-0400A Encoder read head assembly
37. 25-8024A Encoder strip
38. 20-9210A Tailstock arm
39. 25-8028 Guide, waycover TS bottom
40. 59-0013 Hydraulic cylinder

SL-40 Casting Assembly w/Tailstock and Parts List



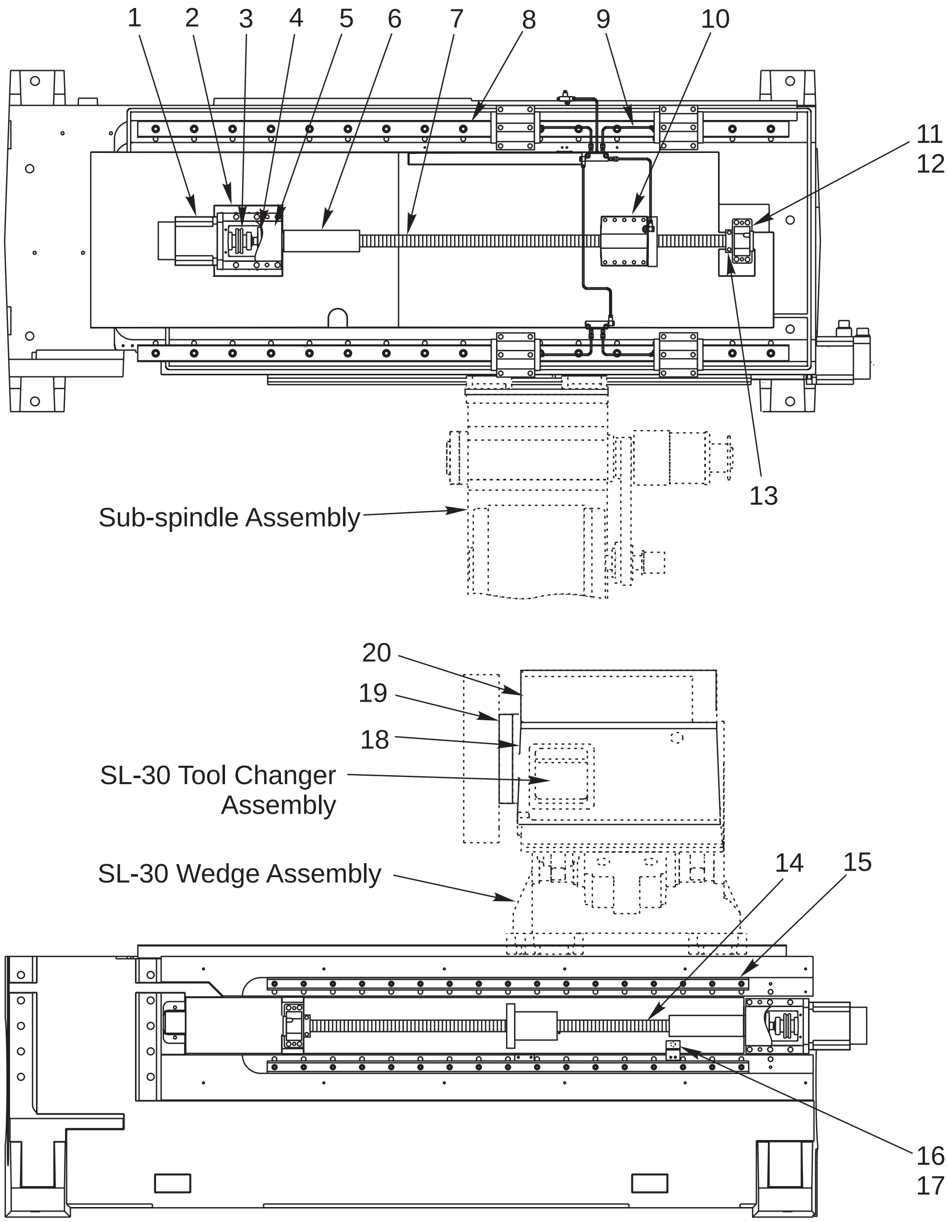


1. 22-2629 Stub Shaft Key
2. 62-0016 Motor
3. 25-9203 Motor Mount Cover Plate
4. 26-7233A Deflector Shield Gasket
5. 30-0450 Ball Screw Assembly
6. 20-0841 Rear Support
7. 55-7423 Standoff
8. 25-7267 Y-Axis Mounting Bracket
9. 32-2040 Z-Axis Limit Switch
10. 30-8325A Oil Line Assembly
11. 20-0150 Nut Housing Machined
12. 58-3031 Banjo Elbow 5/16 F x M6 M
13. 22-7458 Linear Guide Cam
14. 50-9305 Linear Guide
15. 24-7325 Str Fit Metric Linear Guide
16. 54-0030 Support Wheel
17. 25-8297 Tailstock Waycover Rail/Guide
18. 20-8807A Tailstock Head Machined
19. 20-8617 Strain Relief Conduit
20. 20-8618 Strain Relief Conduit
21. 20-8203A Tailstock Body Machined
22. 30-8335 Oil Line Assembly
23. 25-8296 Z-Axis Waycover Bottom Guide
24. 26-8320 Tailstock Guide Strip
25. 59-6655 Guide Rail Rubber Plug
26. 50-8205 Tailstock Linear Guide
27. 25-6651 Drip Rail
28. 32-0017 Read Head
29. 20-8228 Hydraulic Cylinder Mount
30. 25-8300 Encoder Strip
31. 59-0034 Hydraulic Cylinder



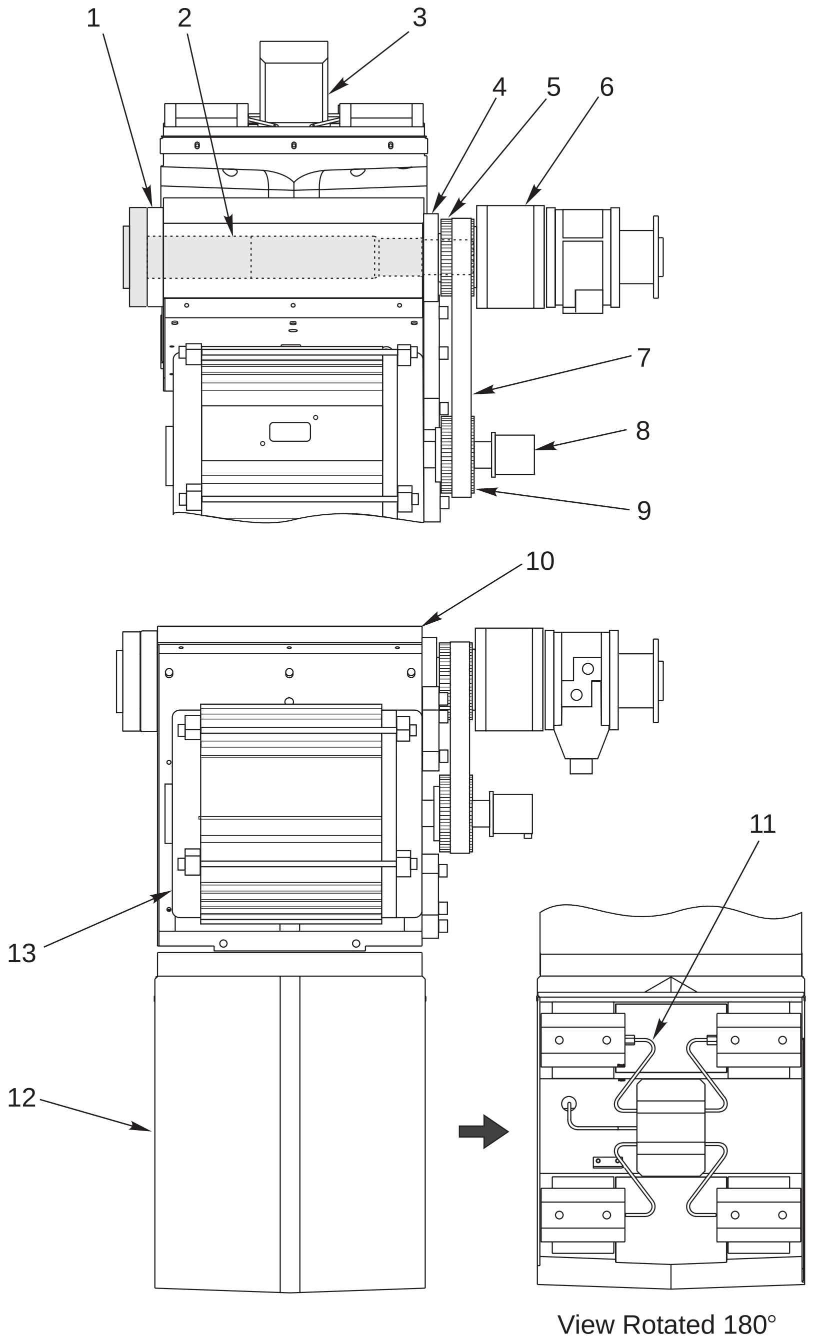
1. 62-0016 Motor
2. 20-0151 Motor Mount
3. 20-9212 Bearing Cartridge Housing
4. 20-0735 Snap Lock Ring Bumper
5. 24-9970C Z-Axis Ball Screw
6. 50-9971 Z-Axis Linear Guides (2)
7. 20-1769 Z-Axis Bumper (Support End)
8. 20-0152 Z-Axis Support Bearing Housing
9. 30-0201 Support Bearing Assembly
10. 30-1215 Coupling Assembly
11. 20-0150 Ball Screw Nut Housing Machined
12. 20-8807A Tailstock Head Machined
13. 20-1764 Tailstock Base Machined
14. 25-8001A Read Head
15. 50-0028 B-Axis Linear Guides (2)
16. 52-0042 Hydraulic Cylinder
17. 20-1767 Cylinder Attach Bracket

TL-25 Casting Assembly and Parts List

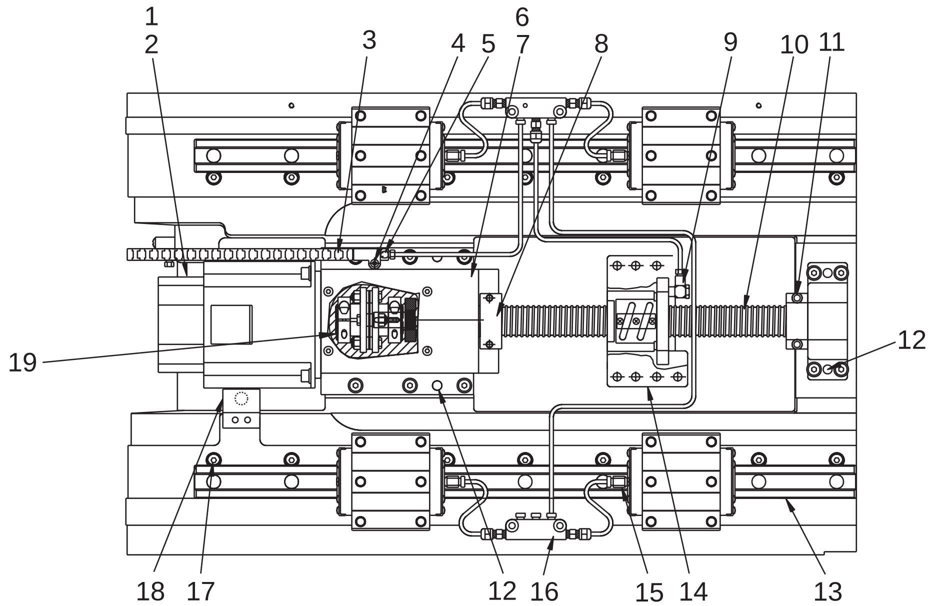


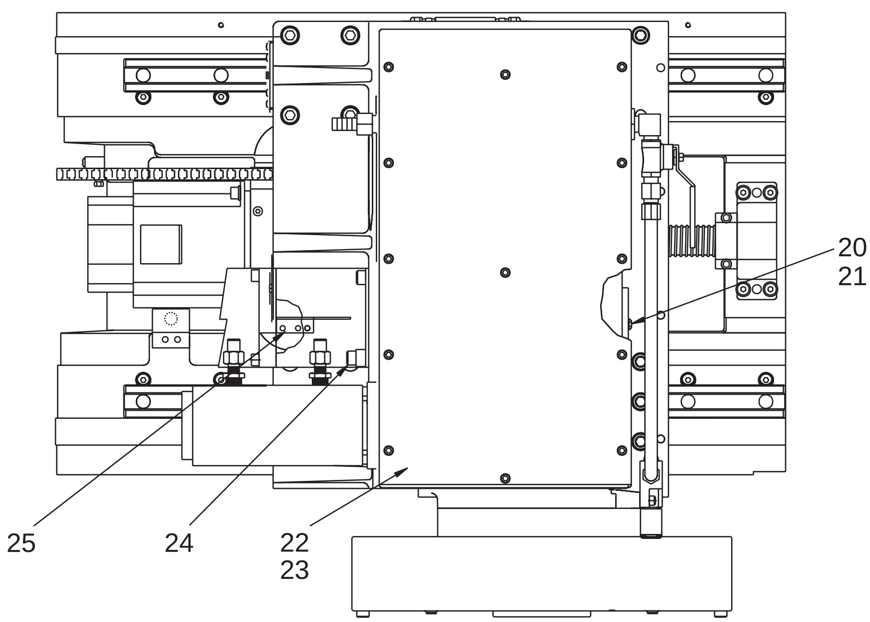
1. 62-0014 Motor (2)
2. 20-7010A Motor Mount (2)
3. 30-1220A Coupling Assembly (2)
4. 30-0154 Motor Housing Bearing (2)
5. 25-7042A Motor Mount Cover (2)
6. 20-0143 Snap Lock Ring Bumper
7. 30-1962 Z-Axis Ball Screw Assembly
8. 50-9010 Linear Guide Rail (2)
9. 30-8863 Oil Line Assembly
10. 20-9007 Nut Housing Machined
11. 20-0132 Bearing Housing Machined (2)
12. 51-2025 Bearing (2)
13. 20-7185 Ball Screw Support Bumper (2)
14. 30-3556 B-Axis Ball Screw Assembly
15. 50-3400 Sub-spindle Linear Guide Rail (2)
16. 32-2040 Limit Switch
17. 25-7267 Switch Mounting Bracket
18. 20-8771A Tool Changer Housing
19. 20-8507A Turret Coupling Mount
20. 20-0169A Tool Changer Housing Cover

TL-25 Sub-Spindle Assembly and Parts List

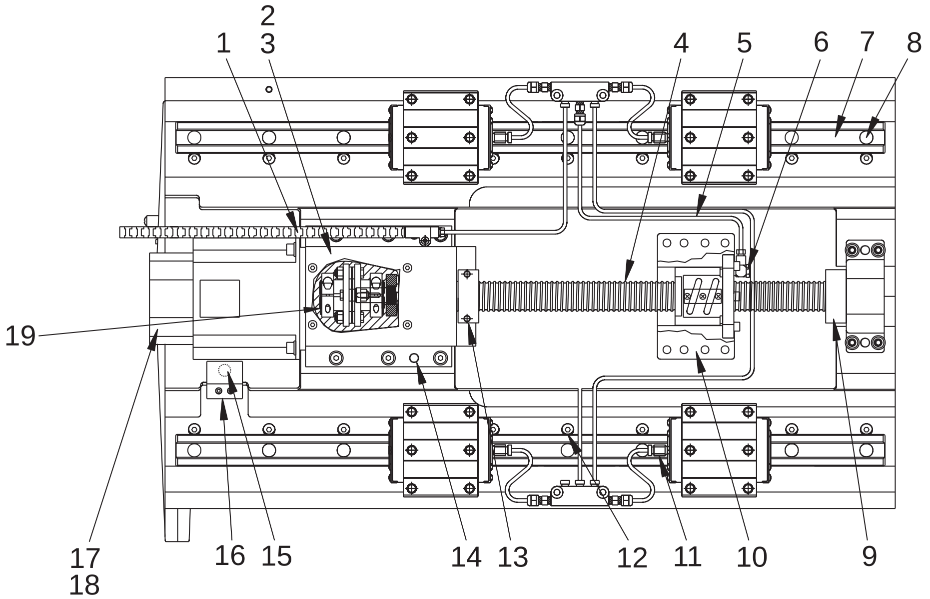


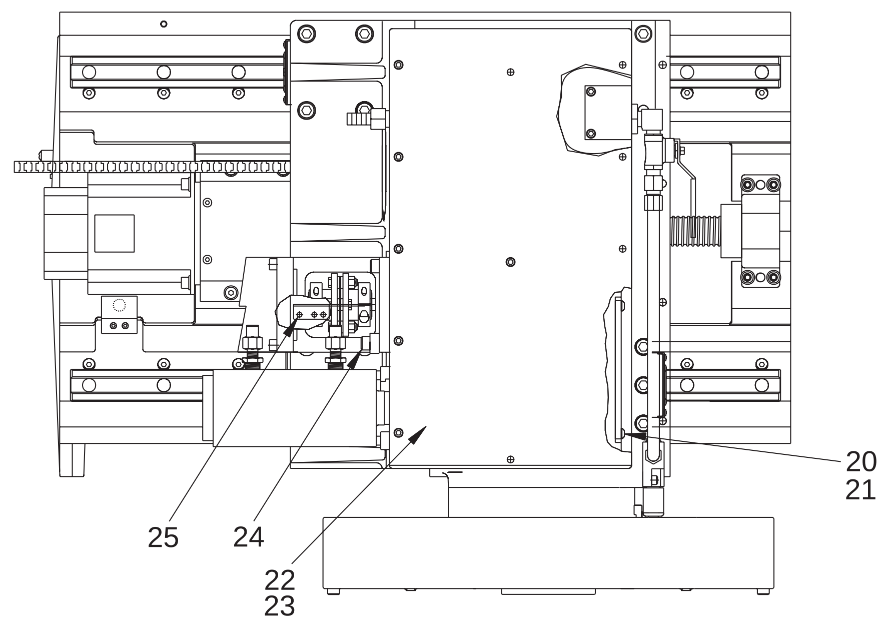
1. 20-0609 Front Cap
2. 20-0608A Spindle Shaft
3. 20-0627 Nut Housing Machined
4. 20-7442 End Cap
5. 20-0610 Spindle Pulley
6. 90-0008 ZKP100 Rotating Union
7. 54-0095 Belt
8. 60-1815 Encoder
9. 20-0611 Sub-spindle Motor Pulley
10. 20-0630A Spindle Head Machined
11. 30-1616A Oil Line Assembly
12. 20-5576 Sub-spindle Base Machined
13. 62-1010D Motor 5HP





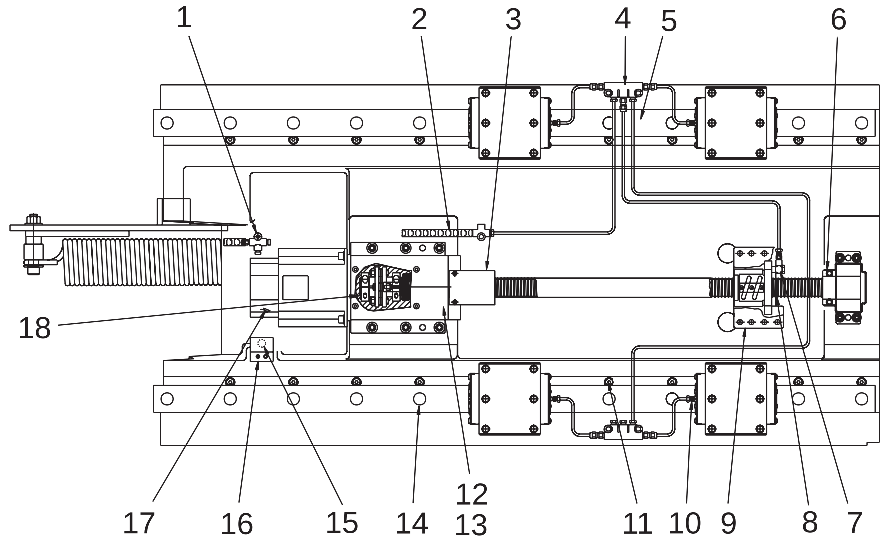
1. 62-0009 Motor w/Brake
2. 22-2629 Stub Shaft Key
3. 30-1044 Oil Line Carrier
4. 41-1717 Long Stud/Set Screw
5. 58-2110 Sleeve Nuts Lube Assembly
6. 25-7042A Snap Lock Motor Mount Cover Plate
7. 26-7233A Deflector Shield Gasket
8. 20-7185 Z-Axis Motor End Bumper
9. 58-3031 Banjo Elbow 5/16 F x M6 M
10. 30-0616B X-Axis Ball Screw Assembly
11. 20-7185 Z-Axis Support End Bumper
12. 48-0045 Dowel Pin
13. 50-8549 Linear Guide
14. 20-7008F Nut Housing Machined
15. 24-7325 Str Fit Metric Linear Guide
16. 30-8716 Lube Line Assembly
17. 22-7458 Linear Guide Cam
18. 25-7266 X-Axis Mounting Bracket
19. 30-1220A Coupling Assembly
20. 20-8535 Tool Changer Access Plate
21. 57-8546 TC Access Plate Gasket
22. 57-8576 TC Cover Gasket
23. 20-8545 TC Housing Cover
24. 20-8364 Spacer
23. 25-7459 Trip Table Bracket

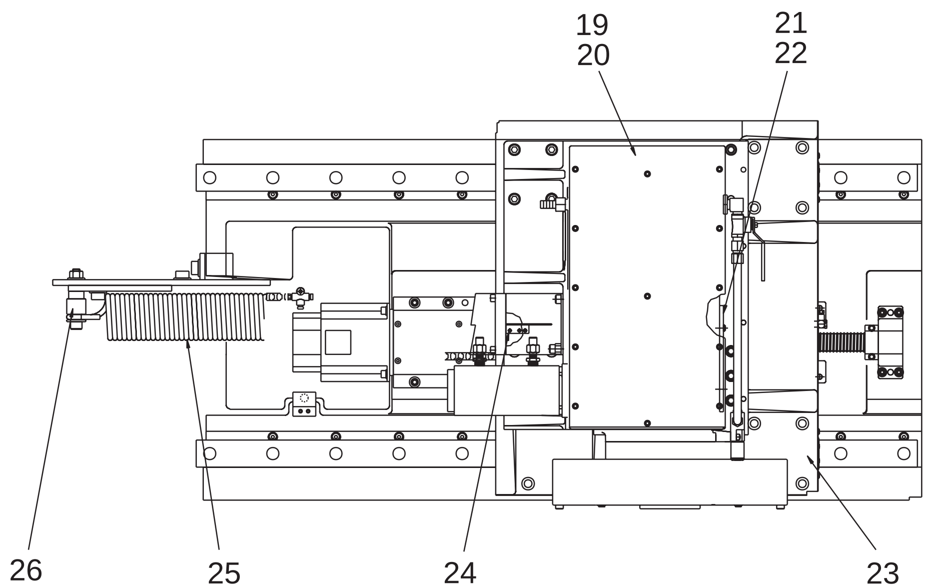




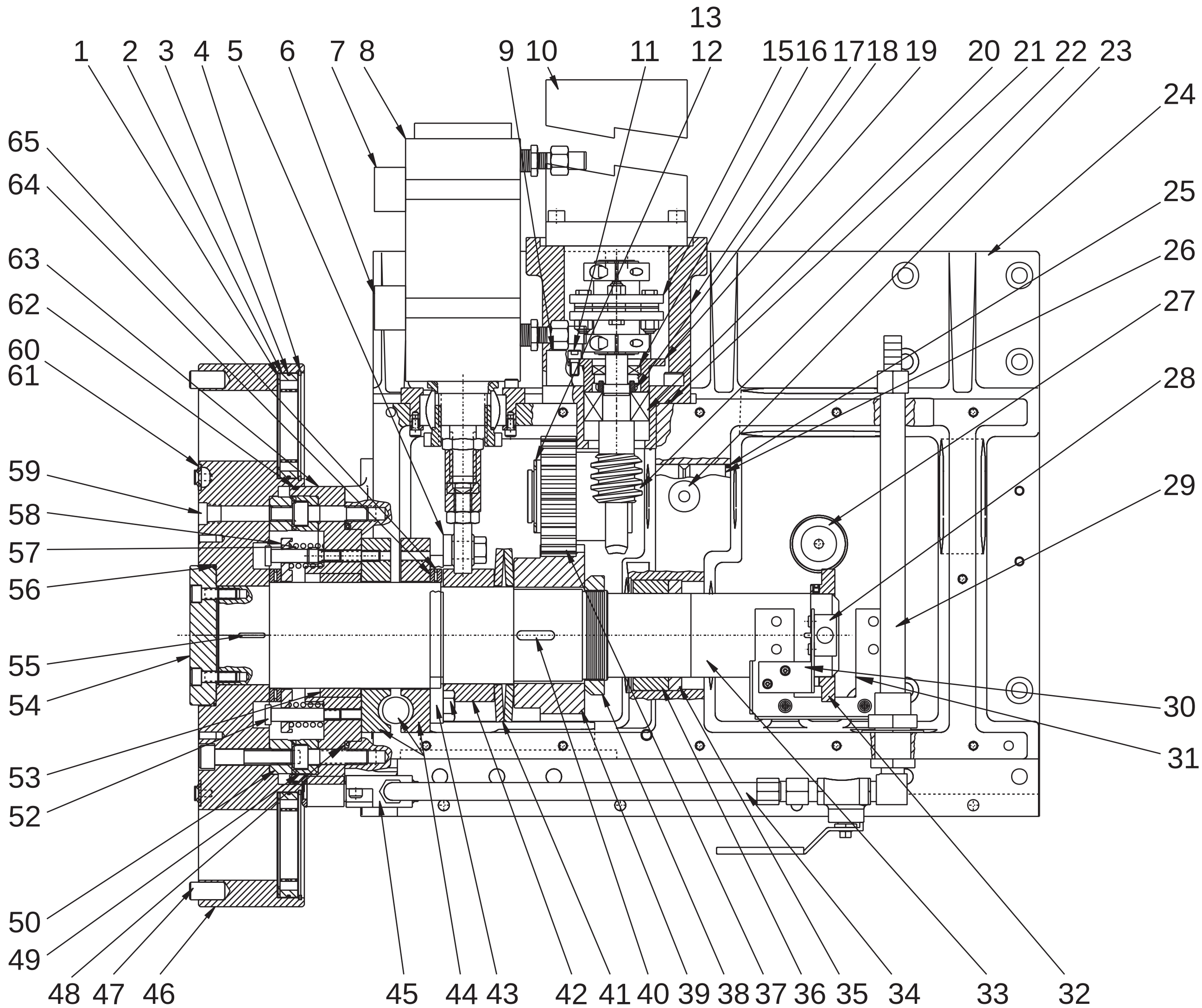
1	30-1044	Oil Line Assembly
2.	25-7042A	Snap Lock Motor Mount Cover Plate
3.	26-7233A	Deflector Shield Gasket
4.	30-0618B	X-Axis Ball Screw Assembly
5.	30-0593	Wedge Oil Line Kit
6.	58-3031	Banjo Elbow 5/16 F x M6 M
7.	50-8766	X-Axis Linear Guide
8.	59-6600	Guide Rail Plug
9.	20-7474	Support End Bumper
10.	20-7008F	Nut Housing Machined
11.	24-7325	Str Fit Metric Linear Guide
12.	22-7458	Linear Guide Cam
13.	20-7474	Motor End Bumper
14.	48-0045	Dowel Pin 3/8 x 1-1/2
15.	32-2055	X-Axis Home Limit Switch
16.	25-7266	Limit Switch Mounting Bracket
17.	22-2629	Stub Shaft Key
18.	62-0009	Motor w/Brake
19.	30-1220A	Coupling Assembly
20.	20-8535	Tool Changer Access Plate
21.	57-8546	TC Access Plate Gasket
22.	57-8576	TC Cover Plate
23.	20-8545	TC Housing Cover
24.	20-8364	Spacer
25.	25-7459	Table Trip Bracket

SL-40 Wedge Assembly and Parts List





1. 58-2760 2-Way Manifold
2. 30-1044 Oil Line Carrier
3. 20-7474 Motor End Bumper
4. 30-1530 Oil Line Assembly
5. 50-9011 Linear Guide
6. 20-7474 Support End Bumper
7. 58-3031 Banjo Elbow 5/16 F M6 M
8. 30-1397A X-Axis Ball Screw Assembly
9. 20-9007 Nut Housing Machined
10. 24-7325 Str Fit Metric Linear Guide
11. 22-7458 Linear Guide Cam
12. 25-7042A Snap Lock Motor Mount Cover Plate
13. 26-7233A Deflector Shield Gasket
14. 59-6600 Guide Rail Plug
15. 32-2063 X-Axis Home Limit Switch
16. 25-7267 Limit Switch Mounting Bracket
17. 62-0009 Yaskawa Sigma Motor w/Brake
18. 30-1220A Coupling Assembly
19. 20-8545 Tool Changer Housing Cover
20. 57-8576 TC Cover Gasket
21. 20-8535 TC Access Plate
22. 57-8546 TC Access Plate Gasket
23. 20-8204 X-Riser
24. 25-7459 Trip Table Bracket
25. 93-0211 Cross Slide Spring Kit
26. 20-8721 Swing Arm Bushing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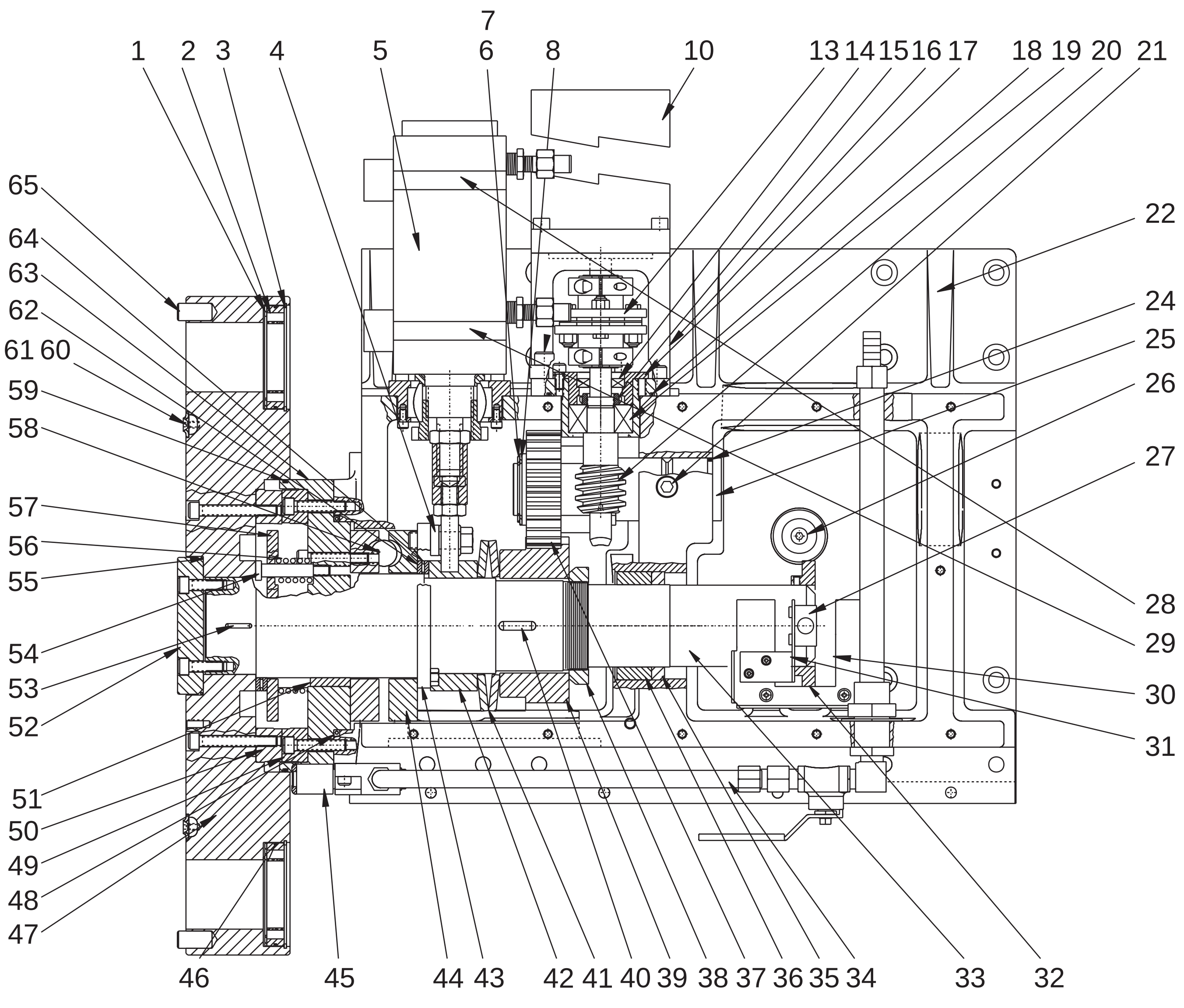
SL-20 Tool Changer Assembly Parts List

1. 51-2984 Thrust washer TRB-3446
2. 20-8523 Nut tool holder
3. 57-2994 O-ring
4. 56-2090 Retaining Ring RR-300
5. 22-8538 Rod end spacer
6. 32-2153 Unclamp switch
7. 32-2154 Clamp switch
8. 30-3650 Air Cylinder assembly
9. 20-8364 Spacer anti-rotate T/C
10. 93-0346 Motor
11. 40-1632 1/4-20 x 1/2
12. 49-4115 Washer
13. 56-9057 Retaining Ring
14. Not Used
15. 30-1220A Coupling assembly
16. 57-2129 Seal
17. 20-8512A Housing worm
18. 51-2042 Bearing locknut BH-04
19. 20-8515 Clamp bearing worm
20. 51-7001 Bearing
21. 57-2022 O-ring
22. 20-8509 Shaft worm
23. 59-2057 5/16 steel ball
24. 20-8503A Turret housing
25. 57-2831 O-ring
26. 20-8510 Shaft transfer T/C
27. 20-8537 Retainer spring
28. 32-2010 Switch (30" Cable)
29. 30-3655 Coolant line assembly
30. 25-8534 Home bracket
31. 25-8536 Switch bracket
32. 20-8533 Ring switch T/C
33. 20-8530 Shaft Turret T/C
34. 58-8657 Copper line
35. 57-1045 Seal
36. 20-8539 Bearing rear
37. 20-8511A Gear cluster T/C
38. 46-7016 Locknut
39. 20-8522A Gear spur T/C
40. 22-8544 Key gear spur T/C
41. 24-4010 Bellville washer
42. 22-8550A Spacer Bellville T/C
43. 20-8516 Lever cam T/C
44. 93-8138 Cam Turret T/C
45. 30-3660A Transfer housing
46. 20-8531B Turret T/C
47. 48-0049 Dowel pin 1/2 x 1
48. 57-0029 Seal CR29841
49. 20-8506A Coupling, turret female
50. 20-8505A Coupling, turret male
51. 59-2059 15/16 Steel Balls
52. 49-1010 Shoulder bolt 3/8 x 1 1/2
53. 20-8557 Bushing and 57-0029 Seal
54. 20-8532 Retainer turret T/C
55. 22-8543 Key
56. 57-2154 O-ring
57. 59-0035 Spring, Turret Coupling
58. 20-8518 Retainer springs T/C
59. 58-3105 Pipe plug 1/4 NPT
60. 57-8970 Coolant plate gasket
61. 20-0516 Plate Cover coolant
62. 57-2150 O-ring
63. 20-8507A Turret mounting coupling
64. 51-3001 Bearing thrust needle
65. 51-2983 Thrust washer TRD-4860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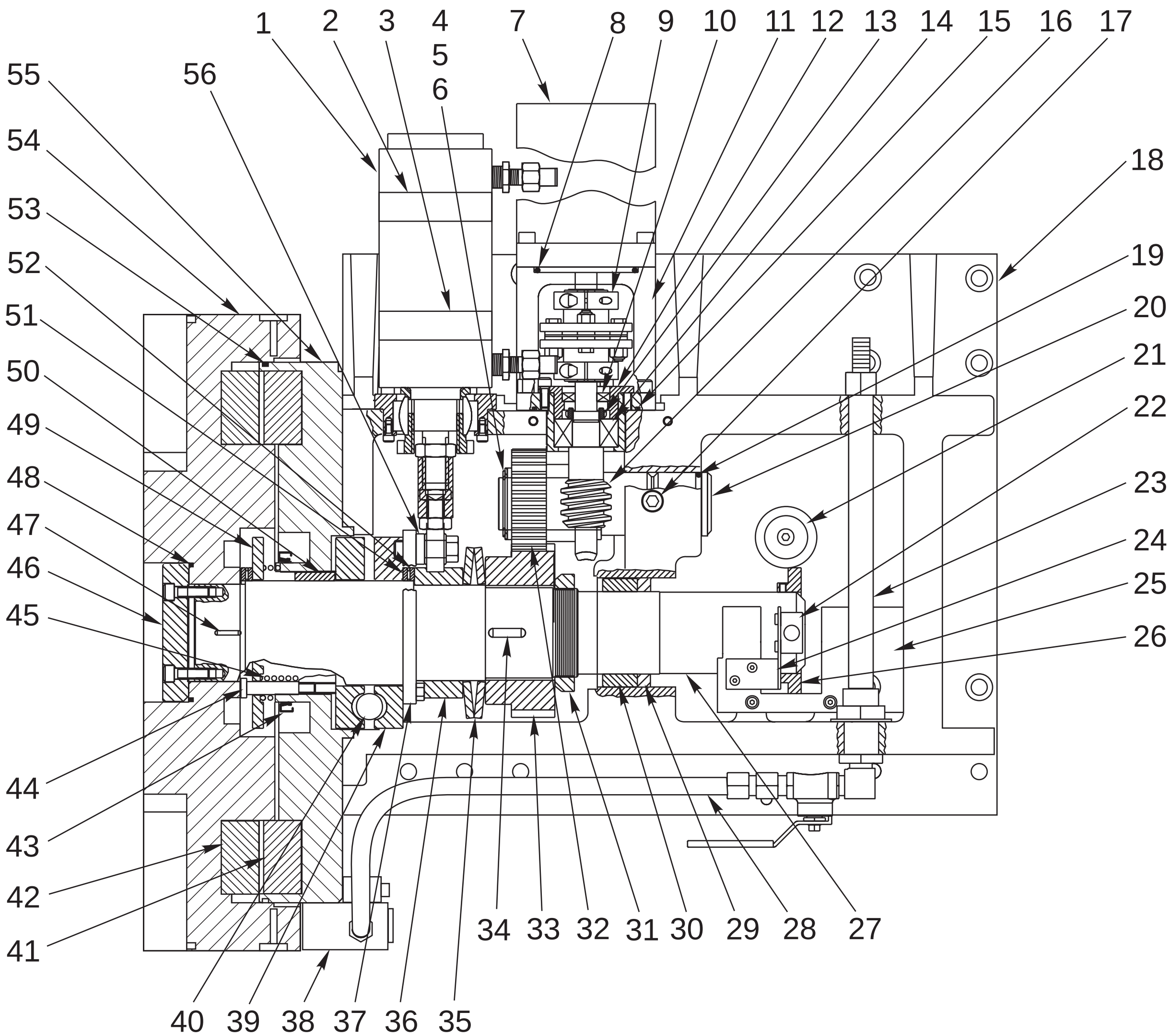
SL-30 Tool Changer Assembly Parts List

1. 51-2984 Thrust washer TRB-3446
2. 20-8321 Nut tool holder
3. 56-2090 Retaining ring RR-300
4. 22-8538 Spacer rod end T/C
5. 30-3650 Air cylinder assembly
6. 56-9057 Retaining ring 5100-150
7. 49-4115 Washer 1 1/2 steel
8. 45-2001 .002 Shim
9. Not Used
10. 93-0346 Motor
11. Not Used
12. Not Used
13. 93-30-1220A Coupling assembly
14. 57-2129 Seal CR6372
15. 51-2042 Bearing locknut BH-04
16. 20-8512A Housing Worm
17. 20-8515 Clamp bearing worm T/C
18. 57-2022 O-ring 2-150 V-1164-75
19. 51-7001 Ball bearing
20. 20-8509 Shaft worm
21. 59-2057 5/16 steel ball
22. 20-0674 Machined housing
23. Not Used
24. 57-2831 O-ring 2-130 buna
25. 20-8510 Shaft transfer T/C
26. 20-8537 Retainer spring T/C
27. 32-2011 30" telemechanique switch
28. 32-2154 Clamp reed switch
29. 32-2153 Unclamp reed switch
30. 25-8536 Clamp bracket
31. 25-8534A "A" Home BracketT/C
32. 20-8533 Ring switch
33. 20-8530 Shaft turret T/C
34. 30-3655 Coolant tubing
35. 57-1045 Seal CR23646
36. 20-8539 Bearing Rear T/C
37. 20-8511A Gear Cluster T/C
38. 46-7016 Lock nut
39. 20-8522A Gear spur T/C
40. 22-8544 Key gear spur T/C
41. 24-4010 Bellville washer
42. 22-8550A Space Belleville T/C
43. 20-8516 Lever Cam T/C
44. 93-8138 Cam turret T/C
45. 30-1957 Transfer Housing
46. 57-2994 O-ring 2-039 buna
47. 20-0671 Turret
48. 57-0030 O-ring
49. 20-8768A Coupling Turret male
50. 20-8769A Coupling Turret Female
51. 20-8557 Bushing and 57-0029 Seal
52. 20-8532 Reatiner Turret T/C
53. 22-8543 Key turret T/C
54. 49-1010 Shoulder bolt 3/8 x 1 1/2
55. 57-2154 O-ring 2-240 buna
56. 59-0035 Die springs
57. 20-8518 Spring Retainer T/C
58. 59-2059 15/16 balls
59. 57-2975 O-ring 2-172 buna
60. 20-0516 Plate turret cover
61. 57-8970 Gasket plate coolant T/H
62. 51-2983 Thrust washer TRD-4860
63. 20-0676 Mount, coupling turret
64. 51-3001 Bearing thrust needle
65. 48-0049 Dowel pin 1/2 x 1

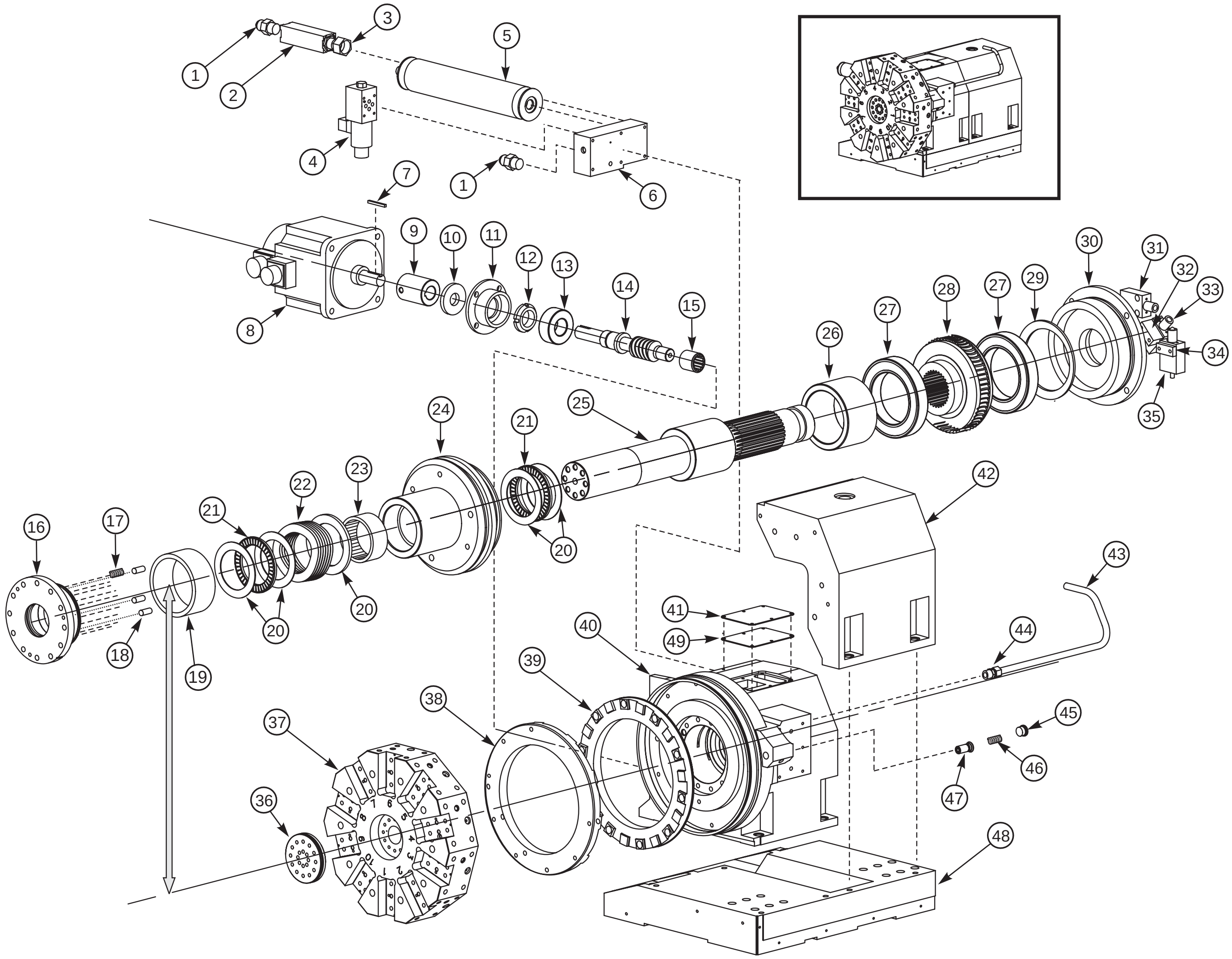
SL-40 Tool Changer Assembly



SL-40 Tool Changer Assembly Parts List

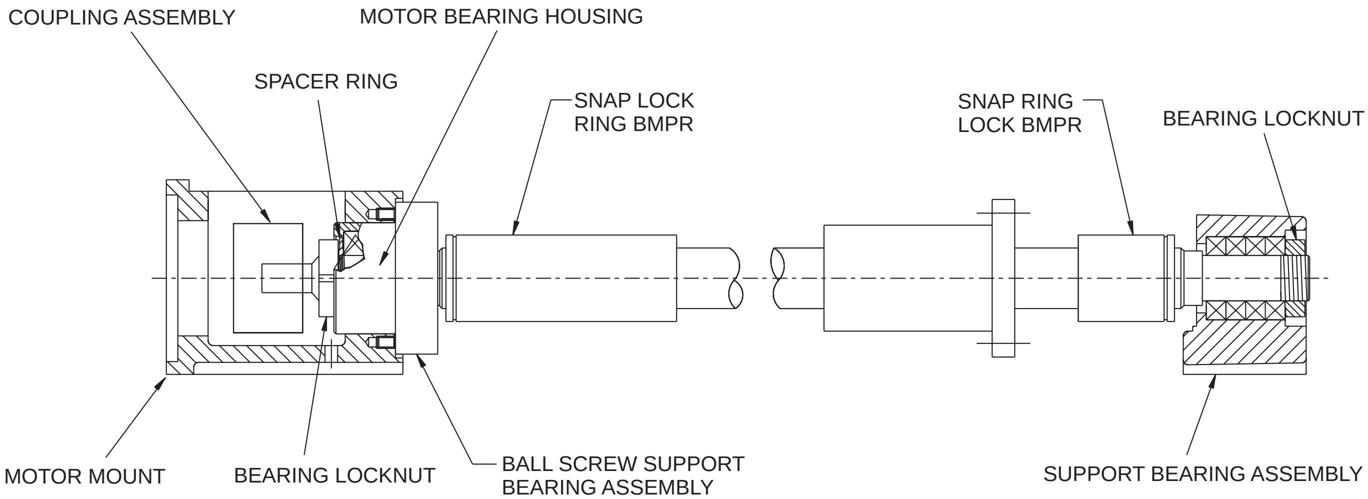
1. 30-3650 Air Cylinder Assembly
2. 32-2162 Clamp Switch
3. 32-2161 Unclamp Switch
4. 49-4115 1-1/2 Steel Washer
5. 56-9057 Retaining Ring 5100-150
6. 45-2001 Shim .002 Thick
7. 62-0014 Motor
8. 57-0075 O-Ring 2-02 Buna
9. 30-1220A Coupling Assembly
10. 57-2129 Worm Seal
11. 20-8512A Worm Housing
12. 20-8515 Worm Bearing Clamp
13. 51-2042 Bearing Locknut BH-04
14. 51-7001 Ball Bearing 5204-1SB-Kff
15. 57-2022 O-Ring
16. 20-8509 Worm Shaft
17. 59-2057 5/16 Steel Balls
18. 20-0249 TC Housing Machined
19. 57-2831 O-Ring 2-130 Buna
20. 20-8510 TC Transfer Shaft
21. 20-8537 TC Spring Retainer
22. 32-2011 Switch (30" Cable)
23. 30-3655 Coolant Line Assembly
24. 25-8534 Home Bracket
25. 25-8536 Clamp Bracket
26. 20-8533 TC Switch Ring
27. 20-8530 TC Turret Shaft
28. 58-7242 Coolant Tubing
29. 57-1045 Seal CR6372
30. 20-8539 TC Rear Bearing
31. 46-7016 Locknut
32. 20-8511A TC Gear Cluster
33. 20-8522A TC Spur Gear
34. 22-8544 TC Spur Gear Key
35. 24-4010 Belleville Washer (2)
36. 22-8550A Belleville Spacer
37. 20-8516 TC Cam Lever
38. 30-3660A Transfer Coolant Nozzle Haas Turret, (30-1159 BOT Turret, 30-6065 VDI Turret)
39. 93-8138 TC Turret Cam (2)
40. 59-2059 15/16 Steel Balls
41. 20-0247 Female Turret Coupling
42. 20-0248 Male Turret Coupling
43. 57-0029 Seal CR29841
44. 49-1010 Shoulder Bolt 3/8 x 1-1/2
45. 59-0035 Die Springs
46. 20-8532 TC Turret Retainer
47. 22-8543 TC Turret Key
48. 57-2154 O-Ring 2-240 Buna
49. 20-8518 Spring Retainer
50. 20-8557 Bushing and 57-0029 Seal
51. 51-3001 Needle Thrust Bearing
52. 51-2983 Thrust Washer TRD-4860
53. 57-0047 O-Ring
54. 20-0397 Turret Block
55. 20-0250 Coupling Mount
56. 22-8538 TC End Rod Spacer

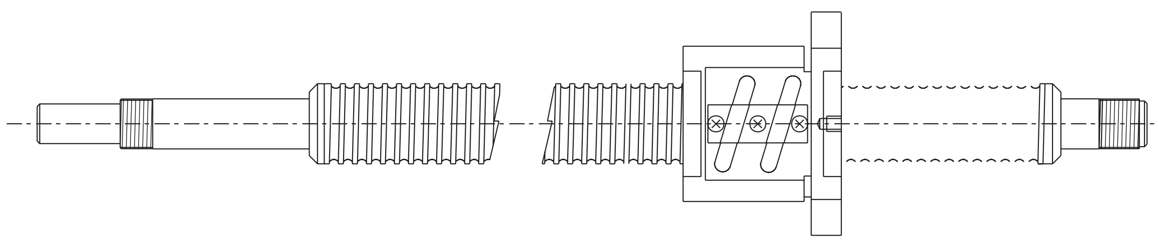
SL-40 Hydraulic Tool Changer



1. 58-0038 Fitting ORB
2. 58-0723 Check Valve
3. 2266-6-8s
4. 93-0590 Solenoid
5. 52-0156 Hydraulic Accumulator
6. 20-2437 Valve Block
7. 20-2443 Key Shim
8. 62-0014 Servo Motor
9. 20-2428 Rigid Coupling
10. 57-1025 Seal
11. 20-2427 Worm Retainer
12. 51-2041 Bearing Lock Nut
13. 51-0159 Bearing
14. 20-2425 Worm Shaft
15. 51-0161 Bearing
16. 20-2431 Piston Retainer
17. 59-0669 Die Spring
18. 48-0042 Dowel Pin
19. 20-8557 Front Bushing
20. 51-0158 Thrust Washer
21. 51-0157 Thrust Bearing
22. 59-0670 Shims
23. 51-0172 Needle Bearing
24. 20-2432 Hydraulic Piston
25. 20-2430 Turret Shaft
26. 20-2434 Worm Bushing
27. 51-0160 Bearing
28. 20-2433 Worm Gear
29. 59-0671 Belleville Spring
30. 20-2435 Flanged Bearing Retainer
31. 32-2234 Proximity Switch
32. 20-2472 Support Block
33. 32-2130 Home Switch
34. 20-2438 Support Block
35. 32-2235 Proximity Switch
36. 20-2426 Turret Worm Clamp
37. 20-2436 BOT Worm Turret
38. 20-0247 Female Turret Coupling
39. 20-0248 Male Turret Coupling
40. 20-2422 T/C SL-40 Housing
41. 25-5452 T/C Access Plate
42. 20-2424 T/C Housing
43. 58-0728 Coolant Tube
44. 58-3087 Compression Fitting
45. 58-0080 Plug
46. 59-0103 Spring
47. 20-0401 Coolant Shaft
48. 20-2423 X Riser X
49. 57-0346 Gasket

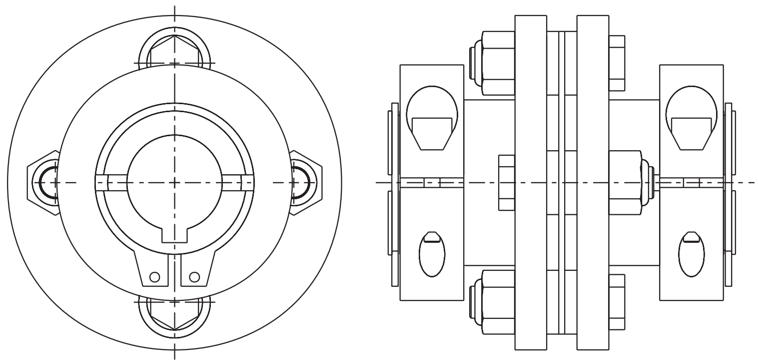
Ball Screw Assembly



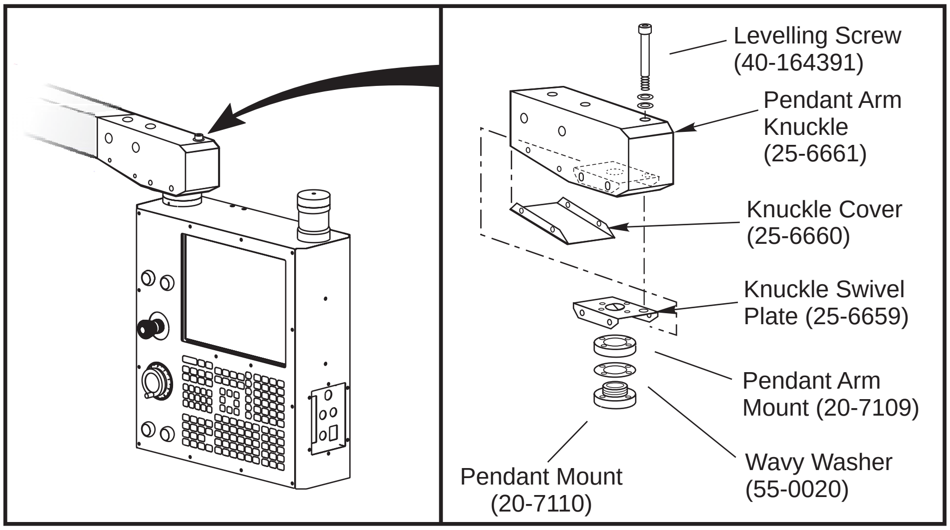


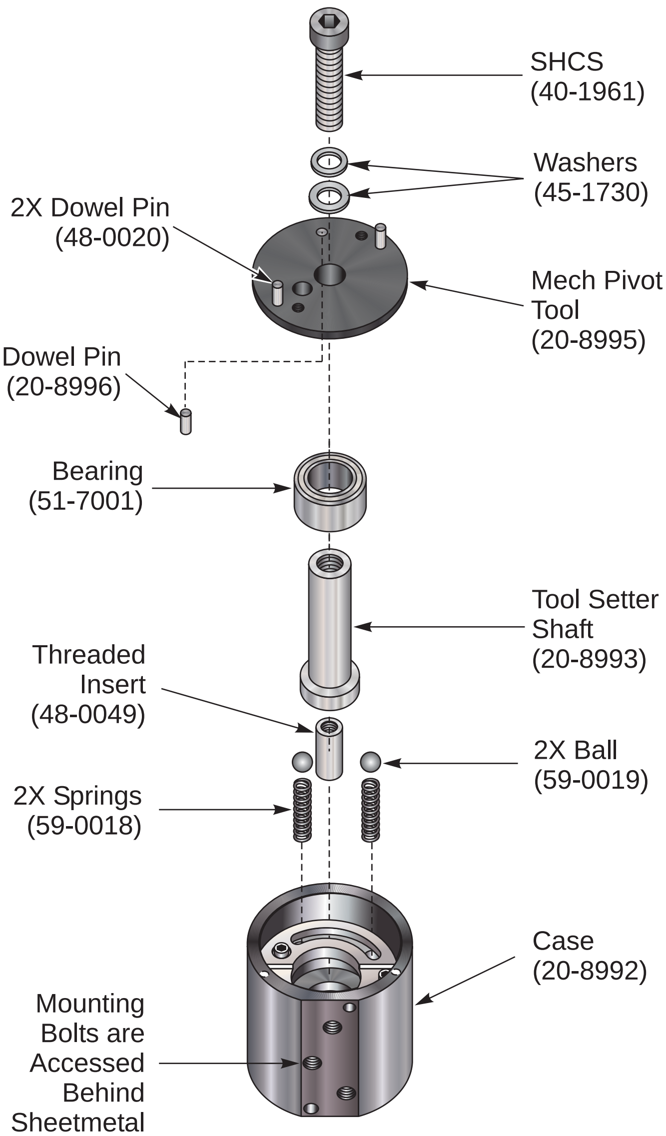
BALL SCREW ROTATED 90°

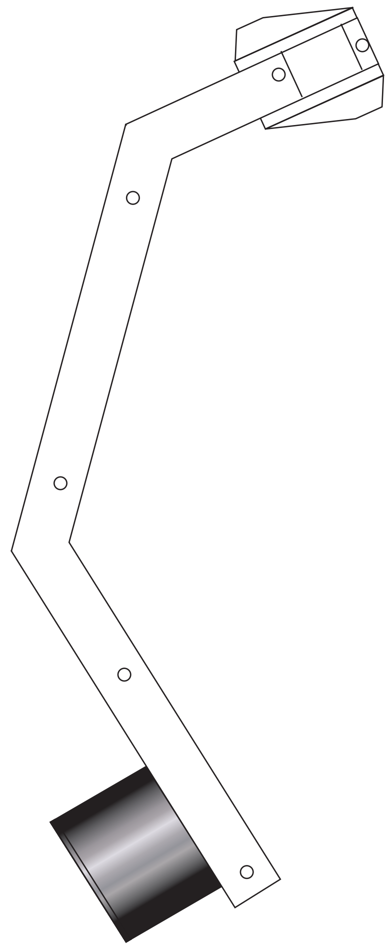
BALL SCREW ASS'Y "A"	BALL SCREW	SNAP LOCK RING BMPR	MOTOR MOUNT	COUPLING ASS'Y	APPLICATION
30-2977 BS ASS'Y 32mm	24-8765 BALLSCR 32mm	NONE	20-7010A	30-1220A	MINI LATHE (Z)
30-2972 BS ASS'Y 32mm	24-8765 BALLSCR 32mm	NONE	20-7010A	30-1220A	MINI LATHE (X)
30-2290 BS ASS'Y 32mm	24-7146 BALLSCR 32mm	20-0735 SNAP LOCK RING BMPR 1.75	20-7010A	30-1220A	SL10 (Z)
30-2244 BS ASS'Y 32mm	24-8548B BALLSCR 32mm	20-1126 SNAP LOCK RING BMPR 1.68	20-7010A	30-1220A	SL10 (X)
30-0615 BS ASS'Y 32mm (1.26) X 33.268	24-9013 BALLSCR 32mm (1.26) X 33.268	20-0142 SNAP LOCK RING BMPR 6.00	20-7010A	30-1220A	SL20 (Z)
30-0617 BS ASS'Y 32mm (1.26) X 48.228	24-9012 BALLSCR 32mm (1.26) X 48.228	20-0143 SNAP LOCK RING BMPR 7.00	20-7010A	30-1220A	SL30 (Z)
30-1397A BS ASS'Y 32mm (1.26) X 25.650	24-7146 BALLSCR 32mm (1.26) X 25.650	20-0141 SNAP LOCK RING BMPR 4.00	20-7010A	30-1220A	SL40 (X)
30-0618B BS ASS'Y 32mm (1.26) X 16.475	24-8765 BALLSCR 32mm (1.26) X 16.475	NONE	20-7010A	30-1220A	SL30 (X)
30-0616B BS ASS'Y 32mm (1.26) X 13.525	24-9548 BALLSCR 32mm (1.26) X 13.525	NONE	20-7010A	30-1220A	SL20 (X)
30-0450 BALLSCR 40mm (1.57) x 57.897	24-0003A BS ASS'Y 40mm (1.57) x 57.897			30-1215	SL40 (Z)



WHERE USED		APPLICATION
30-2972	BS ASS'Y 32mm	MINI LATHE (X)
30-2977	BS ASS'Y 32mm	MINI LATHE (Z)
30-2290	BS ASS'Y 32mm	SL10 (Z)
30-2244	BS ASS'Y 32mm	SL10 (X)
30-0615	BS ASSY 32mm(1.26) x 33.27	SL20 (Z)
30-1962	BS ASSY 32mm(1.26) x 48.23	SL30 (Z)
30-1397A	BS ASSY 32mm(1.26) x 25.65	SL40 (X)
30-0616B	BS ASSY 32mm(1.26) x 13.53	SL20 (X)
30-0618B	BS ASSY 32mm(1.26) x 16.78	SL30 (X)
30-0157	BS ASSY 32mm(1.26) x 25.65	SL40 (Z)
30-0450	BS ASSY 40mm (1.57) x 57.90	SL40 (Z)

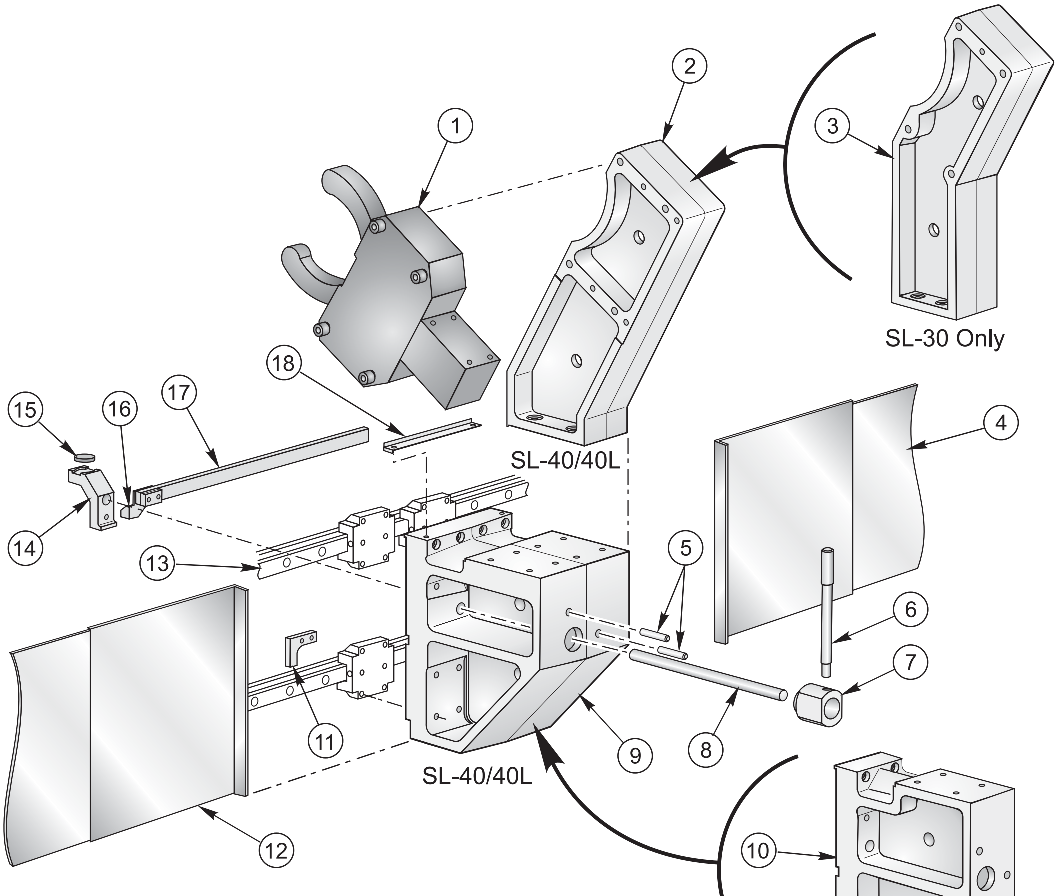

Levelling Screw
(40-164391)
Pendant Arm
Knuckle
(25-6661)
Knuckle Cover
(25-6660)
Knuckle Swivel
Plate (25-6659)
Pendant Arm
Mount (20-7109)
Wavy Washer
(55-0020)
Pendant Mount
(20-7110)





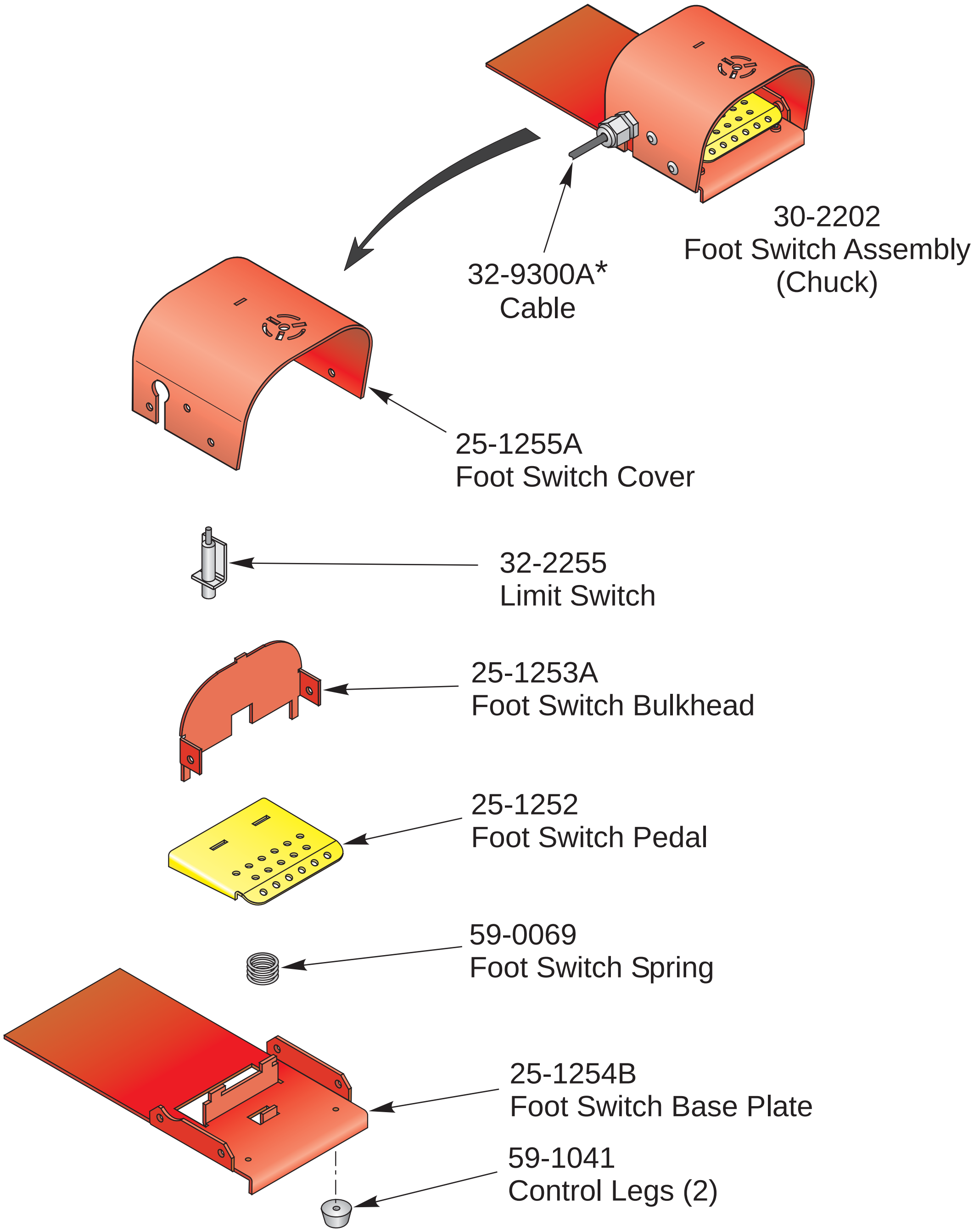
Tool Setting Arm

SL-10.................(20-1053)
SL-20-30............(20-8989)
SL-30 Big Bore..(20-0474)
SL-40.................(20-8291)

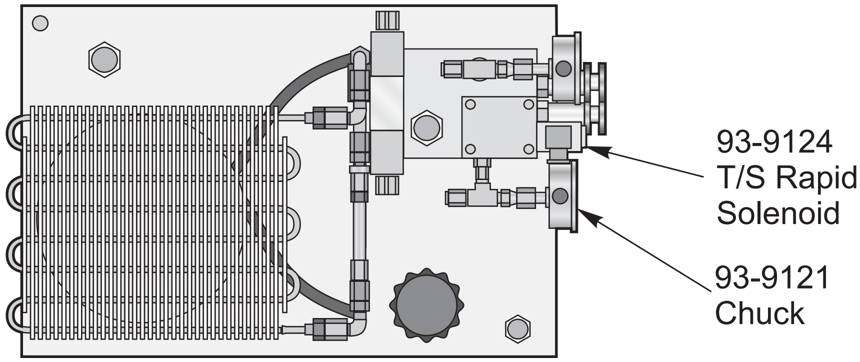


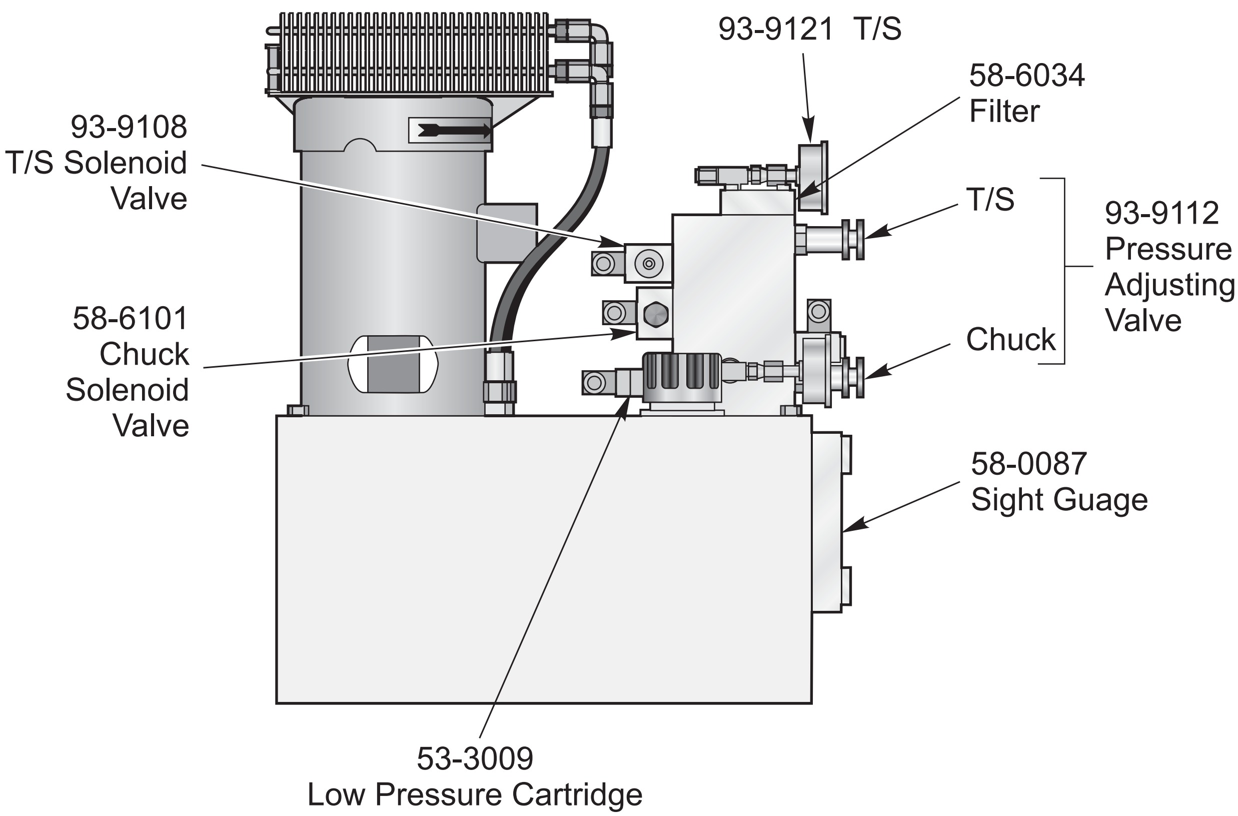
1. Steady Rest (Customer Supplied)
2. 20-1750 Steady Rest Mount Machined (SL-40/40L)
3. 20-1649 Steady Rest Mount Machined (SL-30)
4. 25-4598 Waycover LT T/S (SL-40/40L)
   25-8756A Waycover LT T/S (SL-30)
5. 48-0009 Dowel Pin 1/2 x 3 1/4
6. 20-0858 Handle
7. 20-1626A Handle Collar
8. 20-1627B Locking Pin (SL-40/40L)
   20-1621B Locking Pin (SL-30)
9. 20-1751A Steady Rest Base Machined (SL-40/40L)
10. 20-1648 Steady Rest Base Machined (SL-30)
11. 20-1620 Steady Rest Limit Stop
12. 25-4600A Waycover Steady Rest (SL-40/40L)
    25-1316 Waycover Steady Rest (SL-30)
13. 50-0027 Linear Guide
14. 20-1625B Steady Rest Brake (SL-30)
    20-2406 Steady Rest Brake (SL-40/40L)
15. 57-0045 Brake Pad
16. 20-1620 Right Travel Stop
17. 20-1628A Steady Rest Push Bar (SL-40/40L)
    20-1622 Steady Rest Push Bar (SL-30)
18. 25-1320A Strip Shield (SL-40/40L)
    25-1314 Strip Shield (SL-30)

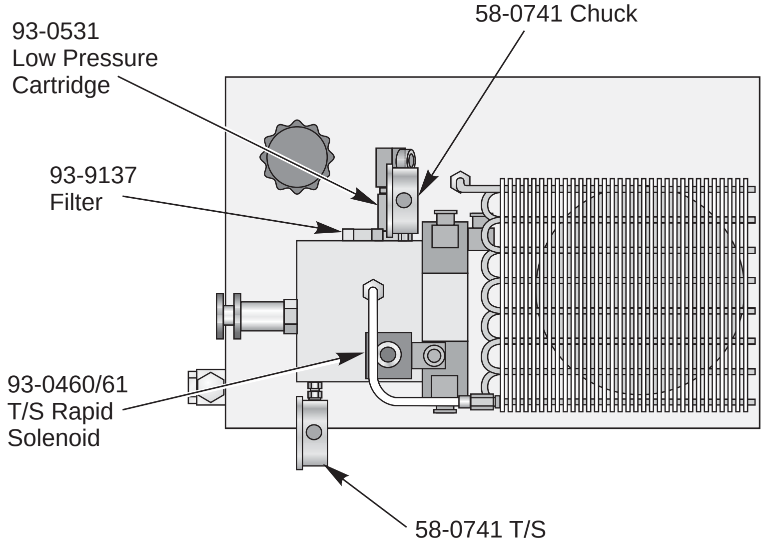
Foot Switch Assembly

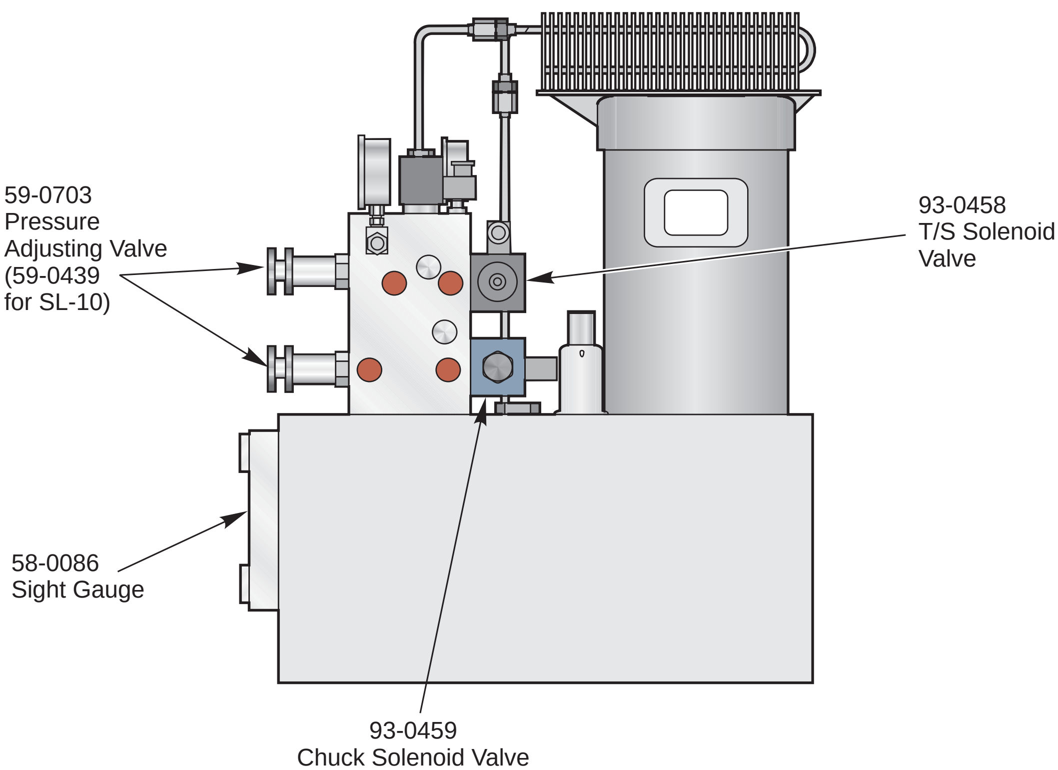


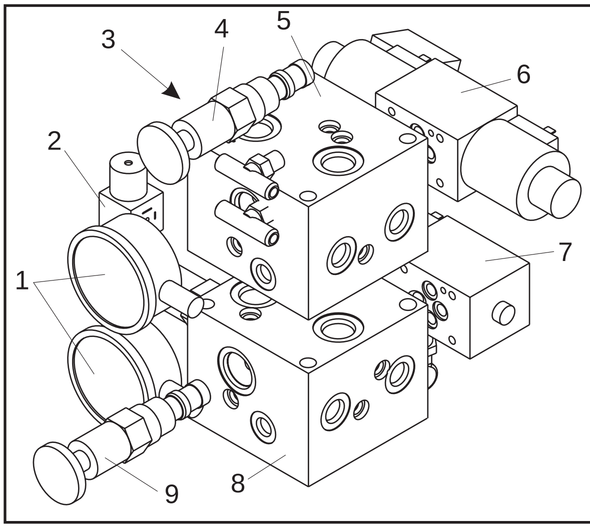
* 32-9300B Cable w/30-5105 and 30-5106 Foot Switch Assemblies
32-9311B Cable w/30-2202 Foot Switch Assembly (SL-20/30)
32-9312B Cable w/30-2202 Foot Switch Assembly (SL-40)

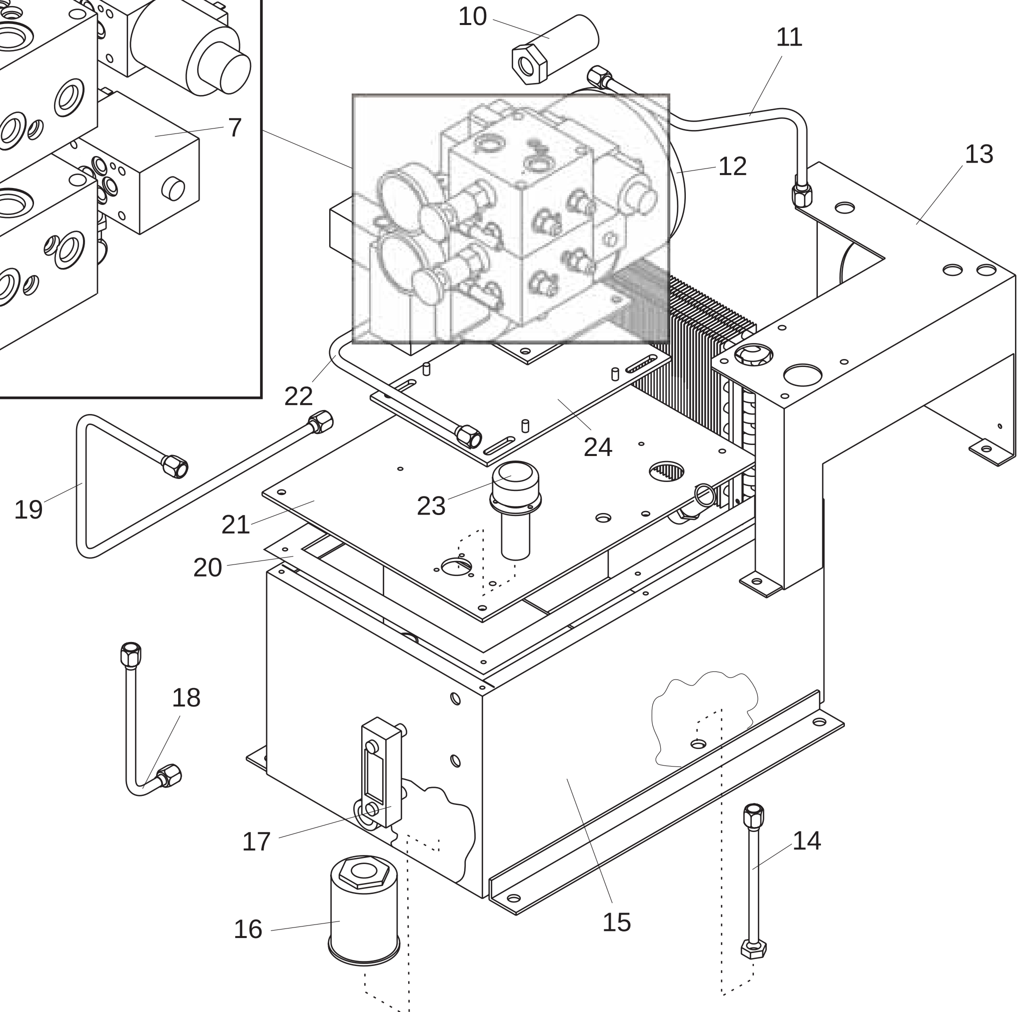

93-9124
T/S Rapid
Solenoid
93-9121
Chuck


93-9121 T/S
58-6034
Filter
93-9108
T/S Solenoid
Valve
T/S
93-9112
Pressure
Adjusting
Valve
58-6101
Chuck
Solenoid
Valve
Chuck
58-0087
Sight Guage
53-3009
Low Pressure Cartridge


58-0741 Chuck
93-0531
Low Pressure
Cartridge
93-9137
Filter
93-0460/61
T/S Rapid
Solenoid
58-0741 T/S


59-0703
Pressure
Adjusting Valve
(59-0439
for SL-10)
93-0458
T/S Solenoid
Valve
58-0086
Sight Gauge
93-0459
Chuck Solenoid Valve



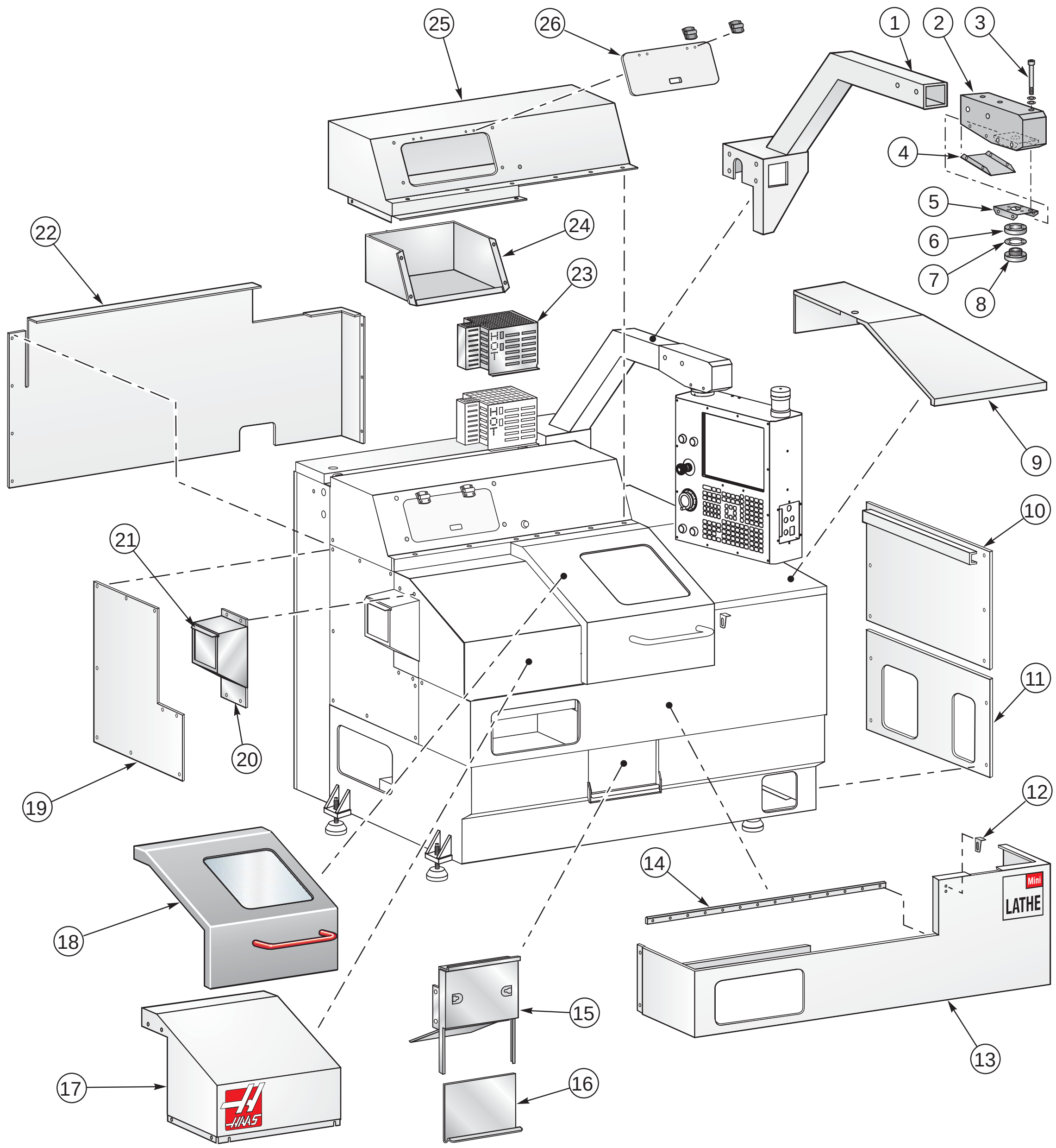


1.	58-0741	Gauge
2.	53-3009	Pressure Switch
3.	90-0114	Hydraulic Valve
4.	59-0439	Pressure Adjusting Valve
5.	20-3109	Valve Block (Tailstock)
6.	90-0105	Hydraulic Valve (Tailstock)
7.	90-0104	Hydrulic Valve (Chuck)
8.	20-3108	Valve Block (Chuck)
9.	59-0439	Pressure Adjusting Valve
10.	58-0875	In-Line Filter
11.	58-0879	Hydraulic Tube
12.	62-0999A	Pump Motor
13.	25-6938	Valve Block Bracket
14.	58-0855	Hydraulic Tube
15.	25-6936	Reservoir
16.	59-0798	Suction Strainer
17.	59-0797	Level Sight Gauge
18.	58-0858	Hydraulic Tube Return
19.	58-0856	Hydraulic Tube Pressure
20.	57-0389	Reservoir Gasket
21.	25-6935	Reservoir Cover Plate
22.	58-0857	Hydraulic Tube Pressure
23.	59-0799	Filter Breather
24.	25-6937	Subplate Motor Mount

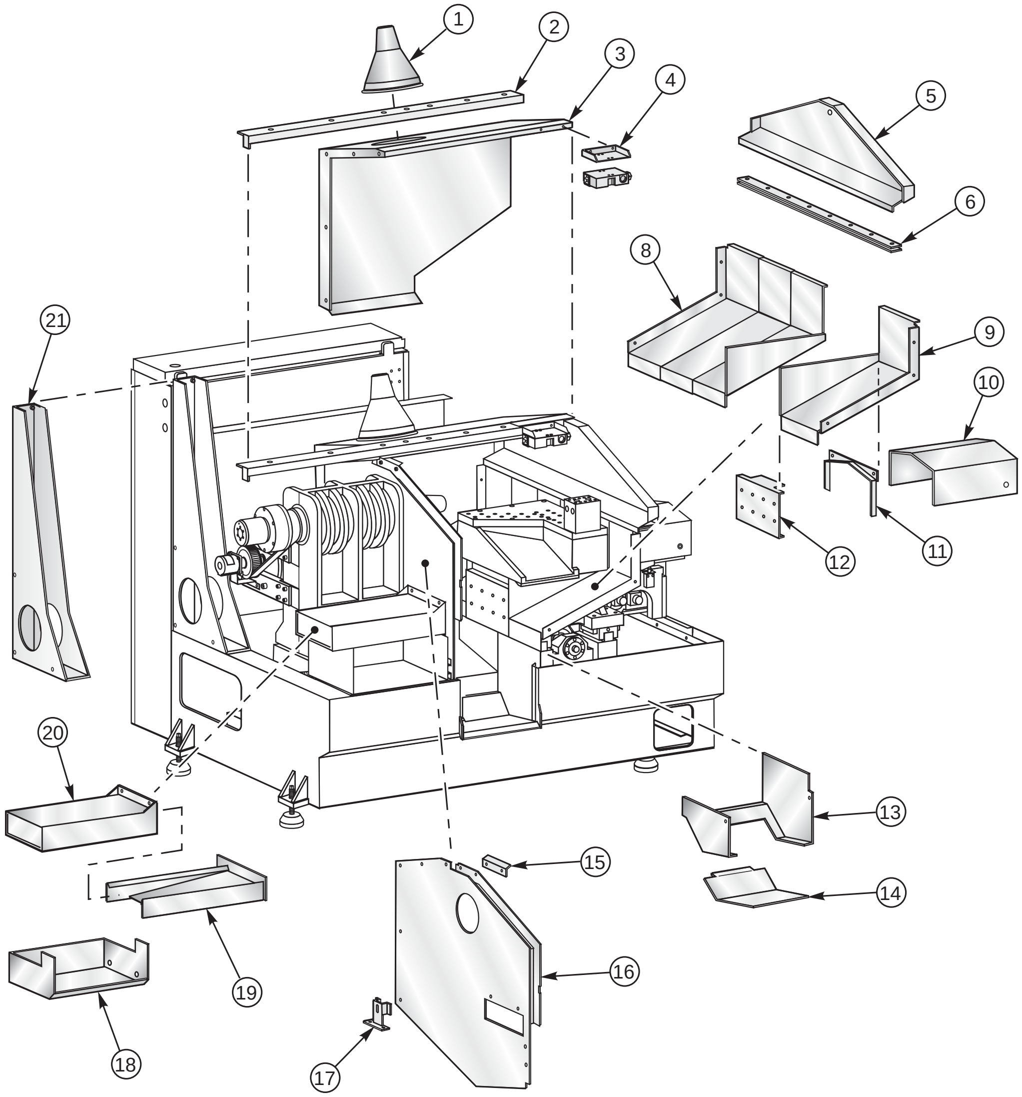
Filter Replacement

Filter Manufacturer	Oil Filter Part Number	Replacement Element Part Number
Pall	58-1064	58-1065
Hydac	58-1064	58-1066
Flow Ezy	58-1064	58-1067

Mini Lathe External Sheetmetal and Parts List

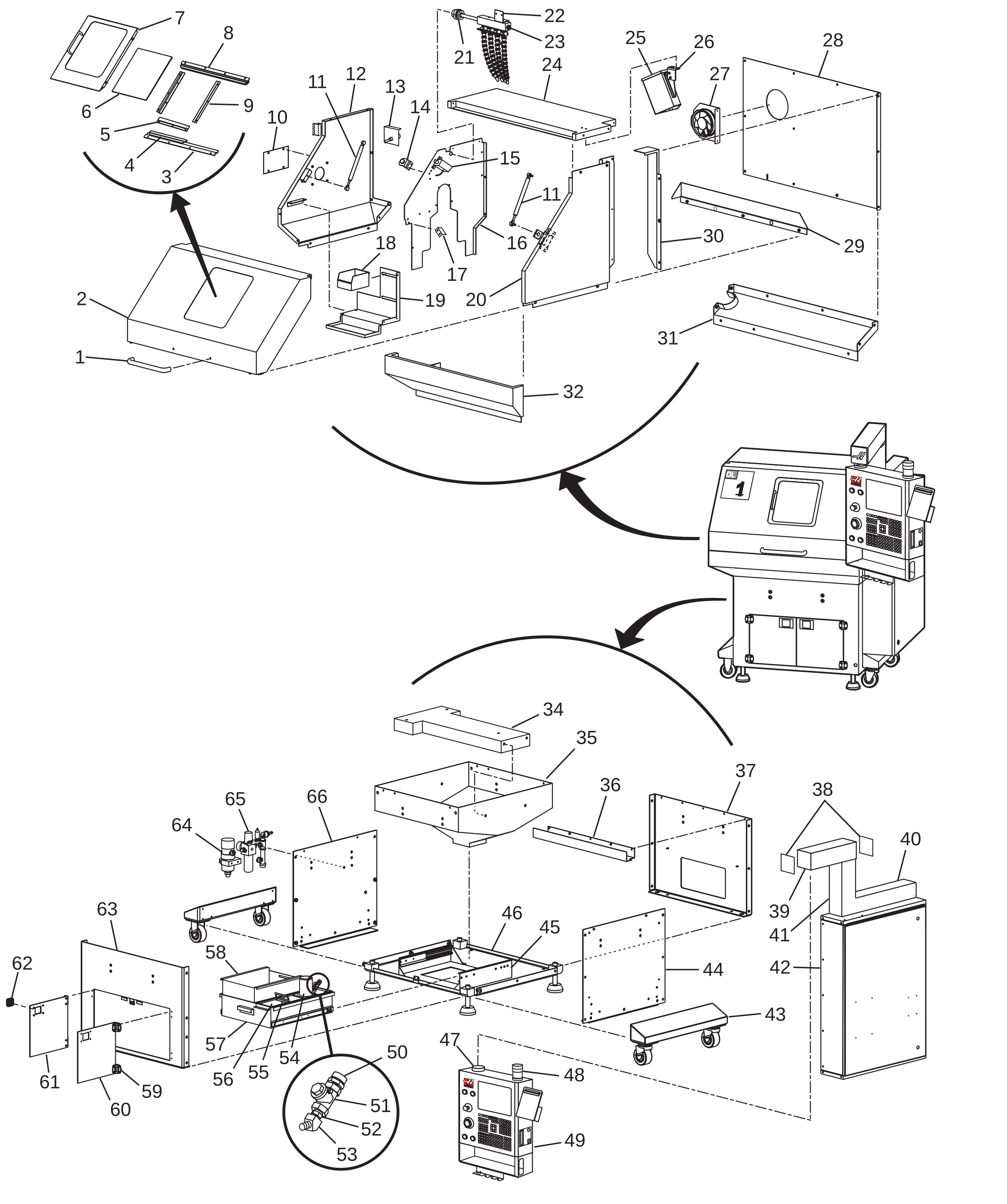


1.	20-1292	Pendant Arm	14.	20-1224	Door V-Track
2.	25-6661	Pendant Arm Knuckle	15.	25-4148	Chip Tray Door Bracket
3.	40-164391	Leveling SHCS	16.	25-4128	Chip Tray Door
4.	25-6660	Knuckle Cover	17.	25-4121	Spindle Cover
5.	25-6659	Knuckle Swivel Plate	18.	30-2961	Door Assembly
6.	20-7109A	Pendant Arm Mount	19.	25-4122	Left End Panel
7.	55-0020	Wavy Washer	20.	25-4124	Coolant Collector
8.	20-7110A	Pendant Mount	21.	25-4125	Coolant Collector Door
9.	25-4110	Top Right Cover	22.	25-4112	Back Panel
10.	25-4111	Right End Panel	23.	32-0042	Regen Cover
11.	25-4106A	Lube Cover	24.	25-4144	Toolbox
12.	25-6152A	Air Hose Bracket	25.	25-4108	Top Hat
13.	25-4109	Front Skirt	26.	25-4145	Toolbox Door



1.	32-0106	Work Light Assembly
2.	25-4092	Upper Roller Track
3.	25-4105A	Splash Liner
4.	25-4100	CE Hanger
5.	25-4136	Header
6.	20-1240A	Guide Bar Assembly
7.	Not Used	
8.	25-4134A	Rear Way Cover
9.	25-4135A	Front Way Cover
10.	25-4133	Z-Axis Sliding Cover
11.	25-4139A	Z-Axis Way Cover Wiper
12.	25-4132C	Saddle Bra
13.	25-4143	Chip Tray Body
14.	25-4130	Chip Tray
15.	26-0054	Door Brass Wiper
16.	25-4104A	Fixed Bulkhead
17.	25-4107	Bulkhead Bracket
18.	25-4089	Part Tray
19.	25-4138	Part Catcher Drawer
20.	25-4147	Part Catcher Drawer Frame
21.	25-4102A	Stand

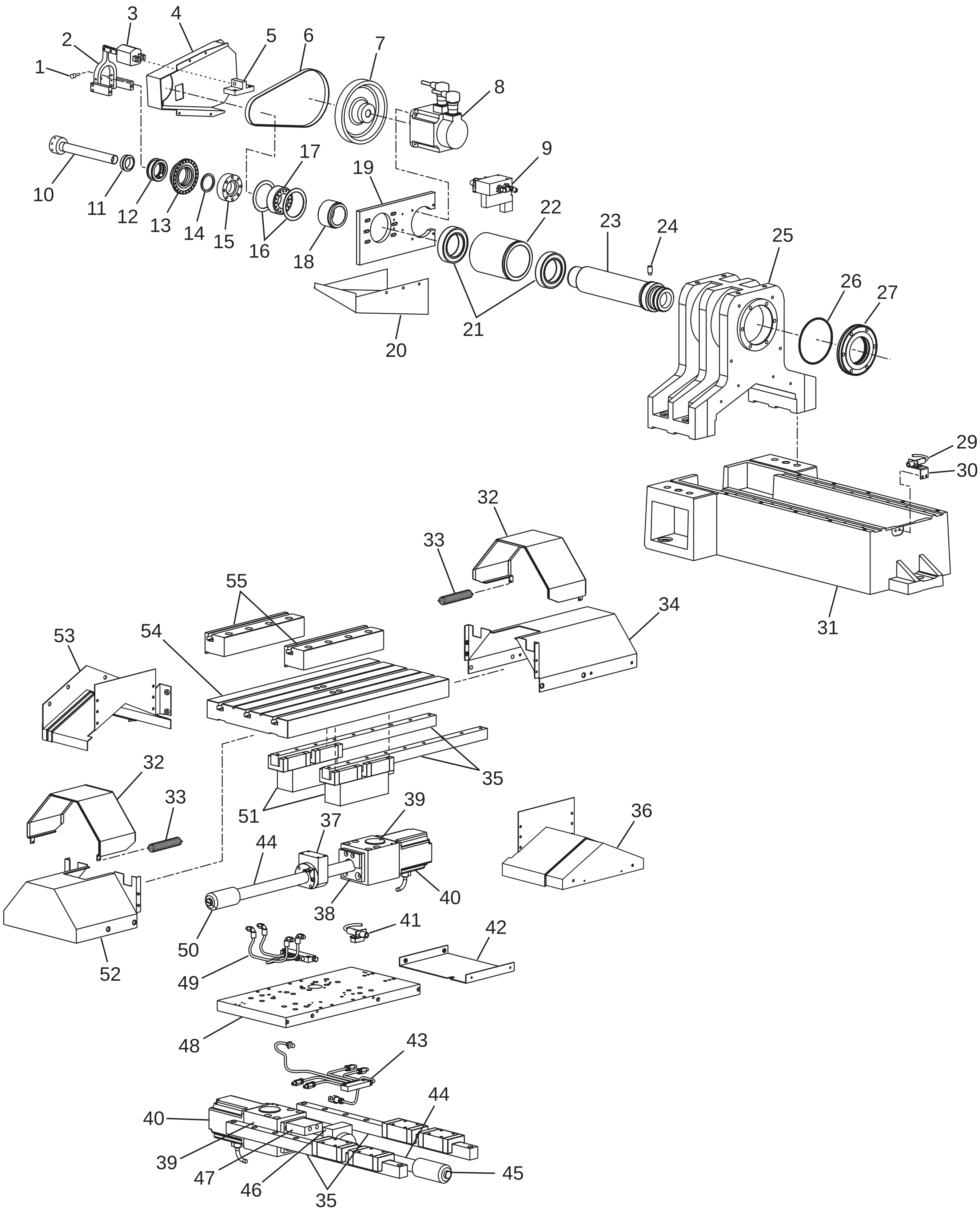
Office Lathe External Sheetmetal and Parts List



Office Lathe External Sheetmetal and Parts List

1. 59-0754 Chrome Handle
2. 25-6905 Set-Up Door Panel
3. 25-6070A Window Rail
4. 28-0175 Bottom Window Guide
5. 25-6247A Bottom Window Frame
6. 28-0173A Window
7. 25-7549 Operator Door Panel
   59-0901 Small Handle
8. 25-6081 Window Guide Bracket
   28-0174 Top Window Guide
9. 25-6084A Left Window Side Frame
   25-6108 Right Window Side Frame
10. 25-7198 Junction Box Cover
11. 59-0101 2X Gas Spring
12. 25-6907 Left Panel
13. 59-2746 Reverse Acting TV-4DMP Model CS-1781
    25-7579 Drawbar Relief Bracket
14. 32-1210A Chuck Release Button
    25-6924 Chuck Release Bracket
15. 25-7553 Door Switch Bracket
    32-2305 Proximity Switch
16. 25-6912 Spindle Partition
17. 25-7573 Coolant Splash Shield
18. 59-0712 3X AKROBIN AKRO-Mils 30-210 Red
19. 25-7916 Tool Tray
20. 25-6908 Right Panel
21. 58-1679 Bulkhead Fitting NPT-3/8 x 1.000 Dia.
22. 25-6796A Coolant Manifold Bracket
23. 30-8487 Spindle Head Manifold Assy
24. 25-6909 Top Panel
25. 32-0229 Work Light Housing
26. 25-4789A Work Light Adjust Bracket
27. 66-1480 Fan 5.91 x 6.78 in. 200 cfm
    25-6923 Fan Bracket
    66-1485 Fan Guard
28. 25-6910 Back Panel
29. 25-7500 Horizontal Cables Back Cover
30. 25-7501 Vertical Cables Back Cover
31. 25-6911 Bottom Back Panel
32. 25-6906 Bottom Front Panel
33. NOT USED
34. 25-7355A Long Machine Support
35. 25-7491A Base Basin
36. 25-7499 Back Cables Trough
37. 25-7351A Base Rear Panel
38. 14-1962 2X End Cap Assy
39. 20-3263A Pendant Arm
40. 25-6948A Pendant Arm Cover
41. 25-6946A Pendant Arm Support
42. 32-9841 Electrical Control Box Assy
43. 30-7741 Right Swiveling Caster
    30-7742 Left Swiveling Caster
44. 25-7348A Base Right Panel
45. 25-7072 Coolant Tank Support
46. 25-7350 Base Bottom
47. 30-0857B Pendant Mount Assy
48. 28-0024 Top Beacon Light Assy
49. 25-1125A Front Pendant Enclosure
50. 58-3662 .375 Garden Hose Fitting
51. 59-2228 .375 Swing Valve Brass
52. 58-3600 .375 Hex Nipple
53. 58-1721 45 Degree Elbow
54. 32-5005 Coolant Pump Kit
55. 25-6838 Coolant Tank Filter
56. 25-7070 Pump Assy Bracket
57. 25-7069 Coolant Tank
58. 25-7071 Chip Tray
59. 59-0023 4X Door Hinge
60. 25-5856A Right Base Door
61. 25-5855A Left Base Door
62. 58-0227 2X Push Close Latch
63. 25-7346A Base Front Panel
64. 59-0814 Auto Lube Pump
65. 30-8257 Air Regulator Assy
66. 25-7347A Base Left Panel

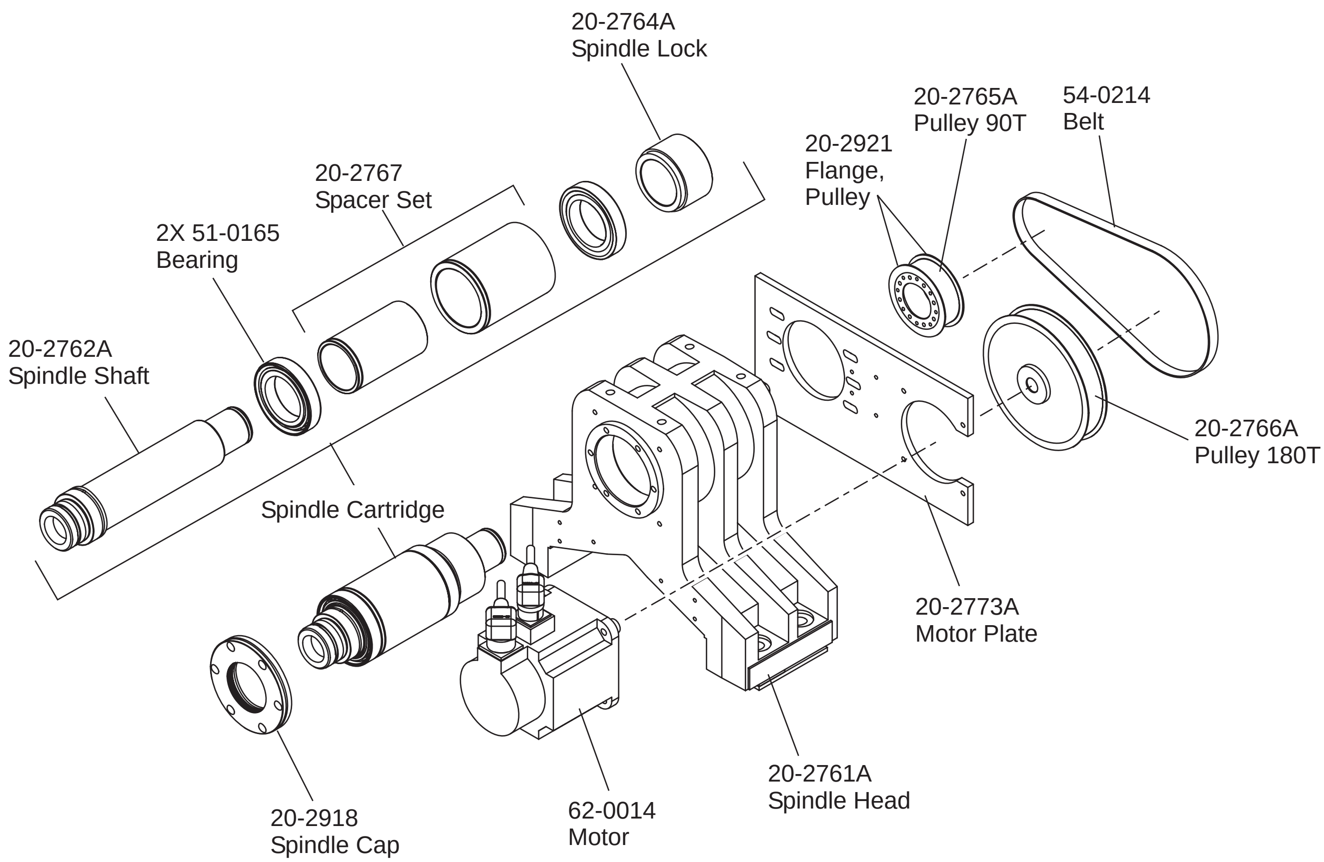
Office Lathe Internal Sheetmetal and Parts List



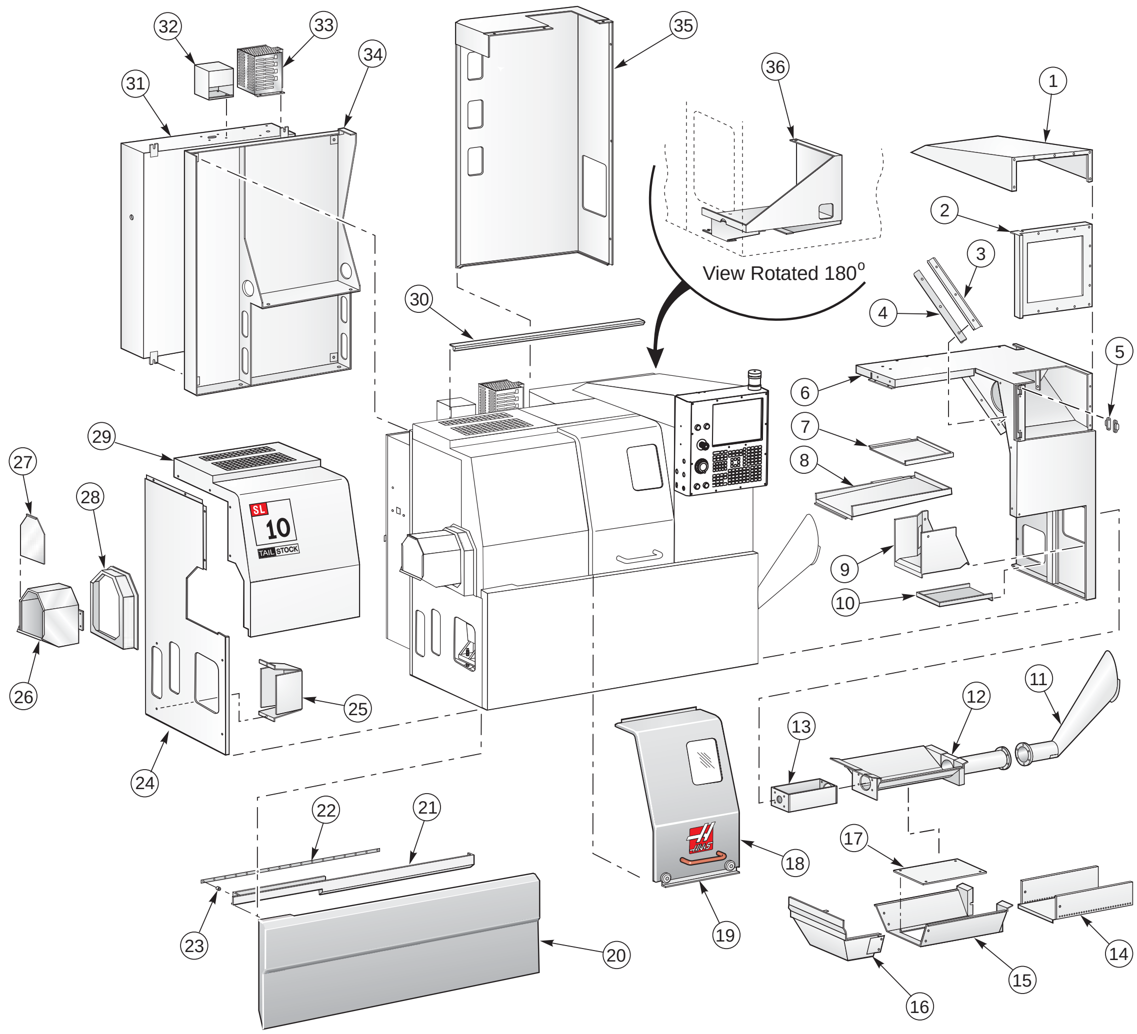
Office Lathe Internal Sheetmetal and Parts List

1. 49-0122 2X Track Roller
2. 20-3088A Lever AAC
3. 59-0789 Air Cylinder AAC
4. 25-6828A Spindle Belt Cover
5. 20-3090 Cylinder Mount AAC
6. 54-0214 Belt
7. 20-2766A Pulley 180T 3mm
8. 62-0014 Servo Motor
9. 30-8277 Solenoid Assy
10. 20-3087 Drawbar AAC (30-7451 Air Collet Closer)
11. 20-3107 Locking Collar AAC (30-7451 Air Collet Closer)
12. 20-2056 Coolet Closer Cone (30-7451 Air Collet Closer)
13. 20-2055 Detent Ring (30-7451 Air Collet Closer)
14. 57-2057 Fiber Washer
15. 20-3091 Drawbar Bushing
16. 20-2921 2X Pulley Flange 90T 3mm
17. 20-2765A Pulley 90T 3mm
18. 20-2764A Spindle Lock 60mm
19. 20-2773A Motor Mount Plate
20. 25-7548A Spindle Cable Shield
21. 51-0165 2X Bearing
22. 20-2767 Spacer Set 60mm
23. 20-2762A Spindle Shaft
24. 22-4052 5C Lock Screw
25. 20-2761A Spindle Head Machined
26. 57-2875 O-Ring
27. 20-2918 Spindle Cap
28. NOT USED
29. 32-2195 Proximity Switch
30. 25-5846 Switch Bracket
31. 20-2739A Bed Machined
32. 25-6848 2X X-Axis Floater Waycover
33. 59-0883 4X Spring - Ext - 3/8 x 2.50 lg x .035
34. 25-5842A X-Axis Waycover
35. 50-0106 4X Linear Guide
36. 25-6068B Z-Axis Right Waycover
37. 20-3082 X-Axis Nut Housing
38. 20-2748 X-Axis Bumper
    20-2754 Ball Screw Bearing Cap
39. 20-2747 2X Motor Mount
    59-1086 Plug
40. 62-2495A 2X Servo Motor
41. 32-2193 Proximity Switch
    20-2834 Switch Spacer
42. 25-6847 X-Axis Bottom Waycover
43. 30-7542B Y-Axis Lube Line Assy
44. 24-0110 2X Ball Screw
45. 20-2751 Y-Axis Ball Screw Bumper
46. 20-2746A Y-Axis Nut Housing
47. 20-2750 Y-Axis Bumper
48. 20-2742B Saddle Machined
49. 30-7541C X-Axis Lube Line Assy
50. 20-2749 Ball Screw Bumper
51. 20-2741 2X Saddle Spacer
52. 25-6831 X-Axis Short Waycover
53. 25-6067A Z-Axis Left Waycover
54. 20-2743A Table Machined
55. 20-2775 2X Riser Rail

Office Lathe Exploded Spindle Head

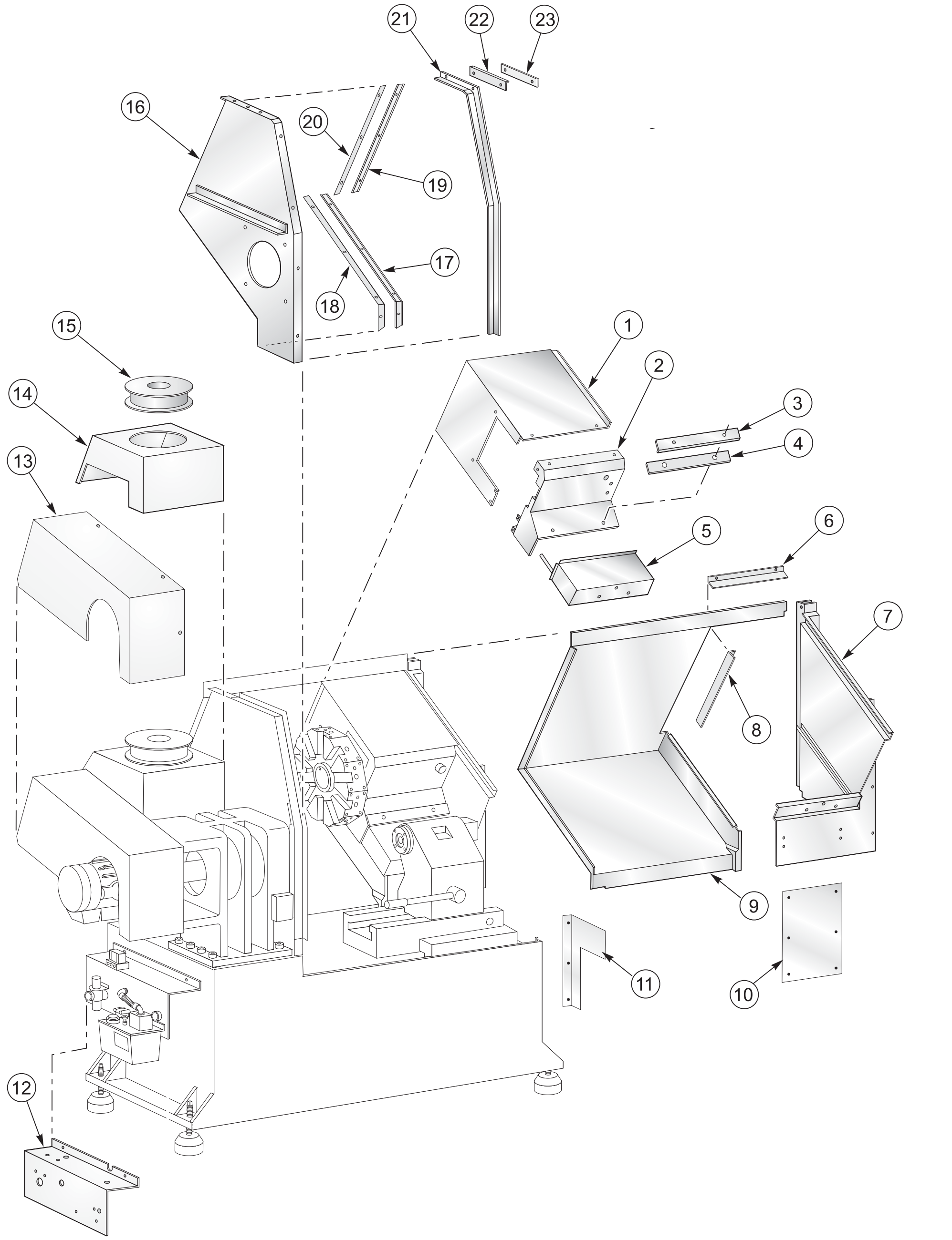


SL-10 External Sheetmetal and Parts List

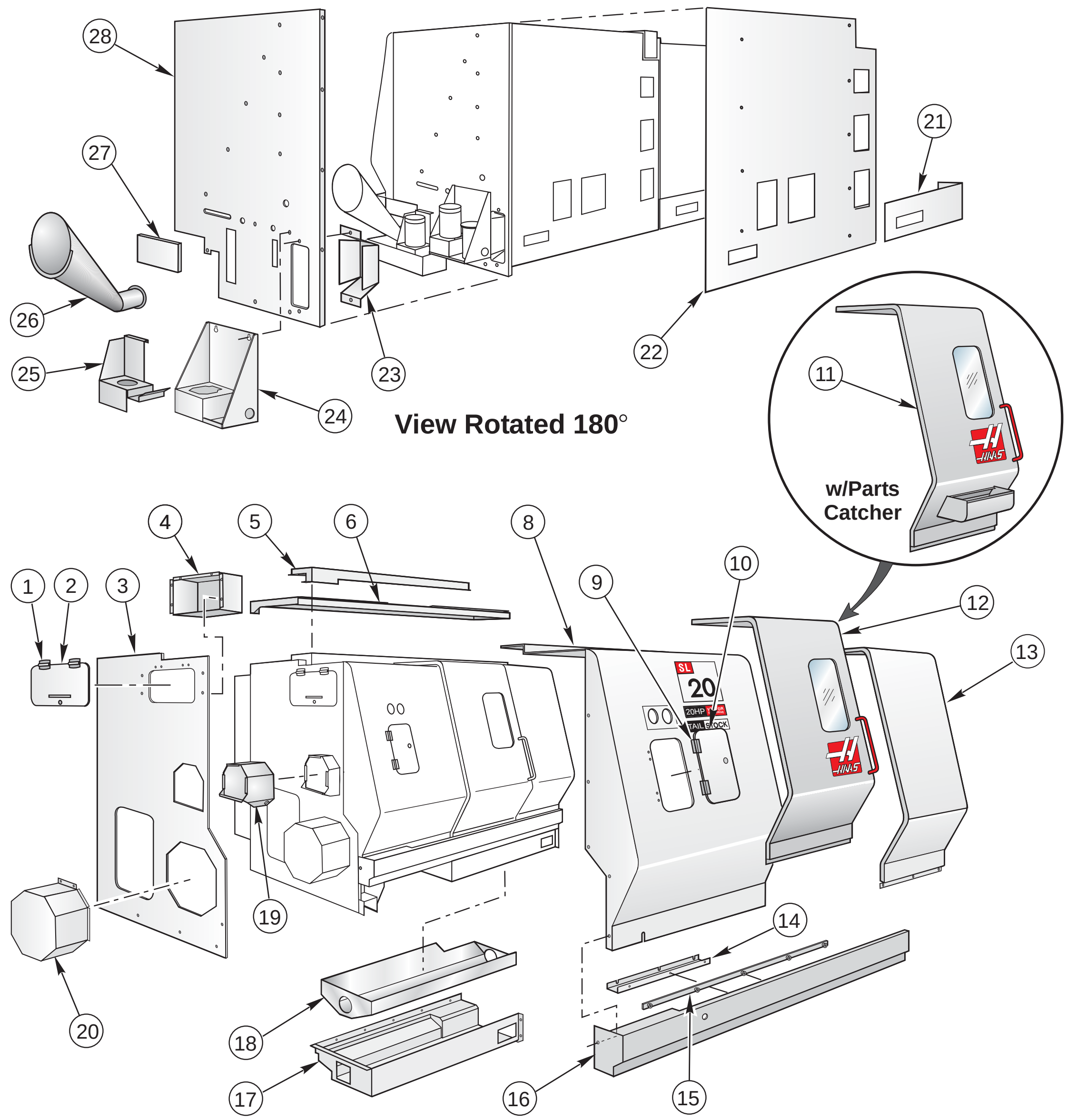


1.	25-0875	Monitor Cover
2.	25-0876	Pendant Back Cover
3.	25-0879	Z-Axis Right Bottom Wiper Retainer
4.	26-0030	Z-Axis Right Bottom Wiper Felt
5.	59-0009	R-Type Hinge Half
6.	25-0868A	Right Side Panel Weldment
7.	25-1002	Tailstock Pan
8.	25-0890	NOTS Tray
9.	25-1023	Motor Pump Coolant Tray
10.	25-0889	Coolant PM Tray
11.	25-0548	Discharge Chute Weldment
12.	25-0887	Auger Pan Weldment
13.	25-6551	Auger Mount
14.	25-0888	Chip Tray Extension
15.	25-0878B	Chip Tray Right
16.	25-0877B	Chip Tray Left
17.	25-6574	Chip Tray Bottom
18.	25-0858	Door Weldment (25-0016 Window)
19.	25-0860	Door Inner Liner
20.	25-0862	Front Skirt
21.	25-0865	Lower Door Rail
22.	22-6506	Door V-Track
23.	20-6016	Door V-Track Spacer
24.	25-6190	Bottom Left Side Panel
25.	25-0398	Tramp Lube Oil Bottle Panel
26.	25-6185	Coolant Collector
27.	25-0606	Coolant Collector Door
28.	25-6150	Coolant Collector Enclosure
29.	25-6189A	Top Left End Panel
30.	26-0869	Upper Door Rail
31.	25-0025D	Main Electrical Control Box
32.	25-8709	J-Box
33.	32-0042	Regen Assembly
34.	25-0857	Control Box Bracket
35.	25-0867	Rear Panel
36.	25-0863	Hydraulic Pump Mount Weldment

SL-10 Internal Sheetmetal and Parts List

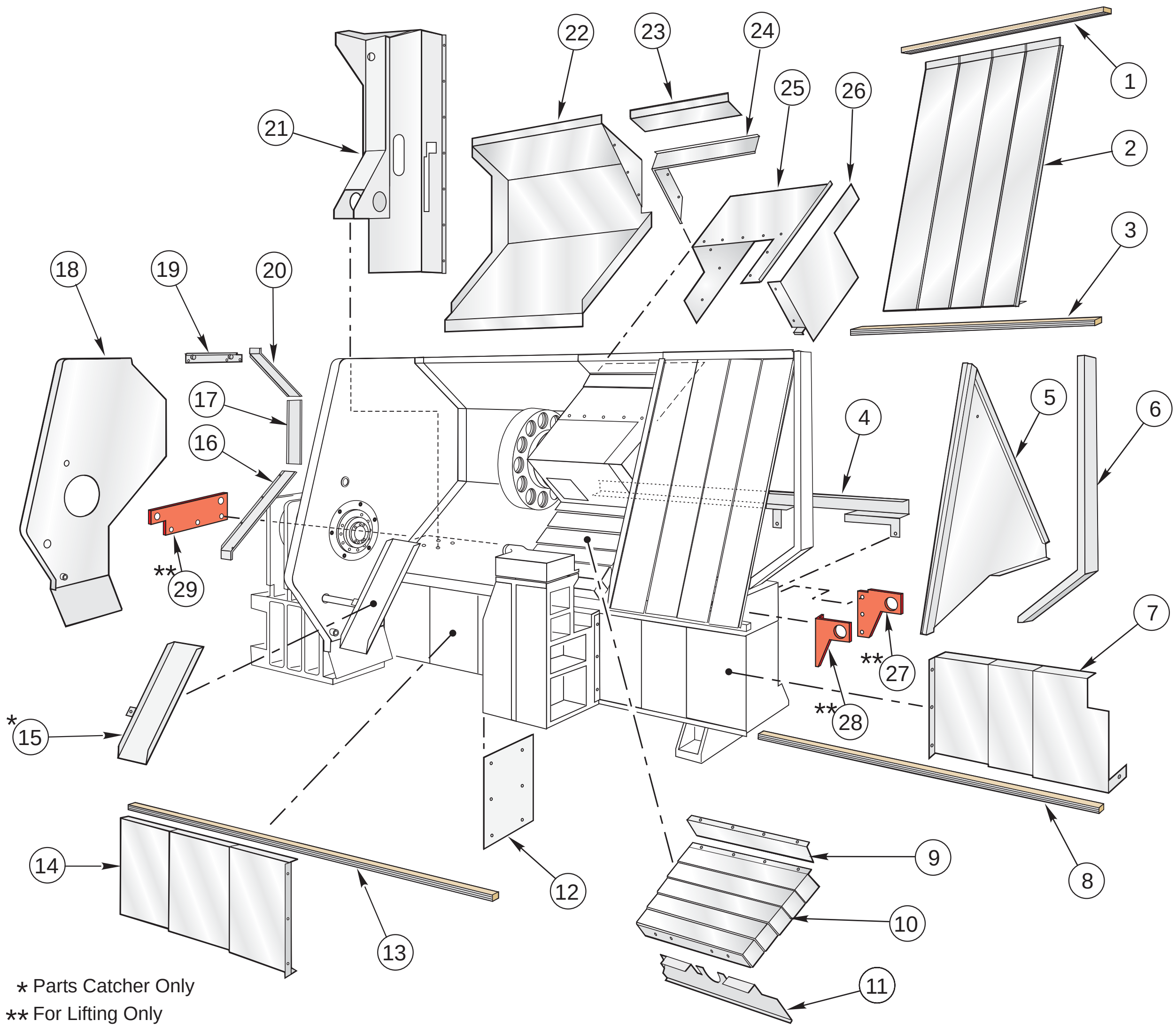


1.	25-0870	X-Axis Top Cover	13.	25-0885	Belt Cover
2.	25-0871	X-Axis Front Cover	14.	25-0886	Fan Mount
3.	25-0983	X-Axis Wiper Retainer	15.	36-3035	Spindle Motor Fan
4.	26-0038	X-Axis Way Cover Felt	16.	25-0861	Fixed Bulkhead
5.	25-0872	X-Axis Way Cover	17.	25-0880	Z-Axis Left Bottom Wiper Retainer
6.	26-0034	X-Axis Top Wiper Felt	18.	26-0032	Z-Axis Left Bottom Wiper Felt
7.	25-0866	Moving Bulkhead	19.	25-0881	Z-Axis Left Top Wiper Retainer
8.	26-0035	X-Axis Side Wiper Felt	20.	26-0033	Z-Axis Left Top Wiper Felt
9.	25-0873	Z-Axis Sliding Cover	21.	25-0859	Door Drain
10	26-0036	Cover, Z-axis Right	22.	26-0039	Door Wiper
11.	25-6138A	Chip Shield Wedge SL-10	23.	25-0947	Top Wiper Retainer
12.	25-7195	Lube Rack Bracket			



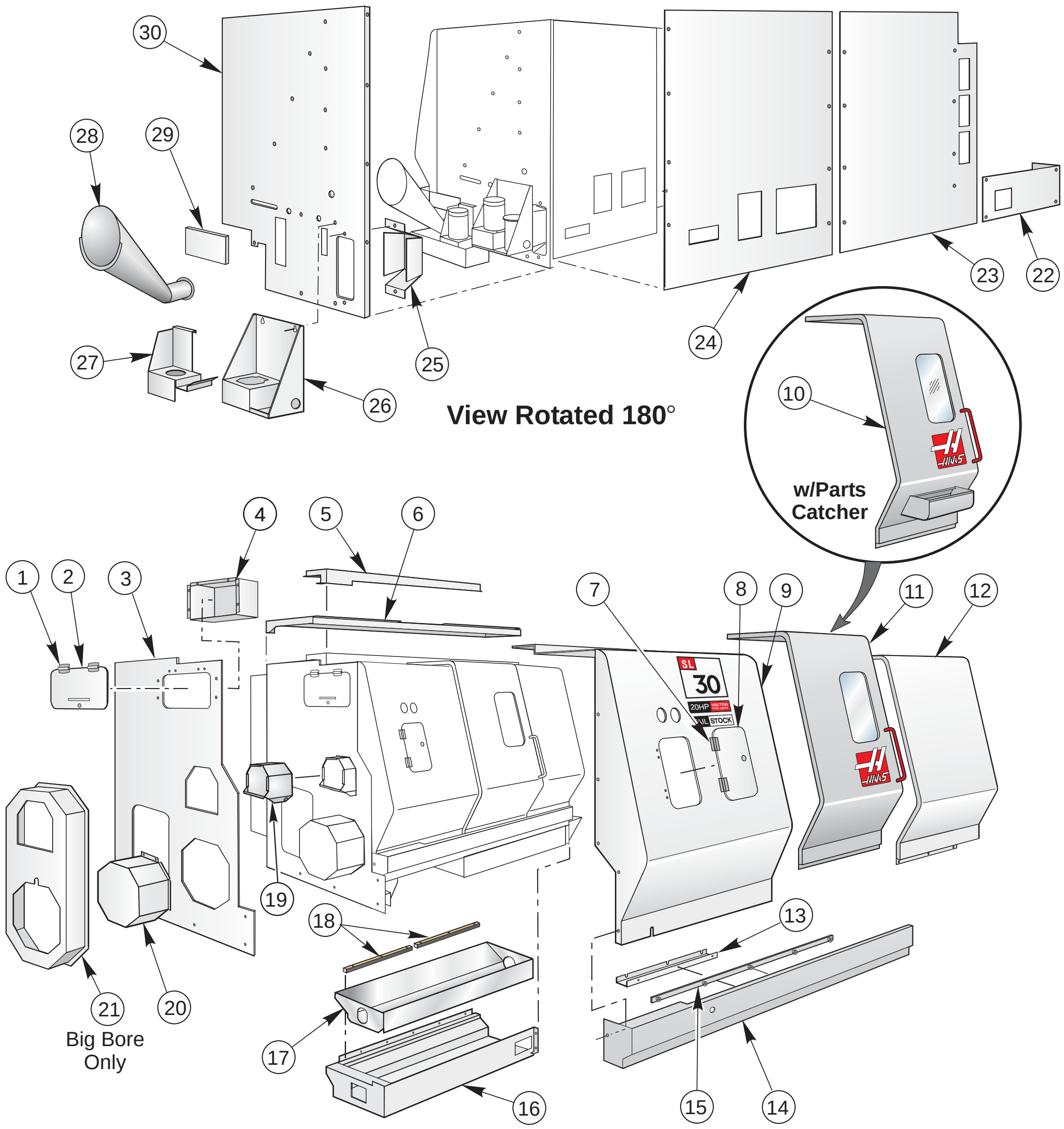
1.	59-0023	Door Hinges
2.	25-1350	Toolbox Door
3.	25-8909F	Left Side Panel
4.	25-1349	Toolbox
5.	25-8935D	Top Door Roller Mount
6.	25-8916B	Top Panel
7.	Not Used	
8.	25-8924G	Left Front Panel
9.	59-0023	Door Hinges
10.	25-8021	Access Door
11.	30-1489	Door Assembly w/Parts Catcher
12.	30-1486A	Door Assembly
13.	25-8919C	Right Front Panel
14.	25-8784C	Door Drip Panel
15.	22-6506	Door V-Track
16.	25-8903C	Front Rail
17.	25-6550A	Chip Auger Tray
18.	25-8971C	Chip Auger Pan
19.	25-0607	Coolant Collector
	25-0606	Door
20.	22-6115A	Motor Enclosure
21.	25-0428	Left Bottom Rear Cover
22.	25-1459A	Rear Cover
23.	25-0398	Tramp Lube Oil Pan
24.	25-0243B	HP Pump Bracket
25.	25-8067B	Coolant Pump Mount
26.	25-0548	Discharge Chute
27.	25-6628	Discharge Chute Filler
28.	25-8914F	Right End Panel
	25-0623C	Right End Panel (TL-15)

SL-20 Internal Sheetmetal and Parts List

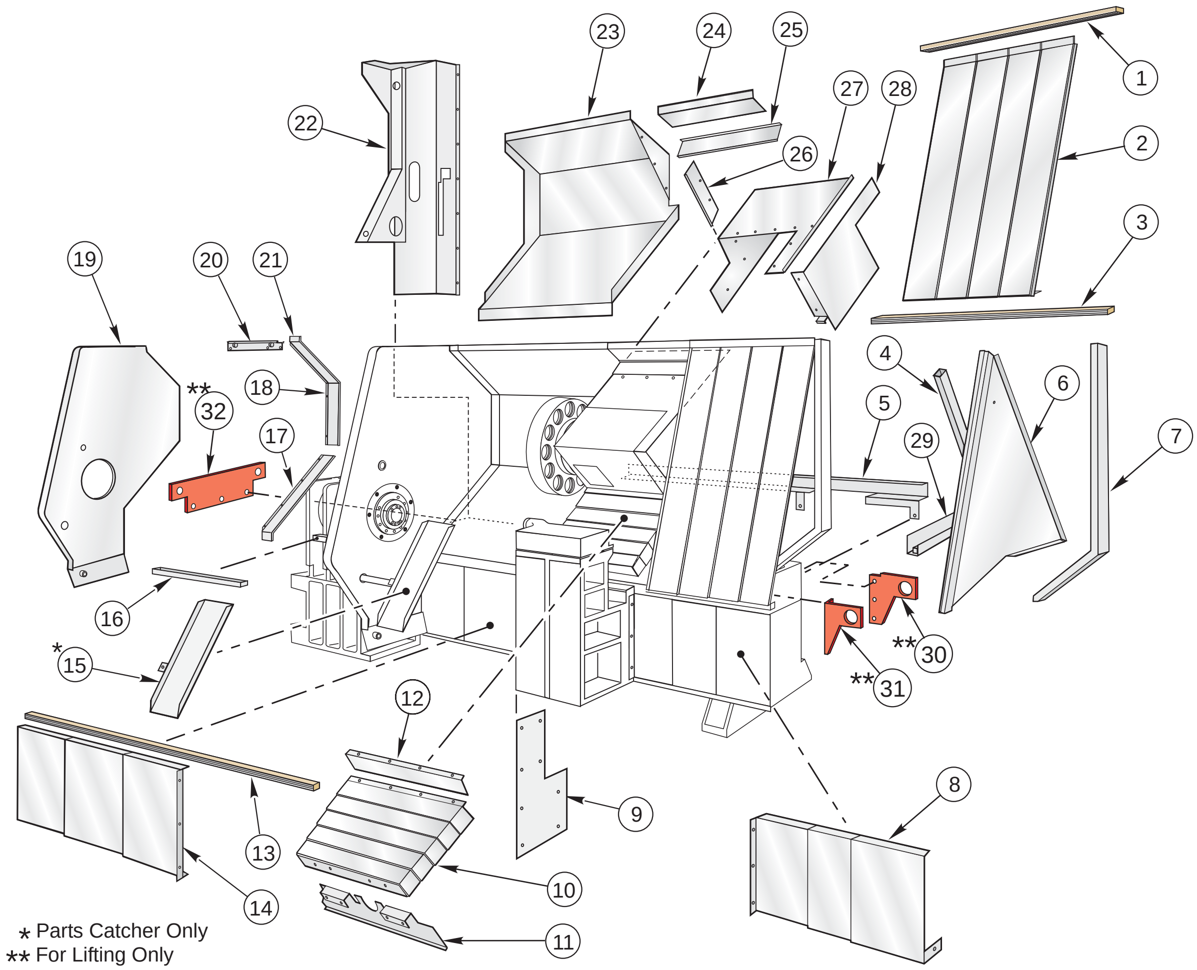


* Parts Catcher Only
** For Lifting Only

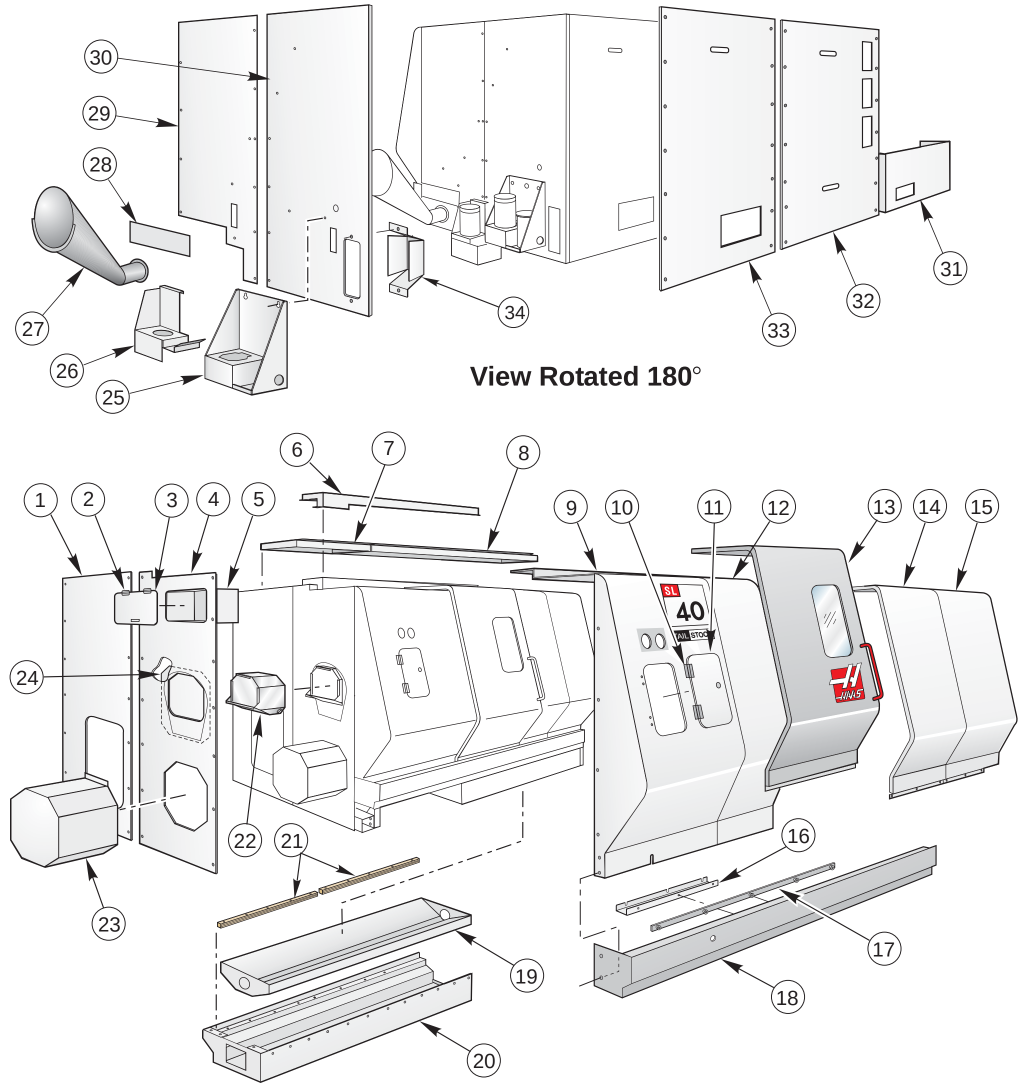
1.	22-8053	Upper Waycover Guide
2.	25-8051	Z-Axis Waycovers
3.	22-8052	Lower Waycover Guide
4.	25-4423	Cable Rail
5.	25-8933D	Moving Bulkhead
6.	25-8908A	Right Support
7.	25-4329	Tailstock Right Waycovers
8.	22-8075A	Lower Tailstock Waycover Guide
9.	25-6458	Tool Changer Front Plate
10.	25-8665A	Tool Changer Waycover
11.	25-8926C	Front Wedge Cover
12.	25-0250A	Tailstock Cover
13.	25-4317	Upper Tailstock Waycover Guide
14.	25-4316	Left Tailstock Waycovers
15.	25-6512	Parts Catcher Tray (Optional)
16.	25-4320	Z-Axis Bottom Wiper
17.	25-4321	Z-Axis Back Wiper
18.	25-8938E	Fixed Bulkhead
19.	30-3191	Upper Door Wiper Assembly
20.	25-4322	Z-Axis Top Wiper
21.	25-8925C	Control Box Mounting Bracket
22.	25-8921D	Rear Sliding Cover
23.	25-8928A	Tool Changer Tunnel Panel
24.	25-4324	X-Axis Wiper
25.	25-8605B	Tool Changer Sliding Cover
26.	25-8694A	Tool Changer Splash Shield
27.	20-1633	Right Rear Lifting Bracket
28.	20-1632	Right Front Lifting Bracket
29.	20-1631	Left End Lifting Bracket



1.	59-0023	Door Hinges (2)
2.	25-1350	Toolbox Door
3.	25-8814E	Left Side Panel
4.	25-1349	Toolbox
5.	25-8819C	Top Door Roller Mount
6.	25-8818D	Top Right Panel
7.	59-0023	Door Hinges (2)
8.	25-8021	Access Door
9.	25-8820E	Left Front Panel
10.	30-1490	Door w/Parts Catcher Assy
11.	30-1487	Door Assy
12.	25-8786C	Right Front Panel
13.	25-6513A	Door Drip Tray
14.	25-8774C	Front Rail
15.	22-6023	Door V-Track
16.	25-6557	Chip Tray
17.	25-8880B	Chip Auger Pan
18.	20-1521	Lower Tailstock Waycover Guide
19.	25-0607	Coolant Collector (25-0606 Door)
20.	25-6115A	Motor Enclosure
21.	25-6510	Motor Enclosure (Big Bore)
22.	25-0517	Left Bottom Rear Panel
23.	25-0526	Center Rear Panel
24.	25-0518	Right Rear Panel
25.	25-0398	Tramp Lube Oil Pan
26.	25-0243B	HP Pump Bracket
27.	25-8067B	Coolant Pump Mount
28.	25-0548	Auger Discharge Chute
29.	25-0283	Chip Tray Filler
30.	25-8813G	Right Side Panel

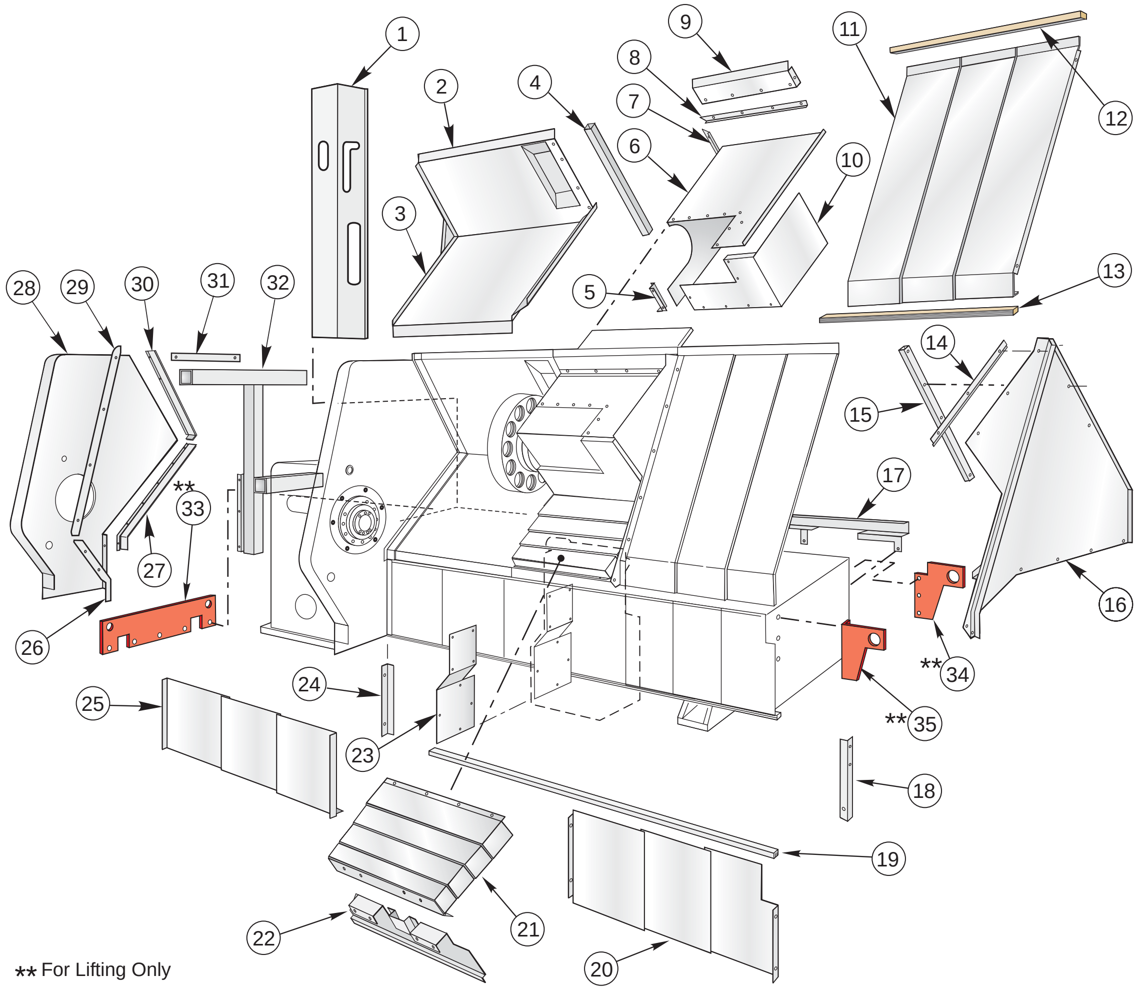


1. 22-8049 Z-Axis Top Waycover Guide
2. 25-8047 Z-Axis Waycover
3. 22-8048 Z-Axis Bottom Waycover Guide
4. 22-8783 Moving Bulkhead Support
5. 22-0830 Cable Channel Cover
6. 25-8843A Moving Bulkhead
7. 25-6319 Right End Support Bracket
8. 25-8025B Right Tailstock Waycover
9. 25-0251A Tailstock Cover
10. 25-8757 Tool Changer Waycover
11. 25-8755C Front Wedge Cover
12. 25-6458 Tool Changer Waycover Mount
13. 25-8774 Upper Tailstock Waycover Guide
14. 25-8756B Left Tailstock Waycover
15. 25-6512 Parts Catcher Tray (Optional)
16. 25-8849A Z-Axis Drip Tray
17. 30-3647 Z-Axis Lower Wiper Assembly
18. 30-3646 Z-Axis Middle Wiper Assembly
19. 25-8824C Fixed Bulkhead
20. 30-3192 Door Wiper Assembly
21. 30-3645 Z-Axis Upper Wiper Assembly
22. 25-8807B Control Box Mounting Bracket
23. 25-8754C Rear Sliding Cover
24. 25-8782B Tool Changer Tunnel Panel
25. 30-3648 X-Axis Top Wiper Assembly
26. 30-3649 X-Axis Side Wiper Assembly
27. 25-8823B X-Axis Tool Changer Sliding Cover
28. 25-8772A Tool Changer Splash Shield
29. 25-8830A X-axis Drip Channel
30. 20-1591 Right Rear Lifting Bracket
31. 20-1590 Right Front Lifting Bracket
32. 20-1589 Left End Lifting Bracket



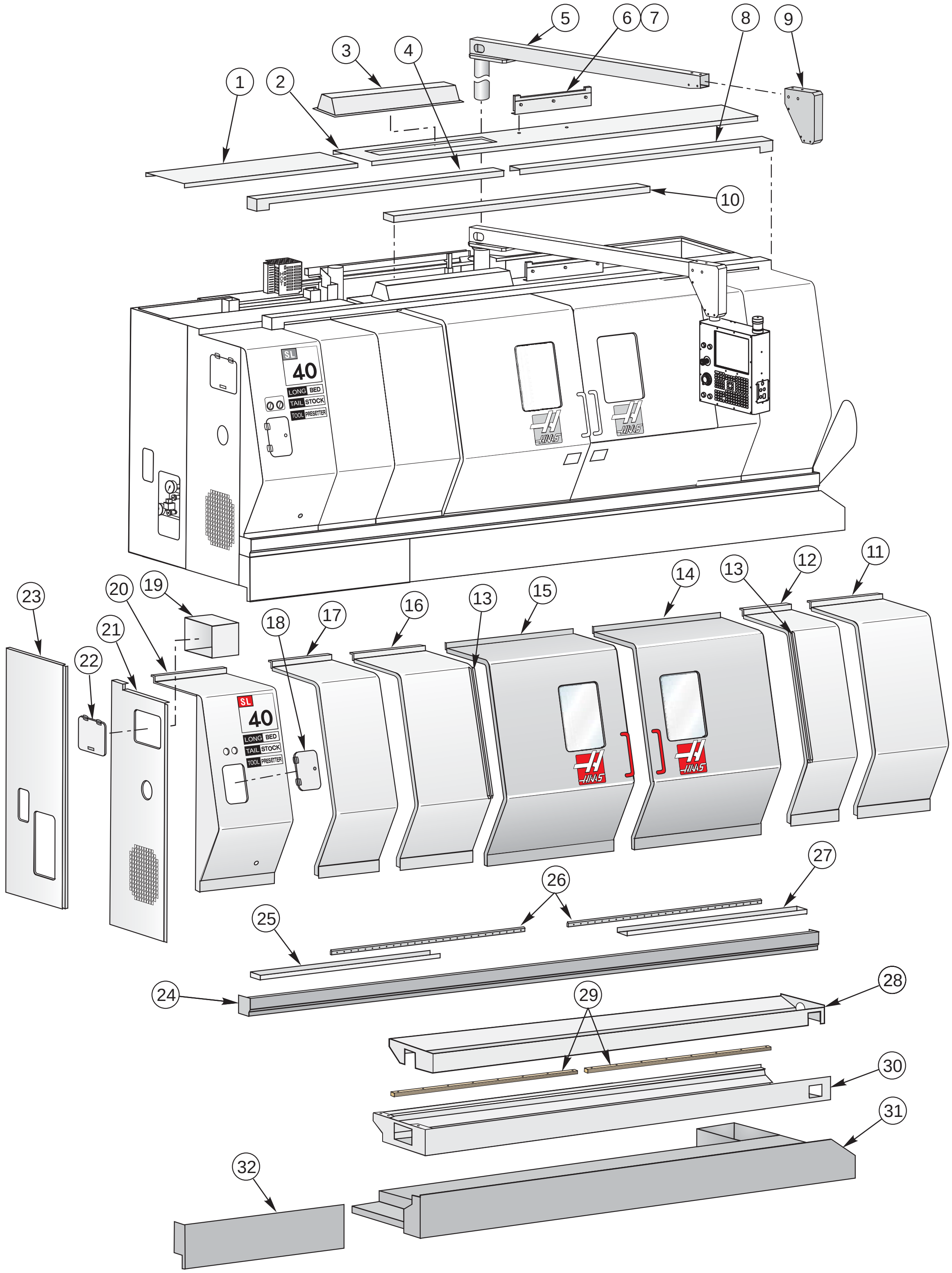
1. 25-0780 Left End Rear Panel
2. 59-0023 Toolbox Door Hinge
3. 25-1350A Toolbox Door
4. 25-8211F Left End Front Panel
5. 25-4729 Toolbox
6. 25-8285B Door Rail Mount
7. 25-8218A Left Top Panel
8. 25-8219A Right Top Panel
9. 25-8206A Front Left Panel
10. 59-0023 Access Door Hinge
11. 25-8021 Access Door
12. 25-8207A Front Left Middle Panel
13. 30-1488 Door Assembly
14. 25-8208B Front Right Middle Panel
15. 25-8209A Front Right Panel
16. 25-6311 X-Axis Drip Tray
17. 22-6023 Door V-Track
18. 25-8235 Front Rail
19. 25-8269A Chip Auger Pan
20. 25-6601 Chip Tray
21. 22-8301 Lower Tailstock Waycover Guide (2)
22. 25-0640C Coolant Collector
23. 25-6129 Motor Enclosure
24. 25-0641 Left End Front Panel Filler
25. 25-0243B HP Pump Bracket
26. 25-8067B Coolant Pump Mount
27. 25-0548 Auger Discharge Chute
28. 25-0164 Discharge Chute Filler
29. 25-8213C Right End Front Panel
30. 25-8214C Right End Rear Panel
31. 25-0783 Rear Lower Left Cover
32. 25-0784 Rear Middle Panel
33. 25-0781 Rear Right Panel
34. 25-0398 Tramp Lube Oil Pan Bracket

SL-40 Internal Sheetmetal and Parts List

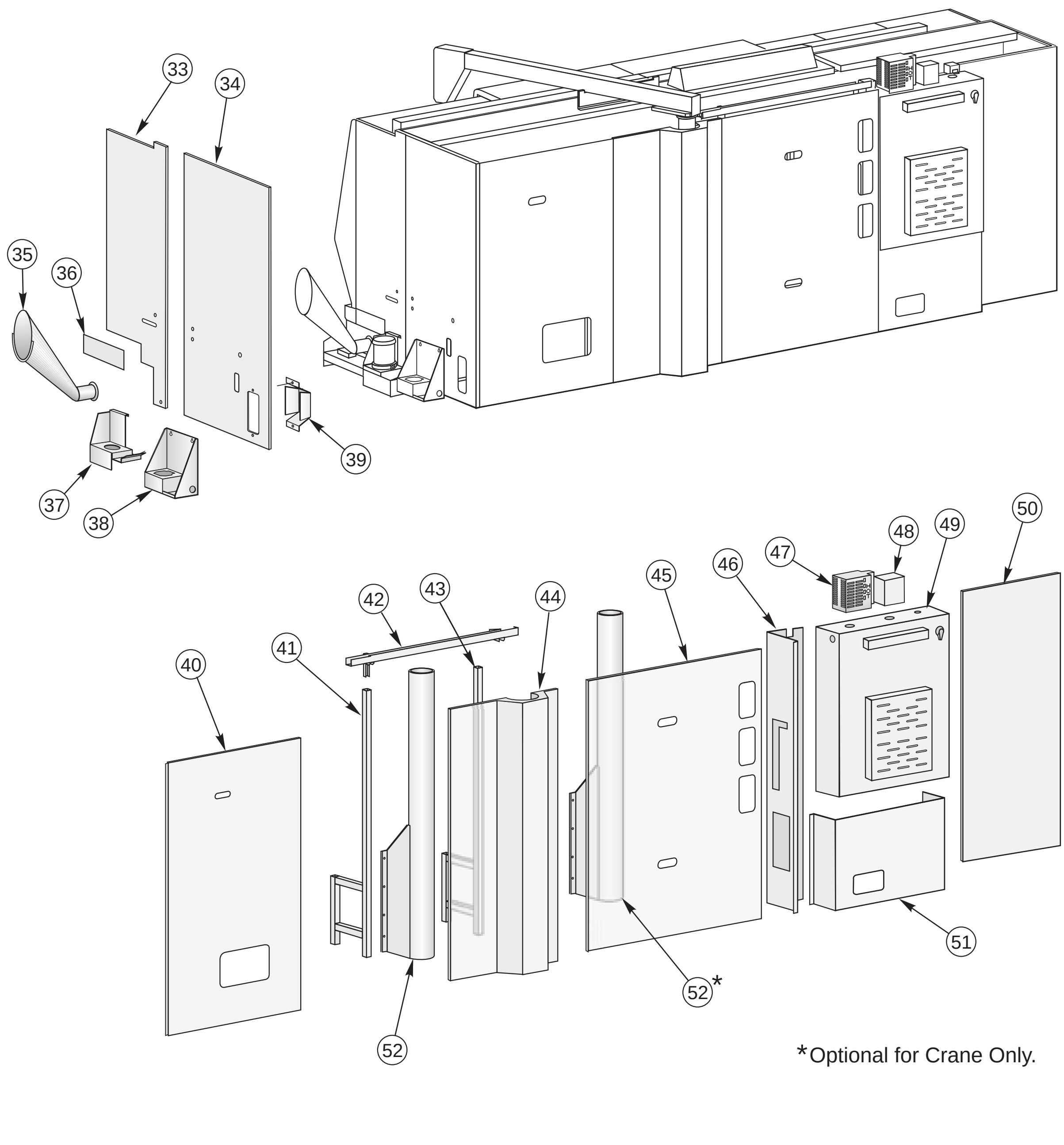


1.	25-0782	Control Box Mounting Bracket
2.	25-0145B	Z-Axis Top Rear Sliding Cover
3.	25-8246B	Z-Axis Bottom Rear Sliding Cover
4.	25-8653A	Z-Axis Waycover Support Bracket
5.	25-8261A	Tool Changer Cover Spacer
6.	25-8262C	Tool Changer Cover
7.	25-8253	X-Axis Vertical Wiper
8.	25-8254	X-Axis Horizontal Wiper
9.	25-8265	X-Axis Tunnel Panel
10.	25-8263	Tool Changer Splash Shield
11.	25-8247	Z-Axis Top Right Waycover
12.	25-8295	Z-Axis Top Waycover Guide
13.	25-8296	Z-Axis Bottom Waycover Guide
14.	25-8264	Z-Axis Strip
15.	22-8275	Moving Bulkhead Support
16.	25-8244C	Moving Bulkhead
17.	19-5793	Cable Channel Cover
18.	25-8241A	Right Enclosure Support
19.	25-8297	Tailstock Waycover Guide
20.	25-8249	Z-Axis Bottom Right Waycover
21.	25-8250	X-Axis Waycover
22.	25-8245A	Front Wedge Cover
23.	25-0252	Tailstock Cover
24.	25-8298	Spindle Housing Vertical Rail Drip
25.	25-8248	Z-Axis Bottom Left Waycover
26.	25-8267A	Lower Door Chip Seal
27.	25-8252A	Z-Axis Horizontal Wiper
28.	25-8243C	Fixed Bulkhead
29.	25-6312	Vertical Door Seal
30.	25-8251A	Z-Axis Vertical Wiper
31.	30-3193	Door Wiper Assembly
32.	22-8237A	Spindle Housing Support
33.	20-1634	Left End Lifting Bracket
34.	20-1636	Right Rear Lifting Bracket
35.	20-1635	Right Front Lifting Bracket

SL-40L External Sheetmetal (Sheet 1 of 2)



SL-40L External Sheetmetal (Sheet 2 of 2)

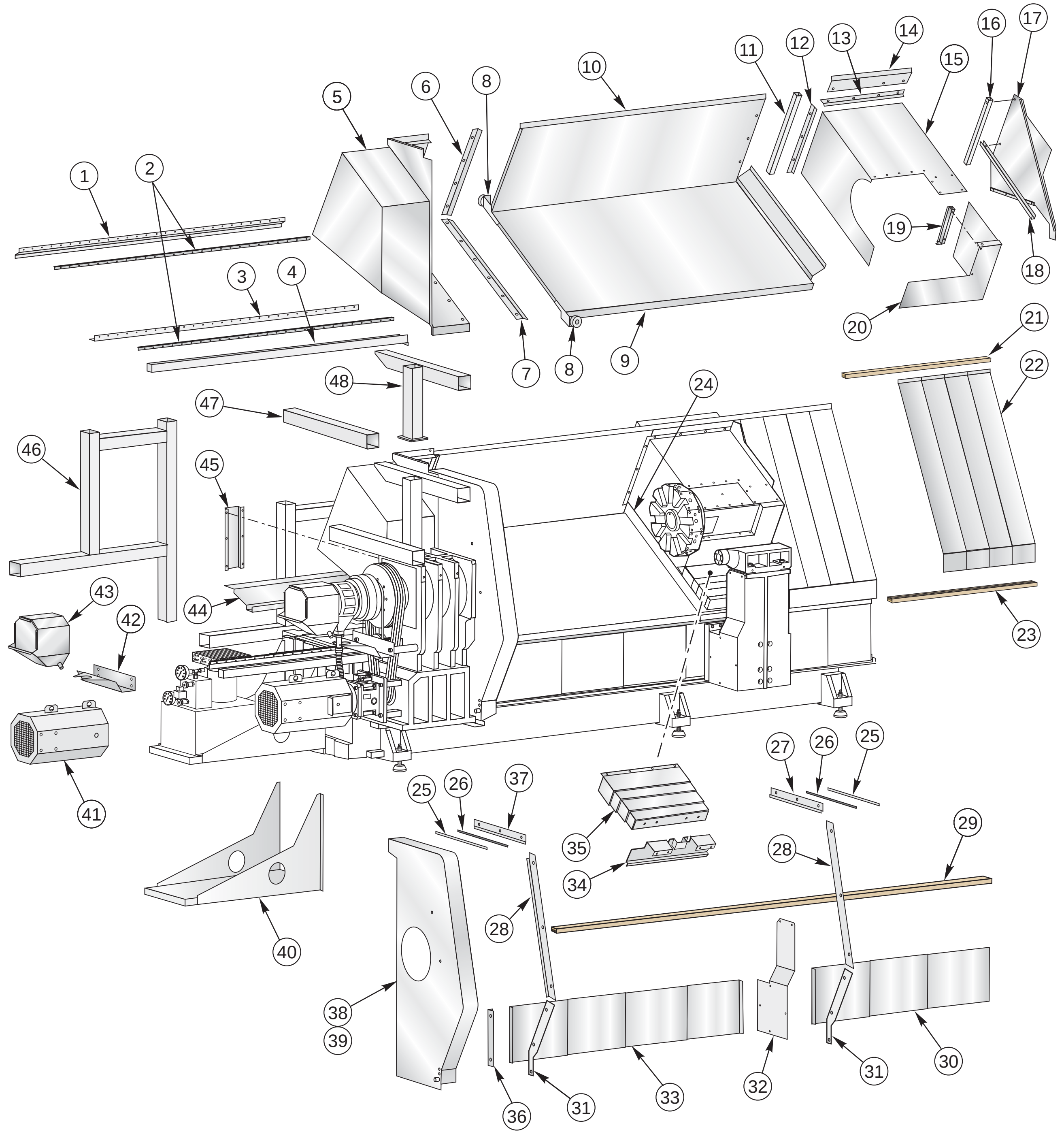


BACK VIEW

SL-40L External Sheetmetal Parts List

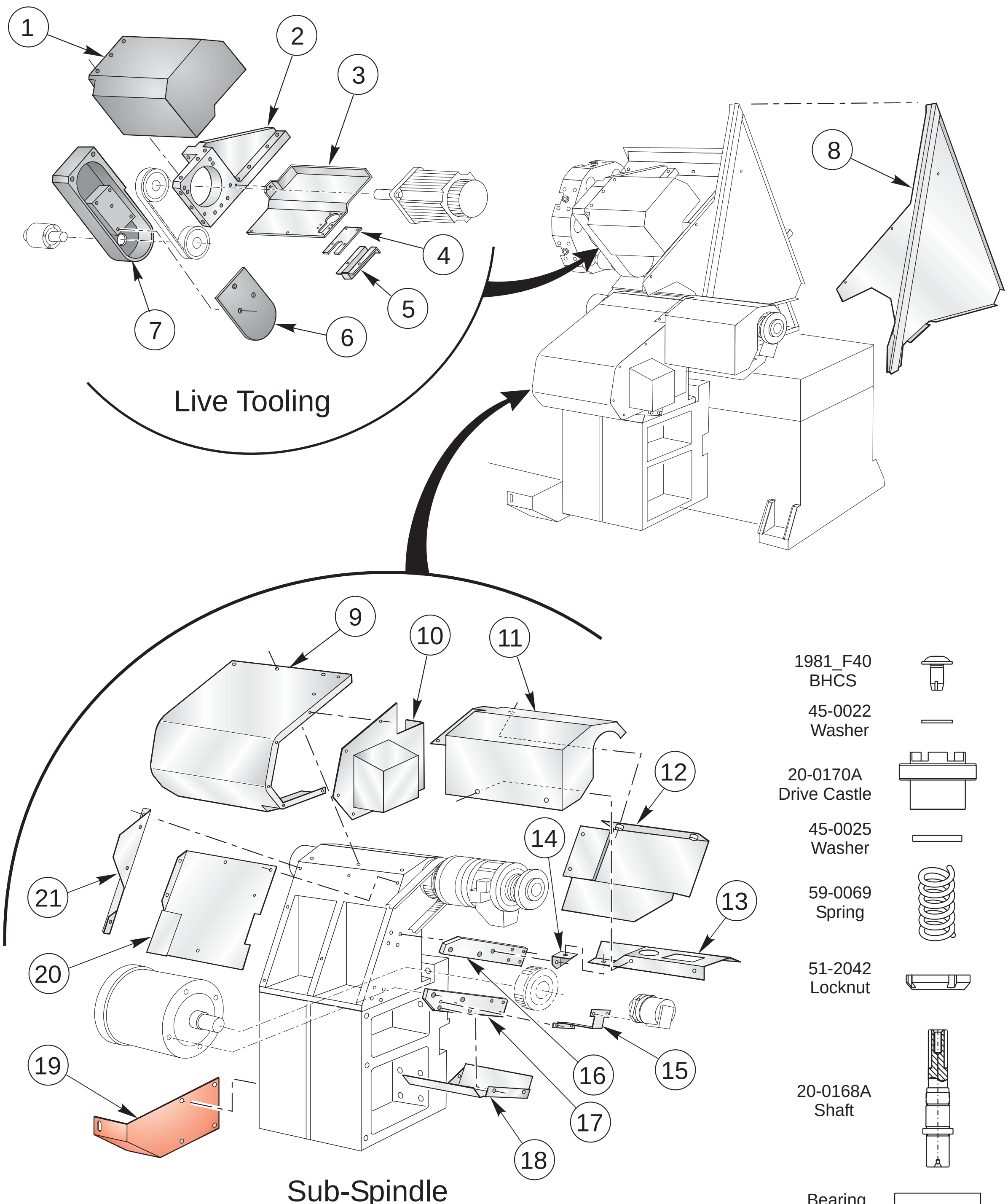
1. 25-4541 Left Top Front Panel
2. 25-4542 Right Top Front Panel
3. 25-4723 Light Fixture Body
4. 25-4563 Left Top Door Mount
5. 20-1775 Pendant Boom Arm
6. 20-1773 Boom Arm Detent
7. 25-4578 Boom Arm Detent Support
8. 25-4562 Right Top Door Mount
9. 25-4633 Pendant Arm End Cover
10. 25-4564 Door Support Bridge
11. 25-4539 Front Right Panel
12. 25-4535 Front Right Middle Panel
13. 25-6316 Drip Channel (2)
14. 25-4560 Right Door
15. 30-1488 Left Door
16. 25-8207A Front Left Middle Panel
17. 25-4543 Front Left Spacer Panel
18. 25-8021 Access Door
    59-0023 Hinges (2)
19. 25-1349 Toolbox
20. 25-8206A Front Left Panel
21. 25-5444 Left End Front Panel
22. 25-1350 Toolbox Door
    59-0023 Hinges (2)
23. 25-4546 Left End Rear Panel
24. 25-4533 Front Beam
25. 25-4558 Left Door Drip Rail
26. 20-1772 Z-Axis Roller V-Track (2)
27. 25-4557 Right Door Drip Rail
28. 25-4571 Chip Auger Pan
29. 25-4603 Lower Tailstock Waycover Guides (2)
30. 25-4570 Chip Tray
31. 25-4530 Coolant Tank
32. 25-4555 Lower Left Front Apron
33. 25-4540 Right Front Panel
34. 25-8214C Right Rear Panel
35. 25-0548 Auger Discharge Chute
36. 25-0164 Discharge Chute Filler
37. 25-8067B Coolant Pump Mount
38. 25-0243B HP Pump Mounting Bracket
39. 25-0348 Tramp Lube Oil Pan Bracket
40. 25-0781 Right Rear Panel
41. 20-0841 Right Back Panel Support
42. 25-4577 Monitor Cable Tray
43. 20-1768 Left Back Panel Support
44. 25-4554 Center Back Panel
45. 25-0784 Back Left Center Panel
46. 25-4532 Control Box Support
47. 30-3353 Regen Assembly
48. 25-8709 J-Box
49. 25-0025D Main Electrical Control Box Assembly
50. 25-4553 Left Back Panel
51. 25-0783 Left Back Lower Panel
52. 20-1254 Boom Support (2)

SL-40L Internal Sheetmetal



SL-40L Internal Sheetmetal Parts List

1. 25-4572 Rear V-Track Mount
2. 20-1772 Z-Axis V-Track (2)
3. 25-4573 Front V-Track Mount
4. 25-4556 Z-Axis Drip Channel
5. 25-4581 Tool Pocket
6. 25-4588 Z-Axis Top Wiper
   25-4590 Felt Clamp
7. 25-4589 Z-Axis Bottom Wiper
   25-4591 Felt Clamp
8. 25-4574 V-Track Rollers (2)
9. 25-4596 Z-Axis Bottom Left Waycover
10. 25-4595 Z-Axis Top Left Waycover
11. 22-8293A Z-Axis Waycover Support Bracket
12. 25-8253 X-Axis Vertical Wiper
13. 25-8254 X-Axis Horizontal Wiper
14. 25-4587 X-Axis Tunnel Panel
15. 25-8262C Tool Changer Cover
16. 22-8275 Bulkhead Support
17. 25-4580 Moving Bulkhead
18. 25-8258 Drip Channel
19. 25-8263 Splash Shield Support
20. 25-8261A Tool Changer Splash Shield
21. 25-4592 Z-Axis Top Front Waycover Guide
22. 25-4597 Z-Axis Right Waycovers
23. 25-4593 Z-Axis Bottom Front Waycover Guide
24. 26-8323 X-Axis Seal (Plastic)
25. 25-4566 Upper Door Wiper Back Plate (2)
26. 26-0086 Upper Door Wiper Felt (2)
27. 25-4568 Right Door Splash Shield
28. 25-6312 Vertical Door Seal (2)
    26-0087 Felt
29. 25-4585 Top Tailstock Waycover Guide
30. 25-4599 Tailstock Right Waycover
31. 25-8267A Lower Door Chip Seal
32. 25-0252 Tailstock Cover
33. 25-4737 Tailstock Left Waycover
34. 25-4586 Front Wedge Cover
35. 26-8250 X-Axis Waycover
36. 25-8298 Spindle Housing Vertical Rail Drip
37. 25-4567 Left Door Splash Shield
38. 25-4579 Fixed Bulkhead
39. 25-4745 Fixed Bulkhead Support
40. 25-4531 Left End HPU Support
41. 25-0128 Motor Enclosure
42. 25-4071 Shield
43. 25-0640C Coolant Collector
44. 25-4569 Bottom Cable Wedge Tray
45. 25-4583 Skate Board
46. 20-1776 Control Cabinet Truss
47. 25-4582 Box Support
48. 20-1777 Roof Support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Live Tooling
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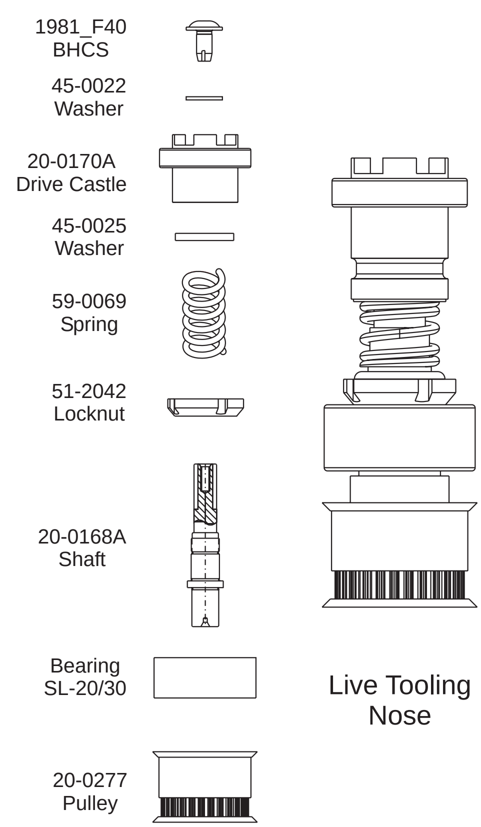
Sub-Spindle


1981_F40
BHCS
45-0022
Washer
20-0170A
Drive Castle
45-0025
Washer
59-0069
Spring
51-2042
Locknut
20-0168A
Shaft
Bearing
SL-20/30
20-0277
Pulley
Live Tooling
Nose

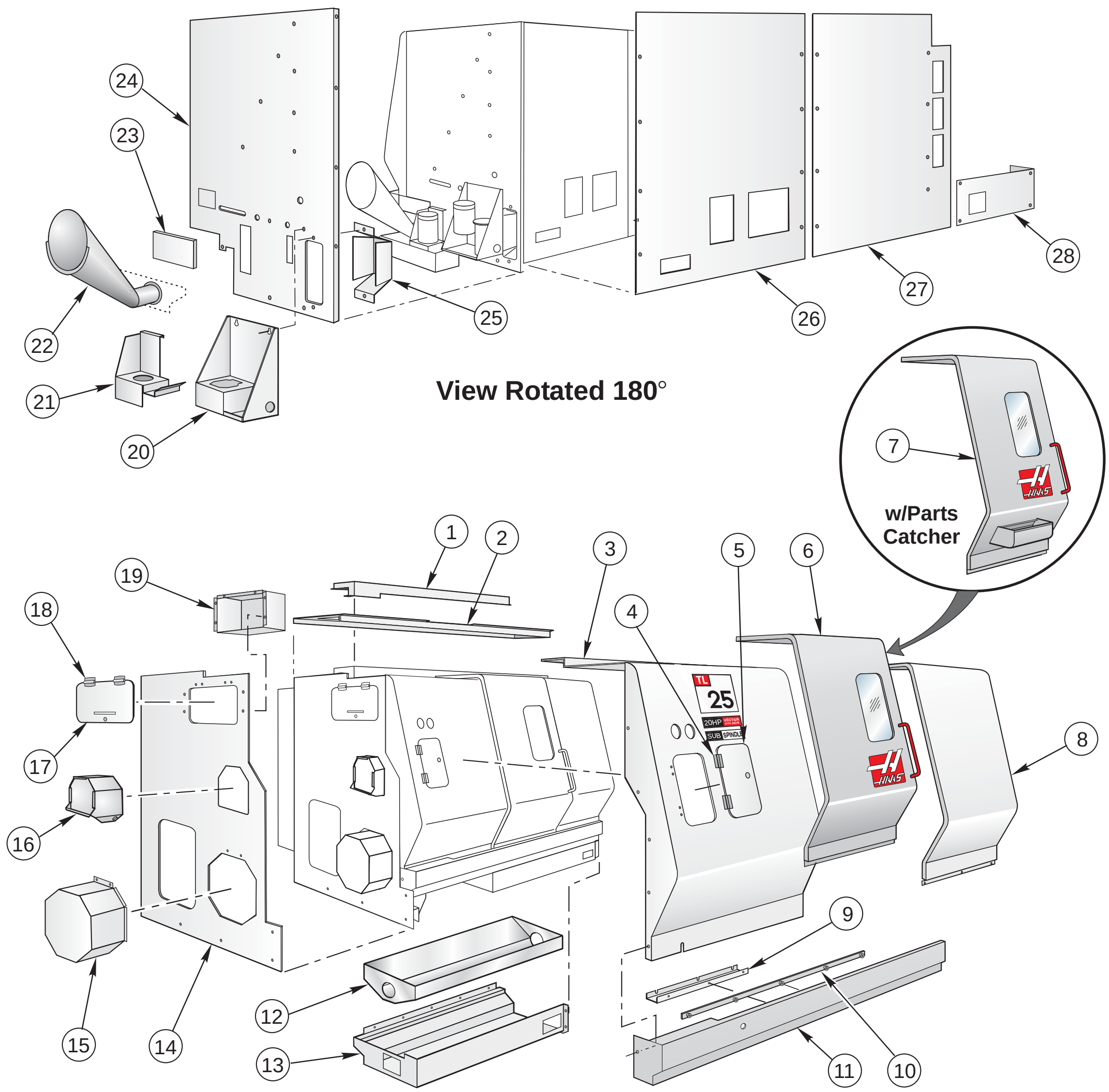
Live Tooling

1. 25-0138 Hood
2. 20-0163 Brace
3. 25-0137 Tray
4. 25-0135 Channel Cover
4a. 25-6552 Channel Cover (Larger Turret)
5. 25-0136 Channel
5a. 25-6553 Channel (Larger Turret)
6. 20-0161 Belt Arm Cover
7. 20-0162 Belt Arm

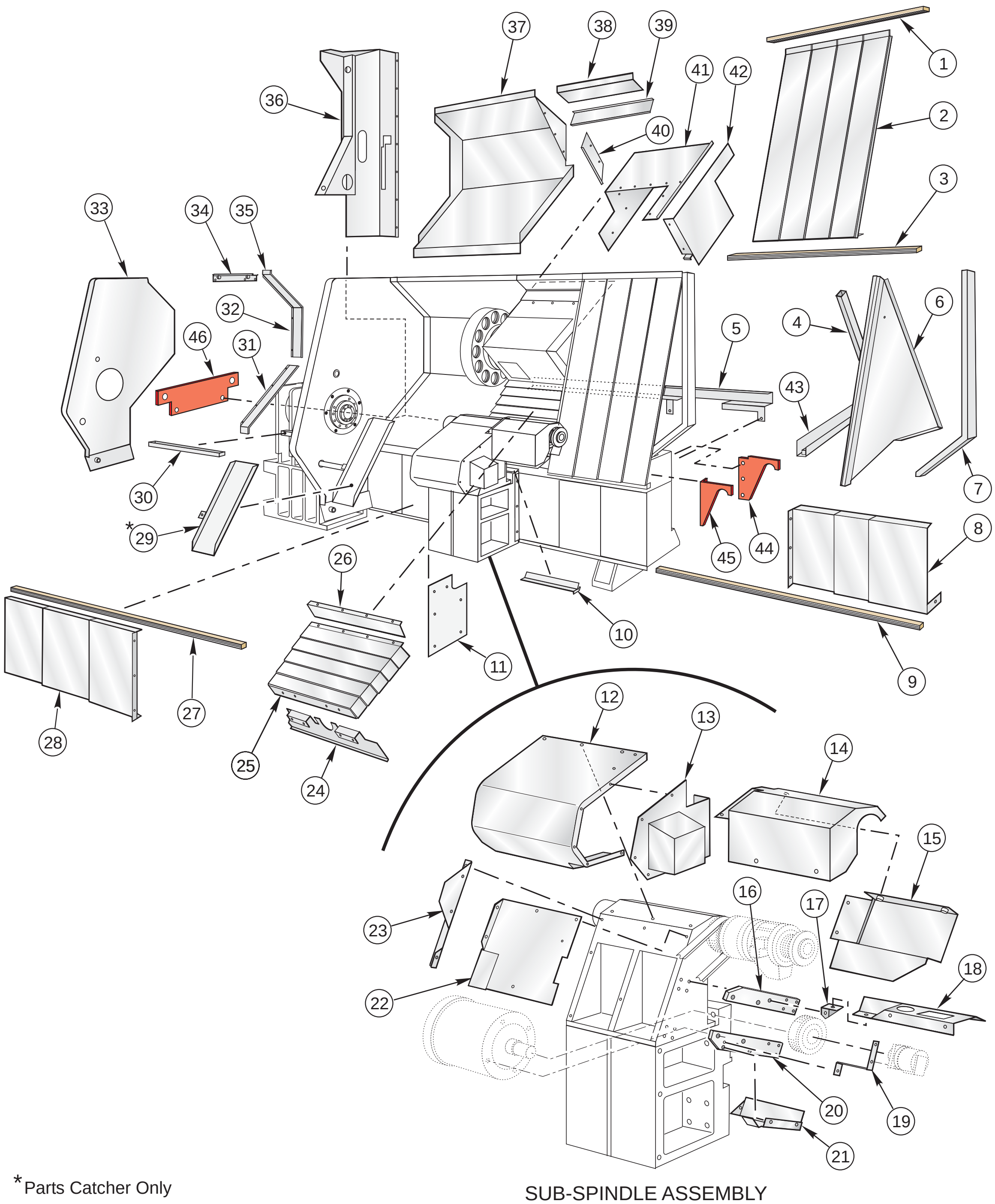
Sub-Spindle

8. 25-0617 Moving Bulkhead
9. 25-0610 Motor Cover
10. 25-0611 Encoder Cover
11. 25-0619 Front Union Shroud
12. 25-0618 Rear Union Shroud
13. 25-0620 Bottom Union Shroud
14. 25-0621 Little Bracket
15. 25-0615 Encoder Bracket
16. 20-0631 Upper Motor Arm
17. 20-0632 Lower Motor Arm
18. 25-0613A Duct Shield
19. 25-0665A Shipping Bracket
20. 25-0612 Heat Shield
21. 25-0614A Fan Shield

TL-25 External Sheetmetal and Parts List



1. 25-8819C Top Door Roller Mount
2. 25-8818D Top Right Panel
3. 25-8820D Left Front Panel
4. 59-0023 Door Hinge (2)
5. 25-8021 Access Door
6. 30-1487A Door Assembly
7. 30-1490 Door w/Parts Catcher Assembly
8. 25-8786C Right Front Panel
9. 25-6513A X-Axis Drip Tray
10. 22-6023 Door V-Track
11. 25-8774C Front Rail
12. 25-8880B Chip Auger Pan
13. 25-6557A Chip Tray
14. 25-8814E Left Side Panel
15. 25-6115A Motor Enclosure
16. 25-0607 Coolant Collector (25-0606 Door)
17. 25-1350 Toolbox Door
18. 59-0023 Door Hinge (2)
19. 25-1349 Toolbox
20. 25-0243B High Pressure Pump Bracket
21. 25-8067B Coolant Pump Mount
22. 25-0548 Auger Discharge Chute
23. 25-0283 Chip Tray Filler
24. 25-4345A Right End Panel
25. 25-0398 Tramp Lub Oil Pan Bracket
26. 25-0518 Right Rear Panel
27. 25-0526 Center Rear Panel
28. 25-0517 Left Bottom Rear Cover

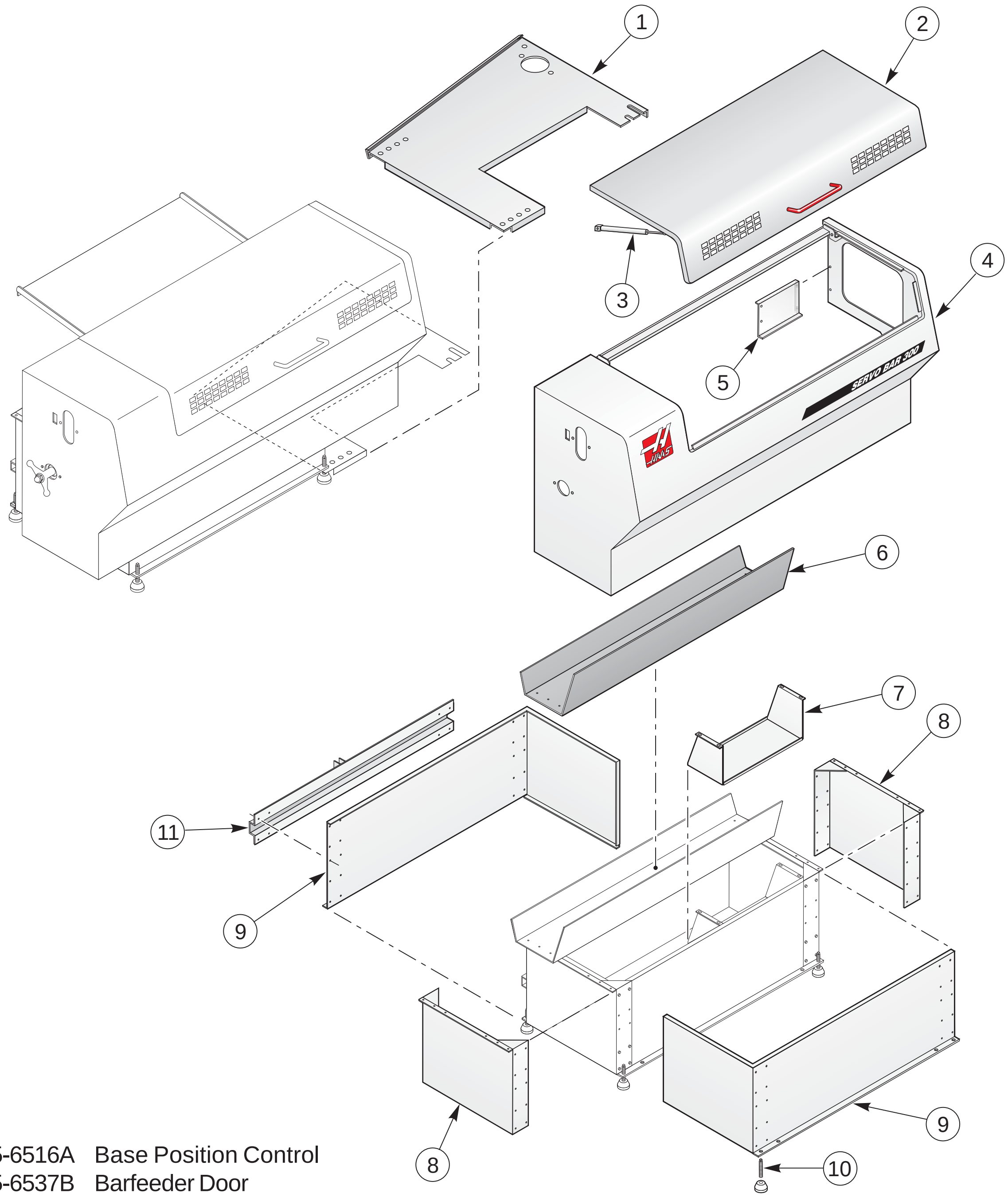


*Parts Catcher Only

TL-25 Internal Sheetmetal Parts List

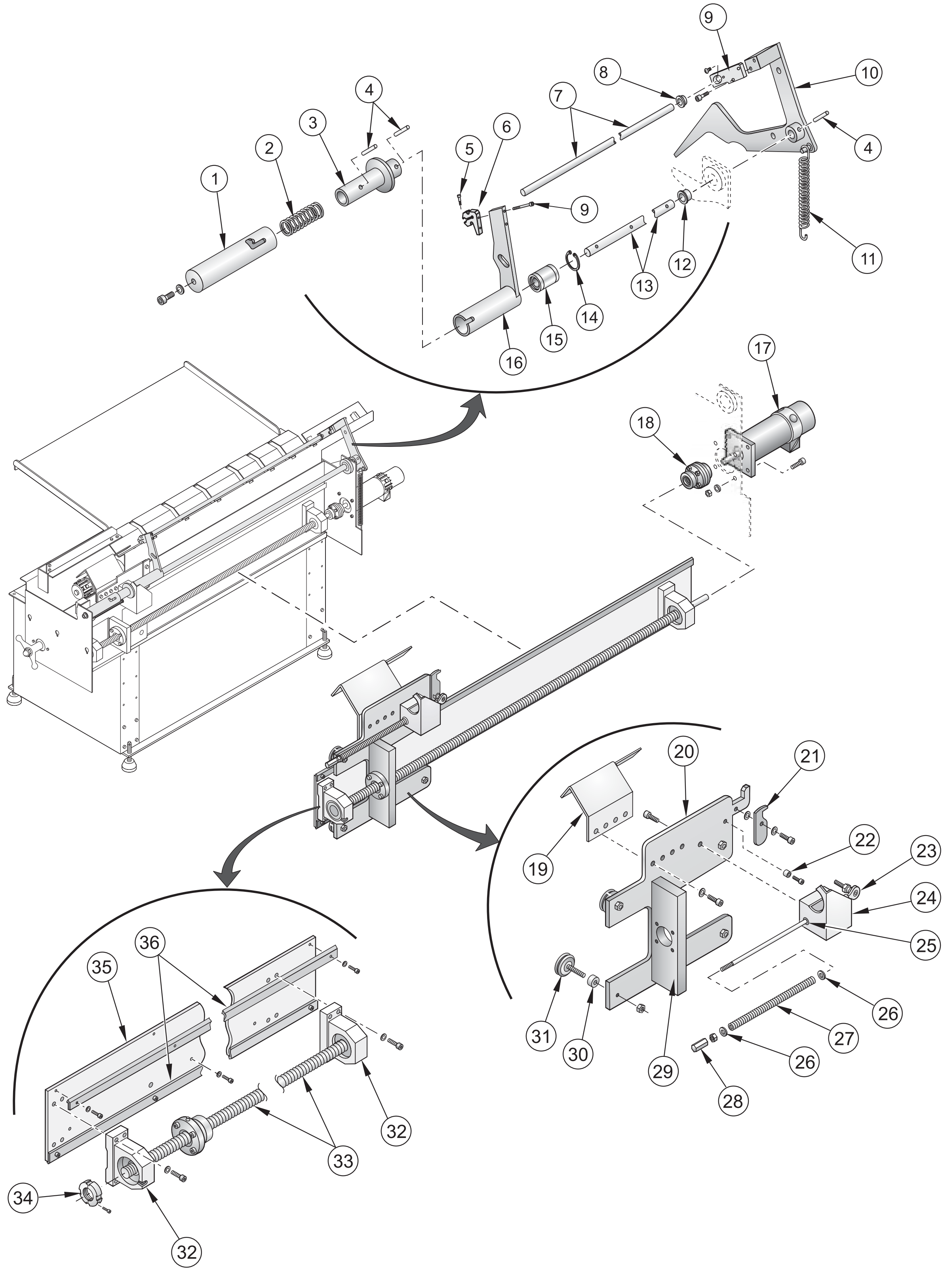
1. 22-8049 Z-Axis Top Waycover Guide
2. 25-8047 Z-Axis Waycover
3. 22-8048 Z-Axis Bottom Waycover Guide
4. 22-8783 Moving Bulkhead Support
5. 22-0830 Cable Channel Cover
6. 25-8843A Moving Bulkhead
7. 25-6543A Right End Support Bracket
8. 25-4348 Right Sub-spindle Waycover (4)
9. 20-1521 Lower Tailstock Waycover Guide
10. 25-8841A Sub-spindle Base Plate
11. 25-4344 Sub-spindle Base cover
12. 25-0610 Motor Cover
13. 25-0611 Sub-spindle Encoder Cover
14. 25-0619 Front Union Shroud
15. 25-0618 Rear Union Shroud
16. 20-0631A Upper Motor Arm
17. 25-0621 Little Bracket
18. 25-0620 Conduit
19. 25-0615A Encoder Mounting Bracket
20. 20-0632A Lower Motor Arm
21. 25-0613B Lower Heat Shield
22. 25-0612A Heat Shield
23. 25-0614A Fan Shield
24. 25-8755C Front Wedge Cover
25. 25-8757 Tool Changer Waycover
26. 25-6458 Tool Changer Waycover Mount
27. 25-8774 Upper Tailstock Waycover Guide
28. 25-4349 Left Sub-spindle Waycover (4)
29. 25-6512 Parts Catcher Tray (Optional)
30. 25-8849A Z-Axis Drip Tray
31. 30-3647 Z-Axis Lower Wiper Assembly
32. 30-3646 Z-Axis Middle Wiper Assembly
33. 25-8824C Fixed Bulkhead
34. 30-3192A Door Wiper Assembly
35. 30-3645 Z-Axis Upper Wiper Assembly
36. 25-8807B Control Box Mounting Bracket
37. 25-8754C Rear Sliding Cover
38. 25-8782B Tool Changer Tunnel Panel
39. 30-3648 X-Axis Top Wiper Assembly
40. 30-3649 X-Axis Side Wiper Assembly
41. 25-4354 X-Axis Tool Changer Sliding Cover
42. 25-8772A Tool Changer Splash Shield
43. 25-8830A X-Axis Drip Channel
44. 20-1591 Right Rear Lifting Bracket
45. 20-1590 Right Front Lifting Bracket
46. 20-1589 Left End Lifting Bracket

Barfeeder Sheetmetal and Parts List



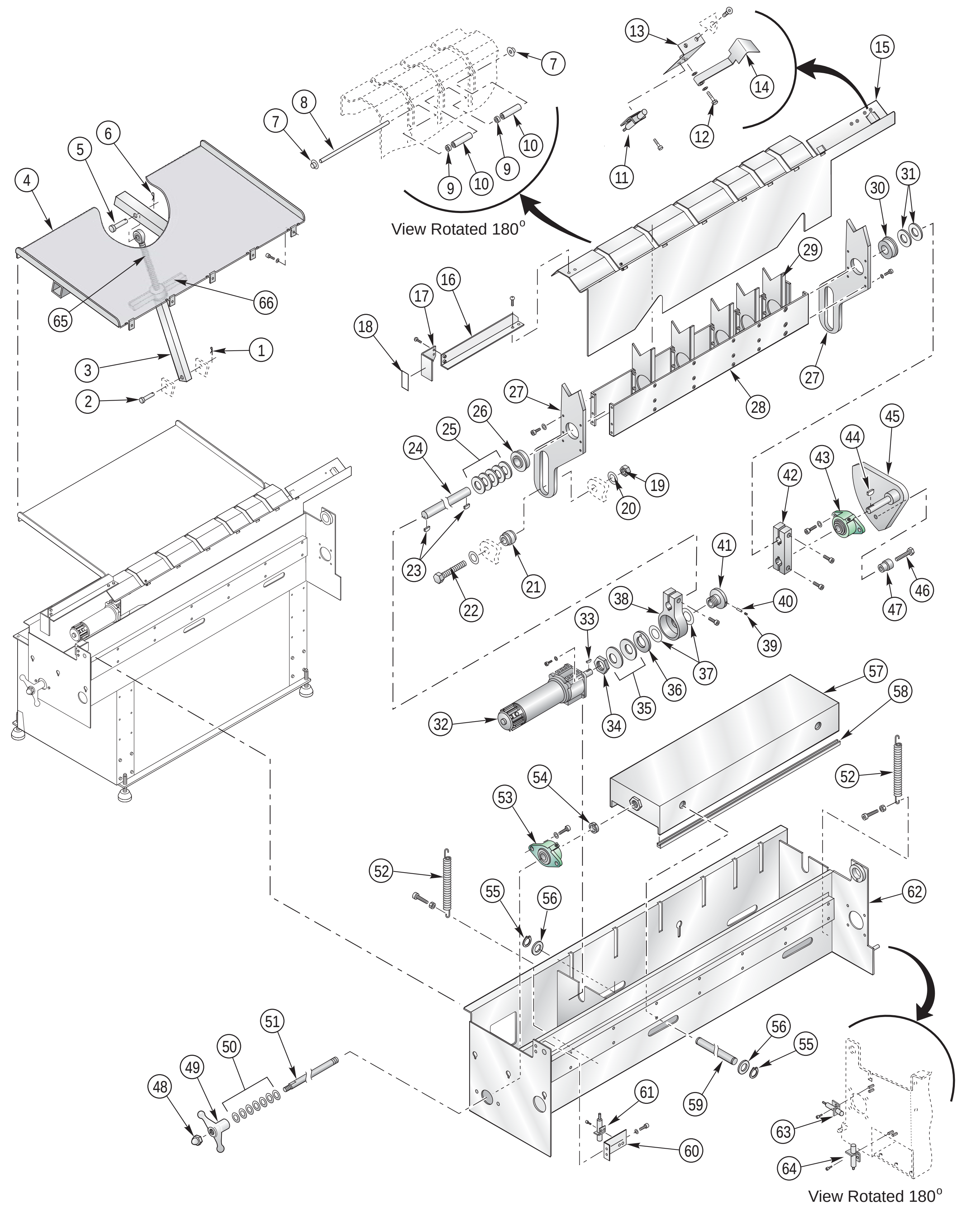
1. 25-6516A Base Position Control
2. 25-6537B Barfeeder Door
3. 59-0101 Gas Spring
4. 25-6534A Barfeeder Main Enclosure
5. 25-0165 Right Rear Support
6. 25-6542 Storage Pan
7. 25-6526 Control Tray
8. 25-6538 Adjusting End Supports
9. 25-6539 Bottom Bar Base
10. 44-0004 Leveling Screw
11. 25-6540 Charging Table Beam

Barfeeder External Parts



BARFEEDER EXTERNAL PARTS LIST

1. 20-6480 Rotation Control Push Rod
2. 59-3024 Spring 1.5 X 6
3. 20-6481 J-Slot Control Bushing
4. 48-1657 Dowel Pin 5/8 X 1-1/2
5. 49-1015 Shoulder Bolt 1/4 X 1/2
6. 20-6483 Push Rod Connector
7. 20-6484 Push Rod
8. 20-0357 Flange Bushing 3/4 in.
9. 20-6032 Push Control Bushing 3/4 in.
10. 20-6485 Control Arm Positioner
11. 59-3026 Spring 1-1/8 X 8.5 X .148
12. 20-0356 Flange Bushing 1 in.
13. 20-6023 Rotational Control Shaft
14. 56-0007 Retaining Ring 1-9/16 in.
15. 51- 1016 Linear Bearing 1 in.
16. 20-6482 Pusher Control Arm
17. 62-2501 Servo Motor
18. 30-1220P Coupling Assembly
19. 25-6520 Bar Pusher Finger
20. 22-6501 Base Bar Carriage
21. 25-6521 Latch Pusher Bar
22. 20-9256 Spacer
23. 59-6701 5/16 Ball Joint w/Stud
24. 25-6522 Fork Activator Bar
25. 25-6502 Latch Linkage Rod Bar
26. 54-0054 Flange Bushing 5/16 in.
27. 59-3027 Spring 1/2 X 10
28. 58-1750 Coupling Nut 5/16-24
29. 20-6478 Ballscrew Bearing
30. 22-9256 Spacer
31. 54-0030 Guide Wheel
32. 30-0153 Support Bearing Assembly (2)
33. 24-0007 Ballscrew Assembly
34. 51-2012 Bearing Locknut TCN-04-F
35. 25-6525 Rail Mounting Plate
36. 22-6505 Barfeeder V-Rail

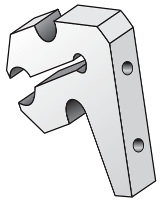

View Rotated 180°
View Rotated 180°

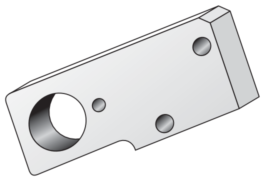
1. 49-1203 1/8 x 1 Cotter pin
2. 49-1201 3/4 x 3 Clevis pin
3. 22-6503 Support stand
4. 25-6541 Charging table
5. 49-1202 1 x 6 Clevis pin
6. 49-1203 1/8 x 1 Cotter pin
7. 46-0011 1/4 Push cap nut
8. 20-0341 Transfer table
9. 22-9256 Bushing extractor
10. 58-1982 Tubing urethane 3/8 OD x 1/4 ID
11. 32-2036 Limit switch (end of bar)
12. 49-1019 Shoulder bolt 1/4 x 1
13. 25-6528 Bar end mounting
14. 25-6529 Bar end switch paddle
15. 25-6527A Bar transfer table
16. 25-6546 Height indicator support bracket
17. 25-6547 Height indicator flag
18. 29-0051 Height gauge decal
19. 46-1702 Nut
20. 45-1739 Washer
21. 54-0010 Cam follower
22. 43-7000 Bolt
23. 49-0101 Key
24. 20-6487 Lifting arm shaft
25. 45-0013 Washer
26. 51-1017 Bearing
27. 25-6530 Motion control lift arm
28. 25-6532 Motion control torque box
29. 25-6531 Motion control intermediate arm
30. 51-1017 Bearing
31. 22-7477 Pressure plate
32. 32-0011 Shuttle motor assembly
33. 49-0100 Key
34. 20-0216 Slip clutch nut
36. 55-0010 Spring washer
36. 22-7477 Pressure plate
37. 45-2020 Plastic washer
38. 20-6486 Motor end clutch linkage
39. 44-1624 Set screw
40. 48-0005 Dowel pin
41. 20-0215 Slip clutch hub
42. 20-6533 Cam end slip linkage
43. 51-1015 3/4 Flange bearing
44. 49-0100 Key
45. 20-6488 Cam shaft assembly
46. 43-7000 Bolt
47. 54-0010 Cam follower with 22-7034 spacer
48. 46-0010 3/4-10 Cap nut
49. 59-0102 Clamp handle 3/4-10
50. 45-0004 3/4 Flat washer
51. 20-6026A Height adjusting
52. 59-0110 Spring 6 x 27/32 x .106
53. 51-1015 Flange bearing 3/4
54. 54-0057 Shaft collar 3/4
55. 56-0085 Snap ring
56. 45-0013 Washer
57. 25-6549A Height adjusting box
58. 59-7200 Grommet material .125
59. 20-6490A Box cross rollers
60. 25-0338 Home switch bracket
61. 32-2039 Trolley home limit switch
62. 25-6523B Main frame
63. 32-2038 Load Q limit switch
64. 32-2037 Load bar limit switch
65. 22-6025 1" Acme adjusting screw
66. 49-1020 Acme wing nut 1-5

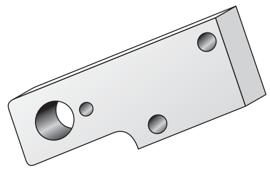
30-1389 – 3/8" Pushrod

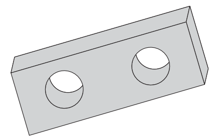
20-6484 – 3/4" Pushrod

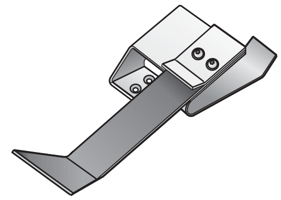
CURRENT


20-1033 Push Rod End Clamp

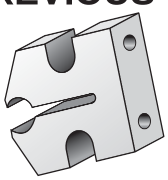

20-1034 Push Rod Control Bushing Holder 3/4”

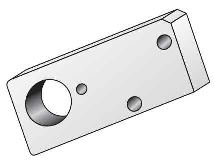

20-1035 Push Rod Control Bushing Holder 3/8”

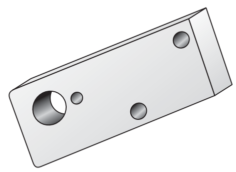

20-1923 Spacer

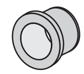

30-1336 Switch Hold Down Assembly

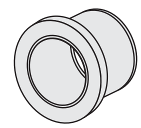
PREVIOUS


20-6483 Push Rod Connector Adapter

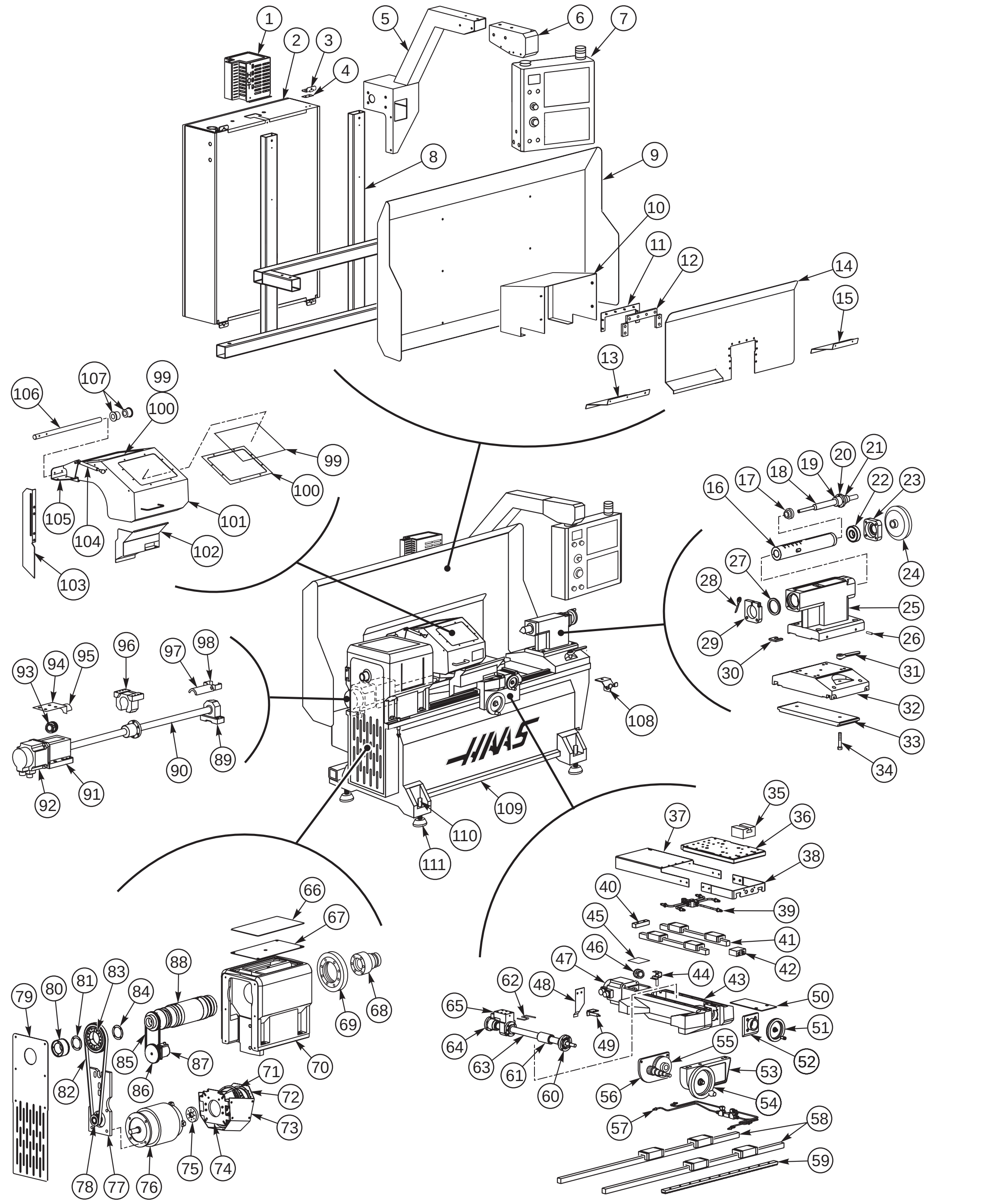

20-6032 Push Rod Control Bushing Holder 3/4”


20-6044 Push Rod Control Bushing Holder 3/8”


51-0055 Nylon Flange Bushing 3/8"

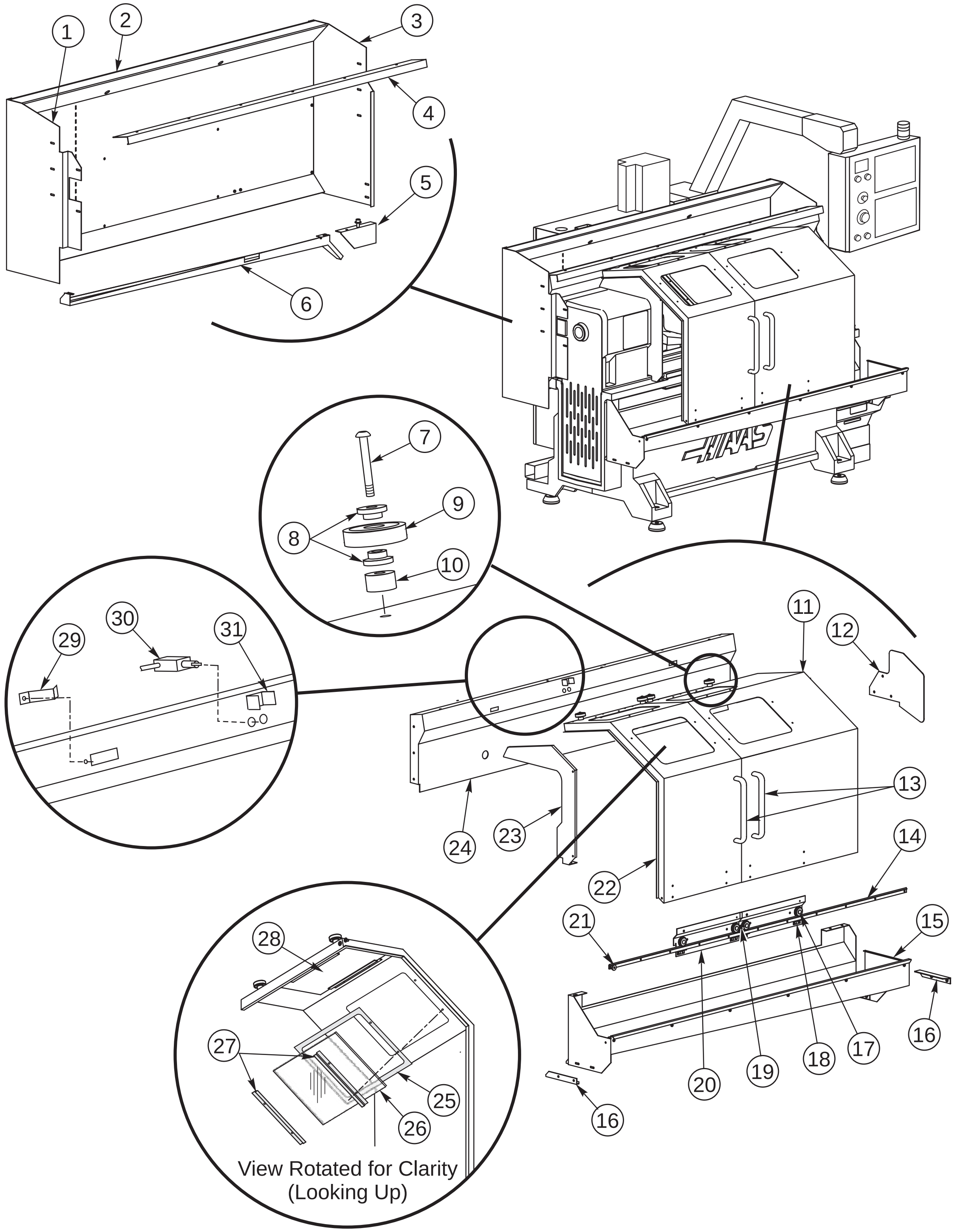

20-0357 Push Shaft Bushing 3/4"

Toolroom Lathe (TL-1)



1. 32-0041 Regen Assy
2. 45-4301 25-4307 Control Cabinet
3. 25-4794 Control Box Isolator (4)
4. 59-0515 Contorl Box Gasket (4)
5. 20-2672 Pendent Arm
6. 25-6661 Arm End Cap (leveling)
7. 25-5524 Control Pendant Shell
8. 20-1936 Control Box Support Frame
9. 25-5449 TL-2 Control Support
   25-6354 LT-1 Control Support Cover
10. 25-4932 X Axis Motor Cover
11. 25-6351 Wiper Retainer
12. 26-0372 Wiper Felt
13. 25-4931 Rear Ballscrew Left Cover
14. 25-6352 Saddle Chip Guard
15. 25-4930 Rear Ballscrew Right Cover
16. 20-1938 TS Quill
17. 20-1957 Quill Drive Nut
18. 20-1939 Drive Screw
19. 20-2453 TS Bearing Spacer

20. 51-2033 Radial Bearing
21. 20-1958 Quill Driver SCR Collar
22. 51-2033 Radial Bearing
23. 20-1940 Nut Retainer
24. 20-1932 Tailstock Handwheel 6"
25. 20-1873 TS Head Housing Machined
26. 20-1954 Setscrew (2x)
27. 26-0374 Quilll Wiper
28. 49-0065 TS Handle Clamp
29. 20-1960 PLT Quill Lock
30. 20-1966 Shim (4)
31. 49-0064 Handle Clamp
32. 20-1872 TL-1 T-Slot Block
    20-2455 TL-2 T-Slot Block
33. 20-1941 Lock Plate
34. HHCS (2)
35. 20-2440 TL-1 T-Slot Block
    20-2463YL-2 T-Slot Block
36. 20-2102 X-Axis Cross Slide
37. 25-5037 Cross Slide Cover
38. 25-5038 Cross Slide Front
39. 30-6406 X-Axis Lube Line
40. 20-1232 Z-Axis Support Bumper
41. 50-0031 Guide Rail (2)
42. 20-2105 X-Axis Manifold
43. 20-1870 Saddle Machined
44. 59-1700 Prox. Switch
45. 25-9203 Cover
46. 30-1220 Coupling Assembly
47. 62-0024 Yaskawa Servo Motor
48. 25-5390 Z-Axis Switch Trip Bracket
49. 32-2132 Prox. Switch
50. 25-5391 Prox. Switch Mounting Bracket
51. 20-1931 X-Axis Handwheel 4.5"
    20-1955 X-Axis Handwheel Handle
52. 20-2549 Saddle SCR Cover
53. 20-1871 Z-Axis Saddle Skirt Machined
54. 20-1930 Z-Axis Handwheel 7.5"
55. 20-1944 Gear
56. 20-1943 Z- Axis Gear Mounting Plate
    20-0466 Pinion
    20-1946 Shaft
57. 30-5370 Z-Axis Lube Line Assembly
58. 50-0030 Z- Axis Guide Rail (2)
59. 20-1947 TL-1 Z-Axis Rack Gear
    20-2464 TL-2 Z-Axis Rack Gear
60. 51-2025 Bearing
61. 20-1952 X-Axis Bumper
62. 58-0608 X-Axis Lube Line, Ballscrew Nut
63. 24-0038 X-Axis Ballscrew
64. 20-7416 Bearing Cartridge
65. 20-1948 X-Axis Ballscrew Nut Housing
66. 20-9062 Tool Mat
67. 20-1942 Spindle Housing Cover
68. 20-1189 Spindle Nose A5/5C
69. 20-0862 Clamp Ring A2-5
70. 20-1869 TL-1 Spindle Housing Machined
    20-2459 TL-2 Spindle Housing Machined
71. 36-3035 Fan Assembly
72. 25-0127 Fan Motor End Plate
73. 25-5036 Fan Enclosure
74. 25-0143 Spindle Enclosure Bracket
75. 20-0147 Balancing Hub Drive Motor
76. 62-1010 5 H.P. Spindle Motor
77. 20-1951 Motor Mounting Plate
78. 20-1934 Motor Sprocket
79. 25-6353 TL-1 Spindle Belt Guard
    25-5448 TL-2 Spindle Belt Guard
80. 20-2471 TL-1 Spindle Extension
    20-2470 TL-2 Spindle Extension
81. 20-2082 Lock Ring, Back
82. 54-0126 Spindle Drive Belt
83. 20-1933 TL-1 Spindle Pully
    20-2461 TL-2 Spindle Pully
84. 20-2081 Lock Ring, Front
85. 54-0084 Encoder Drive Belt
86. 20-0975 Encoder Sprocket
87. 32-1457 Encoder, RTAP
88. Spindle Assembly
89. 20-7009 Bearing Housing Machined
90. 24-0039 Z-Axis Lead Ballscrew
91. 20-7010 Motor Mount
92. 62-0024 Yaskawa Servo Motor
93. 30-1220 Coupling
94. 25-7042 Snap Lock Motor Mount Cover
95. 20-0146 Motor Bumper
96. 20-7008 Ballscrew Nut Housing
97. 20-0637 Support Bumper
98. 25-7080 Bumper Bracket
99. 28-0049 Window (2)
100. 25-5050 Window Retainer (2)
101. 25-6355 Chuck Guard
102. 25-5465 TL-1 Front Chuck Guard
     25-5514 TL-2 Front Chuck Guard
103. 25-5945 Rear Chuck Guard
104. 59-0007 Gas Spring
105. 25-1942 Chuck Guard Hinge Bracket
106. 20-2480 Chuck Guard Hinge Pin
107. 20-0356 Shaft Sleeve (2)
108. 25-5504 Air Gun Hanger
109. 20-1868 TL-1 Base Machined
     20-2451 TL-2 Base Machined
110. 44-0018 Leveling Screw
111. 14-7068 Foot Pad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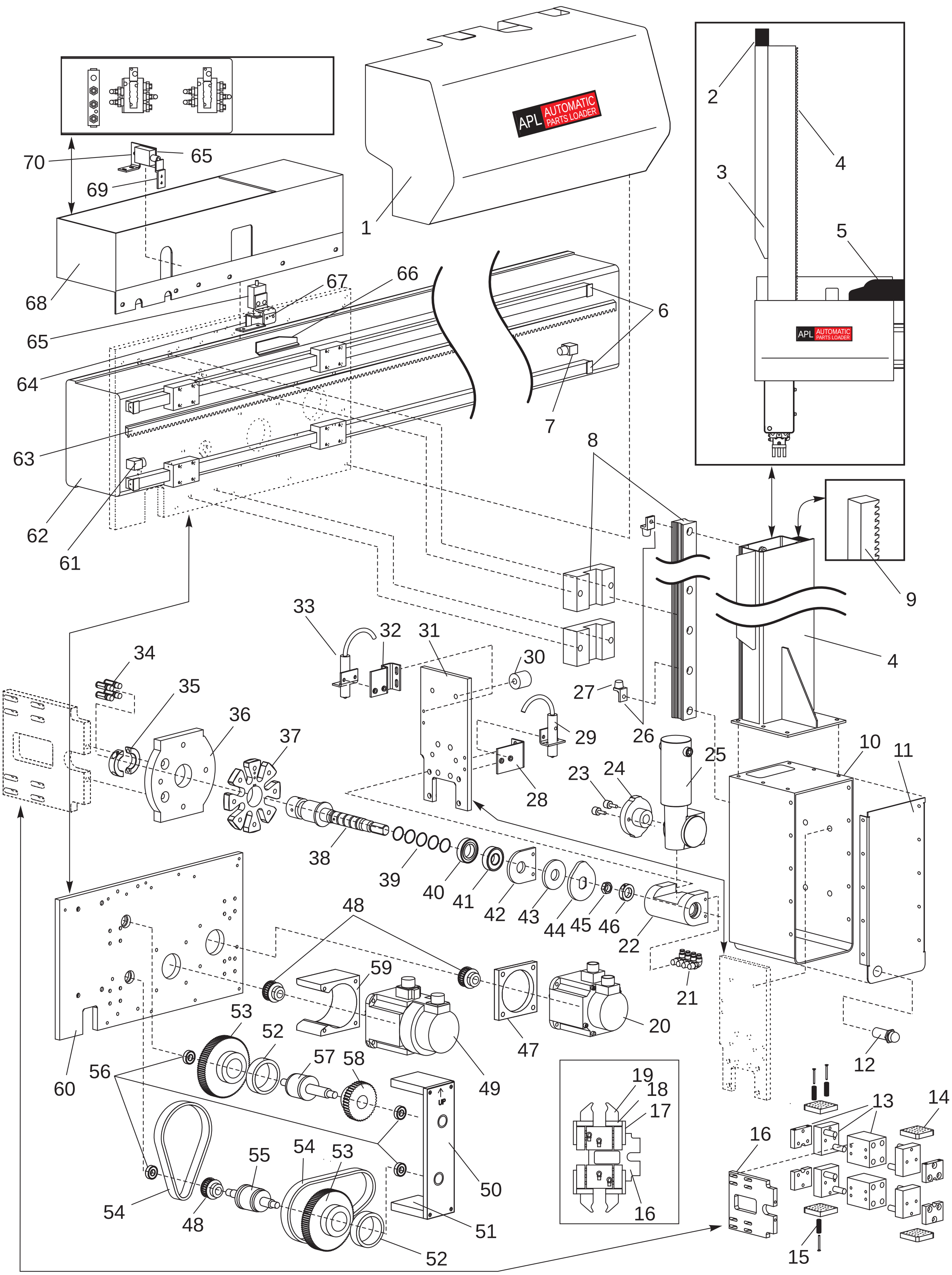
View Rotated for Clarity
(Looking Up)

TL 1-2CE Parts List

1.	25-5932	Left Wing Guard
2.	25-5930	(TL-1-CE) Control Support Cover
	25-6783	(TL-2-CE) Control Suport Cover
3.	25-5931	Right Wing Guard
4.	25-5943	(TL-1-CE) Top Roller Guide
	25-6787	(TL-2-CE) Top Roler Guide
5.	25-5942	Angle Bracket
6.	25-5948	(TL-1-CE) Back Gutter
	25-6789	(TL-2-CE) Back Gutter
7.	40-1979	BHCS ¼-20 x 1-¾
8.	20-0260	Top Door Spacer (2x)
9.	51-2020	Bearing Radial FAFNIR 303
10.	22-7034	Spacer Cam Follower
11.	25-6408	(TL-1-CE) Long Door
	25-6791	(TL-2-CE) Right Door
12.	25-6428	Tail Stock Fin
13.	59-6210	Door Handle (2x)
14.	22-6505	(TL-1-CE) V- Rail Bar Feeder
	20-0963	(TL-2-CE) V- Track Slide Door
15.	25-5939	(TL-1-CE) Front Gutter
	25-6788	(Tl-2-CE) Front Gutter
16.	25-5949	Push Bar
17.	54-0030	Guide Wheel (4x)
18.	25-6019	Door Guide Retainer (4x)
19.	26-0163	Lathe Doors Felt Wiper (2x)
	25-5746	Outer Felt Retainer (4x)
	25-5745	Inner Felt Retainer (2x)
20.	25-5944	Lower Rear Mount (2x)
21.	20-6016	Rail Spacer
	40-0069	BACS ¼-20 x 1
22.	25-6406	Short Door
23.	25-6418	(TL-1-CE) Bulkhead
	25-6790	(TL-2-CE) Bulkhead
24.	25-5941	(TL-1-CE) Read Guard
	25-6784	(TL-2-CE) Rear Guard
25.	26-0177	Front Window Gasket (2x)
26.	28-0170	Front Window (2x)
27.	25-6250	Window Retainer (8x)
28.	28-0171	Top Window (2x)
29.	25-4043	Latch Spring
30.	32-5075	(TL-1-CE) Telemecanque Switch (2x)
31.	25-6429	(TL-2-CE) Door Stop


APL AUTOMATIC PARTS LOADER
APL AUTOMATIC PARTS LOADER
UP
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70

LATHE APL PARTS LIST

1. 25-0704 Carriage Cover
2. 59-0197 Cable Carrier
3. 25-0705 Cable Carrier Mount
4. 25-0703 B-Axis Ram
5. 59-0196 Cable Carrier
6. 50-0008 Linear Guide
7. 20-0739 Hard Stop
8. 50-0009 Linear Guide
9. 20-0749 B-Axis Rack
10. 25-0768 Rotator Housing
11. 25-0769 Rotator Cover
12. 87-6535(6700,6710) Light
13. 30-6466 Gripper Assy
14. 20-2299 Jaw
15. 20-2297 Gripper Finger
16. 20-0747 Gripper Plate
17. 20-0755 Gripper Flange
18. 20-0757 Gripper Plate
19. 20-0756 Gripper Jaw
20. 62-0014 Servo Motor
21. 1/8X156X90 Fittings
22. 20-0790 Spindle Bearing Housing
23. 51-0000 Cam Follower
24. 20-0792 Geneva Plate Pin
25. 62-0007 Motor
26. 20-0759 Z-Axis Hard Stop, Lower
27. 59-1056 Bumper Support
28. 25-0716 Bracket, Switch
29. 32-2257 Prox Switch
30. 20-0795 Motor Mounting Spacer
31. 20-0789 Motor Mounting Plate
32. 25-0770 Switch Counter Bracket
33. 32-2256 Prox Switch
34. 5/32X10-32 Tube Fittings
35. 20-1008 Taper Clamp
36. 20-0746 Rotator Plate
37. 20-0791 Geneva Plate
38. 20-0793 Spindle
39. 57-2248 O' Ring
40. 51-0079 Bearing
41. 51-0078 Sealed Bearing
42. 20-1006 Friction Plate
43. 57-0157 Seal
44. 20-0794 Rotator Trip Block
45. 46-0007 Jam Nut
46. 51-0081 Collar Clamp
47. 20-0743 A-Axis Motor Spacer
48. 20-4519 Drive Pulley
49. 62-0009 Servo Motor
50. 20-0744 Bearing Support
51. 20-0745 Bearing Spacer
52. 20-4264 Lock Ring
53. 20-4509 Driven Pullet
54. 54-0218 Belt
55. 20-0758 Idler Shaft
56. 51-4000 Radial Bearing
57. 20-0741 Drive Shaft
58. 20-5164 Pinion
59. 20-0742 W-Axis Spacer
60. 20-0740 Carriage Plate
61. 20-0739 Hard Stop
62. 25-0693 Beam
63. 20-0738 Horizontal Rack
64. 25-0082 Switch Bracket
65. 32-2010 Limit Switch 24"
66. 25-0715 Trip Bracket
67. 25-6826 Home Bracket
68. 25-0696 Cable Junction
69. 20-0760 Trip Block
70. 25-0714 Limit Switch Bracket

AC – Alternating Current
AMP – Ampere
APC – Automatic Pallet Changer
APL – Automatic Parts Loader
ASCII – American Standard Code for Information Interchange
ATC – Automatic Tool Changer
ATC FWD – Automatic Tool Changer Forward
ATC REV – Automatic Tool Changer Reverse
AWG – American Wire Gauge
BHCS – Button Head Cap Screw
BT – British Tooling (Common usage)
CAD – Computer Assisted Design
CAM – Computer Assisted Manufacturing (Assisted Machining)
CAT-5 – Category 5 Cable
CB – Circuit Breaker
CC – Cubic Centimeter
CCW – Counter Clock Wise
CFM – Cubic Feet per Minute
CNC – Computerized Numeric Control
CNCR SPINDLE Concurrent Spindle with axis motion
CRC – Cyclic Redundancy Check digit
CRT – Cathode Ray Tube
CT – Caterpillar Tooling
CTS – Clear To Send
CW – Clock Wise
DB – Draw Bar
DC – Direct Current
DGNOS – Diagnostic
DHCP – Dynamic Host Configuration Protocol
DIR – Directory
DNC – Direct Numerical Control
DOS – Disk Operating System
DTE – Data Terminal Equipment
ENA CNVR – Enable Conveyor
EOB – End Of Block
EOF – End Of File
EPROM – Erasable Programmable Read Only Memory
E-STOP – Emergency Stop
FHCS – Flat Head Cap Screw
FT – Foot
FU – Fuse
FWD – Forward
GA – Gauge
HHB – Hex Head Bolts
HP – Horse Power
HS – Horizontal Series of Machining Centers
ID – Inside Diameter
IGBT – Isolated Gate Bipolar Transistor
IN – Inch
I/O PCB – Input Output Printed Circuit Board
LAN – Local Area Network
LB – Pound
LCD – Liquid Crystal Display
LED – Light Emitting Diode
LO CLNT – Low Coolant
LOW AIR PR – Low Air Pressure
LVPS – Low Voltage Power Supply
MB – Megabyte (1 million)
MCD RLY BRD – M -Code Relay Board
MDI – Manual Data Input
MEM – Memory
M-FIN – M -code Finished
MM – MilliMeter
MOCON – Motor Control
MOTIF – Motor Interface
MSG – Message
MSHCP – Metric Socket Head Cap Screw
NC – Numerical Control
NC – Normally Closed
NO – Normally Open
OD – Outside Diameter
OPER – Operator
P – Pocket
PARAM – Parameter
PCB – Printed Circuit Board
PGM – Program
POR – Power On Reset
POSIT – Positions
PROG – Program
PSI – Pounds per Square Inch
PST – Pallet Schedule Table
PWM – Pulse Width Modulation
RAM – Random Access Memory
RET – Return
REV CNVR – Reverse Conveyor
RJH – Remote Jog Handle
RPM – Revolutions Per Minute
RTS – Request To Send
RXD – Receive Data
SDIST – Servo Distribution PCB
SFM – Surface Feet per Minute
SHCS – Socket Head Cap Screw
SIO – Serial Input/Output
SKBIF – Serial Key Board Inter Face PCB
SMTC – Side Mount Tool Changer
SP – Spindle
T – Tool Number
TC – Tool Changer
TIR – Total Indicated Runout
TNC – Tool Nose Compensation
TRP – Tool Release Piston
TS – Tail Stock
TSC – Thru the Spindle Coolant
TXD – Transmit Data
VDI – Verein Deutscher Ingenieure
VMC – Vertical Machining Center
WAN – Wide Area Network